Advances in Geographical and Environmental Sciences

Aakriti Grover
Anju Singh
R. B. Singh *Editors*

Sustainable Health Through Food, Nutrition, and Lifestyle

IGU UGI

Springer

Advances in Geographical and Environmental Sciences

Advances in Geographical and Environmental Sciences synthesizes series diagnostigation and prognostication of earth environment, incorporating challenging interactive areas within ecological envelope of geosphere, biosphere, hydrosphere, atmosphere and cryosphere. It deals with land use land cover change (LUCC), urbanization, energy flux, land-ocean fluxes, climate, food security, ecohydrology, biodiversity, natural hazards and disasters, human health and their mutual interaction and feedback mechanism in order to contribute towards sustainable future. The geosciences methods range from traditional field techniques and conventional data collection, use of remote sensing and geographical information system, computer aided technique to advance geostatistical and dynamic modeling.

The series integrate past, present and future of geospheric attributes incorporating biophysical and human dimensions in spatio-temporal perspectives. The geosciences, encompassing land-ocean-atmosphere interaction is considered as a vital component in the context of environmental issues, especially in observation and prediction of air and water pollution, global warming and urban heat islands. It is important to communicate the advances in geosciences to increase resilience of society through capacity building for mitigating the impact of natural hazards and disasters. Sustainability of human society depends strongly on the earth environment, and thus the development of geosciences is critical for a better understanding of our living environment, and its sustainable development.

Geoscience also has the responsibility to not confine itself to addressing current problems but it is also developing a framework to address future issues. In order to build a 'Future Earth Model' for understanding and predicting the functioning of the whole climatic system, collaboration of experts in the traditional earth disciplines as well as in ecology, information technology, instrumentation and complex system is essential, through initiatives from human geoscientists. Thus human geoscience is emerging as key policy science for contributing towards sustainability/survivality science together with future earth initiative.

Advances in Geographical and Environmental Sciences series publishes books that contain novel approaches in tackling issues of human geoscience in its broadest sense—books in the series should focus on true progress in a particular area or region. The series includes monographs and edited volumes without any limitations in the page numbers.

Aakriti Grover · Anju Singh · R. B. Singh
Editors

Sustainable Health Through Food, Nutrition, and Lifestyle

Springer

Editors
Aakriti Grover
School of Global Affairs
Dr. B.R. Ambedkar University
New Delhi, Delhi, India

R. B. Singh
Department of Geography
Delhi School of Economics
University of Delhi
New Delhi, Delhi, India

Anju Singh
Department of Geography
Aditi Mahavidyalaya
University of Delhi
New Delhi, Delhi, India

ISSN 2198-3542 ISSN 2198-3550 (electronic)
Advances in Geographical and Environmental Sciences
ISBN 978-981-19-7229-4 ISBN 978-981-19-7230-0 (eBook)
https://doi.org/10.1007/978-981-19-7230-0

This Springer imprint is published by the registered company Springer Nature Singapore Pte Ltd.
The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

A Homage to the Memory of Our Mentor-Master and Co-Editor

Prof. R. B. Singh
(b. 3 February 1955 ~ d. 22 July 2021)

Life is 'time' between birth and death, and therefore until we have time, we may relish the moments on the planet Earth. Professor Ram Babu Singh, unfortunately, could not see the child of his efforts as 'time' surpassed him. However, he lives through the ripples caused by his deeds such as this book, for it is

a manifestation of his endeavors. Until his last breath, he dreamed of this book…Alas, his last book.

Having faith that we have had infinite past lives and indefinite yet to come in the future, we hope to meet again, sooner or later, in this unfathomable cosmic geographic space.

Preface

Health has always been a paramount necessity for the growth and development of a society and more so in the present times where pandemic like COVID-19 has shaken the healthcare system of all countries of the world. Despite good healthcare facilities also, many developed countries could not cope with the existing crises. Time and again, it is reiterated that the health of a human resource is vital for the holistic development and growth of the nation. Health is a prerequisite for happiness, and both have a two-way relationship wherein good health is an input for happiness and vis-à-vis.

Health not only encompasses physical health or the mere absence of disease and illness but is a composite of mental/emotional, social, and spiritual health. In this context, the universe of health is magnified making it hard to comprehend and therefore harder to solve! The health systems have become complex and multilayered. Hence, micro-level systems analysis of health care is needed to be understood to solve larger problems and challenges.

For sustainable recovery as well as sustainable preparedness to combat disasters of any scale and sustainable health is imperative. Sustainable health ensures a healthy population at a reasonable cost and is accessible to all. The focus is to have affordable and accessible health care at all levels from teaching and training to the provision of healthcare facilities and research. Sustainable health can be achieved by providing high-quality health care and improved public health services without compromising or harming natural resources or causing severe ecological damage.

The most important drivers of sustainable health are food, nutrition, and lifestyle. Food consumption and its drivers are changing in both urban and rural areas with profound implications for food production. Mapping where food comes from, and why, is critical to understanding consumer trends and their implications. Healthy food is a basic need of human beings. In underdeveloped regions, people are underweight and face malnutrition and deficiency diseases of different micronutrients such as vitamin A, iodine, and protein. A good diet and lifestyle have a tremendous bearing on a person's health, emotional stability, and enthusiasm for life. However, research on sustainable agriculture, nutritional security, food fortification, food machinery and food safety, farmers–industry–start-ups–academia interface, and lifestyle changes

needs attention to achieve sustainable health. The book aims at improving understanding of goals number 1, 2, 3, 6, and 11 of the Sustainable Development Goals. It further tries to uncover the multiple layers of challenges posed to achieve sustainable health.

This book is a well-timed contribution in the field of health/medical geography for it reiterates the importance of food, nutrition, and lifestyle in promoting sustainable health. It also aims to ignite geographers across the Globe to reinvent the subject of Geography of Health. With chapters on diverse topics, the book will be pertinent in unfolding the challenges of health and the means to overcome them in an ecologically viable manner. This book will be valuable to health and epidemiology research institutes. It is ideal reference material for students of geography, sociology, medical science, epidemiology, and social work.

New Delhi, India

Aakriti Grover
Anju Singh
R. B. Singh

Acknowledgements

The genesis of this book can be traced back to astute conversations with Prof. R. B. Singh on the importance of the much-neglected Geography of Health and the consequent need for its resurgence. Needless to say, the devastation and disruption caused by the COVID-19 pandemic have reasserted the value of health, particularly through the means of food, nutrition, and lifestyle. Our foremost thanks to the pathfinder of the book, Prof. Singh.

As the world goes through the grim reality of the pandemic, researchers are continuously working hard to put a drop of water into this fire by contributing academically. We thank all the contributors who, despite being unhealthy, wrote about varied aspects of good health and well-being.

We would like to express our sincere thanks to Prof. Sagnik Dey, Indian Institute of Technology—Delhi, Prof. D. Parthasarathy Indian Institute of Technology—Bombay, Prof. Subhash Anand, Prof. Tejbir S. Rana, Dr. Pankaj Kumar, and our colleagues for supporting us. We also take this opportunity to thank Prof. Rana. P. B. Singh for sharing his insightful learnings and to support this project.

Further, we thank Mr. Ashique V. V. and Ms. Shahnaz Basheer for their constant help. It is said—family is where life begins and love never ends. Deepest thanks to our family for their untiring support and enduring faith.

Our sincere gratitude to the reviewers, editors, and the team of Springer Nature Publishers for your diligent contribution to improving the manuscript.

New Delhi, India
February 2022
Vasant Panchami

Aakriti Grover
Anju Singh
R. B. Singh

Contents

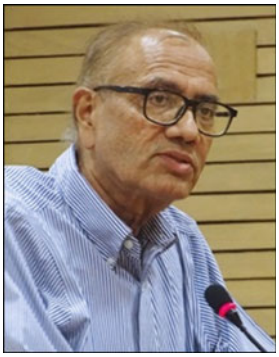
Editors and Contributors

About the Editors

Aakriti Grover World Social Science Fellow, specializes in the urban environment, health and well-being, and disaster management. She is Author of a monograph, titled *Urban Health and Wellbeing: Indian case studies*, with over 15 research papers published in peer-reviewed journals and five chapters. She has visited Poland, Japan, France and Africa for academic purposes. Dr. Grover is Member of the Urban Commission: Re-Thinking Cities and the Urban: from the global to the local, Urban Commission—International Geographical Union, and Life Member of the Indian Society of Remote Sensing, Epidemiological Foundation of India, National Association of Geographical Studies of India, and Association of Geographical Studies.

Anju Singh is Associate Professor of Geography at the Aditi Mahavidyalaya, University of Delhi. Dr. Anju specializes in the field of climatology, urban geography, environmental studies, coastal ecosystems, and water resource management. She has received international travel grants to present research findings at various international forums in Japan. Dr. Anju has published three books including one self-authored book and more than 15 research papers and articles in edited books and in journals of national and international repute. She is also Member of the prestigious BRICS Countries project on Satellite Validation sponsored by the Department of Science and Technology, Government of

India. She has been invited by the National Institute of Open Schooling (NIOS) and the Indira Gandhi National Open University (IGNOU) for preparing reading material. She is Life Member of the National Association of Geographers, India (NAGI), and the Association of Geographical Studies (AGS).



(Late) R. B. Singh (1955–2021), Professor of Geography, Delhi School of Economics, University of Delhi, was first Indian Geographer to have the dual distinction of holding the position of IGU Secretary-General and Treasurer of the IGU, and ICSU Scientific Committee Member (2018–2022). His publications include 19 books, 37 anthologies, and over 260 research papers, which covered environmental studies, land resources, land use/land cover, water and hydrology, disasters and hazard, livelihood, climatic change, urban environment, health and well-being, Sustainable Development Goals (SDGs), environmental monitoring, mountain studies, tourism and RS, and GIS.

The responsible series editor of this book is Dr. R. B. Singh.

Contributors

Olayinka Akanle Department of Sociology, Faculty of Humanities, University of Johannesburg, Johannesburg, South Africa

Yui Akiyama Graduate School of Comprehensive Human Sciences, University of Tsukuba, Tsukuba, Ibaraki, Japan

Mamta Arora Department of Geography, Aditi Mahavidyalaya, University of Delhi, Delhi, India

V. V. Ashique Department of Geography, School of Earth Sciences, Central University of Tamil Nadu, Thiruvarur, India

Shahnaz Basheer Department of Geography, School of Earth Sciences, Central University of Tamil Nadu, Thiruvarur, India

Purva Bhalla Delhi School of Economics, University of Delhi, New Delhi, India

Lekha D. Bhat Department of Epidemiology and Public Health, Central University of Tamil Nadu, Thiruvarur, India

S. Bhuvaneshwari Department of Geography, Bharathidasan University, Tiruchirappalli, India

H. Blaise Nguendo-Yongsi Geospatial Land and Health Research Laboratory (LISET), Institute for Population Studies (IFORD), University of Yaoundé II, Soa, Cameroon

Wenjian Cao School of Economics and Management, Hunan Applied Technology University, Changde, China

Puja Das Department of Geography, The University of Burdwan, Burdwan, India

Nicolai Henri de Kuyper University of Maastricht, Maastricht, The Netherlands

Nirali Dedhia Centre for Technology Alternatives for Rural Areas, Indian Institute of Technology—Bombay, Mumbai, India

Peter Fadeyi Kebbi State Geographical Information System, Birnin-Kebbi, Nigeria

Nikhil Kumar Gouda Department of Media and Communication, School of Communication, Central University of Tamil Nadu, Thiruvarur, India

K. Gowri Priya Department of Epidemiology and Public Health, Central University of Tamil Nadu, Thiruvarur, India

Aakriti Grover School of Global Affairs, Dr. B.R. Ambedkar University, Delhi, India;
Department of Geography, School of Earth Sciences, Central University of Tamil Nadu, Thiruvarur, India

Anupama M. Hasija Department of Geography, Shaheed Bhagat Singh College (E), University of Delhi, Delhi, India

Mariko Ikeda Faculty of Art and Design, University of Tsukuba, Tsukuba, Ibaraki, Japan

Prashasti Jain Department of Psychology, Manipal University Jaipur, Jaipur, India

R. Jegankumar Department of Geography, Bharathidasan University, Tiruchirappalli, India

Muhammad Kamran Wyższą Szkołę Gospodarki Euroregionalnej im. Alcide De Gasperi, Jozefow, Poland

S. A. A. Latheef Department of Genetics, Osmania University, Hyderabad, India

Taibat Lawanson Department of Urban and Regional Planning, University of Lagos, Lagos, Nigeria

Izabella Łęcka Associate Professor, University of Warsaw, Warsaw, Poland

Manisha Department of Migration and Urban Studies, International Institute for Population Sciences, Mumbai, India

G. Mathan Department of Biomedical Science, Bharathidasan University, Tiruchirappalli, India

Tomasz Ochinowski Faculty of Management, University of Warsaw, Warsaw, Poland

Samson Olaitan Olanrewaju Department of Urban and Regional Planning, Osun State University, Osogbo, Nigeria

Yusuf Qudus Oyindamola Department of Sociology, University of Ibadan, Ibadan, Nigeria

B. W. Pandey Department of Geography, Delhi School of Economics, University of Delhi, Delhi, India

Praveen Kumar Pathak Jamia Millia Islamia, Central University, New Delhi, India

R. Pavithra Department of Geography, Bharathidasan University, Tiruchirappalli, India

Weibin Peng Institute of Population Development and Health Governance, Hangzhou Normal University, Hangzhou, China

K. Prakash Department of Geography, Bharathidasan University, Tiruchirappalli, India

Susanta Sen Department of Development Studies, The University of Calcutta, Kolkata, India

Narendra G. Shah Centre for Technology Alternatives for Rural Areas, Indian Institute of Technology—Bombay, Mumbai, India

Anju Singh Department of Geography, Aditi Mahavidyalaya, University of Delhi, Delhi, India

R. B. Singh Department of Geography, Delhi School of Economics, University of Delhi, Delhi, India

Rana P. B. Singh Cultural Landscapes and Heritage Studies, Institute of Science, Banaras Hindu University, Varanasi, India;
ACLA—Asian Cultural Landscape Association, Varanasi, India;
RWYC (Asia)—Reconnecting With Your Culture, Varanasi, India

Harshita Upadhyaya Department of Geography, IIS (Deemed to be University), Jaipur, India

P. Venkatramana Department of Anthropology, School of Social Sciences, Indira Gandhi National Open University, New Delhi, India

Sandro Wiesenberg Faculty of Management and Information Sciences, Tsukuba Gakuin University, Tsukuba, Ibaraki, Japan

Chapter 1
Appraising Visioning Sustainability for a Healthy and Happy Future

Rana P. B. Singh

> *We are all in a life-and-death contest, we are told, between growing numbers of people and [a] limited amount of food. We are in a race and some must inevitably lose. The implicit message is that not everyone will have enough to eat. And how will we come out? (*Lappé and Collins 1978*, p. 4).*

Abstract Food, health, and sustainability have an interconnective and reciprocated system that is influenced by the cultural traditions, environmental contexts, and the impact of transformations over time. The SDG-2 has stressed extractions of hunger while achieving food security, improved nutrition, and sustainable agriculture. These interlinkages have several networks and niches, which are examined and appraised in different regions, in various ways, through many approaches. This small chapter presents some of the examples of such scenarios and synthesises the contradictions of the emerging dimensions as raised in the present anthology. Also illustrated here are the notable contributions in this field by (late) Prof. R. B. Singh (1955–2021), who passed away while this work was in process; this way, this book is a memorial tribute to him.

Keywords Essentiality · FAO · Geosystem · Hinduism · Indian thought · SDG-2 · Sustainability · Types of food

1.1 Visioning

The vital necessity for the survival of humankind is food; moreover, in the ethical and rational domains for making the future happy and harmonious, we all need healthy

R. P. B. Singh (✉)
Cultural Landscapes and Heritage Studies, Institute of Science, Banaras Hindu University, Varanasi, India
e-mail: ranapbs@gmail.com

ACLA—Asian Cultural Landscape Association, Varanasi, India

RWYC (Asia)—Reconnecting With Your Culture, Varanasi, India

A. Grover et al. (eds.), *Sustainable Health Through Food, Nutrition, and Lifestyle*,
Advances in Geographical and Environmental Sciences,
https://doi.org/10.1007/978-981-19-7230-0_1

and nutritious food. In the contemporary world of scarcity and necessity, sustainable nutrition has become a vital issue for the global food system that is mindful of people, the planet, and society. This refers to an increased focus on sustainable farming and sourcing practices, closed-loop supply chains, finding health and nutrition value in waste streams, as well as changes and adjustments in the lifestyles within the ongoing strategies of development for solutions to feed populations in need through sustainably, satisfactorily, substantially, and substitutivity. In this era, sustainable nutrition is at the heart of all the top health and nutrition trends.

In 2022 (estimated), the world's food system will need to provide for 7.96 billion people; by CE 2030, that number will rise to 8.55 billion; by 2050, it is projected to rise to almost 10 billion. This trend is already a major contributor to health and environmental decline. About 821.6 million people (in CE 2021) are still undernourished, and about 2.2 billion have micronutrient deficiencies. NCDs, such as diabetes, heart disease, several malignancies, and obesity, are the biggest risk factor for mortality worldwide (see FAO et al. 2019). Rapid urbanisation and an increase in the world's population have both had significant effects on the food supply and dietary recommendations. Diets high in beneficial nutrients should be sustainable in terms of their cost, availability, cultural acceptability, and flexibility, as well as their effect on the environment and human health. Evidence linking socioeconomic status with dietary health is mounting across cultural contexts (Green et al. 2018).

One of the Sustainable Development Goals (SDGs, no. 2) is considered a unifying global goal-setting agenda that "promises to ensure food security and nutrition within sustainable food systems". However, achieving that goal is riddled with uncertainty because of how the world currently produces and consumes foods, where health and issues are sustainability are at the margin! The global trends of diets and food systems show that those diets are neither healthy nor sustainable, which has implications for achieving SDG-2. The alarming question persists: "Where there is sufficient scientific and ethical justification to strive for healthy, sustainable diets, how can policies and interventions be constructed and implemented in specific national contexts? Is it ethically acceptable to mandate specific interventions such as taxes, incentives, nudges, and subsidies without regressive consequences"? (Fanzo 2019, p. 170). The concept of "healthy and sustainable diets" and the ethical considerations to achieving healthy and sustainable diets for sustainable development are the burning questions need to be addressed critically on human and regional grounds.

1.2 Overviewing Sustainability

Sustainability is anticipated to be a multidirectional and multidimensional challenge, with the food production system and diets playing a vital role. Obtaining nutritious and sustainable food in the future is a pressing concern that requires worldwide cooperation (Stare 2020, p. 1). It is difficult to define the term "sustainability" since it might signify different things depending on the context in which it is used. In

1987, the Brundtland Commission of the United Nations presented the most generally cited definition of sustainable development, in which it states that sustainable development satisfies the demands of the present without sacrificing the ability of future generations to satisfy their own needs (Brundtland 1987, p. 10). An eminent expert noted that mankind depends on nature for food and water, survival materials, and protection from grave environmental risks such as diseases and natural disasters. Yet, for a species that relies on the beneficence of nature, or what scientists refer to as "environmental services", we do a bad job of maintaining the physical basis of our life (Sachs 2015). In fact, sustainability covers the environment, the economy, health, and nutrition, as well as other interrelated factors. The Food and Agriculture Organization (FAO) of the United Nations definition of sustainable diets reflects this interconnectedness, where it states, sustainable diets are those diets with low environmental consequences that contribute to food and nutrition security and healthy life for the present and future generations. Sustainable diets are those that minimise negative effects on biodiversity and ecosystems, are nutritionally sufficient, safe, and healthy, are easily available, and cost as little as possible without sacrificing quality, all while making efficient use of scarce natural and human resources (Burlingame and Dernini 2012, p. 7).

The Sustainable Development Goal, SDG-2, stresses to "End hunger, achieve food security and improved nutrition, and promote sustainable agriculture" (see, UNSD 2016). This goal recognises the reciprocity between promoting sustainable agriculture, uplifting small farmers, promoting gender equality, ending rural poverty, assuring healthy lifestyles, and tackling climate change, as well as other issues addressed by the 17 Sustainable Development Goals in the Post-2015 Development Agenda (see Burchi and Holzapfel 2015, p. 17). As the global population continues to expand, it will be imperative to boost agricultural output sustainably, strengthen the global supply chain, reduce food losses and waste, and guarantee that everyone suffering from hunger and malnutrition has access to nourishing food. Many members of the world community feel that eradicating hunger within the next generation is doable and are collaborating to accomplish this objective. Land, good soils, water, and plant genetic resources are essential inputs for food production, and their rising scarcity in many areas of the globe makes it necessary that they can be used and managed sustainably.

SDG-2 proceeds for the sustainable solutions through ending hunger in all its forms by 2030 and above all achieving food security. It is expected to optimally ensure that everyone everywhere has sufficient good-quality food to enjoy a healthy life. Achieving this goal will require better access to food and the widespread enhancement of sustainable agriculture. This will support improving the productivity and incomes of small-scale farmers by promoting equal access to arable land, appropriate technology and markets, sustainable food production systems, and a resilient tradition of agricultural practices. Additionally, it requires increased investments through international cooperation to strengthen the productive capacity of farming in developing countries (see UNSD 2016).

The current scientific evidence for the health benefits of many botanicals is still in development, which can make rational claims on foods and also beverages challenging. It is noted about the emerging science and growth in the standard research literature for a variety of botanicals such as turmeric (anti-inflammatory/joint pain), cocoa (heart health), green tea (weight management), and *ashvagaṅdhā* (*Withania somnifera*, used for stress relief/sleep). The quality and safety of botanicals are important considerations for regulatory authorities. Moreover, a new conscience emerged towards chemical-free pure natural, and organic foods that will suit to keep the body healthy and pleasant. On this line, taking safety as the major issue, some regulatory bodies like European Food Safety Authority (EFSA) have guided science-based safety assessments and a compendium of botanicals. That is how the method of extraction is an important consideration for the quality and safety of the botanical, as well as the taste of the final product. Botanicals have a dual role as a way to supply taste, however also perceived health halos in areas like immunity, digestive health, energy, stress, sleep, cognition, etc.

1.3 Essentiality of Food

In Hindu tradition, food plays a significant role in the system of religious performances and rituals; the food offered to the deities (*prasāda*) is thought to have the salvific quality that bestows considerable religious merit, purifying body, mind, and spirit, thus in a way considered as a giver of spirituality that has a distinct place in the cultural traditions and lifestyles (Singh 2022, p. 122). Temple cooks are usually Brahmanas and follow strict standards of personal cleanliness concerning nature and also the human body. There is a widespread belief that the consciousness of the cook enters the food and influences the mind of the eater. Taking *prasāda* that has been cooked and offered with devotion inclines the mind towards spirituality. The *prasāda* that has been on the altar is especially sacred being possessing the blessings of divinity and is handed out to worshippers, either by the priest at the shrine or as worshippers leave the temple.

In classical Hindu scriptures, the category of food is characterised by totality or divine essence, as called "*anna devo bhava*", i.e. "Food is God" (Khare 1992; Olivelle 2002; Smith 1990), thus making a bridge linking human conscience and sublime power. The *Maitrayanīya Upanishad* mentions that "Food itself is God" (*Anna brahmeti*); thus, metaphorically providing sacred food to the deity is considered to be the best means to please him. The cultural connotation of *prasāda* refers to a sacred item ascribed and produced in ritual and serves as a gesture to please and make the deity happy; that is how it follows a basic principle of Hindu ritual by which devotees can "please" the gods through propitiation (Singh 2022, p. 123). According to the classical religious texts of Hinduism, three broad categories of food are described for health, nutrition, and interrelated lifestyles and resultantly broad effects (see Table 1.1).

Table 1.1 Characteristics of the types of foods in ancient Indian thought

Se	Type (mode)	Qualities	Result/effect	Example
1	*Sāttvika* (goodness)	Sweet, soft, nourishing	Vitality, strength, cheerfulness	Pure vegetarian, e.g. milk and vegetables
2	*Rājasika* (passion)	Bitter, sour, saltish, tasty	Pain, grief, disease, irritability	Deep-fried, gravy, and heavy-cooked items
3	*Tāmasika* (ignorance)	Spoiled, tasteless, putrid, refuse	Sedative effect on the mind and body	Fish, meat, alcohol, pickles

Source The Bhagavadgītā, 16.8, 9, 10 (Radhakrishnan 1948, p. 345; see Singh 2022, p. 124)

The UN Committee on Economic, Social and Cultural Rights has rightly recognised the right to adequate food as the crucial importance for the happy life of all human rights. The committee considers that the right to adequate food implies: "the availability of food in a quantity and quality sufficient to satisfy the dietary needs of individuals, free from adverse substances, and acceptable within a given culture; the accessibility of such food in ways that are sustainable and that do not interfere with the enjoyment of other human rights" (UNESC 1999, premise no. 8).

The ideal essential dietary pattern scenario comprises of sustainable meals that maintain the body healthy, joyful, and harmonious. This is a key problem of minimal environmental pressure and impact, which are accessible, inexpensive, safe, equitable, and also are culturally acceptable and adaptive. The goals of sustainable healthy diets include preventing all forms of malnutrition (i.e. undernutrition, micronutrient deficiency, overweight, and obesity), decreasing the risk of diet-related NCDs, and supporting the preservation of biodiversity and planetary health for the present and future generations. As a result, diets that promote health and sustainability must take into account the many facets of sustainability (FAO 2019, p. 8). Acceptance of healthy and sustainable diets might be crucial for protecting the Earth's natural resources and lowering diet-related mortality, but their adoption could be hindered if such diets proved to be more expensive and unsustainable for some groups. Therefore, we tried to quantify the global costs of healthy and sustainable diets (Springmann et al. 2021, p. 797). Supportive measures include consumer and food regulations, agricultural incentives, and government development support that take into consideration the environmental and health benefits of dietary change. Changing to a Western diet rather than one that is nutritious and sustainable will result in higher expenditures for households, healthcare systems, and the environment (Springmann et al. 2021, p. 805). A review of current dietary patterns shows a constant increase of "unhealthy, unsustainable, and inequitable for many populations". Therefore, multipronged measures are required to understand the impacts of diets to improve human and planetary well-being (Fanzo and Davis 2019, p. 495). Of course, not visible; however, the impact of different diets has also its content and consequence on arrangement of diverse cultural traditions and environmental conditions. It is suggested that "a more comprehensive examination of the environmental impacts of diets will help

clarify life cycle assessment data of how and where food is grown, and lead to a more complete view of the relationship between diets and ecosystems" (Fanzo and Davis 2019, p. 501). To make sustainable healthy diets available, accessible, affordable, safe, and desirable, food system changes are needed and could be guided by the following actions (FAO 2019, p. 13):

1. *Ensure that affordable and desirable foods for a sustainable healthy diet are available* and accessible for the most vulnerable. Address inequities and inequalities, and consider the perspective of people who experience poverty and deprivation.
2. *Promote capacity development strategies for behaviour change*, including consumer empowerment, and effective food and nutrition education.
3. *Quantify and balance the potential trade-offs* to make sustainable healthy diets available, accessible, affordable, safe, and appealing for all.
4. *Develop national food-based dietary guidelines* that define context-specific sustainable healthy diets by taking into account the social, cultural, economic, ecological, and environmental circumstances.

On the trajectory of growing population pressure, the global food system will be confronted with extraordinary problems in the foreseeable future. Consequently, they will have to fulfil the nutritional requirements of a growing population and a rising demand for proteins. However, development is occurring in the context of increasing environmental constraints (water resources, climate change, soil health) and the need to enhance agricultural livelihoods. Food systems must be properly managed and controlled to guarantee that food system transformation is redesigned to enhance nutrition and health, provide sustainable and resilient ecosystems, promote fair and equitable livelihoods, and reduce climate change (Gillespie et al. 2013). The first phase is to find many positives across policy and investment choices that aim for no damage. One such example is the revitalisation of China's Loess Plateau, which resulted in poverty reduction, natural resource revitalisation, and more employment opportunities (Webb et al. 2020). The second phase is to make clear, evidence-based policy decisions and investments that analyse trade-offs and options methodically. The third phase is to bolster institutions and the competence to carry out these relevant choices. The fourth phase is to build feedback systems that permit real-time policy and process alterations, unanticipated effects, and shifting conditions (Fanzo et al. 2022, p. 27). And the next phase is to find packages of mechanisms for more cohesive system-wide actions as opposed to marginal adjustments (Barrett et al. 2020).

The conclusion of a recent research is that "collaborative efforts by many stakeholders should be increased to guarantee that future generations have access to healthy and sustainable meals". Obviously, food will play an ever-increasing role in the worldwide debate on health (Green, et al. 2018, p. 3239). In the developed world, pastoral agricultural techniques should be encouraged further by the environmental advantages of open landscapes. Furthermore, seafood generated via aquaculture and circular systems might provide high-quality proteins in seacoast regions where such production is possible. If 30% of produced food that is now lost or squandered could be made accessible for human use, a new significant source of food may arise.

Source reduction and food reprocessing seem to be the most effective strategies for eliminating food waste or loss. An example of sustainable intensification and reduction of source may be doubling the yield of vegetable crops while maintaining the same ecological footprint (see Vågsholm et al. 2020). Due to continuous pressure of climatic change, increase of hunger issues and malnutrition, and increasing spaces of social inequalities, diverse food systems, the cry of the masses increase over time. Additionally, there also appear vast opportunities to secure that food systems will produce healthy and safe food in impartial ways that promote environmental sustainability, especially if the world can come together at the UN Food Systems Summit in late 2021 and make strong and binding commitments towards food system transformation (Fanzo et al. 2022). The UN Food Systems Summit, the first of its kind, held during the UN General Assembly in New York in 23rd of September, set the stage for global food systems transformation to achieve the Sustainable Development Goals by 2030, with active involvement and support of the governments, organisations, partnerships, and individuals those continue to submit their commitments to building healthier, more sustainable, and more equitable food systems. Moreover, the Summit process gave rise to several multistakeholders' initiatives led by civil society, farmers, women, youth, and indigenous groups that the Member States commit to deliver on the priorities, needs, and gaps identified in national pathways. In this Summit, there are nearly 300 commitments from civil society, farmers, youth, and indigenous peoples, and the Member States highlight Summit's inclusive process to accelerate action and to transform food systems in keeping the sustainable health through food, nutrition, and nature-based befitting lifestyle, which altogether will make a happy and harmonious world.

1.4 Initiation of the Present Context and Destination

Healthy and happy environmental conditions will lead to a good life, which should constantly be protected, preserved, and revitalised. Reflecting on the growing urban spaces associated with an increasing number of city inhabitants, it becomes essential to plan for particularly urban health, as illustrated in the case of India. Keeping in mind the future needs and demands, the Government of India plans to build a hundred new smart cities. This is in cognizance with the Sustainable Cities and Human Settlements and Sustainable Development Goals to build planned resilient sustainable cities that are prepared for disasters and promote health and well-being (see Grover and Singh 2020, pp. 251–266).

R. B. Singh had already been a part of some projects, directly concerned with sustainable health through food, nutrition, and lifestyle, both collaborative and individual. The findings and field observations were published over time. The topics covered include sustainable development initiatives in Indian geosystems (Singh 1996), environmental degradation and its impact on livelihood strategies (Druijven and Singh 1996), environmental, economic, and social sustainability (Singh 1997a, b), understanding high mountain land use and SDG (Singh 1998), environmental

stress of horticulture on sustainable livelihood and food security (Singh et al. 1998), urban sustainability and global change (Singh 2001), water and environment-related disasters and vulnerability in Indian megacities (Singh and Singh 2005), urban development and environmental impacts (Gardner and Singh 2006), medicinal plants and sustainable livelihood (Panwar et al. 2010), drinking water, sanitation and health (Singh et al. 2015), and urban health and well-being (Grover and Singh 2020).

1.4.1 The Coverage

The present anthology has its initiation first in the doctoral dissertation by the senior editor (Grover 2017), under the supervision of the (*late*) Prof. R. B. Singh (b.3 February 1955 ~ d. 22 July 2021). They together further worked to revise and enhance this work and resultantly published it later (Grover and Singh 2020). The focus of the book has been on the interdisciplinary issues of human health in the changing urban environments of India's largest megacities—Delhi and Mumbai. This monograph offers a better understanding of the emerging field of urban health and well-being while describing the relationship between air pollution and urban health, discussing the International Council for Science Union initiative towards Future Earth's Knowledge-Action Networks on human health and well-being in changing urban environments, and finally attempts to promote a systematic approach towards urban health and well-being.

Long ago, it was warned as a message of awakening: "Human society is, after all, only a product of the collective struggle of all people. If we say that we have no power to change things, who does?" (Lappé and Collins 1978, p. 502). Along the line of the preceding perspectives and prospects, this "anthology" presents varying scenarios from different angles—theoretical, rational, applied, and ideological and illustrated with case studies—hoping that it would inspire and awaken us to understand the scenario we are facing! There are 19 main chapters, which could be broadly categorised into four groups.

The first four chapters attempt to critically review and appraise different interfaces, trends, and perspectives covering sustainable health in territorial planning: food, nutrition, and lifestyle; food consumption patterns and associated health risks in Douala metropolis, Cameroon; organic food production and consumption policies and strategies; and geostatistical study on waterborne disease outbreak in India (2011–2020). The followed up five (Chaps. 5–5) chapters dealt with Chap. 9: peri-urban agriculture and food supply; gender dimension of children malnutrition among tribal children in India; food processing and nutrition delivery; undernutrition among the adult tribal populations of India: review and meta-analysis; and spirituality in sustainable mental health protection: evidence from vocational training of information technology professionals.

The next five chapters (Chaps. 10–14) narrate varying issues like physical activity as a vital element of the development of the concept of healthy cities (SDGs 3 and 11) with the role of local governments (SDG 17); body mass index and healthy

lifestyle among adolescent girls: a case study on Delhi; can doctor's resource allocation improve residents' health?: price, quality, patient mobility; the role of urban gardening in global cities: three case studies in Berlin, Rome, and Tokyo; and distributional analysis and access to fresh fruits and vegetable shops in residential neighbourhoods of Birnin Kebbi metropolis, Nigeria: implications for informal land-use planning. The last five (Chaps. 15–19) present studies of nutrition, lifestyle, and health status among tribal communities: a case study of a particularly vulnerable tribal group of Kerala; living with reduced HIV/AIDS stigma and discrimination: a grounded theory analysis of infected migrants; health vulnerability in the rural communities of Jaisalmer, Rajasthan; an integrated enviro-psychological approach to health; and towards the sustainable understanding of health: perception and worldview on Erectile Dysfunction Nigeria.

Joining hands with like-minded, we believe that people who understand the crises and severity of healthy nutrition will seriously think of making better choices for themselves and the sustainable environment in the long term. And that is what the Earth ("*Gaia*") needs as we move into creating a happy and harmonious future. Injunctions to think *cosmically*, see *globally*, behave *regionally,* and act *locally* but *insightfully* appeal to a cosmic vision, global humanism, and self-realisation. This perspective of lifeways may help in making the human sphere more cohesive, rational, and happy (see Singh and Rana 2020, p. 85).

References

Barrett CB et al (2020) Bundling innovations to transform agri-food systems. Nature Sustain 3(12):974–976

Brundtland GH (ed) (1987) Report of the world commission on environment and development: our common future. Oxford University Press, Oxford

Burchi F, Holzapfel S (2015) Goal 2: end hunger, achieve food security and improved nutrition, and promote sustainable agriculture. In: Loewe M, Rippin N (eds) The sustainable development goals of the post-2015 Agenda: comments on the OWG and SDSN proposals. Deutsches Institut für Entwicklungspolitik gGmbH, Bonn, pp 17–20

Burlingame B, Dernini S (2012) Sustainable diets and biodiversity—directions and solutions for policy research and action. In: Proceedings of the international scientific symposium biodiversity and sustainable diets united against hunger. FAO, Rome

Druijven PCJ, Singh RB (1996) Environmental degradation and its impact on livelihood strategies in the urban fringe of Delhi-some theoretical reflections. In: Singh RB (ed) Disasters, environment, and development. Oxford & IBH Pubulications, New Delhi, pp 355–368

Fanzo J (2019) Healthy and sustainable diets and food systems: the key to achieving sustainable development goal 2? Food Ethics 4:159–174

Fanzo J et al (2022) Sustainable food systems and nutrition in the 21st century: a report from the 22nd annual Harvard nutrition obesity symposium. Am J Clin Nutr 115:18–33

Fanzo J, Davis C (2019) Can diets be healthy, sustainable, and equitable? Curr Obes Rep 8:495–503. https://doi.org/10.1007/s13679-019-00362-0

FAO WHO (2019) Sustainable healthy diets guiding principles. FAO, Rome. https://www.fao.org/3/ca6640en/ca6640en.pdf. Accessed 22 July 2021

FAO, IFAD, UNICEF, WFP & WHO (2019) The state of food security and nutrition in the world: safeguarding against economic slowdowns and downturns, 195 pp. FAO, Rome. Also available at http://www.fao.org/3/ca5162en/ca5162en.pdf. Accessed: 22 July 2021

Gardner JS, Singh RB (2006) Urban development and environmental impacts in a mountain context. In: Singh RB (ed) Sustainable urban development. Concept Publishing Company, New Delhi, pp 67–86

Grover A (2017) Urban health and wellbeing. In: Changing urban environment: a comparative study of Delhi and Mumbai. Unpublished Ph.D. Dissertation in Geography, University of Delhi, Delhi [revised & published: Grover & Singh 2020]

Grover A, Singh RB (2020) Urban health and wellbeing—Indian case studies. In: Advances in geographical and environmental sciences series (ISSN: 2198-3542). Springer Nature Pte Ltd., Singapore. https://doi.org/10.1007/978-981-13-6671-0

Gillespie S et al (2013) The politics of reducing malnutrition: building commitment and accelerating progress. Lancet 382(9891):552–569

Green H et al (2018) Healthy and sustainable diets for future generations. J Sci Food Agric 98:3219–3224. https://doi.org/10.1002/jsfa.8953

Khare RS (1992) The eternal food: gastronomic ideas and experiences of Hindus and Buddhists. SUNY Series in Hinduism. State University of New York Press, Albany

Lappé FM, Collins J (1978) Food first: beyond the myth of scarcity. Ballantine Books, New York

Olivelle P (2002) Food for thought: dietary rules and social organization in ancient India. Royal Netherlands Academy of Arts and Sciences, Amsterdam

Panwar MS, Sharma SK, Singh RB (2010) Medicinal plants and sustainable livelihood. R.K. Books, New Delhi

Radhakrishnan S (1948) The Bhāgvad Gītā, 2nd ed. George Allen & Unwin (India) Pvt. Ltd., Bombay

Sachs JD (2015) The age of sustainable development. Columbia University Press, New York

Singh RB (1996) Sustainable development initiatives in Indian geosystems: case of social forestry. In: Singh RB (ed) Research in geography: land use changes and sustainable development, vol I. APH Publishing, New Delhi, pp 127–138

Singh RB (1997a) Environmental, economic and social sustainability through human development initiatives: case study of an Indian marginal region—Upper Kullu Valley. In: Jones G et al (eds) Proceedings of IGU SG meeting development issues in marginal regions. University of Strathclyde, Glasgow

Singh RB (1997b) Challenges and crisis of sustainability and opportunities for resource management in Indian Himalaya. In: Proceedings of NASDA/UNCRD/ICIMOD seminar on space informatics for sustainable development. UNCRD, Proceeding series, Nagoya: No. 21, pp 51–60

Singh RB (1998) Understanding high mountain land use towards sustainable environmental in Jammu and Kashmir. In: Haigh MJ et al (eds)Headwaters—water resources and soil conservation. Oxford & IBH Publishing, New Delhi, pp 409–422

Singh RB (eds) (2001) Urban sustainability in the context of global change. Science Publishing, Inc., Enfield (NH), USA, and Oxford & IBH Publishing, New Delhi

Singh RPB (2022) Symbolism, sacrality, and foodscapes in Hindu pilgrimage system. In: Munro D, Buttigieg N, Olsen DH (eds) Food, the pilgrim, and faith-based travel. Peter Lang Publishers, New York and Berlin, pp 121–134

Singh RPB, Rana PS (2020) Faith and place: Hindu sacred landscapes of India. In: Edensor T, Kalandides A, Kothari U (eds) The Routledge handbook of place. Routledge, London, pp 75–87

Singh RB, Singh A (2005) Water and environment related disasters and vulnerability in Indian mega cities: case of Delhi metropolitan region. In: Takara K et al (eds) Proceedings of the international conference on monitoring, prediction, and mitigation of water-related disasters. Kyoto University, Kyoto, Japan, pp 691–606

Singh RB, Bas K, Datta P (1998) Environmental stress of horticulture on sustainable livelihood and food security in Kullu Valley. In: Singh RB (ed) Sustainable development of mountain environment in India and Canada. Oxford & IBH Publishing, New Delhi, pp 98–112

Singh RB, Haque S, Grover A (2015) Drinking water, sanitation, and health in Kolkata metropolitan city: contribution towards urban sustainability. Geogr Environ Sustain 8(4):64–81. ISSN: 2071-9388

Smith BK (1990) Eaters, food, and social hierarchy in ancient India: a dietary guide to a revolution of values. J Am Acad Relig 58(2):177–205

Springmann M et al (2021) The global and regional costs of healthy and sustainable dietary patterns: a modelling study. Lancet Planet Health 5(e797–807):2021. https://doi.org/10.1016/S2542-5196(21)00251-5. Accessed 22 July 2021

Stare FJ (2020) The nutrition source: sustainability. Harvard T.S. Chan School of Public Health, Cambridge, MA. https://www.hsph.harvard.edu/nutritionsource/sustainability/. Accessed 22 July 2021

UNESC, UN Economic and Social Council (1999) Committee on economic, social and cultural rights (CESCR), The Right to Adequate Food (Art.11): 12/05/99. E/C. 12/1999/5 (General Comments). https://www.nichibenren.or.jp/library/ja/kokusai/humanrights_library/treaty/data/CESCR_GC_12e.pdf. Accessed: 22 July 2021

UNSD, United Nations Statistics Division (2016) Sustainable development goals: overview. United Nations Statistics Division, Development Data and Outreach Branch, New York. https://unstats.un.org/sdgs/report/2016/goal-02/. Accessed 22 July 2021

Vågsholm I, Arzoomand NS, Boqvist S (2020) Frontiers in sustainable food systems, 21 Feb 2020. https://doi.org/10.3389/fsufs.2020.00016. Accessed 22 July 2021

Webb P et al (2020) The urgency of food system transformation is now irrefutable. Nature Food 1(10):584–585

Chapter 2
Sustainable Health in Territorial Planning

Aakriti Grover, Anju Singh, and R. B. Singh

Abstract Sustainable health has always been a critical component of a society's growth and development, even more so in the modern era, when pandemics like COVID-19 have shaken the healthcare systems of every country on the Earth. Sustainable health is crucial for both long-term recovery and crisis readiness. Food, nutrition and lifestyle are the primary determinants of sustainable health. Food consumption and the factors that influence it are changing in both urban and rural locations, with significant implications for food production. In underdeveloped countries like India, people are underweight and at risk of malnutrition and micronutrient deficiency disorders. Nutritional status has deteriorated in India over decades as a result of insufficient food systems that are neither affordable nor sustainable. Malnutrition was the leading risk factor for death among children under the age of five in all of India's states in 2017. This chapter discusses the critical role of food, nutrition and lifestyle in achieving a sustainable health system. Additionally, the health scenario in India is explored in general, with an emphasis on urban health. This chapter will provide an overview of sustainable health and how these can be incorporated into a country's policy decision-making for a more effective health system.

Keywords Sustainable health · Urban health · Health planning · India

2.1 Introduction

The human population is a resource only when the population is healthy. Individuals who are healthy contribute to their countries' social, economic, ecological and

A. Grover (✉)
School of Global Affairs, Dr. B.R. Ambedkar University, Delhi, India
e-mail: aakriti.cutn@gmail.com

A. Singh
Department of Geography, Aditi Mahavidyalaya, University of Delhi, Delhi, India

R. B. Singh
Department of Geography, Delhi School of Economics, University of Delhi, Delhi, India

A. Grover et al. (eds.), *Sustainable Health Through Food, Nutrition, and Lifestyle*,
Advances in Geographical and Environmental Sciences,
https://doi.org/10.1007/978-981-19-7230-0_2

political growth. They also are prerequisites for creating happiness and wellbeing in society. Considering the vital role health plays, it is one of the global social goals pertinent for realising basic human needs and achieving a better quality of life. Therefore, investment in the health sector can initiate multiple sectors of development in a country, particularly in urban and territorial planning.

Sustainable health ensures a healthy population at a reasonable cost and is accessible to all. The focus is to have affordable and accessible health care at all levels, from teaching and training to the provision of healthcare facilities and research. Sustainable health can be achieved by providing high-quality health care and improved public health services without compromising or harming natural resources or causing severe ecological damage.

2.2 Sustainable Health and SDGs

Sustainable health is linked to many goals both directly and indirectly. The eight Millennium Development Goals (MDGs) were replaced in 2015 by seventeen Sustainable Development Goals (SDGs). Although only one SDG specifically mentions health, it is assumed that health encompasses a wide range of socioeconomic determinants addressed by the other SDGs and that sustainable health necessitates a sustainable world (Borowy 2014).

The SDGs will not be met unless substantial and consistent investments in optimal nutrition are made. SDG 2 aims to "Eliminate hunger, achieving food security and better nutrition, and promoting sustainable agriculture", however, at least 12 of the 17 Goals have indicators that are extremely important to nutrition (sun-movement-strategy-and-roadmap-ban-ki-moon-message—n.d.).

Goal 1: End poverty in all its forms everywhere.

As we know that poverty and malnutrition are strongly related. Social protection is a platform for intervening to improve nutrition. Poverty reduction and improved socioeconomic status are expected to lead to the improvement of the nutritional status of the community.

Goal 2: Eliminate hunger, improve food security and nutrition and promote sustainable agriculture.

Undernourishment is shown to be associated with stunting and being underweight. Signs of commitment to agriculture, a producer of food and incomes, and a potential platform for nutrition interventions can also help achieve sustainable health (Goal 2: Zero hunger|The Global Goals n.d.).

Goal 3: Ensure that all people of all ages enjoy healthy lives and encourage wellbeing.

A variety of methods can accomplish it. As we all know, maternal care throughout pregnancy and childbirth has been related to childhood malnutrition. Therefore, nutrition is influenced by care quality. Many countries consider HIV, tuberculosis and

malaria prevention and treatment to be pro-nutrition policies, resulting in improved mother and child nutrition. A faulty healthcare system exacerbates malnutrition. Increased birth spacing is linked to improvements in mother and child nutrition. Malnutrition is significantly related to morbidity in young children, and interventions to prevent/treat infectious illnesses can help. Nutritional coverage programmes and interventions rely heavily on human resource capabilities (Goal 3: Good health and well-being n.d.).

Goal 4: Ensure that all people have access to high-quality education and that lifelong learning opportunities are available to them.

School grade completion and achievement are linked to nutritional status. Improvements in literacy are also connected to proper diet (SDG Goal 4: Quality Education—UNICEF DATA n.d.).

Goal 5: Empower all women and girls by achieving gender equality.

Women's empowerment is also crucial for good nutrition. Intimate partner violence and nutrition have been linked in the past. Early marriage age is a powerful driver of nutrition outcomes for women and their children (Goal 5: Gender Equality|UNDP in India n.d.).

Goal 6: Ensure universal access to water and sanitation, as well as long-term management.

Water, Sanitation and Hygiene (WASH) is a well-known underlying factor of malnutrition. As a result, putting a premium on these activities can help you enhance your nutritional status and achieve long-term health (GOAL 6: Clean water and sanitation|UNEP—UN Environment Programme n.d.).

Goal 8: Ensure long-term, inclusive and sustainable economic growth, as well as full and productive employment and decent labour for all people.

For countries with a low GDP, national income increases reduce child malnutrition (Goal 8: Decent work and economic growth n.d.).

Goal 10: To reduce inequality within and among countries.

In Brazil and elsewhere, income gains at lower income levels are key drivers of stunting declines. It's a crucial factor in determining nutrition budget allocations.

Goal 11: Make cities and human settlements more inclusive, secure, resilient and long-lasting.

As is generally known, the bulk of urban slum dwellers are low-income workers and slum environments have a substantial WASH component. In urban/concentrated environments, open defecation and hazardous faecal disposal are more of a problem (Goal 11: Sustainable Cities and Communities|The Global Goals n.d.). Physical activity space is linked to the prevention of obesity, overweight and other nutrition-related non-communicable diseases, all of which impact long-term health (Noncommunicable diseases n.d.).

Goal 12: Ensure that consumption and production patterns are sustainable.

Lower food waste in the supply chain keeps food prices down. It maintains a steady supply of nutritious food, which is vital for dietary diversity and healthy diets to prevent non-communicable diseases.

Goal 16: For sustainable development, promote peaceful and inclusive societies, offer universal access to justice, and construct effective, responsible, and inclusive institutions at all levels.

Poverty, malnutrition and hunger are becoming more prevalent in areas afflicted by conflict (Goal 16: Peace, justice and strong institutions n.d.).

Malnutrition is a significant hidden hurdle to achieving the SDGs and often goes unnoticed. It is caused by several linked issues: health care, education, water, sanitation and hygiene, access to food and resources, women's empowerment and more. As a result, better nutrition, food and lifestyle would play a vital role in achieving several SDGs and, eventually, Sustainable health.

2.3 Health Scenario in India

Health is a function of various essential components including nutrition, safe drinking water, sanitation, basic hygiene, environmental conditions, society and community, quality of health services, accessibility and affordability to medicines and most importantly, correct information. All these components are interlinked and require political motivation and will along with financial support. Planning for large country like India is far more a challenge owing to its vast size, population and diversity. However, time-to-time, various programmes, policies, plans, acts and regulations have been introduced by the Government of India in relation to the health sector.

India spends 1.02% of the total GDP on health sector (2015–16), and there is no significant change in this expenditure since 2009–10 (Central Bureau of Health Services 2018). This ratio is quite low with respect to other South Asian countries, and hence, this is the foremost impediment in attaining successful planning. However, there is increasing role of private sector in the recent past. On the other hand, various studies have shown that there is rise in out-of-pocket expenditure on health pushing household below poverty line. Health insurance is a growing segment and does not have full coverage till now. Of the total insured population, public insurance companies, with the remaining covered by private companies, covered 79%.

As per WHO (2014), total expenditure on health as percentage of GDP was 4.69 (Indian Rupee) while private expenditure was 69.96 (Indian Rupee) and general government expenditure amounted to 5.05 (Indian Rupee) (https://apps.who.int/gho/data/node.cco.ki-IND?lang=en). The Human Development Index stood at 0.647 with 129th rank in 2019. The position of India has improved from 0.431 (1990) and is above the South Asian average of 0.642. Since 1990 the life expectancy at birth in India increased by 11.6 years (69.4 years), whereas the average number of schooling

years increased by 3.5 years (6.5 years). The gross national incomes too increased to 6829 per capita (PPP $) (http://hdr.undp.org/en/content/2019-human-development-index-ranking). In 2018–19, world's largest government-funded healthcare programme, Ayushman Bharat-National Health Protection Mission, was announced. The scheme aims to cover 10 crore poor and vulnerable families for secondary and tertiary care hospitalisation.

The achievements in the health sector include increased life expectancy at birth, reduced infant mortality rate and crude death rate, elimination of smallpox, polio and guinea worm and near elimination of leprosy.

India with total population of 1.3 billion people (Census of India 2011) with 31.14% urban and rest rural population strives to achieve Universal health coverage. Demographically, sex ratio of the country improved from 933 in 2001 to 943 females per thousand males in 2011. Estimated birth rate (29.5–20.4%), death rate (9.8–6.4%) and natural growth rate (19.7–10%) are showing a declining trend from 1991 to 2016 (Central Bureau of Health Intelligence 2019). MMR (167 per 100,000 live births in 2011–13) and IMR (74–34 per thousand live births in 1994 and 2016, respectively) have declined substantially but still fail to achieve the targets of Millennium Developmental Goals (Central Bureau of Health Intelligence 2019). The literacy rates have improved with an increase of about 8.2% (2001–2011). Nearly 43% of Indian children are underweight and as per the NFHS 4 data, only 62% of children are fully immunised.

The health challenges of India are complex accompanied with relatively large share in world disease burden. India is laden with triple burden of diseases, wherein communicable, non-communicable and infectious diseases need to be combated. In extensive research, it was observed that the disease burden due to communicable, maternal, neonatal and nutritional diseases dropped from 61 to 33%, whereas disease burden from non-communicable diseases increased from 30 to 55%. The share of DALY increased for both infectious diseases (14–43%) and injuries (9–14%) (1990–2016) suggesting that we are still grappling with the unfinished agenda of infectious diseases (ICMR et al. 2017). The country is clearly going through epidemiological transition accompanied with challenges in all kinds of causes of ill health and death.

Among communicable diseases morbidity cases reported are highest from acute respiratory infections (69%) followed by acute diarrhoeal diseases (22%), typhoid (4%), pneumonia, malaria and tuberculosis (1% each) (2017). As contrast morbidity, mortality was highest from acute respiratory infections and pneumonia (23% each), H1N1 (16%), diarrhoea (10%), acute encephalitis syndrome (7%) in the same period. There has been substantial achievement in controlling communicable diseases, especially malaria, kala azar, dengue, chikungunya and chicken pox. In contrast, there is accelerated rise in the prevalence of chronic non-communicable diseases such as cardiovascular disease (CVD), diabetes, chronic obstructive pulmonary disease (COPD), cancers, mental health disorders and injuries (Central Bureau of Health Intelligence 2019).

2.4 Health Planning in India

Both health and planning are multidimensional concepts involving the processes and activities that extend beyond individual level to state, nation and global levels. Health planning includes improvement of life expectancy, reduction in years of life lost, improvement in quality of life and environment, etc. Although the goals of urban health planning are territorial, the process or activity is initiated at individual level and extend beyond state level or national level having multi-level implementation.

At the national and state levels, the programme, policy formulation and legislation are important activities. Health planning involves diverse set of actions distributed among a number of domains catering to prevention, treatment, rehabilitation and even long-term care. The history of health planning in India can be traced since the time of Asoka, the King of Mauryan Empire, is well known for holding state responsible for providing safe water, shelter, trees implantation at the roadside, care for sick human beings and animals (Kishore and Ray 2001). Over a period of time, India experienced ebb and flow in health planning until independence. The framers of Indian constitution made sufficient provisions for protection, promotion and growth of health, nutrition and safe environment to ensure good health and wellbeing (Kishore 2012). The fundamental rights such as Right to Equality, Right to Freedom, Right against Exploitation and cultural and educational rights empower people to have causes and conditions to lead healthy life. Some notable Directive Principles such as Article 38 states that the State shall secure welfare of people; Article 39 on equal pay for equal work and securing health of workers; Article 42 for provision of just and humane conditions of work and maternity relief; Article 47 on the improvement of level of nutrition, standard of living and to improve public health, Article 48 on protection and improvement of environment and safeguard of forest and wildlife are included in the Constitution. Further, various duties are enumerated in Union, State and Concurrent Lists related with public health such as sanitation, hospital and dispensaries, adulteration of foodstuff and other goods, social security, social insurance, population control and family planning to name a few (Kishore 2012).

In accordance with the international and national goals, planning in India is manifested in the form of five-year plans, policies, programmes and national missions. The central government provides a broader framework and direction for programmes to be undertaken such as smallpox, malaria, tuberculosis, HIV/AIDS, leprosy and others. These programmes are implemented all over the country uniformly with partial or full funding by the central government. The state government is responsible for implementation and execution of all these programmes. Fully centrally funded programmes like family planning, Swachh Bharat Abhiyan (Clean India Mission) and universal immunisation have been successfully executed by the states.

The Union Ministry of Health and Family Welfare is responsible for the implementation of health related programmes, research, provision of technical assistance and funds for control of seasonal disease outbreaks and epidemics. The ministry is also responsible for the implementation of World Bank-assisted programmes like control of malaria, tuberculosis, AIDS and others. Programmes having implications

at the national level come under the Concurrent list like family welfare and population control, medical education and prevention of food adulteration. Public health, hospitals, dispensaries and sanitation fall under the state list (Government of India 2015; Grover and Singh 2020).

2.4.1 Policies, Plans, Programmes and Missions

Policies for health planning came into existence in 1982–83, that is, 35 years after independence. Although written policy did not exist for a long period of time, unwritten strategy did exist and it was implemented through five-year plans. It is to be noted that structured health policy and planning is not a post-independence phenomenon as the first comprehensive health policy and plan document, Health Survey and Development Committee Report, i.e., Bhore Committee Report, was prepared in 1946. The family planning programme was introduced as early as in 1951.

The five-year plans of 1950s and 60s focused on the elimination of epidemics, namely, malaria, smallpox, tuberculosis, leprosy, filaria, cholera and others. The success was partial as the rural urban disparities widened and many sectors of health care needed attention, especially public health delivery. As a result, Murlidhar Committee was set up in 1959 that suggested measures to improve the service condition of doctors and other personnel in order to attract them to rural areas. The third five-year plan focused on establishment of medical colleges, research institutes and training centres for doctors, nurses and auxiliary staff. The aims and objectives remained largely the same in fourth plan except inclusion of water supply and sanitation that were given separate allocation. The widening gap between rural and urban areas became more prominent by the fifth plan leading to focus on accessibility to health services and infrastructure, especially in rural areas. Later, family planning programme received undue attention at the cost of ongoing agenda during the emergency period. As a result, provision of safe drinking water and sanitation remained inadequate or absent. Many water-borne diseases such as diarrhoea, cholera, typhoid, jaundice and others affected the Indian population. Subsequently, the sixth plan was influenced by the international declaration 'Health for all by 2000 AD'. However, privatisation of healthcare system began by the seventh five-year plan that has taken an uncontrolled shape today. Meanwhile in 1983, with the aim of universal health care, the first National Health Policy was announced. Other than this, AIDS, cancer and coronary heart diseases super-specialised corporate hospitals and diagnostic centres boomed during this period. The eighth plan coincided with economic crisis and growing private sector. A committee that is, Expert Committee on Public Health Systems, was set up to review public health. After thorough appraisal of public health programs, it was found that we were facing a resurgence of most communicable diseases and there was need to drastically improve disease surveillance in the country. In response, the ninth plan proposed detection cum response system at district level. Taking lead from all the failures, draft 'New Health Policy' was released

for public debate in 2001. The following year was marked by second Health Policy that aimed at achieving acceptable standards of good health of Indian population, decentralisation, equity, accessibility of health services and provision of affordable private health care (Duggal 2014). The policy recognised the role of traditional medicines. The eleventh plan was envisaged with the central theme of inclusive growth. The twelfth five-year plan was prepared after the consultation of public. It called for Universal Health Coverage through Essential Health Package and to assess the social determinants of health. Major thrust areas were reducing out-of-pocket expenditure (OOP), ensuring accessibility of vaccines, medicines and technology, increasing staff, Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy (AYUSH) doctors, disaster management areas, nutrition promotion, improve sanitation and provide safe drinking water facilities (Planning Commission 2013; Grover and Singh 2020).

After a gap of 14 years, the National Health Policy was announced in 2017. By this time, many epidemiological changes had taken place. Accordingly, the priorities shifted to reduction of non-communicable and infectious diseases; providing health care in 'assured manner' to all; focus on AYUSH, particularly yoga and emphasis on Make in India products and knowledge. Besides health policies and plans, India has comprehensive Population Policy, Nutrition Policy, Water Policy and Environmental Policy that are closely associated with human health. For insuring people, Pradhan Mantri Swasthya Suraksha Yojana (PMSSY) in 2006, Janani Shishu Suraksha Karyakram (JSSK) and Janani Suraksha Yojana were launched.

Integrated Child Development Services (ICDS) scheme, Mid-day Meal (MDM) Programme, Special Nutrition Programme, National Nutritional Anemia Prophylaxis Programme (NNAPP), Reproductive and Child Health Programme and School Health Programme, Integrated Disease Surveillance Projects (IDSP) Voluntary Blood Donation Programme (VBDP) and Rajiv Gandhi National Drinking Water Mission (RGNDWM) are some important programmes floated by the government (Lakshminarayanan 2016; http://shodhganga.inflibnet.ac.in/bitstream/10603/145095/15/15_chapter%205.pdf; Patel 2015).

Innumerable programmes to combat communicable and non-communicable diseases have been launched from time-to-time by different ministries. Among the prominent communicable diseases programmes are for leprosy, filaria, TB, immunisation, guinea worm, vector-borne diseases and AIDS control. Prominent non-communicable diseases that got attention are goitre, cancer, blindness, mental health, drug de-addiction, occupational diseases, deafness, fluorosis, diabetes, stroke, oral health and pulse polio.

The Swachh Bharat Mission/Clean India Mission (2014–19) has been a breakthrough in spreading awareness about clean environment and need of proper sanitation facilities. AMRIT launched in 2015 aims to reduce the expenditure incurred by patients on the treatment of non-communicable diseases like cancer and heart diseases. Government also sponsored health insurance scheme, Ayushman Bharat Yojana (National Health Protection Mission), in 2018, whereby it aims to provide health cover worth Rs. 500,000 to population below poverty line for treatment of serious ailments.

On the basis of ownership, health infrastructure can be public, government, private or individually owned. Additionally, charitable institutions, religious organisations like churches and NGOs and public sector bodies like atomic energy, railways, port trust, reserve bank and armed forces also own dispensaries, clinics, nursing homes and hospitals (Grover and Singh 2020).

2.5 Concluding Remarks

As the cities are growing faster than ever before, the concentration of global health challenges is increasing in cities. The urban environment is becoming more complex and dynamic which put forward numerous limitations for urban health planning. These limitations increase the health inequities and disparities in urban areas.

Physical and social environment along with accessibility to health services are three major factors affecting health care in urban areas. Diminishing natural land cover especially green cover, increasing density, slums, pollution and poor sanitation are major challenges for urban planners. Additionally, income inequalities have created gaps in access to health care among people from different social status.

It can be easily concluded that financing health sector is a major challenge in India. The share of centre's contribution is decline every year accompanied with increased role of private players juxtaposing the objective 'health for all'. Human resources in health sector too are deficient. These limitations are also confirmed in the present situation, whereby the world is trying to overcome the COVID-19 pandemic. It is asserted again that the role of public sector health services is irreplaceable and essential for fighting crises situation. It is therefore recommended that government healthcare services upgrade their quality and private healthcare system to offer affordable services (ICSU 2011). Health planners shall adapt more inclusive approach to promote urban health equity.

References

Borowy I (2014) Sustainable health: the need for new developmental models. Bull World Health Organ 92(10):699. https://pubmed.ncbi.nlm.nih.gov/25378720

Census of India (2011) Provisional population totals. Ministry of Home Affairs, Government of India

Central Bureau of Health Intelligence (2018) National health profile 2018. Directorate General of Health Services, Ministry of Health and Family Welfare Retrieved from http://www.cbhidghs.nic.in/WriteReadData/l892s/Before%20Chapter1.pdf

Central Bureau of Health Intelligence (2019) National health profile 2018. Directorate General of health services, Ministry of health and family welfare, Government of India

Duggal R (2014) Health planning in India. Retrieved from http://www.cehat.org/cehat/uploads/files/a168.pdf

Goal 2: zero hunger. The Global Goals. https://www.globalgoals.org/2-zero-hunger. 5 Feb 2022

Goal 3: good health and well-being. https://www1.undp.org/content/singapore-global-centre/en/home/sustainable-development-goals/goal-3-good-health-and-well-being.html?utm_source=EN&utm_medium=GSR&utm_content=US_UNDP_PaidSearch_Brand_English&utm_campaign=CENTRAL&c_src=CENTRAL&c_src2=GSR&gclid=Cj0KCQiA3fiPBhCCARIsAFQ8QzUv5GyMCHmnAQbqCSs2OglQGc2EkqyFs331zam0oJNIU4q2ocpvM0MaAqP3EALw_wcB. 5 Feb 2022

Goal 5: gender equality. UNDP in India. https://www.in.undp.org/content/india/en/home/post-2015/sdg-overview/goal-5.html?utm_source=EN&utm_medium=GSR&utm_content=US_UNDP_PaidSearch_Brand_English&utm_campaign=CENTRAL&c_src=CENTRAL&c_src2=GSR&gclid=Cj0KCQiA3fiPBhCCARIsAFQ8QzVjWZiEDcPMGiKFXjVw8Q9zYPmzwffY47kKVK9UT3HtiNIRdhjQ_7saAhaUEALw_wcB. 5 Feb 2022

Goal 6: clean water and sanitation. UNEP—UN Environment Programme. https://www.unep.org/explore-topics/sustainable-development-goals/why-do-sustainable-development-goals-matter/goal-6. 5 Feb 2022

Goal 8: decent work and economic growth. https://www1.undp.org/content/oslo-governance-centre/en/home/sustainable-development-goals/goal-8-decent-work-and-economic-growth.html?utm_source=EN&utm_medium=GSR&utm_content=US_UNDP_PaidSearch_Brand_English&utm_campaign=CENTRAL&c_src=CENTRAL&c_src2=GSR&gclid=Cj0KCQiA3fiPBhCCARIsAFQ8QzUy4Z3MLK-RBgA83P0BiBzFGEtXp5Ac_bE8ay45aous6jmEM-JK-zMaAt3TEALw_wcB. 5 Feb 2022

Goal 11: sustainable cities and communities. The Global Goals. https://www.globalgoals.org/11-sustainable-cities-and-communities. 5 Feb 2022

Goal 16: peace, justice and strong institutions. https://www.iq.undp.org/content/iraq/en/home/sustainable-development-goals/goal-16-peace-justice-and-strong-institutions.html?utm_source=EN&utm_medium=GSR&utm_content=US_UNDP_PaidSearch_Brand_English&utm_campaign=CENTRAL&c_src=CENTRAL&c_src2=GSR&gclid=Cj0KCQiA3fiPBhCCARIsAFQ8QzVcu48OFNNwqU8YomqBTS1CHFDtaBKmIFbGGezpCtAaMB7PGbCFnIYaAj3uEALw_wcB. 5 Feb 2022

Government of India (2015) Manual on health statistics in India. Ministry of Statistics and Programme Implementation. Retrieved from http://www.mospi.gov.in/sites/default/files/publication_reports/Manual-Health-Statistics_5june15.pdf

Grover A, Singh RB (2020) Urban health and wellbeing: Indian case studies. Springer

http://shodhganga.inflibnet.ac.in/bitstream/10603/145095/15/15_chapter%205.pdf

http://hdr.undp.org/en/content/2019-human-development-index-ranking

Indian Council of Medical Research (ICMR), Public Health Foundation of India (PHFI) and Institute of Health Metrics and Evaluation (IHME) (2017) The recent state level study on health status of India (1990–2016). ICMR, PHFI and IHME Department of Health Research, Ministry of health and family welfare, Government of India, pp 1–220

International Council for Science (ICSU) (2011) Health and wellbeing in the changing urban environment: a systems analysis approach, an interdisciplinary science plan, pp 1–46. ISBN: 978-0-930357-86-3

Kishor J (2012) Legislation and health promotion in India. Rev Global Med Healthcare Res 3(2). ISSN: 1986-5872

Kishore J, Ray PC (2001) The pioneering social reformers of India. Wisdom Publications, New Delhi

Lakshminarayanan S (2016) Role of government in public health: current scenario in India and future scope. J Family Commun Med 18(1):26–30

Noncommunicable diseases. https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases. 5 Feb 2022

Patel RK (2015) Health status and programmes in India. New Century Publications, New Delhi

Planning Commission (2013a) Twelfth five year plan (2012–2017) faster, more inclusive and sustainable growth, vol 1, pp 1–370. Retrieved from http://planningcommission.gov.in/plans/planrel/12thplan/pdf/12fyp_vol1.pdf

SDG Goal 4: quality education. UNICEF DATA. https://data.unicef.org/sdgs/goal-4-quality-education/. 5 Feb 2022
WHO (2014). https://apps.who.int/gho/data/node.cco.ki-IND?lang=en

Chapter 3
Food Consumption Patterns and Associated Health Risks in Douala Metropolis—Cameroon

H. Blaise Nguendo-Yongsi

Abstract With the urban population growing rapidly, models of food intake have evolved and diversified. The current research aims to provide a comprehensive analysis of city dwellers' food strategies along with their nutritional intake on the one hand, and in another to assess the microbiological quality of those home-made and street-vended foods. A transversal study was carried out within the city in 2021. Using a simple random sampling, 3200 individuals were selected in 18 representative neighbourhoods out of the 121 in the city. The investigation involved (i) a socio-demographic survey in order to apprehend food consumption patterns and (ii) a microbiologic assessment to mainly identify the presence or absence of microbial pathogens. Regardless of age and socio-economic status, almost all city dwellers consume food at home and outside the home. However, street-vended foods account for 47% of food expenses and offer sale opportunities for locally produced items scarcely eaten at home and provide nutritive supplements to low socio-economic status individuals. Should food security be guaranteed in urban areas? Stakeholders in charge of food and nutrition must consider factors that have an effect on the food consumption behaviours of city dwellers. Besides, food inspections must be conducted on a regular basis to achieve food safety.

Keywords Food security · Food safety · Food consumption · Microbial assessment · Lifestyles · Dietary habits · Douala

3.1 Introduction

This twenty-first century is characterized by ever-increasing urbanization. Presently, it is estimated that about half of the world's population resides in towns and cities, and that figure is projected to rise to 75% by 2050, at a growing rate of 65 million urban dwellers annually. According to UN-Habitat (2014), this urban growth is particularly

H. Blaise Nguendo-Yongsi (✉)
Geospatial Land and Health Research Laboratory (LISET), Institute for Population Studies (IFORD), University of Yaoundé II, Soa, Cameroon
e-mail: sir_nguendoyongsi@hotmail.com

A. Grover et al. (eds.), *Sustainable Health Through Food, Nutrition, and Lifestyle*, Advances in Geographical and Environmental Sciences,
https://doi.org/10.1007/978-981-19-7230-0_3

concentrated in Africa and Asia. With regard to Africa, Sub-Saharan Africa (SSA) is the area experiencing the highest urban growth, i.e. 3.5% per year. It is even expected that this rate will hold into 2050 (AUC 2015). It is also projected that between 2010 and 2050, some SSA cities will account for up to 85% of the population, including thousands of urban centres, of which two mega-cities already have over 10 million inhabitants (Lagos, Cairo) (UN 2016). In the next 30 years, urban dwellers will outweigh rural residents for the first time in Africa. This is already the case in some African countries such as Gabon, where urban residents represent 87% of the total population. Currently, cities in SSA accommodate 472 million people, and this number will grow to 810 million people by 2035 (Fig. 3.1).

Those cities are of great usefulness for their role in fighting poverty and sustaining economic growth. In fact, the GDP of many African countries is concentrated, and even reliant, on the productivity of their cities (Lwasa 2014). However, most of the urban growth seen in SSA has been poorly planned and has resulted in the proliferation of informal settlements or mega slums (Fig. 3.2).

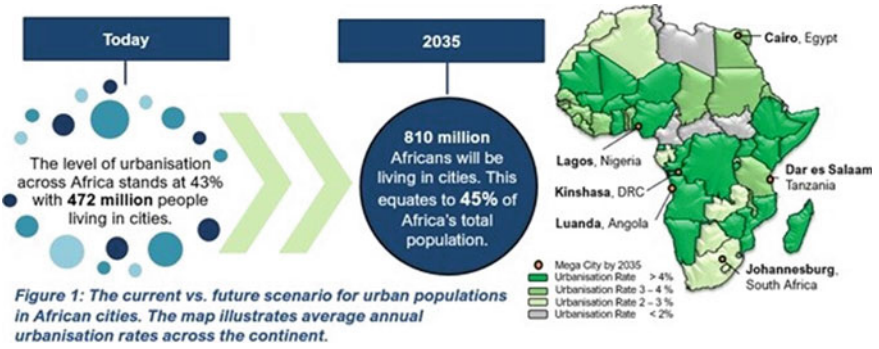


Fig. 3.1 Current versus future scenario for urban populations in African cities

Fig. 3.2 Implications of urbanization in Africa. *Source* Costaras (2020)

As it currently stands, urban growth in Africa is marked by unannounced and unregulated growth, aggravated by the legacy of colonialism and neo-liberalism that spawned weak urban planning institutions (Pieterse and Parnell 2014). This fast urban growth has modified the continent's demographic landscape (AEO 2016). Yet, urbanization in SSA has failed to bring about inclusive growth, which, in turn, has resulted in several challenges. As the surging demand for living space in urban areas consumes arable land and green spaces, the scale of Africa's urbanization is already taking a toll on the environment, including by polluting precious water sources and compromising air quality (Fox and Beall 2012; UN-Habitat 2015). Another negative impact of urbanization in SSA is evidenced in the expanding issue of food (in)security in urban centres. A crucial aspect of food security pertains to the quantity and quality of food, which are associated with the food supply network. This issue has become a topic of increased scholarly study. Food consumption is evolving and diversifying through the types of food consumed and the increase of food-related diseases. Yet, with some notable exceptions, little attention has been paid to the consumption patterns of food. Since policies need to be grounded in a holistic approach that explicitly positions and addresses food and nutrition (in)security within the broader context of nutrition and health, the present study aims to fill this lacuna by providing a discussion of the interrelationships between urbanisation and food insecurity, i.e. food consumption patterns and health risks associated with food processing.

3.2 Material and Methods

3.2.1 Study Area

This study was conducted in Douala, the economic capital of Cameroon. Port and coastal town (near the Atlantic Ocean), Douala stretches over 210 km^2 with an approximate population of 3.6 million inhabitants, giving a population density of 177.79 inhabitants/km^2 (Fig. 3.3). Douala is the Cameroonian main metropolis and owes its growth to the rural–urban migration that has pushed thousands of citizens to leave their villages to settle in the city. With a current population of 3,663,000 inhabitants, the city experiences challenges that are common to African cities, such as that of feeding an ever-growing population.

3.2.2 Study Design and Sampling

This is a cross-sectional study conducted from March 2020 to March 2021, adopting a mixed research method, that is, a quantitative and a qualitative approach. The target populations included inhabitants living within the urbanized area made up of the five boroughs (Douala I, Douala II, Douala III, Douala IV, and Douala V). Douala

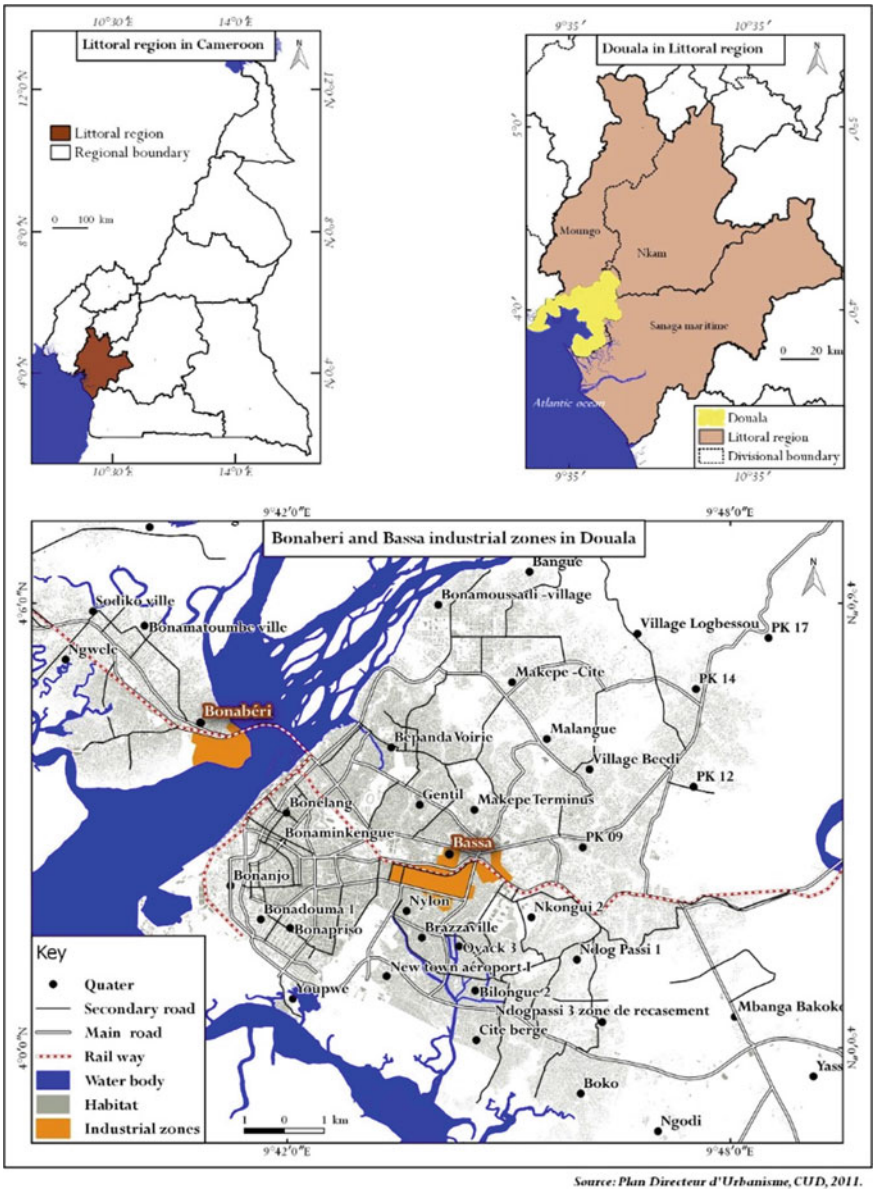


Fig. 3.3 Location of Douala metropolis in Cameroon

VI, which is a rural and island area, was excluded. Data used come from a cross-sectional study carried out by the *Geospatial Land and Health Research Laboratory* (LISET) of the Institute for Population and Research Studies (IFORD). Although the whole city constituted the basis of our sampling, a double strata sampling was carried out. First, 18 representative neighbourhoods out of the 121 that make up the city. Secondly, 3200 individuals were selected from those neighbourhoods, using the following formula:

$$n = \frac{z^2 \times p(1-p) \times f \times k}{r \times e^2}$$

(n sampling size, e margin error, f average household size, k non-response rate, r proportion of households with expenditure on food, z the value of normal distribution for a desired confidence level of $1 - \alpha$; p coverage rate).

3.2.3 Data Collection and Analysis

The survey was conducted by teams of final year students of the Institute for population studies and of the School of Health Sciences of the Catholic University of Central Africa. The investigation involved (i) a socio-demographic survey (using structured questionnaires) in order to apprehend food consumption patterns and (ii) a microbiologic assessment to mainly identify the presence or absence of microbial pathogens. The process of collecting and analysing samples is described in the box below (Box 3.1). Computer programs used for data analysis were Epi Info (recording raw data, verifying, and validating the data collected). The Chi-square method was used to test for significance in proportions. *P*-values < 0.05 were taken as a statistically significant association. Quantitative data on the microbial counts obtained from the experiment were subjected to the analysis of variance (ANOVA). The observed difference among the mean values of samples was compared using Duncan Multiple Test using SPSS 20 for windows (SPSS Inc., Chicago, Illinois). Results of enumeration were expressed as mean ± standard deviation log10 cfu/g for all food samples.

3.2.4 Ethical Considerations

Informed written consent was obtained from each study participant after explaining the objective of the study. All the information about the study participants was kept confidential.

Box 3.1 Procedure for the Microbiological Analysis of Foods and Beverages in Douala

[The below microbiological analysis procedure derives from the protocol we developped in our prevous study whose reference is: published in 2014, NguendoYongsi (2014)]

Sample collection: After four days of theoretical and practical training, the investigations teams visited targeted households to collect food and beverages samples. All the samples were aseptically collected in sterile containers, were maintained in chilled state using coolants (ice pack), and transported to the laboratory (*Laboratoire Biodiagnostics-Vallée 3 Boutiques, Deido Douala*), were stored at a temperature of 4 °C and analyzed within 1–2 h of collection. Contents were examined microscopically for parasites and/or bacteria following direct wet mount preparations in normal saline and iodine solution (FAO/WHO 1997).

Microbiological analysis: For the microbiological assay, 25 g of food samples were taken, and 100 g of beverages were taken to the laboratory where direct smear method and formol ether concentration methods were used as described by WHO (1991). In fact, each of the specimens was checked for its label, quantity and procedure of collection.

- ***for bacteria***: Enumeration of bacterial load in each sample was done by statistical process control method where the colony forming units (CFUg − 1/CFUml − 1) of the food samples were determined. 1 g (for solid food) or 1 ml (for beverage) of the food sample was measured and added to 9 ml of sterilized saline (0.85% NaCl), mixed well to make a dilution of tenfold. From the 10−1 dilution further dilutions of 10−2, 10−3, 10−4, 10−5 and 10−6 were prepared. A spread plate of each dilution was done on plate count agar plates and incubated at 37 °C for 16–18 h. After incubation, the plates were analysed and CFUs were counted for appropriate plates. For isolating the bacteria, enrichment culture was done by inoculating 0.5 g (for solid samples) or 0.5 ml (for liquid samples) of the food sample in 4.5 ml peptone water broth and incubated for 6–8 h at 37 °C. The growth in the medium was depicted as turbidity in the broth. Aloopful from broth was streaked on nutrient agar, eosin methylene blue agar, MacConkey agar, Mannitol salt agar, Cetrimide agar and deoxycholate citrate agar plates were incubated at 35–37 °C for 24 h and pure cultures of isolated bacteria were obtained. Microscopic examination and biochemical characterisation of the isolates was carried out as per the standard laboratory protocol (Tambekar et al. 2008) and the isolates were identified using Bergey's manual of determinative bacteriology, 9th edition (Holt 1993).
- ***for viruses' detection***: since we were interested in hepatitis, virus-causing, combined techniques based on direct flocculation methods and Nucleic Acid Sequence Based Amplification (NASBA) were used (Girones et al. 2010).

- ***for parasites***: The diagnosis was made on direct wet mount, formalin-ether concentration, and with confirmation of positive stool specimens on Ziehl–Neelsen and Trichrome stained slides. A portion each of the food samples was processed with a direct microscopic technique to detect cysts, trophozoites, eggs and larva of intestinal parasites immediately. The remaining part of the samples was transported to research laboratory. Samples examinations were performed using the formol-ether concentration technique. Both the 10 × and 40 × objectives were used for detection of eggs and larvae of helminths and cysts and trophozoites of protozoan parasites. Iodine solution was used to detect and identify cysts of protozoan parasites. Presence of faecal coliforms were determined using Brilliant Green Lactose Bile broth (44.50 C/48 h), followed by confirmation of gas positive tubes using Eosin methylene Blue agar.

3.3 Results

3.3.1 Socio-demographic Details

A total of 3200 households were selected to participate in this study. However, 2900 completed the questionnaires and properly undertook the microbiological survey, yielding a response rate of 90.6%. Of the 2900 householders, 1872 (64.5%) were males and 1028 (35.5%) were females, that is a sex ratio of 1.82. The mean age of the participants was 39.00 years, ranging from 18 to 78 years. The school attendance varied among the respondents, with a majority of them (51.8%) having the secondary level. A high proportion lives in extended families (48.6%), with an average monthly income of 61,000 FCFA (≈ 102 US$) (Table 3.1).

3.3.2 Food Consumption Patterns

Urban growth is mainly due to rural exodus; food consumed by urban dwellers reflects both their cultural origins and their urban affiliation (Table 3.2).

Uncontrolled urbanization points out the food scenario in the city, essentially because of the manner it affects consumption patterns. The divide between city dwellers' feeding practices reflects the different socio-cultural backdrops, economic occupations, and lifestyles. Table 3.3 on eating habits shows that people do not eat the same way. Some enjoy slight food when others enjoy fat, some consume in-home foods, while others prefer canned or processed foods. Each city dweller develops specific feeding practices habits but which, in reality, are the result of a long social construction and learning dietary habits.

Table 3.1 Socio-demographic characteristics of the respondents

Continuous variables	Mean	SD
Age (year)	39	11.31
Average number of individuals per household	6.5	04.2
Average number of meals per day	1.8	02.3
Average monthly cash income (in CFA)†	61,000	13.7
Categorical variables	**Number**	**Percent**
Gender		
Male	1872	64.5
Female	1028	35.5
Marital status		
Single	730	25.2
Married/in a relationship	1748	60.3
Divorced/widow	422	14.5
Educational level		
Illiterate	67	02.3
Primary	570	19.7
Secondary	1195	41.2
University	1068	36.8
Economic activity		
Unemployed/retired	230	07.9
Civil servants and employees	1055	36.4
Informal activities and small business	1241	42.8
Self-employed (company owners, big traders, liberal professions)	374	12.9
Family structure		
Nuclear	1309	45.1
Extended (with relatives)	1408	48.6
Domestic servants living with	183	06.3
Frequency of food consumption		
Once a day	667	23.0
Twice a day	1953	67.4
Three times a day	280	09.6

†1 CFA = 0.0019 US$

It comes out that urban dwellers use a variety of foods and consume them regardless of the time of day. Reasons or motivations explaining such feeding behaviours are varied (Fig. 3.4).

Using the FAO food classification (2011), food consumed by Douala inhabitants are grouped as given in Table 3.2. Samples were collected for microbiological quality assessment, in particular as regards to aerobic mesophilic count (AMC), total

Table 3.2 Foods consumed by city dwellers in Douala

Food category	Food items	Ingredients/components	Method of cooking
1. Unprocessed foods	Lettuce/cabbage	No	Ready mixing of raw ingredients
	Carrot/salad	No	Ready mixing of raw ingredients
	Avocados/pineapple/mangoes	No	Ready mixing of raw ingredients
2. Semi processed food beverages	*Kossam* beverage	Non-pasteurized milk, sugar, and water	Mixing of ingredients and chilling
	Folere beverage	Sorrel leaves, sugar, and water	Mixing of ingredients and chilling
	Ginger beverage	Ginger, sugar, and water	Mixing of ingredients and chilling
	Jus de fruit	Fresh fruits, ice, sugar, and water	Mixing of ingredients only
	Poisson braisé	Fresh fish, oil, salt, onion, and spices	Steaming
	Poulet braisé	Chicken, oil, salt, and spices	Steaming
	Shawarma	Meat, cereal, vegetable oil, salt, and spices	Mixing of ingredients and heating
	Pain chargé	Bread, corned beef, bologna, and sardines	Ready mixing of raw ingredients
	Sausage/meatballs	Pork or beef meat, oil, and seasonings	Mixing of ingredients and steaming
	Oeuf boulli	Eggs and other seasonings	Boiled egg and mixing of ingredients
3. Processed food	*Riz-sauce d'arachide*	Rice, roasted peanuts, salt, oil, tomato, and other spices	Boiled rice served with chopped roasted peanuts mixed with spices and meat or fish
	Ndole	Biter leaves, fresh groundnuts, salt and other spices, and crawfish	Mixing of ingredients and steaming

(continued)

Table 3.2 (continued)

Food category	Food items	Ingredients/components	Method of cooking
	Kondre	Green plantain, oil, meat, and other spices	Mixing of ingredients and steaming
	Sauce jaune	Dasheen, muskox skin, and spices	Mixing of ingredients and steaming
	Fufu and Eru	Cassava, eru leaves, muskox skin, and palm oil	Pounded fresh cassava served with boiled leaves immersed in oil, spices, and muskox skin
	Okok	Okok leaves, vegetables, palm oil, and peanuts	Slurry okok leaves immersed in grounded roasted peanut
	Pommes pilées	Irish potato, beans, salt, and spices	Slurry pounded potato with beans
	Soya	Beef meat, oil, salt, and spices	
	Sanga	Fresh maize, cassava leaves, salt or sugar, and water	Mixing of ingredients and steaming
	Beignet-haricot	Flour, salt, beans, oil, and spices	Sauteing and frying

Table 3.3 Food consumption patterns of city dwellers in Douala

	In-home food/beverages		Street food/beverages		
	Unprocessed foods	Processed food	Unprocessed foods	Semi processed food beverages	Processed food
Breakfast	76 (11.5%)	41 (06.2%)	188 (28.5%)	303 (45.9%)	52 (07.9%)
Lunch	89 (05.6%)	394 (24.7%)	77 (04.8%)	288 (18.1%)	746 (46.8%)
Diner	21 (03.2%)	390 (60.4%)	52 (08.0%)	118 (18.3%)	65 (10.1%)

$P < 0.05$ (based on ANOVA)—*Source* Field investigations, 2020

coliform count (TCC), and bacteriological count. Considering the mean bacteriological count, Table 3.4 shows that high aerobic mesophilic count ranged from 1.71 to 3.71 * 105 CFU/g to 1.67–4.10 * 103 CFU/g coliform. It was found that vegetables, fresh fruits, and beverages mostly contain the bacteriological count of organisms, whereas legumes and beverages mostly contain the total coliform count.

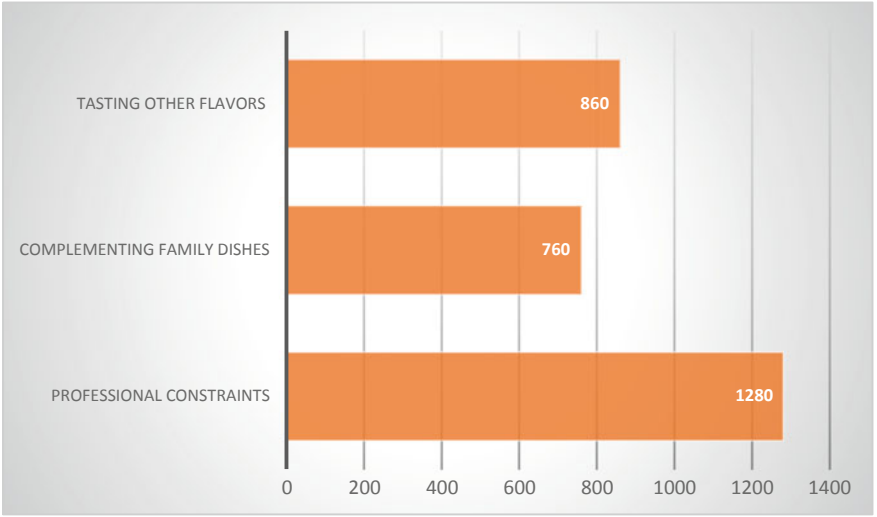


Fig. 3.4 Reasons explaining feeding practices in Douala

Table 3.4 Microbial count of food groups collected in selected households and street food spots in Douala

	Home-made foods		Street foods	
Food groups	Aerobic mesophilic count (CFU/g)	Total coliform count (CFU/g)	Aerobic mesophilic count (CFU/g)	Total coliform count (CFU/g)
Vegetable	$1.23 * 10^5$	$1.88 * 10^3$	$3.71 * 10^5$	$2.91 * 10^3$
Meat/fish	$0.79 * 10^5$	$0.96 * 10^3$	$2.47 * 10^5$	$1.73 * 10^3$
Mix dishes	$0.71 * 10^5$	$1.00 * 10^3$	$1.71 * 10^5$	$1.67 * 10^3$
Cereals/fresh fruits	$1.37 * 10^5$	$2.19 * 10^3$	$3.70 * 10^5$	$4.10 * 10^3$
Legumes and starch food	$0.82 * 10^5$	$0.91 * 10^3$	$2.89 * 10^5$	$3.81 * 10^3$
Flour and meat-based	$1.02 * 10^5$	$1.98 * 10^3$	$2.96 * 10^5$	$2.42 * 10^3$
Beverages	$2.15 * 10^5$	$2.53 * 10^3$	$3.21 * 10^5$	$3.48 * 10^3$

• Vegetables: Salads, cabbages, carrots, and avocados
• Meat/fish: Stewed beef/pork, shawarma, and grilled chicken/fish
• Mix dishes: Eru, kondrè, ndolè, rice, and peanut sausage
• Cereals/fresh fruits: Maize, pineapple, mangoes, papayas, and oranges
• Legumes and starch food: Boiled peanuts, steamed beans, and pounded Irish potato
• Flour and meat-based: Beignet-haricot (fritters of flour and fried beans), Œuf boulli (boiled egg), and bread with meat
• Beverages: Kossam, Folerè, and ginger

For any food and beverage assessed, it was found that pathogenic microbial contamination was beyond the recommended microbiological standards. According to the growth on selective and differential media and biochemical tests (WHO 1991), isolates identified were bacteria pathogens (*Escherichia coli, Staphylococcus aureus, Klebsiella sp., Pseudomonas sp., Shigella, Citrobacter, Enterobacter aerogenus, and Salmonella spp*), parasitic germs (*Entamoeba histolytica, Giardia intestinalis, Cyclospora cayetanensis, Cryptosporidium parvum)* (Table 3.5).

3.4 Discussion

The food dimension in cities is currently a significant worldwide problem. First, there is the issue of supply with regard to the increase and changes in food demand. There are also problems relating to various groups of city dwellers, such as food insecurity of the poor and changes in eating habits and practices of most citizens. This study assessed food consumption patterns in the main Cameroonian metropolis. Few city dwellers do not take the three daily meals recommended by WHO (2017). The economic crisis that shakes the country for a decade has had unavoidable impacts on the labour market. Most city dwellers are involved in informal activities where incomes are known to be low (Bonnet and Venkatesh 2016). Consequently, with an average monthly income of 61,000 FCFA, the households' weak spending power has led many families to reduce the number of daily meals. People eat only when it is essential to do so: either breakfast and lunch, or breakfast and dinner, or lunch and dinner. Family structure can partially explain such an alternative choice: most investigated households are extended families with a 6.5 average number of individuals per household. Coupled with their low-income levels, such family sizes can hardly meet the WHO recommendations regarding meals frequency and quality, as previously reported in Senegal and South Africa (Anderson et al. 2010; Schonfeldt and Gibson 2012). Globally, individuals had a higher adherence for lunch because regardless of professional occupation type (self-employee, employee, student, etc.), the break lasts two hours, and people have enough time to either return home and eat or seek a street-vended food spot. Thus, food consumption as an individual or social phenomenon is extremely complex, as it is related to a multitude of interacting internal and external factors, including culture and education, lifestyle, and socio-economic status (Holdsworth and Landais 2019). Throughout their feeding pathway, city dwellers choose street foods. This finding is evidence that food preferences are changing in SSA cities (Auma et al. 2020). In fact, in recent years, a growing volume of food consumption has occurred outside the home and entails food bought from street vendors (Osei-Kwasi et al. 2020). Cost affordability (prices are adapted to the purchasing power of all social categories) and payment flexibility (payment can be made later, moreover either in cash or in-kind) explain the choice of street foods, but not only: does the large variety of foods on sale contribute significantly to the provision of a diversified diet. However, Andreyeva et al. (2010) warn us that "food consumption outside the home by the household's main wage earners could have

Table 3.5 Enumeration of pathogenic micro-organisms (* 104 cfu g^{-1}) found in foods and beverages in Douala (regardless of home-made foods or street foods)

Food groups	Bacteria								Parasites				Viruses	
	Ec	Sa	Ks	Ps	Sf	Cf	Ea	Se	Eh	Gi	Cp	Cc	HA	Nv
Vegetable	2.56	1.20	0.83	0.40	1.30	1.65	0.86	9.60	1.47	3.06	0.82	1.77	3.11	0.05
Meat/fish	0.20	0.00	0.20	0.00	0.13	0.09	0.03	4.02	0.14	1.00	0.00	0.00	0.03	0.00
Mix dishes	0.42	0.05	0.00	0.03	0.00	0.17	0.01	1.04	0.07	0.04	0.45	0.53	0.14	0.00
fresh fruits	1.21	1.07	0.70	1.03	2.06	1.74	1.36	5.68	2.18	1.05	0.87	0.92	0.67	0.20
Legumes and starch food	0.21	0.00	0.00	0.52	0.18	0.00	0.25	1.10	0.34	0.91	0.46	0.33	0.42	0.14
Flour and meat-based	0.05	0.03	0.55	0.06	0.67	0.00	0.00	2.95	0.00	0.04	0.00	0.12	0.02	0.00
Beverages	2.39	1.21	0.61	1.90	3.07	4.30	7.82	10.80	2.67	1.56	0.67	0.74	1.33	0.74

Ec *Escherichia coli;* ***Sa*** *Staphylococcus aureus;* ***Ks*** *Klebsiella sp.;* ***Ps*** *Pseudomonas sp.;* **Sf** *Shigella flexneri;* ***Cf*** *Citrobacter freundi;* ***Ea*** *Enterobacter aerogenus;* ***Se*** *Salmonella entritis;* ***Eh*** *Entamoeba histolytica;* ***Gi*** *Giardia intestinalis;* ***Cp*** *Cryptosporidium parvum;* ***Cc*** *Cyclospora cayetanensis;* ***HA*** *Hepatitis A;* ***Nv*** *Norovirus*

deleterious effects if expenditures outside are made at the expense of the quality and quantity of food eaten at home". Besides, another trend in food consumption in Douala is the infatuation for semi-processed foods, which are mainly made up of products imported from western and middle-east countries. This pattern is similar to patterns commonly found in other developing societies. For example, the "snacks and drinks" pattern shared several items with the "chicken or beef processed food" and "snacking" patterns ascertained in Brazil and Ghana or Kenya (Olinto et al. 2012; Green et al. 2020). These included salty snacks, soda, beer, canned foods, fried foods, and sweetened products (Becquey et al. 2010). The "fruit and vegetables" pattern is similar to the "healthy pattern" found in Iranian studies (Azizi et al. 2015). Finally, a "balanced" pattern identified in Bangladesh included the same components as the "fruit and vegetables" and "fish and rice" patterns (Chen et al. 2006). Our findings support the view that individuals have lower adherence to "traditional-like" diets that are in-home food, possibly related to the rapid economic development. Low adherence to home-made foods and even to the "fruit and vegetables" pattern is a common finding in both LMICs (Holdsworth et al. 2020). An explanation might be the lack of awareness with respect to the advantages of fruit and vegetable consumption and their limited accessibility and availability due to large reliance on imported produce (Turner et al. 2020). In line with previous studies conducted in LMICs (Bojorquez et al. 2015; Osei-Kwasi et al. 2021), we found that adherence to a traditional-like diet (in-home food) was more prominent for city dwellers of low economic status. This can be a certain extent explained by the fact that high socio-economic status individuals have a tendency to choose modern western-like "trendy" foods as a matter of glamour (Smith and Baghurst 1992), while low socio-economic inhabitants have lesser access to expensive imported foods (other than essential subsidized food items). Thus, they are likely to maintain their classic diet (home processed foods), which generally includes low-cost staple foods, widely consumed and often subsidized to fulfil the minimum caloric needs of a household (Cockx et al. 2017; Popkin et al. 2012).

However, patterns in consumption lifestyle have resulted in major epidemiologic shifts in foodborne diseases, early recognized by Hippocrates (460 B.C.) who reported that there is a strong connection between food consumed and human illness. Pathogens involved in foodborne diseases being from different types, we had to identify them for monitoring purposes. The tests reveal that the majority of samples were contaminated with diverse pathogens, as proven by the presence of aerobic mesophilic counts ranging between 1.71 * 105 and 3.71 $\times$ 105 CFU/g in all samples. The discrepancies revealed in the aerobic mesophilic count of mixed meals, fruits, and vegetables may be attributable to the unsanitary circumstances under which street foods are served, hence resulting in contamination from serving utensils (Nonga et al. 2015). In this context, the high level of microbial contamination in these foods is attributable to an increase in microbial load during sprout, exposure of leaves to the soil, and soil accumulation in leaf folds (Seow et al. 2012). The presence of total coliform counts in food groups can be attributed to contamination resulting from improper processing, incomplete heating, use of contaminated water during preparation and washing, or secondary contamination via skin infections and nose

nares of food handlers and contact with contaminated equipment such as chopping boards, knives, and serving wares (Weil et al. 2006). This study's findings differ from those of Mafune et al. (2016) but are comparable to those of Gitahi et al. (2012), who found 3.27 log10 cfu/g in cereals, 3.32 log10 cfu/g in mixed meals, and 4.63 log10 cfu/g in vegetables. Differences in enumeration of micro-organisms between the two investigations may be attributable to contamination of items by street vendors during handling, processing, and vending (Nguendo-Yongsi 2014). The presence of Escherichia coli (in around 24.6% of food samples), which is generally considered as faecal contamination of water, indicates the potential presence of enteric pathogens. Their abundance in meals such as meat mixtures may be attributable to heat processing failure or post-processing contamination, as well as a lack of sanitation and hygiene in handling and storage (Tavakoli and Riazipour 2008). The greatest detection of *S. aureus* was identified in fresh fruits and legumes, indicating contamination through the skin, mouth, or nose of food workers via coughing and sneezing during handling, processing, or vending (Diaz-Lopez et al. 2011). This analysis detected Salmonella enteritidis and related it to meat-based products, beef, milk, poultry, and eggs. Vegetables and beverages were highly contaminated, presumably due to their handling and preparation procedures. As with the other organisms (Shigella, Pseudomonas, and Citrobacter), they may have been introduced via the unwashed hands of diseased food handlers. In this research, one of the risk factors for the infection of goods sold on the street was the preservation and eating of leftover foods. It has been observed that items left out for two days or more by vendors contained harmful micro-organisms. According to reports, viruses are the most prevalent cause of waterborne sickness. In our investigation, the Hepatitis A virus and Norovirus have been identified as the two most prevalent viral causes of foodborne illness. It was linked to shellfish and contaminated food handlers in Douala. Whereas Norovirus outbreaks occur in food service settings such as street eating-slots, where infected food workers are typically the cause of outbreaks, frequently by handling ready-to-eat items, such as fresh fruits and vegetables, with their bare hands prior to serving. In Douala, protozoa such as *Giardia intestinalis, Cryptosporidium parvum, Cyclospora cayetanensis*, and *Entamoeba histolytica* were the most prevalent foodborne parasites. Despite the fact that many of these organisms can also be transmitted through soil or person-to-person contact, our research revealed that they are occasionally transmitted through foods such as raw fish and crabs, raw chicken and pork meat, and raw vegetables and fresh fruits contaminated with human or animal faeces. However, certain goods, such as mixed meals and meat-based foods, may have been affected by food service employees with poor hygiene or who work in unsanitary environments. In terms of beverages, there are a variety of beverages used at home or sold on the street or in roadside businesses, including tea, carbonated soft drinks, fruit juices, coffee, and unpasteurized milk. But the most popular beverages are kossam and Folere. During the warm season (November–May), a significant section of the population of all ages and socio-economic backgrounds consumes these two beverages. According to our study, they contain a substantial quantity of micro-organisms. The presence of micro-organisms was indicated by an average total viable count (microbial load) of 3.21 * 105 cfu/ml for aerobic mesophilic count and 3.48 * 103

for total coliform count. As the sample isolates were known to be toxic to humans, the presence of total coliforms in all drinks revealed a negative association between food quality and safety. According to research by Parveen et al. (2008) and Rashed et al. (2013), there are a number of risk factors that can contribute to the presence of these pathogenic micro-organisms, including inappropriate handling and processing, the use of tainted water during cleaning and dilution, cross-contamination from rotten fruits, or the use of filthy processing tools like knives, flies, and trays. This can include cleaning and filtering water as possible sources of contamination for drinks and snacks sold by street vendors (Nwachukwu et al. 2008). With regard to total coliforms, faecal coliforms, and faecal streptococci contamination, ice and water added during preparation are potentially major sources (Tasmin et al. 2010). The fact that these drinks (fruit juices, kossam, and foléré) are kept at room temperature may have also helped infecting bacteria thrive, leading to an increased bacterial count.

3.5 Conclusion

Food consumption as an individual or social phenomenon is extremely complex, as it is related to a multitude of interacting internal and external factors, including food availability, culture and education, lifestyle, and socio-economic status. So far, works on food consumption in urban SSA are dominated by the study of consumption accessibility. Analysis of food consumption by city dwellers and socio-economic groups within the population, addressing food eaten inside and outside the home, and adopting a mixed approach that incorporates socio-demographic and health parameters, offers excellent promise for explaining evolving food consumption patterns in SSA. It appears that urban food consumption patterns change rapidly, particularly with regard to consumption outside the home, which is an important feature of urban life. Urban food patterns are extremely evolutionary because the city is a privileged place for innovation. We can then agree with O'Déyé and Bricas (1985) that "urban food is like a stewed dish in which various distinct spices are combined. Some of them can be recognized, but at the very end of the cooking, new flavours are also recognized, a particular taste that specifically marks the dish". We haven't examined changes in dietary patterns over time. Yet, our results imply that Douala metropolis is undergoing the nutrition transition and the city dwellers tend to fill in fibre-rich traditional foods with high-fat diets. Already exposed to numerous infectious diseases, city dwellers in Douala are actually expected to be laid out to the so-called civilization diseases that are associated with increased consumption of foods and highly-refined manufactured foods. Therefore, there is an urgent need to enhance our understanding of urban food consumption to be ready for subsequent demand, adapt local food production to the urban market, and ensure that choices are not detrimental either to public health or the national economy.

References

Africa Economic Outlook (2016) Sustainable cities and structural transformation. OECD Library, p 389

Anderson C, Bellamy S, Figures M, Zeigler-Johnson C et al (2010) Dietary intake of Senegalese adults. Nutr J. https://doi.org/10.1186/1475-2891-9-7

Andreyeva T, Long MW, Brownell KD (2010) The impact of food prices on consumption: a systematic review of research on the price elasticity of demand for food. Am J Public Health 100(2):216–222

AUC (African Union Commission) (2015) Agenda 2063: the Africa we want. Addis Ababa, p 20

Auma CI, Pradeilles R, Blake MK, Musoke D, Holdsworth M (2020) Factors influencing dietary practices in a transitioning food environment: a cross-sectional exploration of four dietary typologies among rural and urban Ugandan women using Photovoice. Nutr J 19(1):127–137

Azizi H, Asadollahi K, Davtalab Esmaeili E, Mirzapoor M (2015) Iranian dietary patterns and risk of colorectal cancer. Health Promot Perspect 5(1):72–80

Becquey E, Savy M, Danel P, Dabiré HB, Tapsoba S, Martin-Prével Y (2010) Dietary patterns of adults living in Ouagadougou and their association with overweight. Nutr J 9:13–23

Bojorquez I, Unikel C, Cortez I, Cerecero D (2015) The social distribution of dietary patterns. Traditional, modern and healthy eating among women in a Latin American city. Appetite 92:43–50

Bonnet F, Venkatesh S (2016) Poverty and informal economies. In: David Brady, Burton LM (eds) Oxford handbook of the social science of poverty. Oxford University Press, pp 637–659

Chen Y, Factor-Litvak P, Howe GR, Parvez F, Ahsan H (2006) Nutritional influence on risk of high blood pressure in Bangladesh: a population-based cross-sectional study. Am J Clin Nutr 84(5):1224–1232

Cockx L, Colen L, De Weerdt J (2017) From corn to popcorn? Urbanization and food consumption in sub-Sahara Africa: evidence from rural-urban migrants in Tanzania. In: LICOS Discussion Paper, No. 390, Katholieke Universiteit Leuven, LICOS Centre for Institutions and Economic Performance, Leuven

Costaras H (2020) Urbanisation in Africa: creating greater access to customers. https://ww2.frost.com/frost-perspectives/urbanization-in-africa-where-do-the-opportunities-lie/. Accessed 10 June 2021

Diaz-Lopez A, Cantu-Ramirez RC, Garza-Gonzales E, Ruiz-Tolentino L, Tellez- Luis SJ, Rivera G et al (2011) Prevalence of foodborne pathogens in grilled chicken from street vendors and retail outlets in Reynosa, Tamaulipas, Mexico. J Food Prot 74:1320–1323

FAO/WHO (1997) Assuring food safety and quality: guidelines for strengthening national food control systems. Geneva 73

FAO (Food and Agricultural Organization) (2011) Food consumption food Grou. http://www.fao.org/fileadmin/templates/ess/documents/food_security_statisctics/Food\ConsumptionFoodGroups_en.xls. Accessed 13 May 2021

Fox S, Beall J (2012) Mitigating conflict and violence in African cities. Environ Plann Gov Policy 30(6):968–981

Girones R, Alonso-Molina J, Rodriguez-Manzano J et al (2010) Molecular detection of pathogens in water–the pros and cons of molecular techniques. Water Res 44: 4325–4339

Gitahi MG, Wangoh J, Njage PMK (2012) Microbial safety of street foods in industrial area, Nairobi. Res J Microbiol 7:297–298

Green MA, Pradeilles R, Laar A, Osei-Kwasi H, Bricas N, Coleman N et al (2020) Investigating foods and beverages sold and advertised in deprived urban neighbourhoods in Ghana and Kenya: a cross-sectional study. BMJ Open. https://doi.org/10.1136/bmjopen-2019-035680

Holdsworth M, Landais E (2019) Urban food environments in Africa: implications for policy and research. Proc Nutr Soc 78(4):513–525

Holdsworth M, Pradeilles R, Tandoh A, Green M, Wanjohi M, Zotor F et al (2020) Unhealthy eating practices of city-dwelling Africans in deprived neighbourhoods: evidence for policy action from Ghana and Kenya. Glob Food Sec. https://doi.org/10.1016/j.gfs.2020.100452

Holt JG (1993) Bergey's Manual of Determinative Bacteriology. Lippincott Williams and Wilkins, p 816
Lwasa S (2014) Managing African urbanization in the context of environmental change. Interdisciplina 2:263–280
Mafune TS, Takalani TK, Anyasi TA, Ramashia SE (2016) Microbial safety of street vended foods sold in Thohoyandou, South Africa. J Hum Ecol 53: 205–212
NguendoYongsi HB (2014) An assessment of hygiene practices and health status of street-food vendors in Yaoundé, Cameroon. Int J Trop Dis Health 4(11):1153–1170
Nonga HE, Ngowi HA, Mdegela RH, Mutakyawa E, Nyahinga GB, William R, Mwadini MM (2015) Survey of physicochemical characteristics and microbial contamination in selected food locally vended in Morogoro Municipality, Tanzania. BMC Res Notes 8:727
Nwachukwu E, Ezeama CF, Ezeanya BN (2008) Microbiology of polyethylene-packaged sliced watermelon (Citrulluslanatus) sold by street vendors in Nigeria. Afr J Microbiol Res 2:192–195
O'Déyé M, Bricas N (1985) Nourrir les villes en Afrique subsaharienne. Editions l'Harmattan Paris
Olinto MTA, Gigante DP, Horta B, Silveira V, Oliveira I, Willett W (2012) Major dietary patterns and cardiovascular risk factors among young Brazilian adults. Eur J Nutr 51(3):281–291
Osei-Kwasi HA, Mohindra A, Booth A, Laar A, Mi W, Graham F et al (2020) Factors influencing dietary behaviours in urban food environments in Africa: a systematic mapping review. Public Health Nutr 23(14):2584–2601
Osei-Kwasi HA, Laar A, Zotor F, Pradeilles R, Aryeetey R, Green M, Griffiths P et al (2021) The African urban food environment framework for creating healthy nutrition policy and interventions in urban Africa. PLoS One 16(4). https://doi.org/10.1371/journal.pone.0249621
Parveen S, Ahmed MSU, Nasreen T (2008) Microbial contamination of water in around Dhaka city. BJSIR 43(2):273–276
Pieterse E, Parnell S (2014) Africa's urban revolution. Zed Books, London, p 309
Popkin BM, Adair LS, Ng SW (2012) Global nutrition transition and the pandemic of obesity in developing countries. Nutr Rev 70(1):3–21
Rashed N, Azizul H, Saurab KM, Mrityunjoy AM, Majibur R (2013) Microbiological study of vendor and packed fruit juices locally available in Dhaka city, Bangladesh. Int Food Res J 20(2):1011–1015
Schönfeldt H, Gibson HN (2012) Dietary protein quality and malnutrition in Africa. Br J Nutr 108(2):69–76
Seow J, Agoston R, Phua L, Yuk H-G (2012) Microbiological quality of fresh vegetables and fruits sold in Singapore. Food Control 25:39–44
Smith AM, Baghurst KI (1992) Public health implications of dietary differences between social status and occupational category groups. J Epidemiol Community Health 46(4):409–416
Tavakoli HR, Riazipour M (2008) Microbial quality of cooked meat foods in Tehran University's Restaurants. Pak J Med Sci 24(4):595–599
Tambekar DH, Jaiswal VJ, Dhanorkar DV, Gulhane PB, Dudhane MN (2008) Identification of microbiological hazards and safety of ready-to-eat food vended streets of Amravati City, India. J Appl Biosci 7:195–201
Tasnim F, Hossain MA, Nusrath S, Hossain MK, Lopa D, Haque KMF (2010) Quality assessment of industrially processed fruit juices available in Dhaka city, Bangladesh. Malaysia J Nutri 16(3):431–438
Turner C, Kalamatianou S, Drewnowski A, Kulkarni B, Kinra S, Kadiyala S (2020) Food environment research in low- and middle-income countries: a systematic scoping review. Adv Nutr. https://doi.org/10.1093/advances/nmz031
UN (2016) Transforming our world: the 2030 Agenda for sustainable development. United Nations, New York, p 38
UNCTAD (2018) Economic development in Africa report. Available at https://unctad.org/en/PublicationChapters/edar2018_ch1_en.pdf. Accessed 29 Mar 2021
UN-Habitat (2014) UN-habitat 2014 State of African Cities 2014: re-imagining sustainable urban transitions. Nairobi 273

UN Habitat (2015) African forum for urban safety launched'. Available at https://unhabitat.org/africa-forum-for-urban-safety-launched/. Accessed 29 Jan 2021
Wei Q, Hwang S, Chen T (2006) Microbiological quality of ready-to-eat food products in Southern Taiwan. J Food Drug Anal 14: 68–73
WHO (2017) Ambition and action in nutrition 2016–2025. WHO Publications, Geneva, p 64
World Health Organisation (1991) Basic laboratory methods in medical arasitology. Geneva

Chapter 4
Geostatistical Study on Waterborne Disease Outbreak in India [2011–2020]

R. Pavithra, S. Bhuvaneshwari, K. Prakash, R. Jegankumar, and G. Mathan

Abstract The sudden increase of infectious disease occurrences in a specified location and time is called a disease outbreak. The impact could affect, in the least case, the daily life of the population in the collapse of the country's economic and demographic structure. Geospatial technologies have been an important tool in analyzing and making informed decisions to manage public health since the seventeenth century. In recent years, the GIS system's functional capabilities have been tremendously developed that help the decision-makers in identifying the geographical factors, temporal spread, and velocity of the disease, model the data using mathematical algorithms for predictive analysis, and visualize them in real time through the use of connected devices. Waterborne diseases are transmitted by consuming contaminated water (WHO). In the year 2012, WHO estimated that low- and middle-income countries have recorded 842,000 deaths per year, including 361,000 in children under the age of five. In India, The Ministry of Health and Family Welfare has launched the Integrated Disease Surveillance Program (IDSP) to report all the disease outbreaks across the country since 2011. The study used IDSP disease outbreak weekly reports from 2011 to 2020 and the Census of India—2011 data for the analysis. The IDSP report covers most of the waterborne disease outbreaks across the country at a village and district level with how they are managed and reported with their local causes. The voluminous data (2011–2020) is compiled and attributed in the GIS database. The spatial statistics of the data reveal the hot and cold spots spatially across the country, which are associated with the rainfall pattern of India and other local phenomena. Getis–Ord Gi* statistic is used seasonal and annual data of the outbreaks; the *Z*-and *P*-values highlight the high and low clusters, which represents the context of neighboring attributes the study visualizes the outbreak hot spots along the east coast soon after the monsoon month gets over similar pattern is also found in the west coast of India. The spatial pattern and temporal sequencing of waterborne diseases

R. Pavithra · S. Bhuvaneshwari · K. Prakash · R. Jegankumar (✉)
Department of Geography, Bharathidasan University, Tiruchirappalli 620 024, India
e-mail: jegankumar@bdu.ac.in

G. Mathan
Department of Biomedical Science, Bharathidasan University, Tiruchirappalli 620 024, India

A. Grover et al. (eds.), *Sustainable Health Through Food, Nutrition, and Lifestyle*,
Advances in Geographical and Environmental Sciences,
https://doi.org/10.1007/978-981-19-7230-0_4

with the use of geospatial technologies and geostatistical applications would help the governments to control and alleviate the severity and occurrence of the diseases.

Keywords Geostatistics · Getis–Ord Gi · Waterborne diseases · Outbreak · Clusters

4.1 Introduction

Disease outbreak is a sudden increase in the occurrence of a disease in a particular place and time. It may affect a small and localized group or impact thousands of people across an entire continent. It may last for a few days or weeks, or even several years. The number of cases varies according to the disease-causing agent and the size and type of previous and existing exposure to the agent. The geographical distribution and variation in the spread of vector-borne diseases in different seasons and time intervals are very important to monitoring the trends of a prevailing disease.

Diarrhea and food poison are gastrointestinal infections caused by consuming contaminated water and food. United Nations Children's Emergency Fund (UNICEF) reports diarrheal diseases account for nearly 1.3 million deaths per year among children under five years of age. Diarrhea is the second most common cause of child deaths worldwide. More than half of the deaths were recorded in just five countries, viz. India, Nigeria, Afghanistan, Pakistan, and Ethiopia.

Mapping the disease outbreak spatial analysis of disease transmission is increasingly important nowadays at the global level as well as at the country level. This type of mapping and analysis can help to focus on the prevalence of the spread of disease and endemic situations. It also helps estimate the potential use and availability of health resource allocation. The disease outbreak mapping can be used to prioritize when and where planning control campaigns can be held based on the disease outbreak maps. The mapping of disease outbreaks can be helpful in predicting the change in flow direction and intensity of the spreading disease. The outbreak mapping of waterborne diseases using IDSP data is intended for use in outbreak management to inform disease control measures, inform trade policy, and prioritize further surveillance, and control measures.

Waterborne diseases are caused by microorganisms and transmitted through contaminated food and water (WHO 2015). Contaminated food and water can cause diseases such as diarrhea, cholera, polio, and other life-threatening illnesses. According to WHO (2017), 785 million people lack basic drinking water services; also, around 2 billion people use contaminated water sources with feces. Waterborne diseases are largely prevalent in underdeveloped countries and developing countries. It is also estimated that 50% of the world's total population will be living the water-stressed areas. Sanitation and hygiene and waste management are the crucial factors for the cause and transmission of waterborne diseases. United Nations World Water Development Report 2021 states that 29% of the world's total population have no

access to safely managed drinking water service. It is also reported that only 45% of the population has access to safely managed sanitation services.

In India, acute diarrheal disease, food poisoning, cholera, gastroenteritis are important diseases with a large number of people affected. Apart from this, dysentery, jaundice, leptospirosis, salmonellosis, shigellosis, and typhoid are also recorded. The Ministry for Health and Family Welfare (2018) stated that diarrhea had been the leading life-threatening waterborne disease that accounts for 60% of the deaths in India. These diseases are addressed by the Integrated Disease Surveillance Project (IDSP), Directorate of Health Services, Ministry of Health and Family Welfare, and Government of India. IDSP is a centrally functioning disease surveillance scheme under the Ministry of Health and Family Welfare in India, assisted by the World Bank to report and respond to diseases outbreak. A large amount of data on disease reports are collected in order to be able to identify the outbreak of a disease, identify its causes, and take corresponding responsive and preventive measures. An early warning system has been set into place in order to take timely actions.

Calculating and mapping the population affected by waterborne diseases based on various factors have a significant role in making necessary plans and actions to respond and prevent the disease outbreak. This also facilitates a detailed outlook of the spread of these diseases over different regions all over India. This disease outbreak mapping helps educate people and government officials and make them be prepared or respond to and recover from waterborne diseases. To this, the geographic information system (GIS) plays a major role in collecting, manipulating, and mapping the spread of these diseases.

Disease outbreak studies imply finding the cause and effect of the disease (Chowell et al. 2019). The use of GIS in epidemiology has been a great tool to analyze various disease factors in relation to geographical conditions, which are highly influential in the transmission of diseases (Toprak and Erdogan 2008; Lawal and Anyiam 2019). GIS and remote sensing technologies play a vital role in mapping, monitoring, and predicting health-related issues at global and at street level perspectives in order to prevent and/or mitigate (Rogers and Randolph 2003; Hay et al. 2013). In the field of public health, medical GIS has become a significant analytical technology not only to understand the differences but also to understand the similarities around the world. It helps to understand the various diseases in relation to the environment and the population affected by them (Musa et al. 2013; Fotheringham and Rogerson 2007; Wang 2019).

GIS with mathematical models like clustering, regression, and correlation techniques has helped the healthcare agents to take precautionary measures based on priorities derived from multiple factors. The application of GIS is useful in identifying the association of a disease with other diseases as well. Statistical methods were used to create clusters of outbreaks and map the hot spots when the exact location of the disease occurrence was not possible to locate (McKee et al. 2000; Wakefield 2007). Apart from the common factors, such as open defecation, washing clothes, and utensils from public water taps, common sewage system for wastewater and rainwater, poor maintenance of the water supply system, and the outbreak of

diseases in India are so frequent accounting for its festivals celebrated throughout the country (Sarkar et al. 2007).

A state-transition model which simulates disease outbreaks in daily time steps using specified disease-specific parameters was developed to model the spread of infectious diseases. Early detection of outbreaks of diseases is a critical process in controlling them; in many cases, epidemiological spatial data are collected but not well analyzed for surveillance. Based on the historical spatial data, the outbreaks can be manipulated for early detection and managing them in many countries (Watkins et al. 2007). Assessment of spatial variations and temporal trends of the diseases are very important to locate the places of the disease outbreak and hot spots as well the contagiousness character of the disease since this determines the mobility rate (Huang et al. 2012; Jarup 2004; Kistemann et al. 2001). The outbreak of the disease has a close association with the socio-economic conditions of the people, which is a critical factor in understanding the disease outbreak. As a vital factor, this can be used to model the clusters of hot spots (Gourishankar 2021). For every type of waterborne disease, a sophisticated criterion was to be adopted to analyze them (Palaniyandi 2012).

Epidemiological spatial data collection and integration with the GIS applications need to be carried out frequently for a specified interval in order to develop effective surveillance, protection, and prevention of the disease (Eisen and Eisen 2010; Thompson and Etter 2015). This, in some cases, may use third-party open resources available freely over the Internet (Gao et al. 2008). Spatial search processes incorporating statistical techniques have significantly improved the spatial cluster computations, yet these are more generic in nature. To develop a more specific spatial cluster, the methods must include all other constituting factors of the disease like geography, environment, climate, social and economic conditions, etc. (Mclafferty 2015; Semenza et al. 2011; Li et al. 2020; Sirisena et al. 2016; Zhao et al. 2016).

It is noteworthy to optimize the data collected with respect to the statistical methods adopted for the analysis since the method-specific data outliers could lead to an unexpected result. To help achieve preferable data, spatial autocorrelation techniques were developed at global and local levels (Shaweno et al. 2018; Gu et al. 2017). Disease Risk Mapping is a potential technique to spatially locate the areas vulnerable to diseases; there are numerous weighted overlay techniques adopted for vulnerable mapping, e.g., Analytic Hierarchy Process, Artificial Neural Networks, and other Multi-criteria Decision Making techniques (Bidhuri and Jain 2019; Thindwa et al. 2019; Tran et al. 2012).

Of the many efficacies of GIS technology, visualization is one of its major strengths. Representation of spatial data is a complex process that must be taken with utmost care in order to achieve the best understanding of the maps. In the use of graphs and charts, a large number of data can be displayed, and the meaning can be understood, while this becomes trickier with representing on the spatial maps (Mocnik et al. 2020; Smith et al. 2015; Rytkönen 2016). The spatial epidemiological investigation involves two kinds of issues, i.e., estimations and predictions; to statistically analyze these issues, the area under the investigation and the volume of the disease are the two important controlling factors to choose the appropriate statistical

methods. In recent times, the use of the Bayesian method is increasing to map the disease and run simulations with a more sophisticated passion (Catelan and Biggeri 2010; Kirby et al. 2016; Louie and Kolaczyk 2006; Song et al. 2020). In some cases, hierarchical models are also used to model the area-specific relative risks of disease. The model is built upon the disease-specific assumptions to support the hypothesis (Pascutto et al. 2000). In addition to the studies relating to the disease outbreak, it is also important to study and need institutional improvements across various government and private agencies like surveillance systems, collaboration with veterinary sectors, water and sewage networks, diagnostics services, etc. (Semenza et al. 2011).

4.2 Study Area

India is the 7th largest country in the world, covering an area of 3.28 million km^2 India extends between 8° 4′ and 37° 6′ N to 20° 35′ 37.3″ N latitude and 68° 7′ and 97° 25′ to 78° 57′ 46.4″ E longitudes. The climate of India is diversely spread across its geography. A large part of India experiences a tropical climate except for the northern parts stretching parallel to the Himalayas. The tropic of cancer divides India into two equal halves. The southern part lies in the tropical zone, where the temperature is quite high during the summer season. India gets most of the rainfall during the monsoon seasons, starting from July to December as the Southwest and Northeast monsoon seasons.

India is a union of 29 States and 7 Union Territories as of 2011 Census data. States and Union Territories are divided into Districts, Sub-Districts, Corporations, Municipalities, Town Panchayats, Village Panchayats, and Villages for administrative purposes. There are 640 Districts, and nearly 65 million Villages are administered. India is the second most populous country, with a density of 382 people per square kilometer. India is a country well known for its festivals and celebrations. There are at least ten nationwide festivals that are celebrated apart from the state level and family-related functions.

Public healthcare systems in India are not adequate to safeguard the people everywhere (Gupta 2005). India records 18% of the World's infant mortality (under age 5) (UNICEF 2020). Among various diseases, communicable diseases alone account for 53% of the deaths in India (Balarajan et al. 2011). The healthcare capacity of India is largely shared by the private hospitals, which consist of 58% of the hospitals and 81% of the doctors, while 42% of the public hospitals are left out with only 19% of the doctors (Thayyil and Jeeja 2013). Another important factor for poor healthcare service is access to the healthcare systems. Access to the hospitals is certainly dependent on the quality and the cost of the service available, which, according to the Millennium Development Goals (MDGs-2000) by the United Nations (UN), has failed to address. The gap in the provision, utilization, and attainment of healthcare systems in India has not been significantly reduced, as stated by the United Nations (Dutta and Lahiri 2015).

The Indian Meteorological Department (IMD) designates four climatological seasons in India in a year.

(i) **Winter**: cold weather (December–February)
(ii) **Summer**: hot weather (March–May)
(iii) **Monsoon**: rainy in Southern India (June–September)
(iv) **Post Monsoon**: rainy in Northern India (October–November).

Festivals and seasons play a significant role in disease outbreaks in India, especially waterborne diseases.

4.3 Methodology

The disease outbreak data were collected from Integrated Disease Surveillance Project (IDSP) Portal. The data are available online in portable document format (PDF) for each week, including all the disease outbreaks, from which only diarrhea and food poison (waterborne disease) outbreak data were extracted and used for the analysis. The study used the data from the year 2011 to 2020; however, in 2020, the worldwide pandemic due to the spread of coronavirus, IDSP reported minimal outbreaks owing to the nation level lockdown in order to control the spread of the virus. The extracted data is then categorized based on the disease type and analyzed seasonal-wise for each year.

4.3.1 Hot Spot Analysis

Hot spot analysis is a clustering technique. The logic behind the hot spot analysis is Getis–Ord Gi statistics (Getis and Ord 2010). It produces a statistically significant cluster map as high-value clusters (hot spots) and low-value clusters (cold spots) for the weights/values in a dataset. The tool searches for similar values in the neighboring features and represents hot spots or cold spots; hence, a cluster is a significantly associated set of features that affects the entire context of the study. Also, it is certain that administrative boundaries have no influence on disease outbreak/spread.

The Getis–Ord Gi statistics (Hot spot Analysis) is given as

$$\mathbf{Gi}* = \frac{\sum_{j=1}^{n} W_{i,j} X_{i,j} - X \sum_{j=1}^{n} W_{i,j}}{\sqrt{\frac{\left[n \sum_{j=1}^{n} W_{i,j}^2 - \left(\sum_{j=1}^{n} W_{i,j}\right)^2\right]}{n-1}}}$$

where

x_j the attribute is value for feature j;
$w_{i,j}$ is the spatial weight between feature i and j; and

n is equal to the total number of features.

$$X\frac{\sum_j^n x_j}{n} \quad S = \sqrt{\frac{\sum_j^n x_j^2}{n} - (X)^2}$$

Hot spots analysis requires a single attribute column to analyze; hence, the data are totaled based on seasons and months wise. The analysis creates clusters of significant areas of disease outbreaks, where the neighboring districts also have played a crucial role in the spread of the disease for the specified season and month. The results with proper reasoning give insight on the disease for the period of the study based on which necessary action plans can be drawn to avoid and mitigate the disease to save livelihood.

4.3.2 Morbidity Ratio (MR)

$$\text{MR} = \frac{\text{Total number of infected people}}{\text{Number infected people in a state}} * 1$$

Morbidity ratio (CDC 2012) is a measure of frequency; it represents the relative magnitude of two values. The result of this calculation is expressed as the number of infected people out of which one is infected from a particular state. The formula exhibits crucial information to understand the disease outbreak.

4.3.3 Morbidity Rate Per Outbreak (MRO)

$$\text{MRO} = \frac{\text{Number of infected people in a state}}{\text{Total number of times outbreak occured}}$$

The morbidity rate per outbreak is calculated as the number of times the outbreak occurred in a particular state against the total number of infected people in that state. The formula expresses the average number of people infected in the event of a disease outbreak in a state. The result implicitly infers multiple underlying factors in case of a high value; in such scenarios, it is advised to take rapid actions to control further infection of the disease.

4.4 Results and Discussion

According to the Census records in 2011, there were 640 districts in India, and few districts were added in the later years. Each district headquarters in India plays a very crucial role in the public service. District hospital facilitates the health and well-being of the people in the district. They are responsible for monitoring, surveying, mitigating, and controlling any health-related outbreaks and administering the other underlying health subcenters.

4.4.1 Hot Spot Analysis

IDSP has been started with the assistance from World Health Organization (WHO) in the year 2004 to report disease outbreaks in order to take necessary action to curb the morbidity and mortality rates. Since then, there are huge investments made in the health sector to improve the healthcare system. Keeping this in mind, the study reveals the actual conditions, trends, and various other patterns of diarrhea and food poison for the years 2011 to 2020. Any kind of disease outbreak could be related to physical and socio-behavioral conditions. Irrespective of the healthcare systems, this is due to the poor education about the disease (Table 4.1).

The Hot spot analysis shows the disease outbreak in India based on seasonal characteristics. The perspectives of the results are multi-dimensional; involve many physical and socio-behavioral factors influencing the disease outbreak in India. The analysis reveals the spatiotemporal characteristics of diarrhea and food poison (Figs. 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9 and 4.10). Lack of preventive and mitigative measures, the infection, and death rates have not been decreased in the past ten years (2011–2020). Diarrhea is highly associated with climatic conditions, whereas food

Table 4.1 Diarrheal and food poison morbidity and mortality

Year	Diarrhea		Food poison	
	Infection	Death	Infection	Death
2011	28,214	5052	14,518	254
2012	21,750	5102	14,068	248
2013	24,723	5833	21,772	997
2014	22,192	5778	20,084	983
2015	21,618	4743	22,294	978
2016	28,780	4984	21,362	998
2017	16,678	4326	15,029	655
2018	18,495	4741	14,118	599
2019	14,945	5308	15,753	921

Source Compiled from the IDSP data

poison occurs irrespective of climatic conditions. The distribution of the diarrheal disease is clearly separated by the climatic conditions into two parts, viz Eastern.

Indian districts and Western Indian districts. The climatic separation is unevenly found in all the ten years data. Apart from the climatic conditions, the physiographic conditions are also closely associated with diarrhea and food poison. During the winter and summer season, Diarrhea is frequent and widely distributed in the western parts of India in the districts of Gujrat, Maharashtra, Rajasthan, and Karnataka. In the rainy season (Southwest and Northeast Monsoon), many of the eastern districts of West Bengal, Chhattisgarh, Orissa, and Andhra Pradesh was affected with diarrheal infection. Similarly, food poisoning is frequent in western and southern parts of India in all the seasons, while West Bengal (Gangetic Delta) remains an exceptional region where it records a large number of outbreaks throughout the season.

The study period comprised a total of 40 seasons over 10 years (4 seasons per year), in which West Bengal recorded 15 diarrheal outbreaks and 21 food poison outbreaks; the state is being well notified for disease outbreaks. Next to West Bengal, Maharashtra recorded 12 and 6 diarrheal and food poison outbreaks, respectively.

Diarrheal and food poison are reported throughout the year; however, the reports of diarrheal infection are high during the weeks from 16 to 38, i.e., the first week of May to Mid-October every year, as shown in Fig. 4.11. The period is marked by a quick shift in the climatic conditions, which is one of the crucial influencing factors. During this period, many states receive a fair amount of rainfall due to convection, resulting in outbursts of diarrheal infection. Similarly, food poison records are high starting from the 3rd to 32nd week, i.e., January to August (Fig. 4.12). The infection during these weeks is highly correlated for the entire study period (2011–2020), which is an indicator that the infection is very recursive. Exceptionally, 2020 has

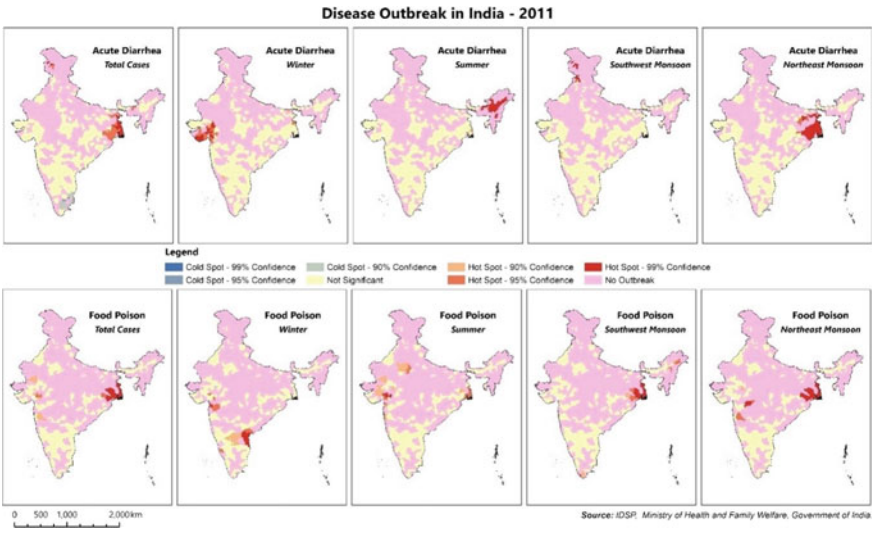


Fig. 4.1 Disease outbreak in India—2011

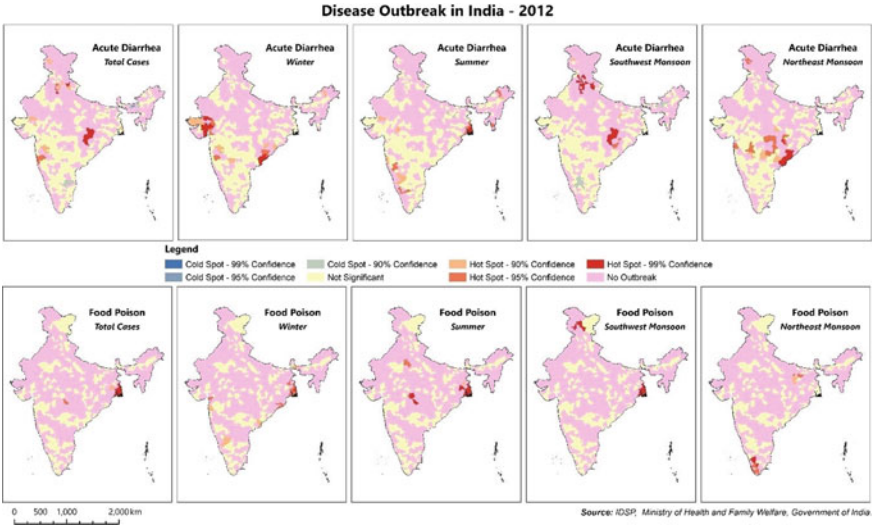


Fig. 4.2 Disease outbreak in India—2012

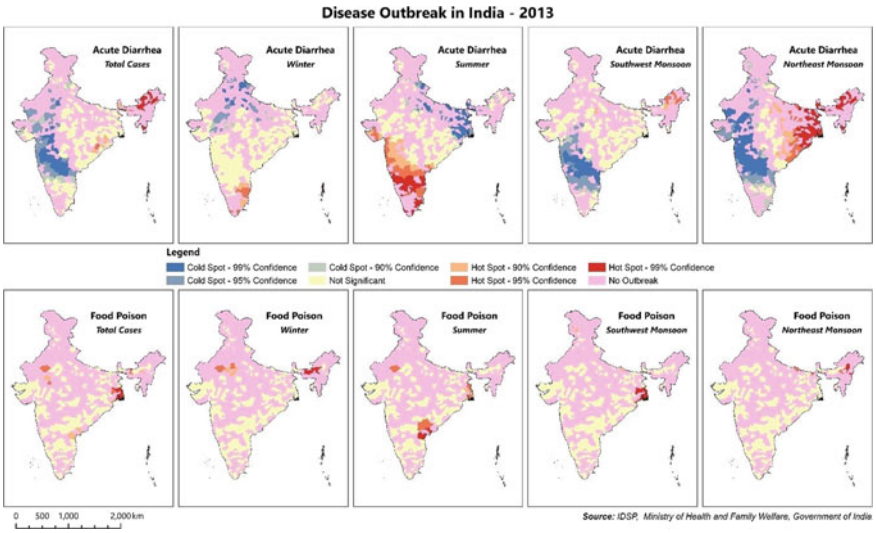


Fig. 4.3 Disease outbreak in India—2013

recorded the lowest infection numbers due to the country-wide lockdowns in order to control the COVID-19 spread (Fig. 4.13).

Diarrheal outbreaks are predominant and widespread in rainy seasons; many of the districts located close to the Gangetic plains have reported a large number of outbreaks during this season, which could be linked to the mixture of sewage water

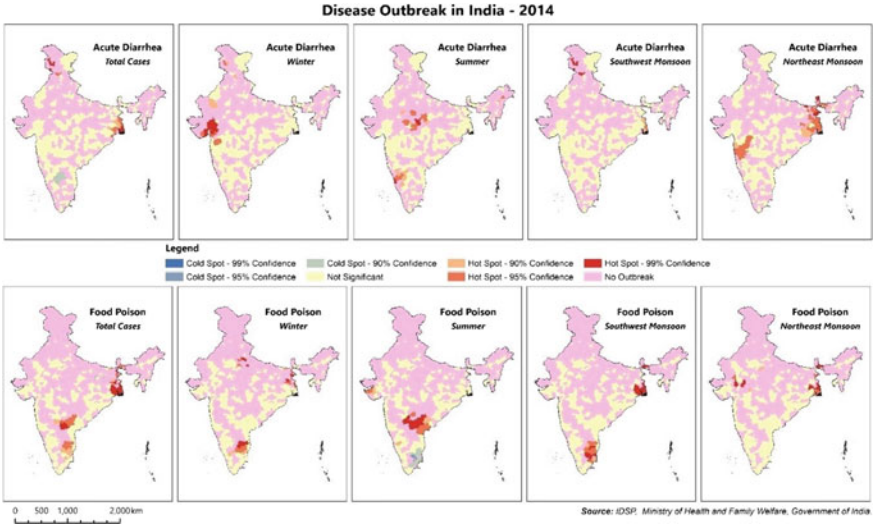


Fig. 4.4 Disease outbreak in India—2014

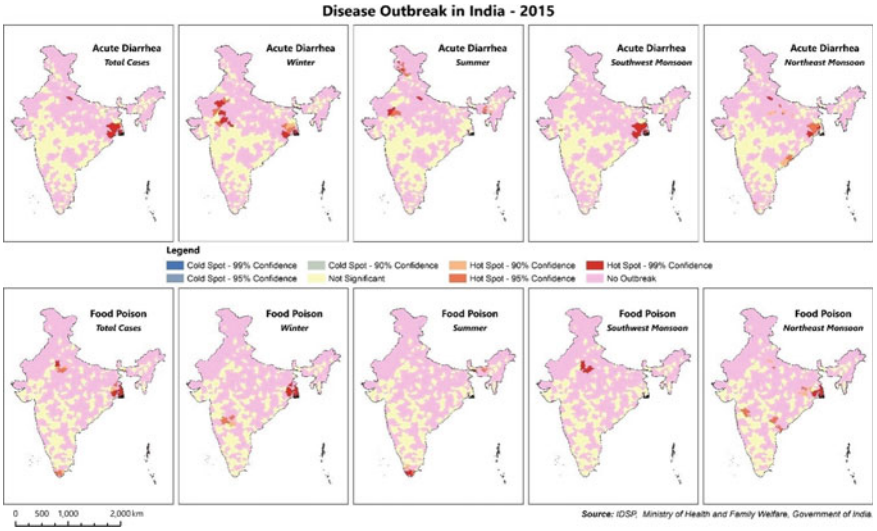


Fig. 4.5 Disease outbreak in India—2015

with the drinking water supply systems. Food poison outbreaks are high during the winter and summer seasons and are reported in a distributed manner; hence, the clusters are also found to be dispersed. Table 4.1 clearly indicates the infection and death in India due to diarrhea and food poison. The infection rate of diarrhea has been decreased almost to half from the year 2011 to 2020; however, the proportion of

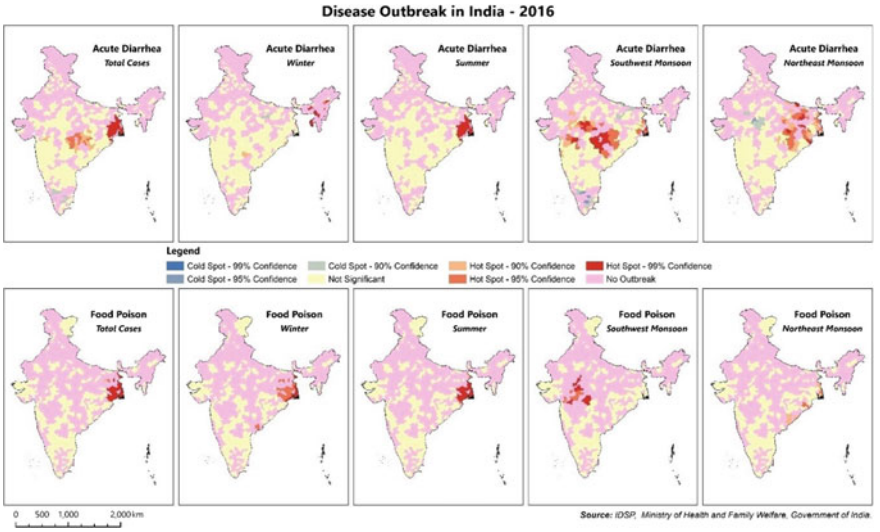


Fig. 4.6 Disease outbreak in India—2016

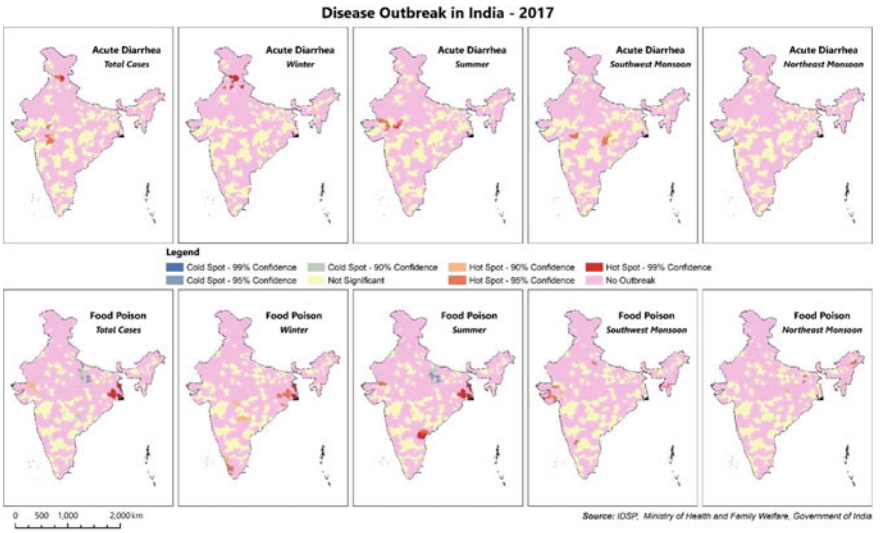


Fig. 4.7 Disease outbreak in India—2017

death to infection has significantly increased during the period, which is an alarming indicator to the healthcare systems to improve the intensive care units across the country. For the same period, the food poison infection rate has not been changed much, while the death rate has been quadrupled during the period, as shown in

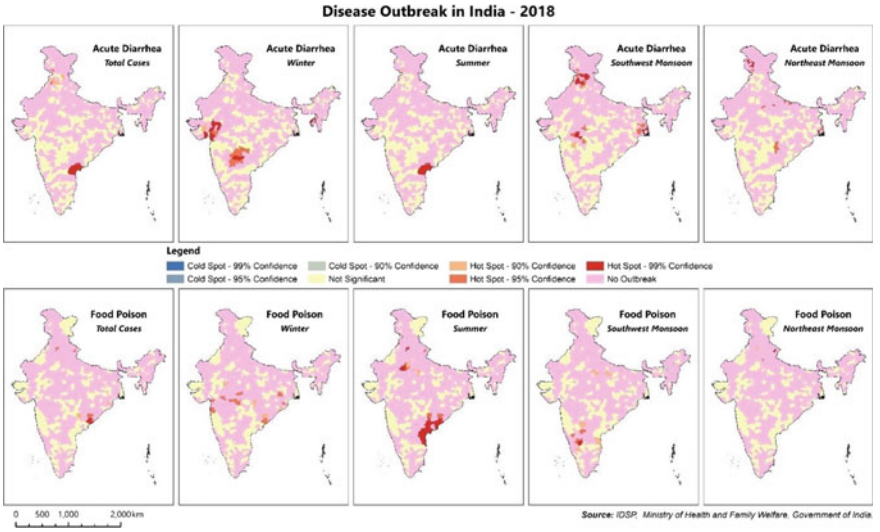


Fig. 4.8 Disease outbreak in India—2018

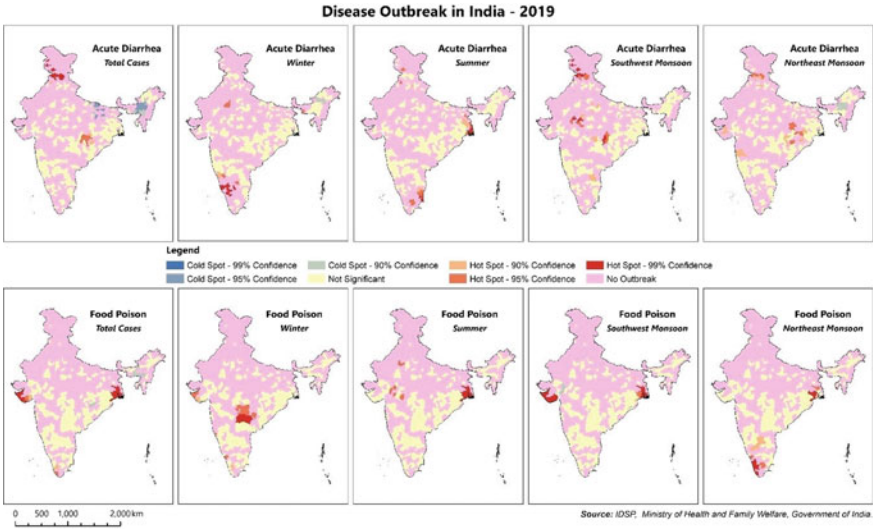


Fig. 4.9 Disease outbreak in India—2019

Fig. 4.11. The local/district healthcare system has managed and mitigated every instance.

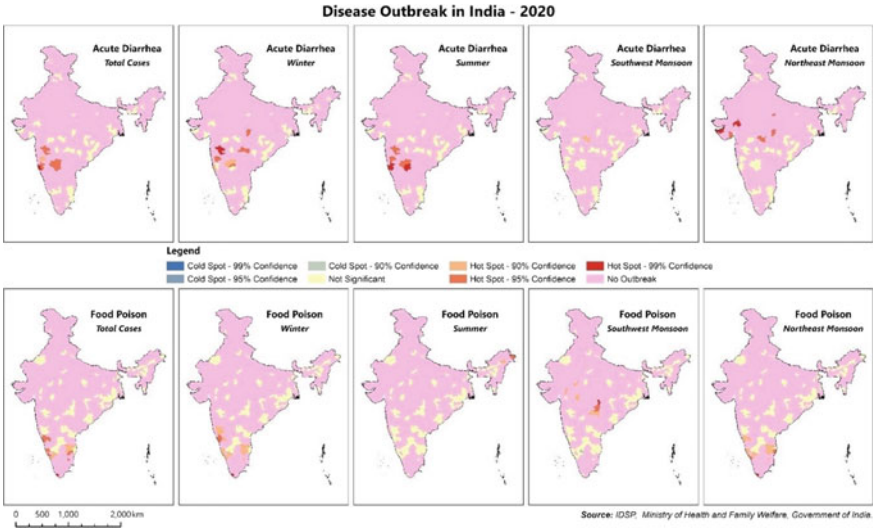


Fig. 4.10 Disease outbreak in India—2020

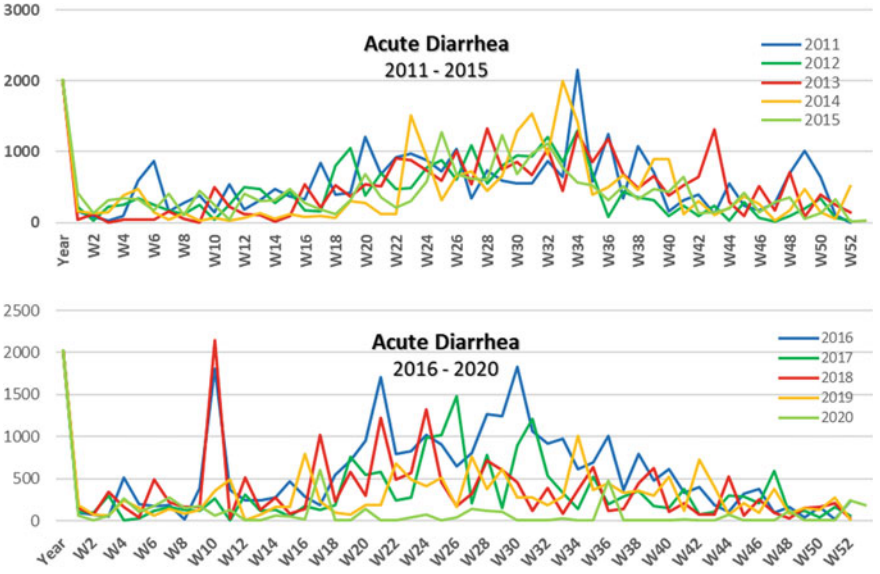


Fig. 4.11 Weekly diarrheal infection during 2011–2020. *Source* IDSP (2020)

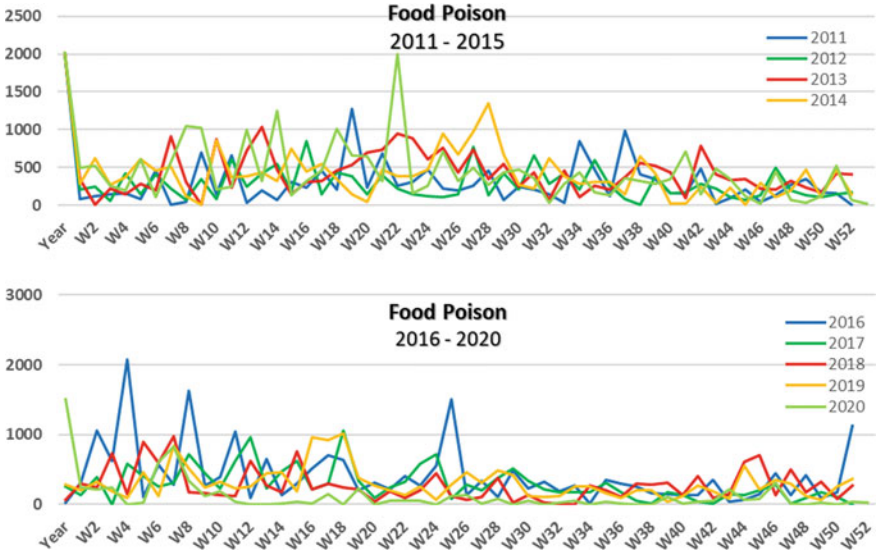


Fig. 4.12 Weekly food poison infection during 2011–2020. *Source* IDSP (2020)

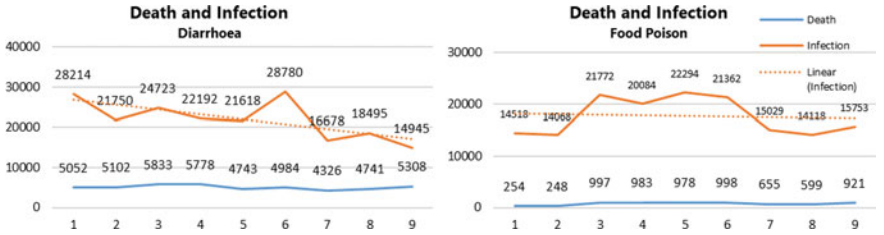


Fig. 4.13 Total infection and death due to diarrhea and food poison during 2011–2019. *Source* IDSP (2020)

4.4.2 Morbidity Ratio (MR)

The morbidity ratio is a statistical method to find the minimum number of people for a particular state of which one is infected for the corresponding state. For example, during the period 2011 morbidity ratio of West Bengal was 5.5, which can be explained as out of 5.5 infected persons, one is from the state of West Bengal. Similarly, all the states were computed for diarrhea and food poison. The computed data is used to generate heatmaps to represent them graphically, as in Fig. 4.11. Both diarrhea and food poison have no significant clusters, and they are independent in general.

The least morbidity ratio value indicates a large number of infected people with respect to the total infected people and vice versa. MR values for every year are summed and derived as a cumulative value to get a general understanding

of the disease. Tables 4.2 and 4.3 display the cumulative MR value of diarrhea and food poison for the period 2011–2020. The low MR states have recorded the highest number of infection cases during the period; similarly, high MR states have contributed the least number of infection cases.

4.4.3 Morbidity Rate Per Outbreak (MRO)

MRO is a statistical expression to infer the average count of infected people in an event of a disease outbreak. Though the result can be misleading in some cases due to the data outliers, the information is very vital since in a single year there were multiple outbreaks have been recorded in a district. The states (Tables 4.3 and 4.4) have low and high morbidity rates per outbreak. Low MRO states have recorded a smaller number of infected people with comparatively less frequency of outbreak. High MRO states have recorded a larger number of infected people with less frequency of outbreaks (Table 4.5).

4.5 Discussion

IDSP data is a huge repository of disease surveillance data since the data are collected every week for all the districts, where any disease outbreaks have been reported. Considering the data for a period of ten years, many statistical and geospatial analyses can be done. Clustering techniques are valuable in locating the hot spots and drawing plans and policies to effectively mitigate and control the further spread of disease outbreaks.

The application of geospatial techniques into epidemiological studies uplifts the understanding of the disease and its spatiotemporal dimensions of occurrence and spread. Outbreak investigations are a rapid response to the disease outbreak. GIS is in extreme use when investigating diseases that are contagious in nature and transformative of pathogens in certain directions and velocities; these characteristics of the disease can be best studied through GIS techniques. The recent advancements in the analytical capabilities like integration of artificial intelligence, mathematical models, simulation algorithms, etc., into GIS software and the visualization of these data as geographical maps, help the policymakers to draw plans and actions to manage them effectively.

The associations between diarrhea and food poison to the climatic conditions are immense and utmost care must be taken to avoid and mitigate morbidity and mortality during the season. The rainy season affects the Gangetic plains severely, causing a steep surge in the infection rate. Along with the climatic conditions, local flood inundation, waterlogging around the settlements, and overflow of drainage systems worsen the condition.

Table 4.2 Cumulative morbidity ratio for acute diarrhea of select Indian states (2011–2020)

	Low morbidity ratio states					High morbidity ratio states				
State	Maharashtra	West Bengal	Chhattisgarh	Chandigarh	Gujarat	Uttarakhand	Haryana	Punjab	Sikkim	Manipur
Total	102.7	108.7	158.1	161.3	175.8	2114.4	2368.5	3557.2	5060.9	8999.5

Source IDSP (2020); Compiled by the author

Table 4.3 Cumulative morbidity ratio for food poison of select Indian states (2011–2020)

	Low morbidity ratio states					High morbidity ratio states				
State	Haryana	West Bengal	Andhra Pradesh	Karnataka	Kerala	Punjab	Sikkim	Tripura	Puducherry	Arunachal Pradesh
Total	37.2	68.8	132.1	137.6	141.1	3301.4	3529.7	3603.7	4444.1	5577.5

Source IDSP (2020); Compiled by the author

Table 4.4 Average MRO for acute diarrhea of select Indian states (2011–2020)

	Low MRO states					High MRO states				
State	Odisha	Tamil Nadu	Assam	Jharkhand	Karnataka	Haryana	Arunachal Pradesh	West Bengal	Himachal Pradesh	Jammu and Kashmir
Average	25.0	31.9	32.1	33.3	33.9	69.3	77.9	81.7	101.5	131.7

Source IDSP (2020); Compiled by the author

Table 4.5 Average MRO for food poison of select Indian states (2011–2020)

	Low MRO states					High MRO states				
State	Tripura	Odisha	Tamil Nadu	Karnataka	Jharkhand	Madhya Pradesh	Rajasthan	Jammu and Kashmir	Kerala	West Bengal
Average	34.9	39.8	40.5	42.8	44.5	66.0	70.9	85.5	86.1	56.8

Source IDSP (2020); Compiled by the author

Table 4.6 Total health expenditure of India as a percent of GDP

	2016–17	2015–16	2014–15	2013–14
Total health expenditure as a percent of GDP	3.8	3.8	3.9	4

Source National Health Accounts—2016

The statistical analysis serves a crucial solution to making geospatial decisions in many ways. Integration of statistical techniques in geospatial applications enables the users to make solid methodologies and better reasoning for a problem. Likewise, hot spot analysis is a recently popularized technique to create spatial clusters. Similarly, morbidity ratio (MR) and morbidity rate per outbreak (MRO) are classical epidemiological methods to understand the ratio of infected people of a particular region with respect to the whole region and the infection rate of a region with respect to each occurrence of the disease in a year; these two methods are very significant to reveal some of the underlying facts related to the disease. These techniques made GIS grow beyond as a tool to visualize the data.

India is no wonder the densest country relative to its areal coverage. India is a developing nation and has to feed the population with its under reserved natural resources. Total health expenditure (THE) is the share of gross domestic production (GDP) for the development of the healthcare sector, which is an important indicator of the healthcare systems developed in a country. Though the demand for healthcare systems across the country is high, the allocation of funds for the developments in the sector has remained relatively challengeable. The total expenditure incurred in the health care sector for India (Table 4.6) during the years 2013–2016 as stated by the National Health Accounts (NHA—2016) and the total health expenditure in some of the countries (Fig. 4.14) of the world. When compared with many developed countries, where the population is very low, India is spending one-third of their percent of expenditure to the GDP, where the population is so huge.

Keeping a healthy population is a continuous process for a country. It needs meticulous planning and serious efforts to prevent and control the disease. One such important area is the drinking water supply system, which is very vulnerable and fragile during monsoon seasons, so the microorganisms can thrive and infect people. For this, the pipelines must be managed properly also the water must be treated with adequate cleansers like chlorine.

Despite the financial issues, India is also lacking in socio-economic factors like housing, safe and potable drinking water, equal and quality education, employment opportunities, transport, etc. As a combined effect of these factors, people are suffering for their health and well-being. In particular, knowledge about the disease alone can prevent a large number of infections and control the spread of the disease further; however, there is a huge gap between the preventive action plans and the behavioral response to it. For example, dumping household wastes at a public place can incubate several microorganisms that may harm the environment and the people living there.

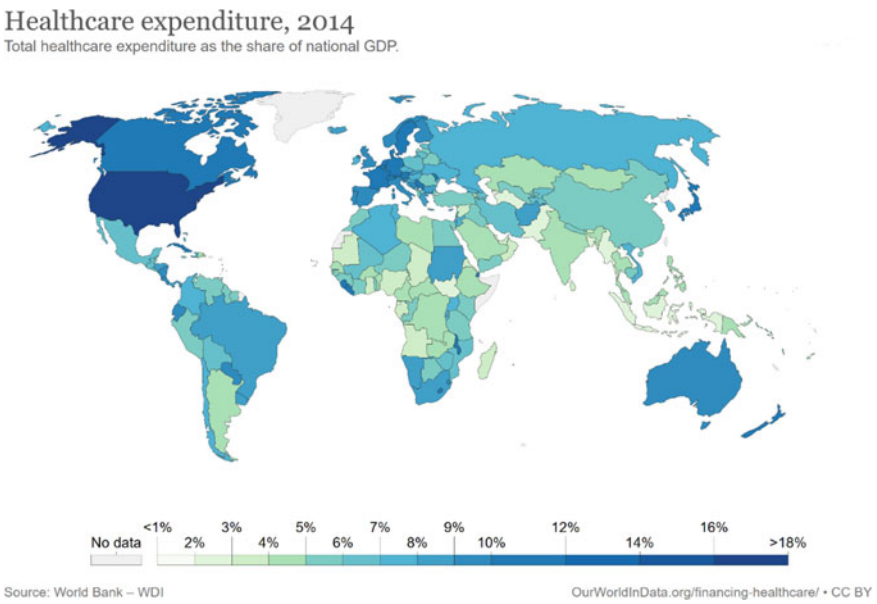


Fig. 4.14 Healthcare expenditure of countries—2014. *Image Courtesy* Our World in data

The results show a close association between climate and disease outbreaks. Precautionary management practices prior to these climatic events could alleviate the rate of infection and mortality. Also, a need for a holistic digital reporting platform, like the Aarogya Setu app, to report any disease outbreak could help to spotlight the focus area to the frontline workers and planners to act quickly in order to stop further spreading and provide appropriate health care to the affected people. Strengthening Primary Health Centers and SubCenters (SC) with the provision of advanced reporting applications and kiosk-like devices is one of the most feasible methods to report and provide health care to the inner parts of India.

Acknowledgements The study has been carried out with support from the Indian Council for Social Science Research (ICSSR) (Award No: RFD/2019-20/GEN/GEOG/287). Our sincere thanks to the Integrated Disease Surveillance Program (IDSP) for the data provided to carry out the research. We also thank the Department of Geography, Bharathidasan University to use GIS facility under DST Purse and UGC SAP.

References

Balarajan Y, Selvaraj S, Subramanian SV (2011) Health care and equity in India. Lancet 377:505–515. https://doi.org/10.1016/S0140-6736(10)61894-6

Bidhuri S, Jain P (2019) Identifying waterborne disease-prone areas using geospatial approach along the right bank of Yamuna River in Delhi. Int J Environ Health Res 29(5):561–581. https://doi.org/10.1080/09603123.2018.1557121

Catelan D, Biggeri A (2010) Multiple testing in disease mapping and descriptive epidemiology. Geospatial Health 4(2):219–229. https://doi.org/10.4081/gh.2010.202

Child Mortality (2020) UNICEF. https://www.unicef.org/media/79371/file/UN-IGME-child-mortality-report-2020.pdf.pdf

Chowell G, Mizumoto K, Banda JM, Poccia S, Perrings C (2019) Assessing the potential impact of vector-borne disease transmission following heavy rainfall events: a mathematical framework. Philos Trans R Soc B 374:1–9. https://doi.org/10.1098/rstb.2018.0272

Drinking-water WHO. https://www.who.int/news-room/fact-sheets/detail/drinking-water. Accessed 03 July 2021

Dutta S, Lahiri K (2015) Is provision of healthcare sufficient to ensure better access? An exploration of the scope for public-private partnership in India. Int J Health Policy Manage 4(7):467–474. https://doi.org/10.15171/ijhpm.2015.77

Eisen L, Eisen RJ (2010) Using geographic information systems and decision support systems for the prediction, prevention, and control of vector-borne diseases. Ann Rev Entomol 56:41–61. https://doi.org/10.1146/annurev-ento-120709-144847

Fotheringham AS, Rogerson PA (2007) GIS and spatial analytical problems. Int J Geogr Inf Syst 7(1):3–19. https://doi.org/10.1080/02693799308901936

Gao S, Mioc D, Anton F, Yi X, Coleman DJ (2008) Online GIS services for mapping and sharing disease information. Int J Health Geogr 7(8):1–12. https://doi.org/10.1186/1476-072X-7-8

Getis A, Ord JK (2010) The analysis of spatial association by use of distance statistics. In: Anselin L, Rey S (eds) Perspectives on spatial data analysis. Advances in spatial science (the regional science series). Springer, Berlin, Heidelberg, pp 127–145. https://doi.org/10.1007/978-3-642-01976-0_10

Gourishankar A (2021) A geospatial analysis of salmonellosis and its association with socioeconomic status in Texas. BioMed Central. https://doi.org/10.1101/2021.05.21.21257607

Gu H, Fan W, Liu K, Qin S, Li X, Jiang J, Chen E, Zhou Y, Jiang Q (2017) Spatio-temporal variations of typhoid and paratyphoid fevers in Zhejiang Province, China from 2005 to 2015. Sci Rep Nat 7(5780):1–11. https://doi.org/10.1038/s41598-017-05928-3

Gupta MD (2005) Public health in India: dangerous neglect. Econ Polit Wkly 40(49):5159–5165. https://www.jstor.org/stable/4417485

Hay SI, Battle KE, Pigott DM, Smith DL, Moyes CL, Bhatt S, Brownstein JS, Collier N, Myers MF, George DB, Gething PW (2013) Global mapping of infectious disease. Philos Trans R Soc B 368:1–11. https://doi.org/10.1098/rstb.2012.0250

Health Care Systems by Country, Wikipedia. https://en.wikipedia.org/wiki/Health_care_systems_by_country. Accessed 05 July 2021

Health Management Information System (HMIS) Ministry of Health and Family Welfare, Government of India. https://nrhm-mis.nic.in/PubStatistical_Publications//Family%20Welfare%20Statistics%20in%20India/HealthandFamilyWelfarestatisticsinIndia201920.pdf. Accessed 05 July 2021

Huang Z, Das A, Qiu Y, Tatem AJ (2012) Web-based GIS: the vector-borne disease airline importation risk (VBD-AIR) tool. Int J Health Geogr 11(33):1–14. http://www.ij-healthgeographics.com/content/11/1/33

IDSP. https://www.idsp.mohfw.gov.in/index4.php?lang=1&level=0&linkid=406&lid=3689

Jarup L (2004) Health and environment information systems for exposure and disease mapping, and risk assessment. Health Environ Inf Syst 112(9):995–997. https://doi.org/10.1289/ehp.6736

Kirby RS, Delmelle E, Eberth JM (2016) Advances in spatial epidemiology and geographic information systems. Ann Epidemiol 27(1):1–9. https://doi.org/10.1016/j.annepidem.2016.12.001

Kistemann T, Dangendorf F, Schweikart J (2001) New perspectives on the use of geographical information systems (GIS) in environmental health sciences. Int J Health Environ Health 205(3):169–181. https://doi.org/10.1078/1438-4639-00145

Lawal O, Anyiam FE (2019) Modelling geographic accessibility to primary health care facilities: combining open data and geospatial analysis. Geo-Spatial Inf Sci 22(3):174–184. https://doi.org/10.1080/10095020.2019.1645508

Li M, Shi X, Li X (2020) Integration of spatialization and individualization: the future of epidemic modeling for communicable diseases. Ann GIS 26(3):219–226. https://doi.org/10.1080/19475683.2020.1768438

Louie MM, Kolaczyk ED (2006) A multiscale method for disease mapping in spatial epidemiology. Stat Med 25:1287–1306. https://doi.org/10.1002/sim.2276

McKee KT, Shields TM, Jenkins P, Zenilman JM, Glass GE (2000) Application of a geographic information system to the tracking and control of an outbreak of Shigellosis. In: 37th annual meeting of the infectious diseases society of America, Philadelphia, 18–21 November 1999, pp 728–733. https://academic.oup.com/cid/article-pdf/31/3/728/20904103/31-3-728.pdf

Mclafferty S (2015) Disease cluster detection methods: recent developments and public health implications. Ann GIS 21(2):127–133. https://doi.org/10.1080/19475683.2015.1008572

Measures of risk, Centre for Disease Control and Prevention. https://www.cdc.gov/csels/dsepd/ss1978/lesson3/section1.html. Accessed 08 July 2021

Mocnik FB, Raposo P, Feringa W, Kraak MJ, Köbben B (2020) Epidemics and pandemics in maps—the case of COVID-19. J Maps 16(1):144–152. https://doi.org/10.1080/17445647.2020.1776646

Musa GJ, Chiang PH, Sylk T, Bavley R, Keating W, Lakew B, Tsou HC, Hoven CW (2013) Use of GIS mapping as a public health tool-from Cholera to Cancer. Health Serv Insights 6:111–116. https://doi.org/10.4137/HSI.S10471

Palaniyandi M (2012) The role of remote sensing and GIS for spatial prediction of vector-borne diseases transmission: a systematic review. J Vector-Borne Dis 49:197–204. https://pubmed.ncbi.nlm.nih.gov/23428518/

Pascutto C, Wakefield JC, Best NG, Richardson S, Bernardinelli L, Staines A, Elliott P (2000) Statistical issues in the analysis of disease mapping data. Stat Med 19:2493–2519. https://pubmed.ncbi.nlm.nih.gov/10960868/

Rogers D, Randolph S (2003) Studying the global distribution of infectious diseases using GIS and RS. Nat Rev Microbiol 1:231–237. https://doi.org/10.1038/nrmicro776

Rytkönen JP (2016) Not all maps are equal: GIS and spatial analysis in epidemiology. Int J Circumpolar Health 63(1):9–24. https://doi.org/10.3402/ijch.v63i1.17542

Sarkar R, Prabhakar AT, Manickam S, Selvapandian D, Raghava MV, Kang G, Balraj V (2007) Epidemiological investigation of an outbreak of acute diarrhoeal disease using geographic information systems. Trans R Soc Trop Med Hyg 101:587–593. https://doi.org/10.1016/j.trstmh.2006.11.005

Semenza JC, Suk JE, Estevez V, Ebi KL, Lindgren E (2011) Mapping climate change vulnerabilities to infectious diseases in Europe. Environ Health Perspect Res 120:385–392. https://doi.org/10.1289/ehp.1103805

Shaweno D, Karmakar M, Alene KA, Ragonnet R, Archie Clements A, Trauer JM, Denholm JT, McBryde ES (2018) Methods used in the spatial analysis of tuberculosis epidemiology: a systematic review. BMC Med 16(196):1–18. https://doi.org/10.1186/s12916-018-1178-4

Sirisena PD, Noordeen F, Kurukulasuriya H, Romesh T, Fernando LK (2016) Effect of climatic factors and population density on the distribution of dengue in Sri Lanka: a GIS-based evaluation for prediction of outbreaks. PLoS One 1–14.https://doi.org/10.1371/journal.pone.0166806

Smith CM, Le SC, Fry H, Bull M, Leach S, Hayward AC (2015) Spatial methods for infectious disease outbreak investigations: a systematic literature review. Eur J Infect Dis Surveill Epidemiol Prev Control 1–21.https://doi.org/10.2807/1560-7917/.ES.2015.20.39.30026

Song C, Shi X, Wang J (2020) Spatiotemporally varying coefficients (STVC) model: a bayesian local regression to detect spatial and temporal non-stationarity in variables relationships. Ann GIS 26(3):277–291. https://doi.org/10.1080/19475683.2020.1782469

Thayyil J, Jeeja MC (2013) Issues of creating a new cadre of doctors for rural India. Int J Med Public Health 3(1):8–11. https://doi.org/10.4103/2230-8598.109305

Thindwa D, Chipeta MG, Henrion M, Gordon MA (2019) Distinct climate influences on the risk of typhoid compared to invasive non-typhoid Salmonella disease in Blantyre, Malawi. Sci Rep 9(20310):1–11. https://doi.org/10.1038/s41598-019-56688-1

Thompson PN, Etter E (2015) Epidemiological surveillance methods for vector-borne diseases. Rev Sci Tech 34(1):235–247. https://doi.org/10.20506/rst.34.1.2356

Toprak D, Erdogan S (2008) Spatial analysis of the distribution of typhoid fever in Turkey. Int Arch Photogrammetry Remote Sens Spat Inf Sci XXXVII(B8):1367–1372. https://www.isprs.org/proceedings/XXXVII/congress/8_pdf/14_ThS20/03.pdf

Tran A, Ippoliti C, Balenghien T, Conte A, Gely M, Calistri P, Goffredo M, Baldet T, Chevalier T (2012) A geographical information system-based multicriteria evaluation to map areas at risk for rift valley Fever Vector-Borne transmission in Italy. Transboundary Emerg Dis 60(2):14–23. https://doi.org/10.1111/tbed.12156

Under-five mortality, UNICEF. https://data.unicef.org/topic/child-survival/under-five-mortality/. Accessed 03 July 2021

Valuing water, UN World Water Development Report (2021). http://www.unesco.org/reports/wwdr/2021/en. Accessed 03 July 2021

Wakefield J (2007) Disease mapping and spatial regression with count data. Biostatistics 8(2):158–183. https://doi.org/10.1093/biostatistics/kxl008

Wang F (2019) Why public health needs GIS: a methodological overview. Ann GIS 26(1):1–12. https://doi.org/10.1080/19475683.2019.1702099

Waterborne Diseases, National Institute of Environmental Health Sciences. https://www.niehs.nih.gov/research/programs/geh/climatechange/health_impacts/waterborne_diseases/index.cfm. Accessed 03 July 2021

Watkins RE, Eagleson S, Beckett S, Garner G, Veenendaal B, Wright G, Plant AJ (2007) Using GIS to create synthetic disease outbreaks. BMC Med Info Decis Mak 7(4):1–14. https://doi.org/10.1186/1472-6947-7-4

Zhao J, Liao J, Huang X, Zhao J, Wang Y, Ren J, Wang X, Ding F (2016) Mapping risk of leptospirosis in China using environmental and socioeconomic data. BMC Infect Dis 16(343):1–10. https://doi.org/10.1186/s12879-016-1653-5

Chapter 5
Peri-urban Agriculture and Food Supply

Mamta Arora, Anupama M. Hasija, and B. W. Pandey

Abstract Peri-urban agriculture is defined as agriculture that has been undertaken on the periphery or fringes of urban areas. Agriculture in the peri-urban region is under tremendous pressure due to rapid urban developmental activities. The aim of the study is to analyze the role of peri-urban agriculture in the food supply. The present study has been constructed on secondary data of Delhi and its periphery. The food supply analysis depicts that high calories food is being produced in Delhi and the districts of CNCR due to the subsistence nature of farming in the area. On the contrary, due to high population pressure, acquisition of land, cultivation of remunerative crops, and availability of less net sown area in the area makes them food deficient in kilocalories. The pattern of food and non-food supply in monetary value depicts that very few districts of Delhi-Central NCR have deficit food and non-food supply in terms of money due to two reasons, first, farmers are quitting farming as a profession, and second, farming at subsistence level. Their agricultural produce gives them enough money so that they can buy food or other articles from the market.

Keywords Food security · Rural–urban fringe · Food supply

5.1 Introduction

Urban food security is a matter of immense concern, especially for the poor of the megacities. The population of urban areas is consistently increasing than the employment or livelihood opportunities leading to the shift of rural poverty to urban

M. Arora (✉)
Department of Geography, Aditi Mahavidyalaya, University of Delhi, Delhi, India
e-mail: mamtaarora2@gmail.com

A. M. Hasija
Department of Geography, Shaheed Bhagat Singh College (E), University of Delhi, Delhi, India

B. W. Pandey
Department of Geography, Delhi School of Economics, University of Delhi, Delhi, India

A. Grover et al. (eds.), *Sustainable Health Through Food, Nutrition, and Lifestyle*,
Advances in Geographical and Environmental Sciences,
https://doi.org/10.1007/978-981-19-7230-0_5

centers. If the trend continues, it will affect the food supply and, ultimately food security of the residents. To make a city resilient, it is essential to make them food secure, which requires numerous actions such as a proficient production system, accessibility and affordability, and efficient governance. In the production process of ensuring adequate food supplies, urban and peri-urban agriculture is an enviable trend for cities future development (Zhong 2021). The study highlights the role of peri-urban agriculture in the sustainable food supply in Delhi.

5.2 Statement of Problem

India, the land of more than a billion people, where a third of the population resides in the urban areas, is experiencing a growth rate of more than 3% (Census of India 2011a, b, c). India is observing phenomenal growth in GDP, per capita income, and food grain production. Despite the remarkable economic growth in non-farm and farm sectors, the country has been ranked 100 among 119 countries in the Global Hunger Index, 2017. Around one-fifth of people are undernourished, of which 51% are women, and 38% are children under five of age. Among all the megacities, Delhi is the preferred choice of migrants, thus experiencing the highest growth (Times of India 2018). A gruesome situation prevails in Delhi as 244 deaths have been reported due to malnutrition (Preappadam 2019) from 2013 to 2016. A study conducted in 2014, "Urban Hunger and Malnutrition," by the Naandi foundation, reveals that Delhi has the highest percentage (11.7%) of severely stunted (chronic malnutrition) children (Gupta 2018).

Delhi being the heart of India, has been experiencing rapid growth of population due to its political and functional importance. The population of Delhi-NCR accounts for nearly one-tenth of India's population. Increasing population is affecting employment opportunities, and shifting rural poverty to Delhi-NCR eventually increases the incidence of urban poverty and malnutrition. Rural poverty is gradually drifting to urban centers as large rural poor migrate to urban centers in search of livelihood (Te lintel 2000).

5.3 Conceptual Framework

The concept of peri-urban has been studied by various scholars with different nomenclature such as urban fringe, fringe, rural–urban fringe, Institutional Desert, mingling of people, area of mixed rural and urban land use, frontier of discontinuity, area of transition, urban fringe and rural fringe (Pryor 1968), primary and secondary fringe, land-use dynamic, Rurban, hinterland, outskirts, countryside, suburbs. Therefore, the peri-urban area has been, by and large, defined as a transition zone with mixed land use, whereas Peri-urban agriculture is defined as agriculture that has been undertaken on the periphery or fringes of urban areas.

The peri-urban area has enormous potential to fulfill the food demands of the civic population. But, agriculture in the peri-urban region is under tremendous pressure due to rapid urban developmental activities. The relationship between population growth and food supply was first established by British Economist Thomas R. Malthus in the eighteenth century (1798), in which growth of population was estimated to progress exponentially whereas food supply increase had been estimated arithmetically. Due to technological innovations, enough food has been produced and supplied to meet human food demand. Moreover, peri-urban agriculture has the great potential to make a positive contribution to the urban food supply by strengthening the local food production system.

The peri-urban agriculture not only fulfills the food demands of the urban residents by supplying fresh and nutritious food but also reducing food miles, contributing to low carbon footprints economic development (Martinez et al. 2010).

5.4 Review of Literature

The concept of peri-urban has been analyzed with urban agriculture, whereas food supply has always been studied with food security. The latter has been defined as "ensuring that all people at all times have both physical and economic access to the basic food they need" (FAO 1983). Legion of research material is available on the relative terms used for peri-urban and food security, but very few studies have been done on urban food supply.

Ochoa (2020), in the study, identified the constraints that limit the growth of the short food supply chain and recognized the prospects derived from the advantages of peri-urban organic agriculture. It has been found that the local food sector has abundant potential to find innovative solutions based on collective approach and local embeddedness.

Feola et al. (2020) identified peri-urban agriculture (PUA) forms of food self-provisioning and proposed a unique viewpoint on PUA as quite a sustainability that could help and transform the discourse of the activity in sustainable urban development.

Olsson et al. (2016) analyzed the resilience potential of three European peri-urban areas of Gent (Belgium), Copenhagen (Denmark), and Gothenburg (Sweden) by improving food production as a part of multifunctional land use. It has been found that policies related to farmland preservation exist, but strategies for micro-level foodgrain production and peri-urban agriculture are not articulated in the planning documentation.

Chakraborty (1982), in the study on feeding the cities, discussed the food supply through the food production system with special reference to West Bengal population growth, social justice, economic growth and urban–rural discrepancy. It has been found that a nation cannot solve its food problem without finding the appropriate unifying mechanisms between urban and rural society.

Yasmeen (2001) discussed the Workers in the urban "Informal" food sector, which are important in the urban food supply chain with reference to the land of the Philippines and India. It has been found that more cooperation among the organizations is needed to facilitate networking and strengthening of local institutions.

Lintelo Marshall and Bhupal (2001) highlighted the nature, extent, and importance of peri-urban agriculture in Delhi. Rapid urbanization and a progressive shift from agrarian to urban poverty have important consequences for urban food security. It has shown that UPA is a significant, dynamic land use and important livelihood strategy for poor urban people. And although geographical locations may shift over time, the phenomenon of UPA will remain.

5.5 Study Area

Geographically, the study area is positioned in a narrow strip of the Indo-Gangetic plain and located at an altitude of 233 m and around 160 km south of the Himalayas. Administratively, Delhi is a core area, and the peripheral area, i.e., CNCR, has been formed of six neighboring districts surrounding Delhi. The area of Central National Capital Region (CNCR) comes under Haryana and Uttar Pradesh. CNCR consists of six ring towns around Delhi, namely, Sonipat, Gurugram, Bhahadurgarh, Faridabad, NOIDA, and Ghaziabad (Fig. 5.1). The study has provided district-level analysis. The districts which have been studied in detail of CNCR are Sonipat, Gurugram, Jhajjar (Bahadurgarh), Faridabad, situated in Haryana, and Gautam Budha Nagar (NOIDA) and Ghaziabad are in Uttar Pradesh. Functionally, it has been administered by the National Capital Region Planning Board (NCRPB).

Physically, Bhangar, Khadar, and the Ridge are the three main segments of the area. Leaving aside the Khadar (Yamuna flood plain) region and the ridge, the whole region is categorized as Bangar or the plain. The Yamuna is the major river of this area, and apart from this, there are three artificial waterways, viz., Western Yamuna, Hindon, and Agra pass through the territory. The drainage of the area is from north to south which follows the general slope. The region is bestowed with fertile soil.

Demographically, the population density of the region is very high and, moreover, growing at a very high rate. The decadal growth rate was 83.1% in CNCR, whereas the NCT of Delhi experienced 21% growth from 2001 to 11. Out of the total, 34% is the working population and the remaining 65% is the non-working population. Furthermore, out of the total working population, 30% of people are the main workers, while just 4% of people are marginal workers. Out of which, main and marginal cultivators are 2% and 3%, respectively (Census of India 2011a, b, c).

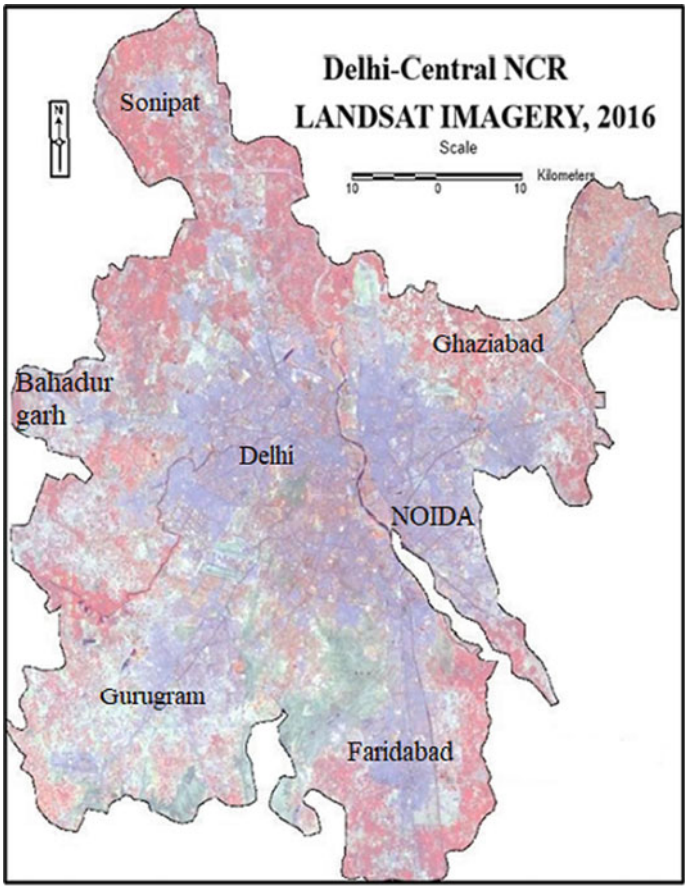


Fig. 5.1 Location of ring towns. *Source* Earth Explorer, http://earthexplorer.usgs.gov

5.6 Methodology

The present study has been constructed on secondary data of Delhi and its periphery. The data has been procured from the Census of India, Statistical Handbook of Delhi, Haryana, and Uttar Pradesh, Agriculture census of India for the years 2001 and 2011. The assessment of food supply is very complex and multi-dimensional due to the inter-linkages of its various variables; therefore, it is difficult to evolve a single indicator for it. In the present study, supply indicators are used to assess the food supply. It is based on the computation of the net availability of food in terms of calories and monetary value (Fig. 5.2).

The following equations have used to calculate Weaver Index are as follow:

(a) Rate of Change: The rate or volume of change in the pattern of general and agricultural land use pattern from 2006 to 2016 has been assessed with the help

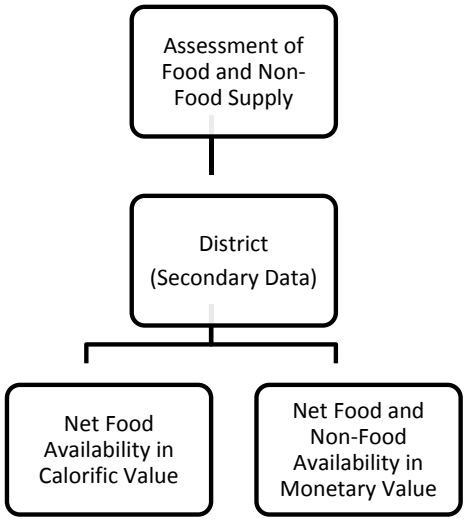


Fig. 5.2 Assessment of food supply. *Source* Prepared by researcher

of Weaver's Index modified by Singh (1974). The modified formula used to determine the change is as follow:

$$\text{Rate of Change} = A/B$$

A Difference in the percentage of land use category of increase
B Difference in the percentage of land use category of decrease.

The concept of the food supply is complex and difficult to standardize as the nature of crops are very diverse. As the idea has a multidimensional characteristic, and various variables are interlinked with each other, therefore, it is difficult to evolve a single indicator for it. Mohammad (2001) had developed a direct method for measuring food security. It is based on the computation of the net availability of food in terms of calories and money value divided by the consumption unit. The positive results indicate food security, while negative results show food insecurity. The method has been modified as only supply indicators have been taken into account, which is based on the computation of net availability of food in terms of calories and monetary value only. Agricultural produce has been converted into calories/money, then Net Food Availability (NFA) has been calculated by multiplying the coefficient of production, i.e., 0.832 (Chakravarty 1970). The gross food available is multiplied by it.

5.7 Peri-urban Agriculture and Food Supply

Across the globe, around 800 million people are involved in urban and peri-urban agricultural activities. Peri-urban agriculture provides numerous benefits ranging from tangible to intangible such as supplies fresh and nutritious food, employment generation, recycling of urban green waste, creation of green belts, establish cities resilience to climate change (FAO 2010), and moreover, supportive in achieving various United Nations Sustainable Developments Goals, 2030. Various studies prove that peri-urban has great potential in providing food and nutritious food to the city residents.

Peri-urban Agriculture and Food Supply in Delhi-Central NCR

In the peripheral areas of Delhi, diverse food grains and non-food grains crops are being cultivated by urban farmers. The former are food crops including cereals, pulses, horticulture, etc., whereas the latter include oilseeds, floriculture, etc., which are considered high-value crops or cash crops.

The Satellite Imagery of Delhi-Central NCR (CNCR), 2016, reveals that the pattern of agriculture varies immensely (Fig. 5.1). The northern part has flourishing agriculture, shown in red color, whereas in the southern part of the study area, the fertile land is shrinking, and secondary and tertiary activities predominate. Delhi-Central NCR is situated in the highly fertile tract with minimal variations in terrain, slope, altitude, climate but dissimilitude can be observed in the characteristics of the soil. The diverse soil offers potential for the cultivation of foodgrains and non-foodgrains.

The area under food grains or food crops is highest in Sonipat, followed by Faridabad, Ghaziabad, Jhajjar in the year 2010–11 (Fig. 5.3). As compared to food crops, non-food crops occupy very less area in the region. In 2010–11, the highest area under non-food crops was reported in Faridabad, followed by Sonipat and Ghaziabad. Change in the area of food and non-food crops has been discussed in Fig. 5.4, which has been calculated with the help of Weaver's Index modified by Singh (1974).

Figure 5.4 envisages that trend in the districts of Delhi-Central NCR is towards non-food grain crops. The crops are increasing due to their high demand and remunerative character. The area under non-food crops has increased in three districts, viz., Faridabad, Sonipat, and Ghaziabad (Fig. 5.4).

5.8 Food Supply in Delhi-Central NCR

Delhi-CNCR has been bestowed with fertile farming resources, especially in terms of net sown area and fallow land, but they are declining due to urbanization and changes in the occupational structure. The trend will eventually affect the food supply of the region in the near future. The region is producing 1110 million kilocalories of food which is enough for around 45,000 people. If fallow land and vacant land available in

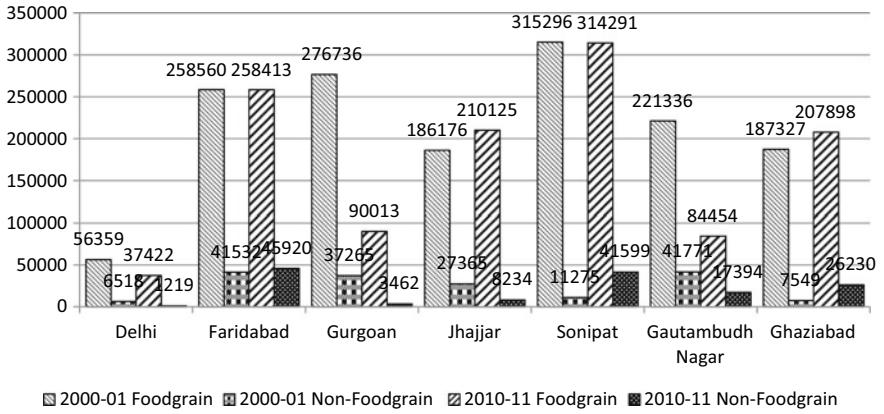


Fig. 5.3 Area under food grains and non-food grain crops. *Source* Compiled by Researcher from Agricultural Census 2000 and 2011. *Note* Area in ha)

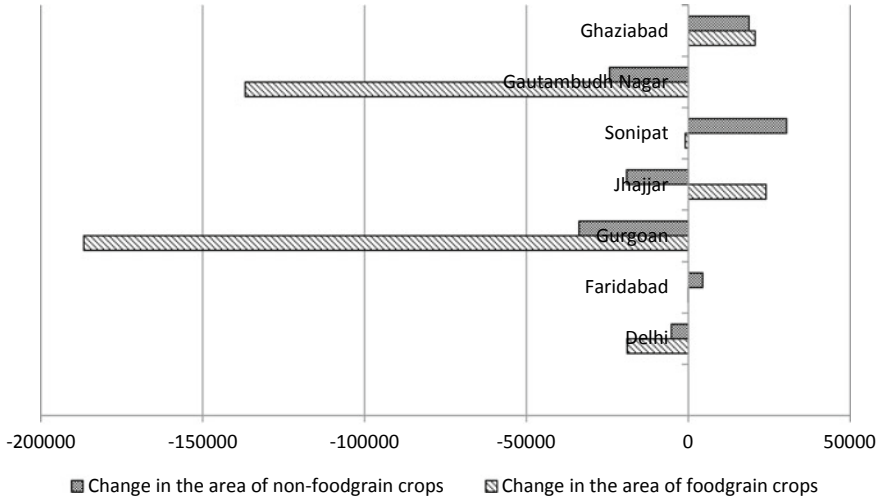


Fig. 5.4 Change in the area of Food grain and Non-Food grain Crops, 2001–2011. *Source* Calculated by the researcher

the region will be put to farming, then an additional 1000 million kilocalories would be produced. On the other hand, in terms of monetary value, the region produces 3180.4 million rupees of food and non-food crops. Net food availability in kilocalories has been measured only for food crops as non-food crops calorific value is not available.

The highest kilocalories are being produced in Gautham Budhha Nagar (465.38) and the lowest in the Gurugram district (31.19). Contrary to the trend, all districts

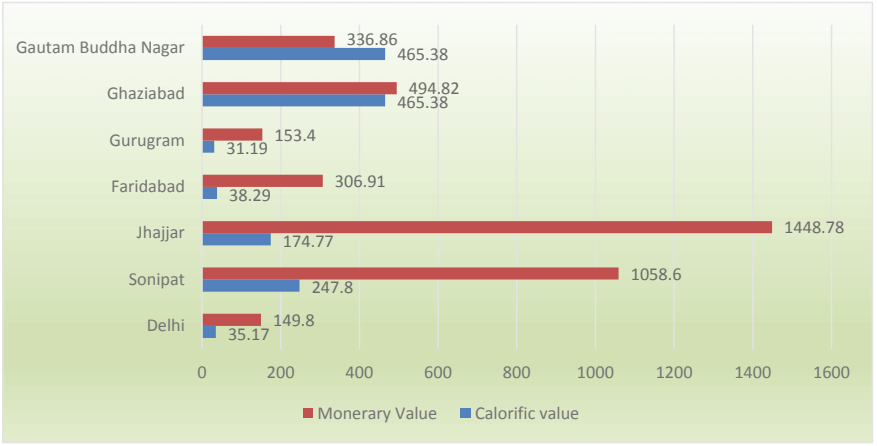


Fig. 5.5 Food and non-food supply in kilocalories and monetary value. *Source* Calculated by researcher

of Delhi-Central NCR have been producing remunerative crops which have high monetary value (Fig. 5.5).

5.9 Assessment of Food Supply in Kilocalories

The spatial distribution of net food availability in calorific value is high in the South-eastern part of Delhi-Central NCR, largely due to favorable agricultural conditions which support the cultivation of rice and wheat as compared to the southwestern part, in which Jowar and Bajara dominate due to scarcity of water. Remaining all the districts are falling under medium calorific values (Fig. 5.6). Low caloric values are largely associated with poor agricultural conditions.

The net food availability in calorific value per acre is highest in Gautam Buddh Nagar (7235) and lowest in Gurugram (318.64). As mentioned earlier, high caloric value crops are cultivated in Gautam Buddh Nagar (465.35) and the lowest in Gurugram (31.19).

5.10 Assessment of Food and Non-food Supply in Monetary Value

Net food availability in monetary value is high in the western part of Delhi-Central NCR, whereas low monetary values are largely associated with subsistence farming

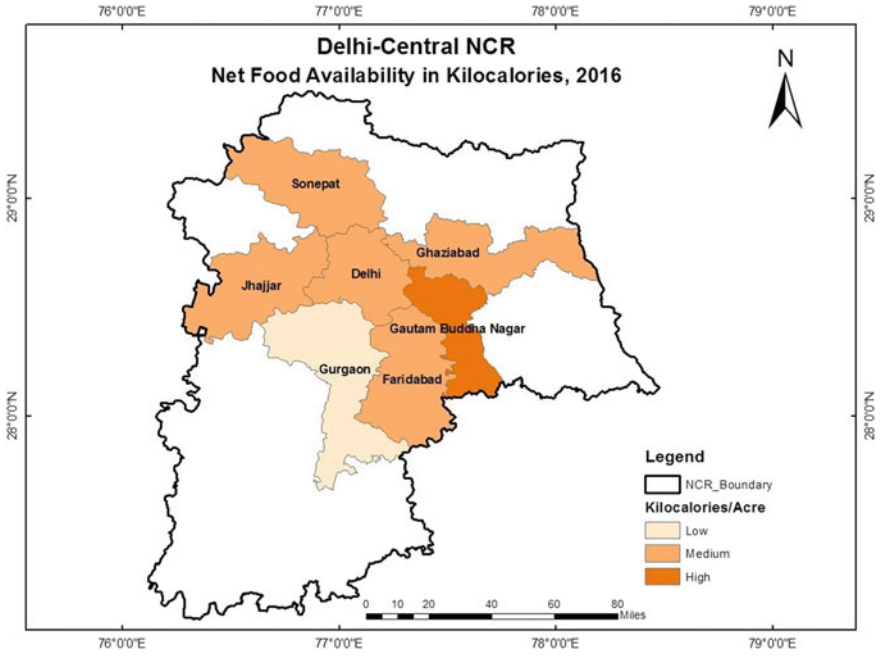


Fig. 5.6 Net food availability in kilocalories, 2016. *Source* Prepared by researcher

located in the south-western part of the region. Rest all districts are falling under the medium monetary value category.

The net food availability in monetary value is highest in Jhajjar (10,437), whereas lowest in Gurugram district (1567) largely because of the cultivation of high valued crops like mustard, sugarcane, etc. Sugarcane is being cultivated in Jhajjar, which gives high returns to the farmers (Fig. 5.7). Contrarily, Gurugram district has more area under fodder crop, which provides low returns to the farmer.

5.11 Conclusion

Peri-urban agriculture plays an important role in supplying fresh food to the residents. The most essential aspect is the recognition of the activity in the local food system. The urban development plan of Delhi must preserve and allot area for peri-urban agricultural activities. The food supply analysis depicts those high calories food is being produced at Delhi-CNCR, which highlights the subsistence nature of the area. But due to high population, acquisition of land, cultivation of remunerative crops, and availability of less net sown area in the area makes them food deficient in kilocalories. The pattern of food and non-food supply in monetary value depicts that very few districts of Delhi-Central NCR have deficit food and non-food supply in terms of

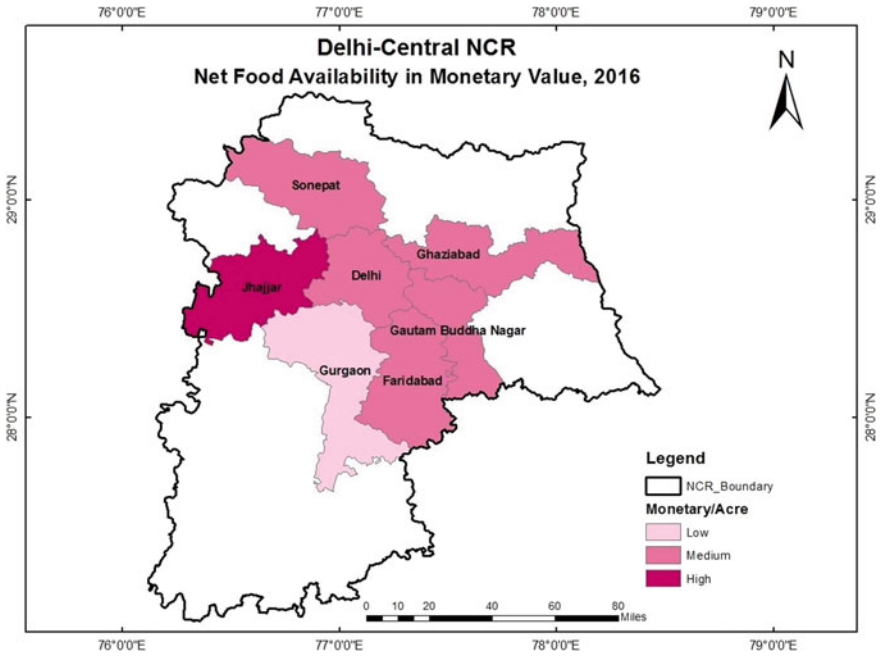


Fig. 5.7 Net food availability in monetary value, 2016. *Source* Prepared by researcher

money as farmers are quitting farming as a profession or cultivating at subsistence level. Their agricultural produce gives them enough money so that they can buy food or other articles from the market.

References

Census of India (2011a) Census atlas, series 31, part XI. Directorate of Census Operation Controller of Publication, Delhi

Census of India (2011b) Primary census abstract, district census handbook, town and village directory, Delhi, part IX, vol XIX. Directorate of Census Operation, Controller of Publication, Delhi

Census of India (2011c) Primary census abstract, district census handbook, town and village directory, series 31, Delhi, part XII A-B. Directorate of Census Operation, Controller of Publication, Delhi

Chakraborty SC (1982) On feeding the cities: some aspects of the Indian scenario. GeoJournal 4:15–25. https://doi.org/10.1007/BF00186701

FAO (2010) Climate smart agriculture: policies, practices, and financing for food security, adoption and mitigation. FAO. https://www.fao.org/3/i1881e/i1881e00.pdf

Feola J, Suzunaga J, Soloer J, Wilson A (2020) Peri-urban agriculture as quite sustainability: challenging the urban development discourse in Sogamoso, Colombia. J Rural Stud 80:1–12. https://doi.org/10.1016/j.jrurstud.2020.04.032

Government of Delhi (1987) Gazetteer of rural Delhi. Delhi Administration, Delhi

Government of Haryana (2006) Haryana statistical handbook. Directorate of Economic and Statistics, New Delhi
Government of Haryana (2016) Haryana statistical handbook. Directorate of Economic and Statistics, New Delhi
Government of National Capital Territory of Delhi (2006) Delhi statistical handbook. Directorate of Economics and Statistics, New Delhi
Government of National Capital Territory of Delhi (2016a) Economic survey of Delhi 2015–2016a. Planning Department, New Delhi, pp 87–99
Government of National Capital Territory of Delhi (2016b) Delhi statistical handbook. Directorate of Economics and Statistics, New Delhi
Government of Uttar Pradesh (2007) Uttar Pradesh statistical handbook. Directorate of Economic and Statistics, New Delhi
Government of Uttar Pradesh (2017) Uttar Pradesh statistical handbook. Directorate of Economics and Statistics, New Delhi
Gupta MD (2018) One in 4 urban children under the age of 5 suffer from malnutrition, Delhi tops list. Hindustan Times. https://www.hindustantimes.com/health/one-in-4-urban-children-under-the-age-of-5-suffer-from-malnutrition-delhi-tops-list-survey/story-CeNCWeLOTDn8sBwSf9qYLP.html
Lintelo TD, Marshall F, Bhupal DS (2001) Peri-urban agriculture in Delhi, India, vol 29. Food, Nutrition, and Agriculture, FAO, Rome 29: 4–13
Martinez S, Hand M, Pra MD, Pollack S, Ralston K, Smith T, Vogel S, Clark S, Lohr L, Low S, Newman C (2010) Local food systems concepts, impacts, and issues, ERR No. 97. United States Department of Agriculture (USDA), Economic Research Report. https://www.ers.usda.gov/webdocs/publications/46393/7054_err97_1_.pdf?v=0
Ministry of Women and Child Development (2021) Malnutrition among women and children. Press Information Bureau, Government of India, 05 Aug 2021. https://pib.gov.in/PressReleseDetailm.aspx?PRID=1742806
Olsson EGA, Kerselaers E, Kristensen LS, Primdahl J, Rogge E, Wästfelt A (2016) Peri-urban food production and its relation to urban resilience. Sustainability 8:1340. https://doi.org/10.3390/su8121340
Olufunke OC, Veenhuizen RV, Drechsel P (2003) Contribution of urban and peri-urban agriculture to food security in Sub-Saharan Africa. Paper presented at the Africa session of 3rd WWF, Kyoto, 17 Mar 2003. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.365.1569&rep=rep1&type=pdf
Preappadam BS (2019) Malnutrition claimed 244 lives in 4 years in Delhi Hospital, reveals RTI query. The Hindu, Published on 02 Apr 2019. https://www.thehindu.com/news/cities/Delhi/malnutrition-claimed-244-lives-in-4-years/article26706599.ece
Times of India (2018) Delhi the top choice of migrants from India, e-paper, 28 Mar 2018. http://timesofindia.indiatimes.com/articleshow/63424990.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst
Yasmeen G (2001) Workers in the urban "informal" food sector: innovative organizing strategies. FAO. http://www.fao.org/3/y1931m/y1931m05.htm
Zhong Q, Wang L, Cui S (2021) Urban food systems: a bibliometric review from 1991 to 2020. Foods 10(3):662. https://doi.org/10.3390/foods10030662

Chapter 6
Gender Dimension of Children Malnutrition Among Tribal Children in India

Puja Das, Susanta Sen, and Manisha

Abstract Malnutrition is considered a catalyst to global burden diseases, and it is a major concern in developing countries like India. Child malnutrition has declined over the decade, but one-third of children are still malnourished, which adversely effects the mental health of children and is a risk factor of child mortality as well as morbidity. About 1.04 million under-5 mortality is occurred due to malnutrition in India. This present study is investigated to examine child malnutrition across gender among the states and major tribal states in India. For this study purpose, National family health (NFHS-4) data is used to analyze gender-wise child malnutrition status among all states and fourteen major tribal states in India. The bivariate and binomial logistic regression model has been done to understand the distribution of malnutrition status among children and the impact of background variables in child malnutrition. These results show that a high prevalence rate of malnutrition is observed in Northern, Central, and Eastern parts of India; it is about 40% in the stunting and underweight indicator among malnutrition parameters. Half of the children belonging to the socially backward class are at a higher risk of malnourishment. The prevalence rate of malnutrition indicators such as stunting and underweight is very high about 50% in the Jharkhand among the major tribal states. Significantly, this study found that female children are less malnourished than male ones but, in Manipur, Meghalaya, and Mizoram, underweight is high among girls compared to boys, and stunting is high in females than the male in Maharashtra among the tribal population. So, this is inspiring that we needed effective nutrition and health policy for reducing malnutrition in India and fulfilling the SDG goals 2 and 5 and targets by 2030.

P. Das (✉)
Department of Geography, The University of Burdwan, Burdwan, India
e-mail: daspuja199412@gmail.com

S. Sen
Department of Development Studies, The University of Calcutta, Kolkata, India

Manisha
Department of Migration and Urban Studies, International Institute for Population Sciences, Mumbai, India

A. Grover et al. (eds.), *Sustainable Health Through Food, Nutrition, and Lifestyle*,
Advances in Geographical and Environmental Sciences,
https://doi.org/10.1007/978-981-19-7230-0_6

Keywords Child malnutrition · Gender · Tribal community · Major tribal states

6.1 Introduction

Malnutrition is one of the largest health problems for children in the world, according to the UN Standing Committee on Nutrition (UNSCN). In some cases, malnutrition can be a direct result of ill health or disease, while in others, it can be fatal due to disease. Malnutrition reduces the physical and mental development of children (Levitsky and Strupp 1995; Mendez and Adair 1999). In developing countries, for example, stunting affects more than 147 million pre-school children (Haddad and Ross 2004). Malnutrition is responsible for 45% of child deaths worldwide. Even under-weight babies are twice as likely to die as well-fed babies. Globally, about 52 million children under the age of five were wasted, 17 million severely wasted, 155 million stunted, and 41 million severely obese (Dukhi et al. 2020). India's child malnutrition rates are still one of the most alarming in the world. According to the Global Hunger Index (2020), India places at the 94th spot among 107 countries. The National Family Health Survey (NFHS 2015–16) found that 38.7% of children under five years are stunted, 19.8% are wasted, and 42.5% are underweight. Since 2006, this figure has declined very slowly, especially for wasting, which has remained about the same. The prevalence of stunting and underweight has declined by only 10% and 5%, respectively, between 2006 and 2016.

Malnourished girls are more likely to reach adolescence with fragile physical conditions that can have serious effects on their health, especially during pregnancy. Stunted and/or anemic adolescent girls are more likely to have complications during and after childbirth, besides to give more likely premature and low birth weight babies. Heavy physical work, discrimination of adequate health care, poor diets, and severely poor nutritional status of many women are closely related to the health status of women and their babies (WHO and UNICEF 2000). Lack of socio-economic conduciveness among households from the marginalized sections has led to widespread undernourishment, where children have suffered the worst health conditions. Studies found that undernutrition children from marginalized communities have a higher risk of non-communicable diseases in their adult age (IIPS and ICF 2017; UNICEF 2009; Gragnolati et al. 2006). So, the reduction of infant and young child malnutrition is essential to the achievement of the Millennium Development Goals (MDGs)-particularly those related to the eradication of extreme poverty and hunger (MDG 1) and child survival (MDG 4). The United Nation Sustainable Development Goals (SDGs) also set targets with the aim to eliminate malnutrition by 2030.

Many efforts are being made to solve the problem of malnutrition in the country. Several departments/ministries of the government are involved in the implementation of various plans and programs to, directly and indirectly, affect the level of nutrition. Integrated Child Development Scheme (ICDS), a major program of the Ministry of Women and Child Development, works to improve the nutrition and health status of

children and pregnant mothers. The Ministry of Food and Civil Supplies operates Public Distribution System (PDS), which provides affordable food to families, while the Ministry of Rural Development manages MGNRES (Mahatma Gandhi National Rural Employment Guarantee Scheme) to increase household income. The Ministry of Tribal Affairs is involved in addressing multiple needs of the tribal population, including hunger and nutrition. In addition, a lot of initiatives are being taken by the private sector and civil society organizations for the development of tribal people. The Government of India has adopted a target and focused-oriented approach where the emphasis is being placed on the health of marginalized groups (SC and ST) and vulnerable groups (women and aged).

In spite of various efforts, no significant control over tribal malnutrition has been found in India, which makes up 8.6% of the total Indian population (Census of India 2011). It is a matter of grave concern that Indian tribes and especially tribal women and children are at higher nutritional risk than other castes due to lack of adequate food. Tribal population known as venerable people, they residing mountainous and forest area and disconnected from the mainland, that's why they can't access proper health facility, for this reason, higher prevalence of malnutrition among children is found in them (Tribal Health Expert Committee Report 2013). Besides, low social status, lack of education, poverty, and marginalization in accessing health care and other social facilities are the major causes for malnutrition among the tribal communities (Bhutta et al. 2004; Rao et al. 2005; Das and Sahoo 2011; Dinachandra et al. 2015). NFHS-4 reports that more than 40% of tribal children in India are stunted and underweight and about 30% wasted. There are several detailed studies for measuring the nutritional status of tribal people. But recent gender-based research on the risk and prevalence of malnutrition among tribal children is very limited. In this context, the present study seeks to determine the gender disparity of malnutrition prevalence among children in fourteen states with high tribal population (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura, Jharkhand, Odisha, Chhattisgarh, Madhya Pradesh, Rajasthan, Maharashtra, and Gujarat) of India. These tribal have shared more than 10% of the tribal population.

6.2 Data and Methods

Data: The study utilizes data from the fourth round of NFHS conducted during 2015–16. The data is publicly available on the Demographic and Health Survey (DHS) website, and therefore, separate ethical approval does not require. The principal objective of the NFHS-4 was to provide comprehensive information on health and family welfare, as well as data on emerging issues in these areas for India and each state and union territory. The NFHS is a large-scale, multi-round survey conducted under the stewardship of the Ministry of Health and Family Welfare (MoHFW), Government of India. NFHS-4 covered 601,509 households, 699,686 women in the age group of 15–49 years, and 103,525 men in the age group of 15–54 years in India. Overall, response rates are quite high (above 90%). For the study purpose, women

and child data files have been used. This study has been included a total of 29,418 (NFHS4) children under five years of age who belong to the tribal communities.

Outcome variables: The outcome variables for the analysis of the gender dimension of childhood malnutrition are stunting (height-for-age), underweight (weight-for-age), and wasted (weight-for-height). Studies show that these three anthropometric indicators are standardized indicators of the nutritional status of children (WHO 2006). Stunting indicates chronic undernutrition, wasting suggests acute undernutrition, and under-weight indicates a composite form of acute and chronic undernutrition (Mejía-Guevara et al. 2015).

Independent variables: A set of socio-economic and demographic determinants of malnutrition among tribal children has been used based on prior literature and data availability. These include -age in a month, sex of the child, birth order, size at birth, birth weight, place of residence, breastfeeding practice, mother's education, mother's nutrition, and wealth status of the household.

Statistical analysis: Bivariate analysis was used to depict the percent distribution of malnutrition by background characteristics and show the prevalence pattern of malnutrition across gender in the state and among tribal communities in India. A binomial logistic regression model was used to analyze the association between background characteristics and malnutrition status among children in tribal communities in India. Results from logistic regression were presented in odd ratio form at 95% confidence interval (CI). Stata-13 software was used to fulfill the objectives of the study.

6.3 Results

6.3.1 Child Malnutrition Across States in India

The levels of childhood malnutrition status are calculated at the all-India level and for individual states (Table 6.1). The results reveal that 40% male and 45% female under-five age group children were stunted in India. Accounting for statewide distribution, stunting among male children was highest in Bihar (49%), followed by Meghalaya (48%) and Uttar Pradesh (48%), and lowest in Goa (19%) and Kerala (19%). Contrariwise, stunting among female children was highest in Bihar (50%) and Uttar Pradesh (48%) and lowest in Kerala (21%) and Goa (22%). The higher prevalence of stunting (more than 40%) among both male and female children was observed among many states like Bihar, Chhattisgarh, Gujarat, Jharkhand, Madhya Pradesh, Meghalaya, Rajasthan, and Uttar Pradesh.

Table 6.1 also presents gender-wise children wasting and under-weight status across states in India. The high prevalence of wasting was found in Jharkhand (26% in male children and 25% in female children) and Gujarat (25% and 23% among male and female children), and lowest in Mizoram (7% both male and female children)

Table 6.1 Gender wise percentage distribution of children malnutrition status in India, 2015–16

State	Stunting		Wasting		Under weight	
	Male	Female	Male	Female	Male	Female
Andhra Pradesh	34.1	31.3	15.8	13.1	34.1	31.0
Arunachal Pradesh	32.4	28.1	14.2	12.2	20.9	16.9
Assam	38.0	34.9	14.3	13.6	30.3	27.6
Bihar	48.5	49.5	19.4	19.0	44.3	46.3
Chhattisgarh	40.8	36.9	23.2	20.6	42.0	38.1
Goa	18.9	21.8	19.3	19.1	20.0	26.4
Gujarat	41.1	39.7	24.6	23.1	43.2	41.0
Haryana	36.5	32.5	19.8	18.5	31.8	29.2
Himachal Pradesh	27.7	24.5	12.9	12.2	22.5	20.7
Jammu and Kashmir	29.1	28.9	10.4	9.7	17.5	16.8
Jharkhand	46.8	44.1	26.4	25.4	48.9	48.7
Karnataka	39.9	37.1	21.1	20.0	37.7	35.6
Kerala	19.3	20.5	15.1	14.7	17.0	16.7
Madhya Pradesh	43.6	41.9	24.0	22.2	45.1	43.5
Maharashtra	37.6	35.7	22.5	21.1	39.0	37.0
Manipur	31.6	29.2	7.6	5.8	14.7	14.0
Meghalaya	47.0	41.7	13.4	14.4	30.5	29.4
Mizoram	31.7	29.2	7.2	7.1	14.1	14.0
Nagaland	32.4	26.8	10.5	9.0	18.6	16.2
Odisha	35.9	34.8	20.3	18.4	37.2	35.7
Punjab	26.4	25.5	15.5	13.1	22.5	20.9
Rajasthan	40.6	38.1	22.2	20.7	39.0	36.3
Sikkim	33.1	26.6	14.3	13.5	16.2	13.9
Tamil Nadu	28.7	26.6	18.8	16.7	26.6	24.0
Tripura	26.6	24.6	17.1	15.2	27.4	24.1
Uttar Pradesh	46.6	46.5	17.0	14.7	39.6	39.8
Uttarakhand	34.3	32.6	17.5	17.3	27.6	26.6
West Bengal	34.1	34.6	19.0	19.5	33.2	35.5
Telangana	30.9	29.4	17.2	15.9	32.3	28.8

and Manipur (8% and 6% among male and female children, respectively). Female children have a high prevalence of wasting than male children only in the state of Meghalaya. Further, the high prevalence of underweight was found in Jharkhand (about 49% both in male and in female children) and lowest in Mizoram (above 14%) and Manipur (above 14%). In approximately half of the states (i.e., 15 out of 29), more than 30% of male and female children have belonged to the underweight category.

6.3.2 Differentials of Malnutrition Status Among Tribal Children

The socioeconomic and demographic differentials of malnutrition status among tribal children in the selected fourteen states of India (Table 6.2). A greater percentage of stunting and underweight were observed in the month of 36–47 and 48–59 age groups of children, whereas wasting was high in 6–8-month age of children. Our results indicated that the incidence of malnutrition was higher in the rural areas, among poor wealth background households, among uneducated and primary educated tribal mothers. On the other hand, the incidence of malnourished children was relatively lower among children in the top two wealth status households and among higher educated mothers. A greater percentage of malnourished children were found among underweight mothers than nourished mothers. A higher occurrence of malnutrition was observed among female children than female children. This indicated that malnutrition is a common characteristic among tribal children from low socioeconomic status.

6.3.3 Gender-Wise Child Malnutrition Status Among Major Tribal States in India

The gender-wise stunting among states with high tribal population in India (Fig. 6.1). The result reveals that the percentage of malnutrition was among female tribal children than male children. The high incidence of stunting was found in Jharkhand (54% in male and 46% in female children) and lowest in Mizoram (27% in male and 28% in female children). Averagely more than 40% of stunting among tribal children was observed in Madhya Pradesh, Chhattisgarh, Maharashtra, Meghalaya, Odisha, and Rajasthan.

The gender-wise wasting among states with high tribal population in India (Fig. 6.2) has a greater percentage of wasting was observed in Jharkhand (29% in male and 29% in female children), whereas lowest in Mizoram (5% in male and 5% in female children). More than 25% of wasting was found in states like Gujarat, Madhya Pradesh, Maharashtra, Odisha, and Rajasthan, and less than 10% of wasting was seen in Manipur and Nagaland.

Similarly, gender-wise underweight (Fig. 6.3) tribal population have a high prevalence of underweight was found in Jharkhand and lowest in Mizoram. More than 45% of underweight was seen in Chhattisgarh, Gujarat, Maharashtra, Odisha, Rajasthan, and less than 20% of underweight was observed in Manipur, Meghalaya, and Nagaland.

Table 6.2 Differential's malnutrition status among tribal children in the fourteen major tribal states, India, 2015–16

Background characteristics	Stunting	Wasting	Under-weight
Age in month			
< 6	25.7	28.3	32.2
06–08	22.8	35.0	35.2
09–11	32.2	34.5	46.2
12–17	43.9	31.5	43.2
18–23	53.6	28.0	50.6
24–35	50.3	24.8	49.4
36–47	49.9	22.1	48.6
48–59	46.9	22.3	49.1
Sex of the child			
Male	45.9	26.7	47.9
Female	42.8	23.4	44.2
Birth order			
1	41.9	23.9	43.5
2–3	44.2	25.6	46.6
3 +	51.9	25.6	51.5
Size at birth			
Very large	42.6	22.3	43.3
Larger than average	40.8	23.0	42.3
Average	43.8	25.2	45.3
Smaller than average	50.5	26.2	51.9
Very small	62.2	32.6	68.8
Birth weight			
< 2.5 kg	50.2	28.5	54.8
> 2.5 kg	39.7	22.2	39.0
Place of residence			
Urban	36.1	23.2	38.4
Rural	45.6	25.3	47.2
Mother's education			
No education	50.8	27.4	52.8
Primary	46.4	23.3	47.7
Secondary	40.0	24.0	41.4
Higher	27.0	22.3	28.8
Mother's nutrition			
Under weight	48.1	31.5	56.7
Normal weight	43.2	21.6	41.1
Over weight	32.2	20.3	28.6

(continued)

Table 6.2 (continued)

Background characteristics	Stunting	Wasting	Under-weight
Breast feeding			
0–5 m	31.8	26.2	36.4
6–12 m	35.1	30.1	42.2
More than 12 m	48.8	26.7	49.6
No breast feeding	45.3	17.2	44.4
Wealth index			
Poorest	49.9	26.9	52.5
Poorer	43.2	24.4	44.7
Middle	42.2	23.2	39.9
Richer	31.8	25.0	38.1
Richest	28.7	16.2	24.9

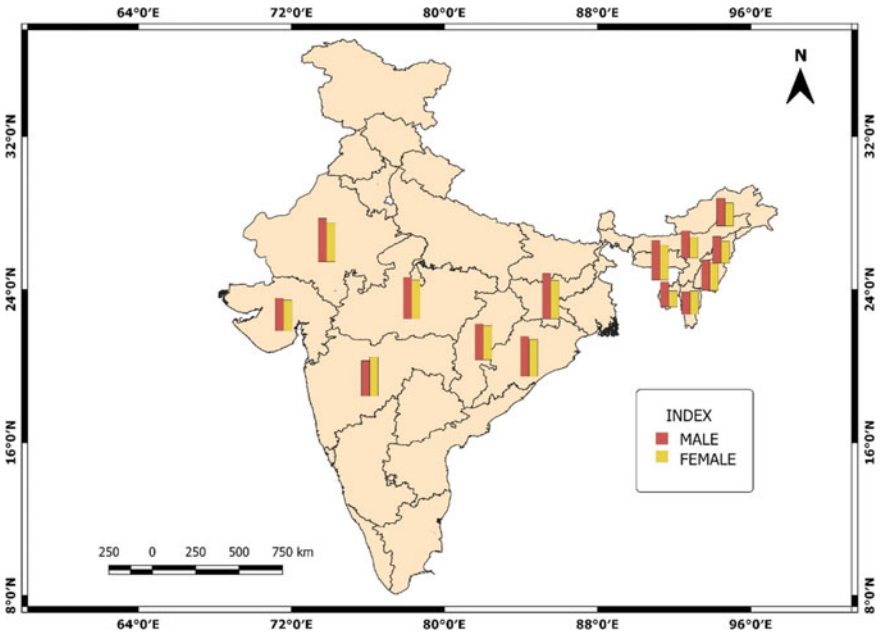


Fig. 6.1 Gender-wise stunting among major tribal states in India

6.3.4 Determinants of Child Malnutrition Among Tribal Children

Logistic regression was undertaken to determine which background characteristics have a statistically net association with the malnutrition status among tribal children (Table 6.3). The dependent variable assumes a value of 1 if a child is less than five

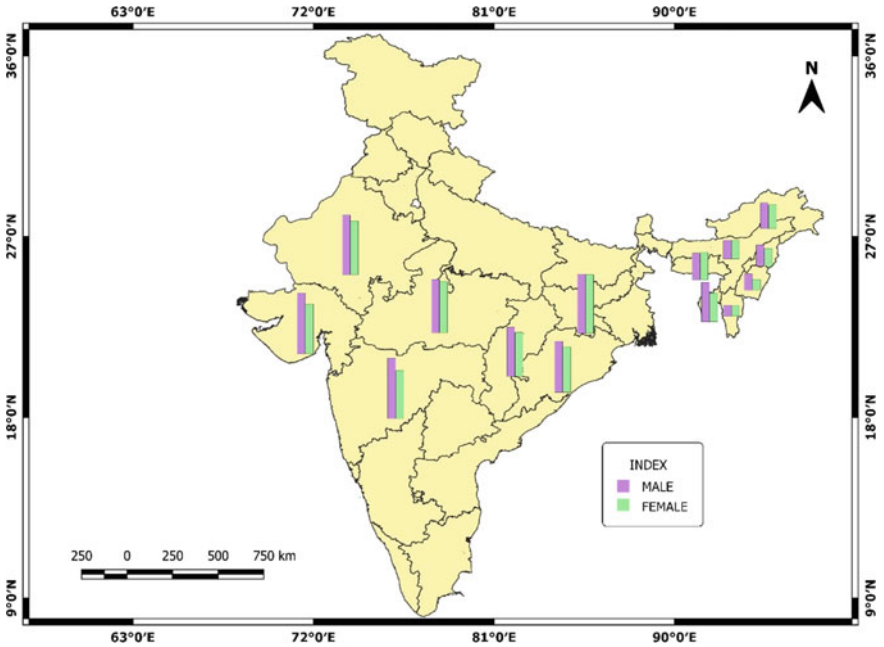


Fig. 6.2 Gender-wise wasting among major tribal states in India

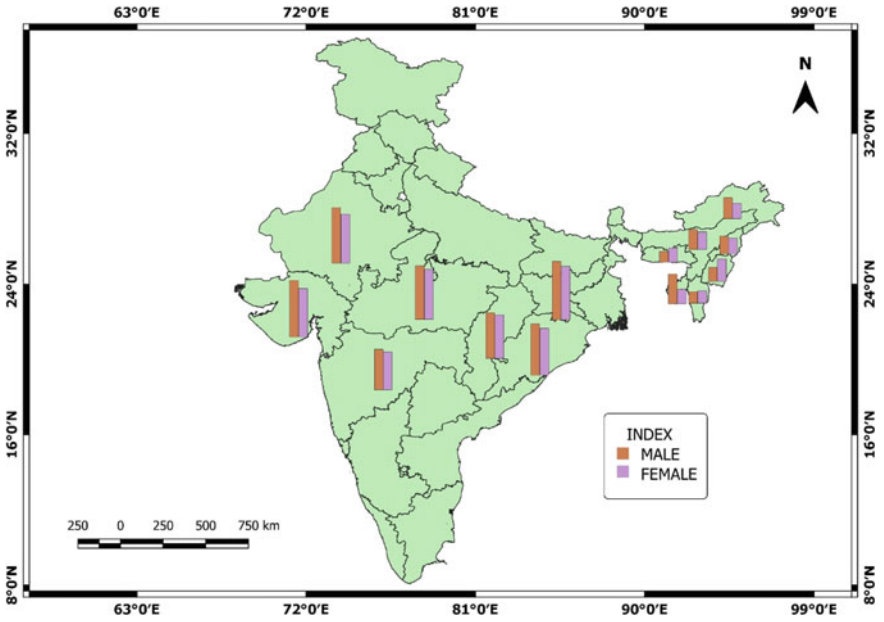


Fig. 6.3 Gender-wise underweight among major tribal states in India

years of age was malnourished (stunting/wasting/underweight) and 0 otherwise. This regression provides the odd ratios for each independent variable along with its level of statistical significance.

Children's malnutrition status varies by mother's education and nutritional levels, wealth quintile, sex of the child, and others factors. The odds of malnutrition status for tribal children were much higher for the mother with lower categories of education condition as compared to the higher category, for male children compared to female children, and for the lower wealth status compared to the richest wealth status, even when other factors were controlled for. As expected, the odds ratios were higher for children residing in the rural area, those belonging to small size at birth and less than 2.5 kg birth weight. The analysis suggests that the odds that female children were 23% stunting, 16% wasting, and 20% underweight lower than male children. Male tribal children raise the odds of malnutrition status even when mother's education, mother's nutrition, wealth, birth weight, birth size, children's age, breastfeeding, and birth order were controlled for.

6.4 Discussion and Conclusion

Malnutrition is one of the major public health problems in India, affecting the growth and development of children. The high prevalence of malnutrition in childhood can be a major cause of malnutrition later in life. Moreover, the high prevalence rate of malnutrition among marginal sections of India is a matter of concern, which adversely affects national development (Dave et al. 2016; Somawar and Phuljhale 2015; Manjunath et al. 2014). Although there are many studies on the high malnutrition rate of indigenous peoples at a different national and sub-national level, studies on the gender basis of malnutrition among tribal children are insufficient.

The study finds that the northeastern states, except Meghalaya, have lower rates of malnutrition among tribal children, while the central states of India have the highest prevalence of malnutrition (Dinachandra et al. 2015, Debnath and Bhattacharjee 2016). The study also finds a gender-based disparity in malnutrition levels among tribal children. In selected states with high tribal population, the nutritional status of female children is better than that of male children (Bhalani and Kotecha 2002; Harishankar et al. 2004; Banerjee and Bandyopadhyay 2005; Ndiklu et al. 2011; Jawaregowda and Angadi 2017). This study also addressed that mother's education and health status were important risk factors of children's malnutrition (Reddy et al. 2016; Islam et al. 2014). Children of higher educated women were less likely to be malnourished. Women having higher education are more aware of health care, feeding practice, and also personal hygiene.

The prevalence rate of malnutrition among children in tribal communities in the central states of India is still high, which indicates the reality of the effectiveness of our various nutrition programs. It is undeniable that indigenous children are at greater risk of malnutrition due to poverty and hunger, poor quality of essential food and nutrition services, loss of forest land and livelihood, geographical remoteness,

Table 6.3 Odds ratios from logistic regression of malnutrition status among tribal children for selected background characteristics in fourteen major tribal states, India, 2015–16

Background characteristics	Stunting		Wasting		Under-weight	
	OR	95% CI	OR	95% CI	OR	95% CI
Age in month						
< 6 [Ref.]	1.00		1.00		1.00	
06–08	0.87	[0.70, 1.02]	0.49	[0.38, 0.63]	0.93	[0.77, 1.12]
09–11	1.42	[1.12, 1.69]	0.42	[0.31, 0.58]	1.32	[1.07, 1.62]
12–17	2.18	[1.82, 2.54]	0.42	[0.32, 0.54]	1.24	[1.04, 1.48]
18–23	3.15	[2.63, 3.69]	0.42	[0.32, 0.54]	1.59	[1.33, 1.90]
24–35	2.60	[2.21, 3.03]	0.42	[0.33, 0.53]	1.73***	[1.46, 2.04]
36–47	2.78	[2.38, 3.27]	0.31	[0.24, 0.40]	1.79***	[1.51, 2.11]
48–59	2.36	[2.02, 2.79]	0.27***	[0.21, 0.34]	1.68***	[1.42, 1.99]
Sex of the child						
Male [Ref.]	1.00		1.00		1.00	
Female	0.77 ***	[0.72, 0.82]	0.84***	[0.76, 0.92]	0.80***	[0.75, 0.85]
Birth order						
1 [Ref.]	1.00		1.00		1.00	
2–3	1.06	[0.99, 1.14]	0.98	[0.88, 1.09]	0.99	[0.92, 1.06]
3 +	1.25**	[1.16, 1.39]	0.93**	[0.80, 1.08]	0.98	[0.89, 1.08]
Size at birth						
Very large [Ref.]	1.00		1.00		1.00	
Larger than average	1.02	[0.86, 1.20]	0.91	[0.69, 1.18]	1.05	[0.88, 1.26]
Average	1.17	[1.01, 1.37]	0.89**	[0.70, 1.13]	1.15	[0.98, 1.36]
Smaller than average	1.29	[1.08, 1.54]	1.09*	[0.82, 1.44]	1.21	[1.00, 1.46]
Very small	1.93***	[1.45, 2.52]	1.55***	[1.03, 2.31]	2.05***	[1.54, 2.73]
Birth weight						
< 2.5 kg [Ref.]	1.00		1.00		1.00	
> 2.5 kg	0.67**	[0.63, 0.72]	0.88**	[0.79, 0.99]	0.48***	[0.44, 0.51]
Place of residence						
Urban [Ref.]	1.00		1.00		1.00	
Rural	1.13***	[1.02, 1.23]	1.07***	[0.92, 1.24]	1.12**	[1.01, 1.24]
Mother's education						
No education [Ref.]	1.00		1.00		1.00	
Primary	0.96**	[0.87, 1.05]	0.70***	[0.60, 0.82]	0.81***	[0.73, 0.89]

(continued)

Table 6.3 (continued)

Background characteristics	Stunting		Wasting		Under-weight	
	OR	95% CI	OR	95% CI	OR	95% CI
Secondary	0.81***	[0.74, 0.88]	0.80**	[0.70, 0.92]	0.75***	[0.68, 0.81]
Higher	0.63***	[0.53, 0.74]	0.88**	[0.68, 1.13]	0.73***	[0.62, 0.88]
Mother's nutrition						
Underweight [Ref.]	1.00		1.00		1.00	
Normal weight	0.81	[0.75, 0.86]	1.11	[0.98, 1.23]	0.53***	[0.49, 0.56]
Over weight	0.63***	[0.55, 0.71]	1.06	[0.86, 1.31]	0.34***	[0.29, 0.39]
Breast feeding						
0–5 m [Ref.]	1.00		1.00		1.00	
6–12 m	0.88	[0.77, 1.02]	0.98	[0.78, 1.23]	1.02	[0.88, 1.18]
More than 12 m	0.96	[0.85, 1.08]	0.94	[0.76, 1.15]	1.14	[1.00, 1.30]
No breast feeding	0.89	[0.76, 1.04]	1.10	[0.85, 1.42]	0.93	[0.78, 1.10]
Wealth index						
Poorest [Ref.]	1.00		1.00		1.00	
Poorer	0.82	[0.76, 0.89]	0.84**	[0.73, 0.96]	0.68***	[0.63, 0.74]
Middle	0.72	[0.65, 0.79]	0.85	[0.76, 1.00]	0.52***	[0.47, 0.57]
Richer	0.54	[0.48, 0.61]	0.79**	[0.65, 0.96]	0.36***	[0.32, 0.42]
Richest	0.46***	[0.39, 0.55]	0.76**	[0.59, 0.97]	0.30***	[0.25, 0.36]

Note *$p < 0.1$, **$p < 0.05$ and ***$p < 0.01$; *Ref.* Reference, *OR* Odd Ratio; *CI* Confidence Interval

inadequate health care, lack of drinking water facilities, lack of sanitation practices and, above all, lack of parental education and awareness. However, it is important to strengthen the implementation of PDS in tribal areas to reduce the rate of malnutrition among children. In addition, the food Security Department must ensure that tribal families are not deprived of their entitled rations due to issues such as not having a ration card. State governments should also consider the importance of providing other nutritious food through PDSS in tribal areas to meet their nutritional needs. Moreover, there is a need to improve the socioeconomic status of the tribal population and to improve childcare and breastfeeding practices.

References

Banerjee B, Bandyopadhyay L (2005) Gender difference in nutritional status. Indian Pediatr 42:400

Bhalani KD, Kotecha PV (2002) Nutritional status and gender differences in the children of less than 5 years of age attending ICDS Anganawad's in Vadodara City. Indian J Community Med 27:124–129

Bhutta ZA, Gupta I, de'Silva H, Manandhar D, Awasthi S, Hossain SMM et al (2004) Maternal and child health: is South Asia ready for change? BMJ 328(3)
Chandramouli C, General R (2011) Census of India. Rural urban distribution of population, provisional population total. New Delhi: Office of the Registrar General and Census Commissioner, India
Das S, Sahoo H (2011) An investigation into factors affecting child undernutrition in Madhya Pradesh. Anthropologist 13(3):227–233
Dave PH, Mistry JJ, Chaudhary MK (2016) Assessment of nutritional status of tribal school going children of Sabarkantha District, Gujarat. Inter J Agri Sci 8:2308–2311
Debnath A, Bhattacharjee N (2016) Understanding malnutrition of tribal children in India: the role of women's empowerment. Taylor & Francis
Dinachandra Singh K, Alagarajan M, Ladusingh L (2015) What explains child malnutrition of indigenous people of Northeast India? PLoS ONE 10(6):e0130567
Endris N, Asefa H, Dube L (2017) Prevalence of malnutrition and associated factors among children in rural Ethiopia. BioMed Res Int
Gragnolati M, Shekar M, Das Gupta M, Bredenkamp C, Lee YK (2006) India's undernourished children: a call for reform and action. HNP discussion paper. The World Bank, Washington DC, USA
Haddad LJ, Ross JS (2004) 5th report on the world nutrition situation: nutrition for improved development outcomes (5). United Nations System Standing Committee on Nutrition (SCN)
Harishankar DS, Dabral SB, Walia DK (2004) Nutritional status of children under 6 years of age. Indian J Prev Soc Med 3(4):156–162
IIPS & ICF (2017) National family health survey (NFHS-4), 2015–16. IIPS, Mumbai. http://rchiips.org/nfhs/NFHS-4Reports/India.pdf
Islam S, Mahanta TG, Sarma R, Hiranya S (2014) Nutritional status of under 5 children belonging to tribal population living in riverine (Char) areas of Dibrugarh district, Assam. Indian J Community Med 39:169–174
Jawaregowda SK, Angadi MM (2017) Gender differences in nutritional status among under five children in rural areas of Bijapur district, Karnataka, India. Int J Community Med Public Health 2(4):506–509
Levitsky DA, Strupp BJ (1995) Malnutrition and the brain: changing concepts, changing concerns. J Nutr 125(8):2212S-2220S
Manjunath R, Kumar KJ, Kulkarni P, Begum K, Gangadhar MR (2014) Malnutrition among under-five children of Kadukuruba tribe: need to reach the unreached. J Clin Diagn Res 8:JC01–JC04
Mejía-Guevara I, Krishna A, Corsi DJ, Subramanian S (2015) Individual and ecological variation in child undernutrition in India: a multilevel analysis. J South Asian Dev 10(2):168–198
Mendez MA, Adair LS (1999) Severity and timing of stunting in the first two years of life affect performance on cognitive tests in late childhood. J Nutr 129(8):1555–1562
Ministry of Health & Family Welfare, Ministry of Tribal Affairs, Government of India (2011) Tribal health in India: bridging the gap and a roadmap for the future. Report of the expert Committee on tribal health
Ndiklu M, Siegl KJ, Singh P, Sabate J (2011) Gender inequalities in food intake and nutritional status of children under five years old in Rural Eastern Kenya. Eur J Clin Nutr 65:26–31
Rao VG, Yadav R, Dolla CK, Kumar S, Bhondeley MK, Ukey M (2005) Undernutrition and childhood morbidities among tribal preschool children. Indian J Med Res 122(1):43
Reddy VB, Kusuma YS, Pandav CS, Goswami AK, Krishnan A (2016) Prevalence of malnutrition, diarrhea, and acute respiratory infections among under-five children of Sugali tribe of Chittoor district, Andhra Pradesh, India. J Nat Sc Biol Med 7(2):155–160
Somawar BN, Phuljhale S (2015) Assessment of nutritional status amongst Bihor tribal children residing in Dharamjaigarh block of Raigarh district (C.G.), India. Inter J Res Med Sci 3:2820–2825
UNICEF (2009) Tracking progress on child and maternal nutrition: a survival and development priority, New York

Chapter 7
Food Processing and Nutrition Delivery

Nirali Dedhia and Narendra G. Shah

Abstract For centuries man has understood the importance of food, diet, and diversity to deliver the required nutrition. What one eats has a profound impact on an individual's health and well-being. Various data sources indicate that India is doing poorly in terms of correct deliveries of Recommended Dietary Allowances (RDA) in spite of the production of about 260 million tonnes of food grains (cereals, pulses, and oilseeds), about 300 million tonnes of fruits and vegetables, about 180 million tonnes of milk, 5.3 million tonnes of meat, and 75 billion eggs per year. Food and nutrition delivery systems have to cater to the adequacy of calories and proteins for energetic humans as well as provide required micronutrients (vitamins, minerals, and food fibres) for imparting immunity. Nutrient deficiency diseases create a burden on the economy on account of not-so-healthy manpower to contribute to national GDP as well as create a burden on "public-healthcare systems". Recent data on child malnutrition, infant mortality, and the prevalence of lifestyle diseases in India and other developing countries is evidence requiring serious attention of the scientific community, executive bodies, and the conscious efforts by individuals themselves. Health costs on the public exchequer finding "health services" and related infrastructure are high, and an "Economy-in transition" can ill afford "malnutrition" and increasing health issues during decades ahead. This chapter discusses the detailed food processing operations (covering farm-to-fork) that can work as a conduit to carry food products both in their natural forms and "minimal processing". Sensory appeal, tastes in particular, of the food is extremely important for the individuals in choosing food options in parallel with the nutrient content. The chapter further provides challenging opportunities in developing newer products to cater to this dual competing requirement towards meeting the goals of lifestyle and wellness world-over.

Keywords Macro- and micronutrient · Malnutrition · Farm-to-fork

N. Dedhia · N. G. Shah (✉)
Centre for Technology Alternatives for Rural Areas, Indian Institute of Technology—Bombay, Mumbai, India
e-mail: prof.narendra.shah@gmail.com

A. Grover et al. (eds.), *Sustainable Health Through Food, Nutrition, and Lifestyle*,
Advances in Geographical and Environmental Sciences,
https://doi.org/10.1007/978-981-19-7230-0_7

7.1 Introduction

Many modern-day developing economies are in a transition phase of economic development and struggling to improve the standard of living of their population. Such economies face a concern of a significant proportion of their population escaping fulfilment of required Recommended Dietary Allowance (RDA) in terms of macro- and micronutrients. Micronutrients such as zinc, iodine, iron, selenium, copper, vitamin A, B-complex, C, and D are known for public health importance (Company 1959). Their deficiencies, particularly in mothers, may have effects on longer-term outcomes of survival, cognition, and cardio-metabolic risk in the children. Addressing the nutritional needs of adolescent girls is equally important as they are future mothers. In the case of adolescent pregnancies, there is a competition of nutrients for maternal as well as foetal growth (Scholl et al. 1994). Considering an example of India, based on its National Family Health Survey (NFHS)-4 conducted in 2015–16, there is 38% and 36% existence of stunted growth and underweight status, respectively, in children below 5 years of age. Over 50% of Indian women are anaemic (National Family Health Survey 2016). In 2020, as per WHO fact sheets, globally, 149 million children below 5 years of age were estimated to be stunted, 45 million were estimated to be wasted, and 38.9 million were overweight or obese. Among adults, 1.9 billion are overweight or obese, and 462 million are underweight (Fact sheets—Malnutrition 2021). A survey in India confirms that maternal and childcare practices, maternal nutrition, maternal education, and socio-economic status, as well as, sanitation are high-risk factors contributing to stunting (Vir 2019). This indicates the immediate requirement of better solutions to tackle the problem of malnutrition. Although progress has been made in addressing micronutrient deficiency in recent years, improvements in South Asia have been too slow to meet Millennium Development Goal (MDG) targets. If current trends continue, SDG (achieving Zero Hunger) will also be missed by 2030 (Progress Towards the Sustainable Development Goals 2016). The children today will be the youth population in 1–2 decades. Any deficiencies in the diet at a young age shall result in a significant diminution in the productive capacity of an individual in adulthood and consequently reduce the Nation's economic growth and well-being.

The ex-Executive director of UNICEF, Carol Bellamy, has mentioned that it is no longer a question of treating severe deficiency in individuals. It is a question of reaching out to whole populations to protect them against the devastating consequences of even moderate forms of vitamin and mineral deficiency. Micronutrients are present in natural food sources such as fruits, vegetables, milk, poultry, meat, legumes, and cereals. However, the accessibility and affordability of all these food sources to the rural population are scant. This aforementioned problem has led to the compromised health of women and, subsequently, their children. The medical and health professionals are currently posturing to address malnutrition by supplementing with appropriate doses of the micronutrients. The authors are making a strong pitch for food-based micronutrient fulfilment recommended through RDA norms.

Agricultural and animal husbandry produce are the primary source of macro and micronutrients for the most part of the population in developing economies. In spite of the production of about 260 million tonnes of food grains (cereals, pulses, and oilseeds), about 300 million tonnes of fruits and vegetables, about 180 million tonnes of milk, 5.3 million tonnes of meat, and 75 billion eggs per year, India faces a grave challenge of a significant proportion of the population being micronutrient deficient. The mission of food safety in 1960–70 has changed its orientation to nutrition safety after many countries have achieved self-sufficiency in food production. There are various community as well as household-level strategies that are being adopted by various countries for tackling the macro- and micronutrient deficiencies. For example, the fortification of food is a promising way to reach out to the needy population. While micronutrient-fortified foods are available (Vir 2019) and also prepared by various organizations to meet the nutritional needs, the data on the prevalence of malnutrition points to inadequate intakes (Smith 2015). Some foods face challenges for acceptability due to the selected food vehicle or generated off-taste. Food-eating preferences indicate more acceptability of culture-centric traditional foods. Research initiatives suggest that multiple strategies may be required to address iron deficiency or anaemia as an intervention involving rice fortification with iron did not remove the anaemia risk altogether (Peña-Rosas et al. 2019). The current goal-a target for food processing (Fig. 7.1) provides guidelines to decisions and policymakers to devise ways to guide and regulate food and nutrition delivery systems.

This chapter discusses some novel food processing techniques that aid in better nutrition uptake and tackling macro- and micronutrient malnutrition at community and household levels. Challenges associated with some food processing techniques from a nutrition point of view are also highlighted. The chapter also discusses the various nutrient delivery techniques that have been developed with novel techniques that can aid in supplementing the diet with various micronutrients, especially for individuals deficient in required micronutrients.

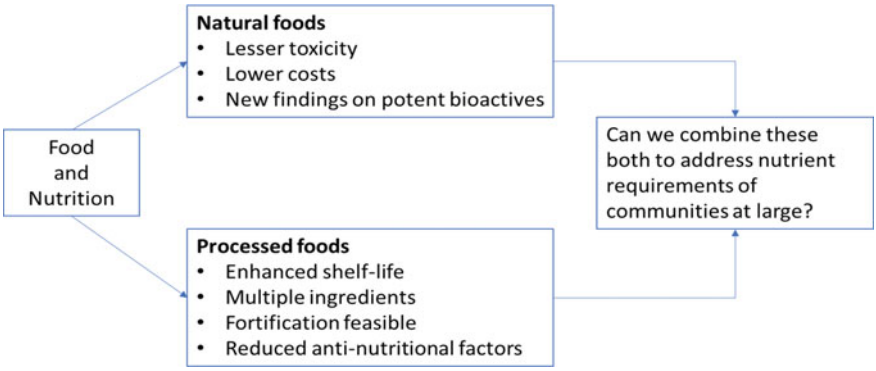


Fig. 7.1 Current goal-target for food processing

7.2 Food Processing Techniques to Enhance Nutrition Delivery

The food matrix is highly influential in determining the fate of the nutrient in the human body upon ingestion (Fardet 2015). The constituents of the food matrix affect nutrient absorption in the body by (i) influencing the digestion process-how easily the enzymes can enter the matrix and act on it to release the nutrients, (ii) certain compounds hamper the action of digestive enzymes, in turn affecting the release of nutrients, and (iii) certain compounds conjugate with nutrients to hamper their absorption in the body. Various food processing techniques are adapted to alter this food matrix and hence enhance the delivery of nutrients. The section below provides a classification of conventional (simple, popularly followed at commercial and household levels) and non-conventional (novel) techniques available in the domain of food processing to deliver nutrients effectively.

7.2.1 Conventional Techniques

7.2.1.1 Soaking

Soaking as a treatment involves soaking seeds or flour of cereals, legumes, and millets in water to reduce cooking time and soften texture prior to germination or cooking (Fardet 2015). The prolonged treatment leads to diffusion into the water of phytates or their degradation by phytase enzyme from the legume and cereal flours. Diffusion of glycosides, alkaloids, oligosaccharides, saponins, polyphenols, and oxalates have been reported for soaked seeds. The extent of removal depends on species, pH of soaking water, and length and conditions of soaking. (Gibson et al. 2006). When almonds, hazelnuts, peanuts, and walnuts were soaked to activate or decrease the phytate content, this was not observed to be the case (Kumari et al. 2020). Soaking causes losses in minerals, proteins, and carbohydrates, which varies with the soaking condition. It, however, improves protein digestibility. Both these vary with soaking conditions (Nestares et al. 2003). Thus, an optimum balance of losses of nutrients, improved digestibility, and reduction of anti-nutritional factors need to be achieved for the desired delivery of nutrients.

7.2.1.2 Cooking

Cooking of food is a popularly used technique performed to improve digestibility, palatability, texture while reducing the content of certain anti-nutritional factors. Cooking affects the food matrix components, which otherwise influence the digestion of other components. Cooking processes can lead to cell rupture, denaturation of proteins, or degradation of heat-sensitive nutrients and thus influence their availability

for enzymatic action in the digestive tract and subsequent absorption (Zaccari et al. 2015). Hot water cooking of bovine liver led to increasing levels of bioaccessible minerals except for zinc. The heating processes lead to the formation of Maillard products that reduce the binding between protein nitrogen and minerals, increasing the bioaccessibility of the latter (da Silva et al. 2017). Steam-assisted cooking has been reported to decrease or increase the β-carotene, calcium, magnesium, and zinc content of carrots and increase their bioaccessibility by 3–16 times depending on the variety (Zaccari et al. 2015). *Oudemansiella radicata* mushrooms subjected to boiling, steaming, frying, and microwaving showed a decrease in content as well as bioaccessibility of minerals due to their leaching or interaction with other food components (Liu et al. 2021). Thus, the availability of nutrients from a food matrix after cooking is highly influenced by physico-chemical changes.

7.2.1.3 Germination

The process of germination of a seed marks the end of its dormancy. Germination leads to regrowth which is characterized by the appearance of sprouts, followed by biochemical processes that lead to hydrolysis of various nutrients. It involves three stages, viz. water uptake by seed, reduction in water uptake, and final increase in water uptake along with protrusion of radicle from seed coat (Ohanenye et al. 2020). During this process, the complex interactions among the macromolecules, antinutritional factors, phytochemicals, and micronutrients are reduced, making the nutrients more available for digestion and subsequent systemic uptake (Nkhata et al. 2018). Germinated rice, when used for the preparation of gluten-free bread, has been shown to improve the content of protein, lipids, γ-aminobutyric acid, and polyphenols, increase antioxidant activity and reduce phytic acid content and glycaemic index with a slight decrease in in-vitro protein digestibility. These improvements have been attributed to the enzymatic activity during the germination process (Cornejo et al. 2015). Germination improves the dietary fibre, bioactive and mineral content of legumes and millets as well (Sharma et al. 2016; Chinma et al. 2021). Phytic acid and tannins are known to negatively impact mineral, protein, starch, and amino acid absorption. Thus, germination decreases the content of these compounds, paving the way for improved nutrient uptake. Activation of grain enzymes such as amylases and proteases leads to changes in starch and protein digestion. Studies show that starch hydrolysis may be delayed due to resistant starch formation since the amylase preferentially attacks the amorphous starch region. Thus, though the free glucose content may increase after germination, the glycemic response may not (Cornejo et al. 2015). Germination as a food processing technique is thus important from a nutrition as well as a functional point of view. It can be conducted at the household level before flour milling. This makes it an easily adaptable technique for community-level use (Gibson et al. 2006) as well.

7.2.1.4 Fermentation

Fermentation is a technique of food processing and preservation that has been used by humans for centuries, such as pickling, cheese, and winemaking. Fruits, vegetables, tubers, grains, and animal products have been subjected to fermentation for reasons of culinary appeal, nutrition, and preservation (Shah and Singhal 2017). The process imbibes unique aroma, flavour, and texture to food while improving its digestibility, degrading anti-nutritional factors, toxins and allergens, transforming phytochemicals into more bioactive and bioavailable forms, and improving the nutritional quality of food. This process also modifies the physical functional properties of food materials due to structural changes in the constituents (Shiferaw Terefe and Augustin 2020). The consumer trend is inclining towards more natural foods (Roman et al. 2017). Thus, this will increase the trend towards the biological enrichment of foods for their vitamins and essential amino acids. Lactic acid bacteria, *Bacillus* spp., certain yeasts, and moulds are the micro-organisms responsible for controlled and uncontrolled fermentation of foods. Desirable and controlled fermentation of foods by micro-organisms produces compounds that are nutritious, whereas uncontrolled fermentation processes by pathogenic micro-organisms may lead to infections, allergies, and toxication (Steinkraus 1997). Traditional knowledge of ethnic fermented foods comes in handy. For example, reports on fermented local fruits, vegetables, tubers, meat, dairy, and seafood suggest the production of micronutrients and bioactive with improved shelf-life of the product (Tamang 2009; Shah and Singhal 2017). By-products of the food industry which generally go for animal feed or fuel applications can be subjected to fermentation processes using suitable starter cultures to help extract materials that can be reused as ingredients in the food industry (Verni et al. 2019).

7.2.1.5 Malting

Malting is a technique that involves steeping in water, germination, and kilning. It is generally performed for barley for the subsequent production of alcoholic (Hardwick 1994) and malted beverages (Wee et al. 2020). Many millets and cereals have also been malted as a part of traditional cuisines or with the intention of improving the nutritive value. Malted flours are generally used in the preparation of weaning and geriatric foods due to their improved nutrient content and digestibility. The enzyme activation and associated function during the germination process cause degradation of proteins and polysaccharides, antinutritional factors. These lead to the production of foods with high nutrient density, low viscosity, and easy digestibility. All of these are important while designing foods for infants and the aged population (Platel et al. 2010; Najdi Hejazi and Orsat 2017). Cereals and legumes are stapling foods in the diet of developing country populations. They are also the main sources of minerals such as iron and zinc, whose bioaccessibility is reported to improve with malting (Platel et al. 2010; Hassani et al. 2016). Malting can be equally performed for indigenous millets to enhance the bioavailability of their nutrients (Tharifkhan et al. 2021).

Thus, the malting technique is being popularly used and could be promoted further in developing countries for populations with nutrient and calorie-deficient diets.

7.2.2 Non-conventional Processing Techniques

7.2.2.1 Food-to-Food Fortification

Food fortification has been considered a pertinent and preventive approach against malnutrition caused by micronutrient deficiencies. This technique involves fortifying or enriching a micronutrient in a suitable food vehicle which is generally a staple in the diet of the deficient population (Bhagwat et al. 2014). Classical examples include the fortification of common salt with iodine and iron, wheat flour with folic acid and cooking oil with vitamins A and D, milk with vitamin D, etc. This technique has its own merits and shortcomings. Technology-wise using a micronutrient form that is more bioavailable but may be less stable to processing may affect sensory properties or increase the cost. Sometimes, the inaccessibility of fortified staples to the target population is of concern. In such a scenario, food-to-food fortification (FtFF), wherein fortifying agent is another food item rich in the desired micronutrient(s) and locally available, proves helpful. Raw materials used to prepare such foods are locally available and help reduce costs (Chadare et al. 2019). FtFF has been defined as "the addition of micronutrient-dense food/s to a recipe (at household level) or food formulation (food industry level), or the replacement of micronutrient-poor/antinutrient-rich ingredients, to substantially increase the amount of bioavailable micronutrient/s, with the aim of improving the micronutrient status of populations where the intake of bioavailable micronutrients is inadequate" (Kruger et al. 2020). Combinations of foods can be developed for improving the mineral, vitamin, and protein content of the blend. Mineral and vitamin levels can be enhanced by using leaf, vegetable, and fruit extracts (moringa, amaranth, sorrel, Ceylon spinach, sesame seed, cumin seeds, baobab fruit pulp, carrot powder, etc.), and protein levels of staple flours can be improved by the addition of legume, insect sources (soy flour, mopane worm). Some studies report good bioaccessibility of minerals from these sources in the food matrix (Jain 2013; Icard-Vernière et al. 2015; Gabaza et al. 2018; Agrahar-Murugkar 2020; Ndiaye et al. 2020). A study in 8–10 year-old-girls on iron food-to-food fortification by the addition of Niger seeds or soybean flour and fermented foods along with lemon consumption in study group reports sustained increase of haemoglobin levels compared to the study group intervened with iron-folic acid tablets (Jain 2013).

7.2.2.2 Emerging Sophisticated Food Processing Techniques

Minimal and emerging processing technologies such as vacuum, freeze-drying, high pressure, microwave, and ultrasound techniques are being attempted by the food industry for the processing of foods. These techniques have the advantage of

causing minimal nutritional loss along with reduced energy consumption. Ultrasound processing, which involves exposing the food material to a frequency range between 20 and 1000 kHz for preservation, causes minimal nutritional damage to fruit juices (Ojha et al. 2018). Microwave treatment, which is used as an emerging sterilization technique, has been reported for minimal nutritional loss in fruits (Chizoba Ekezie et al. 2017). The freeze-drying technique for drying fresh produce also causes a lower reduction in levels of vitamin C (Harguindeguy and Fissore 2020). High hydrostatic pressure-aided soaking has been evaluated for soaking of cereals and millets prior to germination, the pressure treatment has been reported to cause improved water absorption in the millets in a short time (Sharma et al. 2018). This technique is also suggested as a cold pasteurization technique for plant and animal-based foods (Salvi et al. 2016).

7.3 Dietary Diversity as a Strategy to Tackle Malnutrition

Dietary diversity can be defined as diet quality indices used to evaluate nutrient adequacy and overall diet quality. Dietary diversity has been known as a key index of high diet quality in various populations (Salehi-Abargouei et al. 2016). It is a food-based strategy to check micro and macronutrient deficiency in the diet of deficient populations mainly belonging to economically poorer backgrounds or those who have lesser access to fortified foods. The success of the technique lies in integrating it with the principles of bioavailability, interpreted to efficient food synergies with importance to food accessibility, affordability, and outdoor physical activity/lifestyle modifications (Nair et al. 2015). The strategy has long-term sustainability, though takes longer for effect. Partial replacement in the diet helps to avoid drastic dietary changes that improve its acceptability. Using participant counselling methods to improve diet, synergistic combination of foods to enhance nutrient uptake, and diversifying the plate with the incorporation of legumes, vegetables, fruits, and animal-source foods are a part of this strategy. Partial replacement of plant-based relish and unsoaked-maize porridge in the diet of Malawian students with fish-based relish and soaked-maize porridge showed potential improvement in bioavailability of iron and zinc (Gibson and Hotz 2001). Dietary diversification by incorporation of salad, green leafy vegetables, and lemon in the diet of rural women of childbearing age in India has been demonstrated to reduce the prevalence of anaemia (Rao et al. 2014).

7.4 Nutrient Delivery Systems

Nutrient delivery systems mainly focus on providing the nutrients in a form that makes them stable, more soluble, easily absorbable, along with the minimum impact on the sensory profile of the matrix. Macronutrients such as carbohydrates, fats, and proteins should be consumed through food sources unless the requirements are very

high and supplementation is required. Most vitamins, minerals, and essential fatty acids are available from plant and animal food sources. However, in situations where populations face severe deficiency and disorders, supplementation using concentrated, extracted, or synthetic forms becomes inevitable. In such scenarios where the vitamin, mineral, or essential fatty acid is removed from its native matrix and isolated, there is lowered solubility, stability, and absorption capacity. The development and formulation of matrices for delivering these nutrients become important. The necessity for such delivery forms arises when: the micronutrient is unstable to heat, light, or air (such as vitamin A, B-complex, C, D, docosahexaenoic acid, eicosapentaenoic acid), lipophilic (Vitamins A, D, E, K), and hence insoluble in the physiological conditions for absorption, the synthetic form has lower absorption capacity (such as folic acid versus folate, haeme iron versus non-haeme iron), it hampers the taste, colour, and flavour (such as certain iron, calcium salts) of the fortification matrix in which it is added. The delivery form should thus suffice for two or more of the aforementioned difficulties to justify the added cost of the formulations. Figure 7.2 depicts the schematic representation of various vitamin and mineral delivery systems.

Vitamins and minerals in the various protected forms can be consumed as supplements or added to various food matrices such as staples or popularly consumed foods for their delivery to deficient populations. A few techniques (Table 7.1) of the formulation can be used for vitamins, essential fatty acids, and mineral formulations as a part of their delivery system. The technique generally involves encapsulation, i.e.

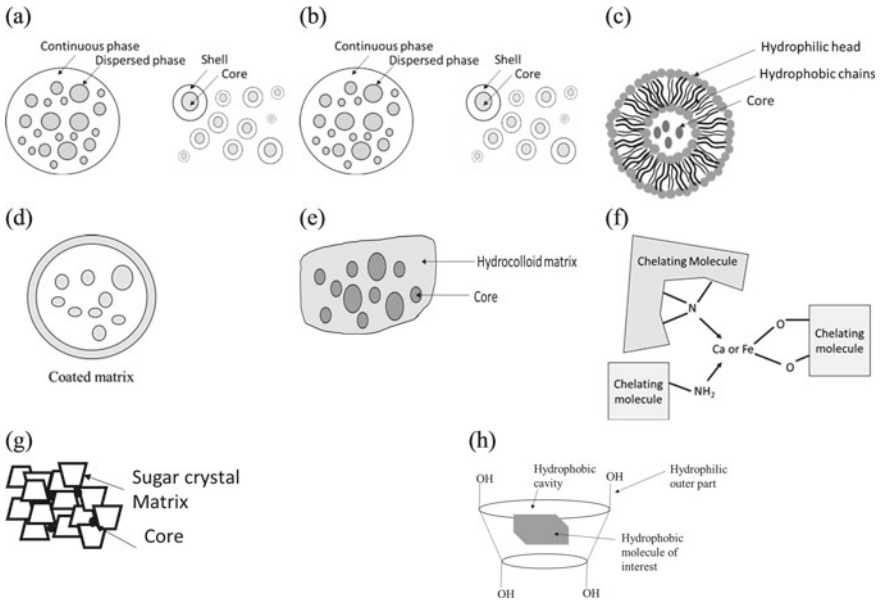


Fig. 7.2 Schematic presentation of different techniques of encapsulation of vitamins and minerals such as **a** microcapsules, **b** nanoemulsions, **c** liposomes, **d** extrudates, **e** co-acervates, **f** chelates, **g** co-crystallites, and **h** inclusion complexes. *Source* Created by the authors

macromolecules such as polysaccharides, peptides, and fats for coating the vitamin or mineral in a protective case. The methods of formation of such cases vary, and each technique has its merit and demerit. The selection of the technique depends on various factors such as the nature of nutrient(s) to be delivered, cost of production, desired stability, matrix effects, and interactions with the system around (Dordevic et al. 2015; Augustin and Sanguansri 2017). Nanotechnology is a relatively newer development extended for nutrient delivery of encapsulates synthesized as nanoform or in nano-dimensions. This nanoscale system is gaining popularity due to its reported improved bioavailability and stability. However, the cost of production and possible toxicity limits the applications. Ongoing research does focus on addressing these concerns (Joye et al. 2014).

7.5 Challenges in Food Processing Towards Nutrient Delivery

The following are the main challenges in the processing of foods intended for improved nutrition:

(i) Changes in the content of heat-labile ingredients during processing
(ii) Spoilage due to improper processing
(iii) Consumer resistance to preservatives added to enhance shelf-life of foods
(iv) Changes in sensory properties due to the fortification of foods
(v) Justification of the cost of processing
(vi) Preference for fresh vis-à-vis processed foods.

Foods that have been processed by germination, malting, and cooking (canning, pasteurization) face the challenge of losing labile vitamins during their further processing (Henry and Heppell 2002) if they have been produced at a commercial scale and intended for prolonged shelf-life. The canning process, a type of in-process partial cooking of legumes, leads to the loss of vitamin C (Rigaux et al. 2016). Germinated legumes are highly nutritious. Albeit, if they are not germinated properly, they are prone to microbial contamination by *Salmonella* species and *Escherichia coli*. Seed disinfection appropriate packaging and storage systems are needed for safe and hygienic delivery of the sprouted products to the masses (Ding et al. 2013).

Food preservatives, added under the purview of regulations, are a safe practice to preserve the eating quality of food. Consumers can have aversions towards chemical preservatives used (Perito et al. 2020). For example, when malted flours are sold as commercial products, preservatives may be added to prolong their shelf-life. In such cases, based on economics, bio-preservatives may be used to keep cleaner labels and improve consumer acceptability (Sruthi and Rao 2021).

Fortification of foods with iron to address anaemia has its drawbacks. Iron can cause the oxidation of lipids present in food. It also adds to a metallic aftertaste. The sensory-related challenges can be tackled by using encapsulated forms of iron salts (Martínez-Navarrete et al. 2002).

Table 7.1 Different techniques of encapsulation for the delivery of vitamins and minerals

Delivery system	Process	Example	Benefits	Reference
Microcapsules	Spray-drying or spray-cooling, or spray-chilling (sensitive vitamins, minerals) techniques can be used	Ferrous sulphate microencapsulation in maltodextrin + gum Arabic + modified starch matrix by spray-chilling	Higher sensory scores to mask the metallic taste, better in vitro bioavailability, useful in milk fortification	Gupta et al. (2015)
Nanoemulsions	Micellar formation Self-emulsification with surfactant and co-surfactant or ultrasonication	Lipophilic vitamins	Increased bioavailability and bioaccessibility of the vitamins	Öztürk (2017)
Liposomes	Microfluidization Ultrasonification Reverse-phase evaporation	Sodium ascorbate liposome with phospholipids	1.77 times more bioavailable, uniform particle size	Gopi and Balakrishnan (2020)
Extrudates	Dispersion of vitamins minerals into the matrix and extrusion Cooling of core-coated matrix	Rice extrudates containing vitamin B_{12} in the presence of hydrocolloids	Good retention, snack form of fortified food	Bajaj and Singhal (2019)
Co-acervates	Formation of three immiscible chemical phases Deposition/precipitation of coating in solution with entrapped core Solidification of coating	Retinyl palmitate coacervation with gum acacia–gelatin	Improved stability, aid in handling and incorporation in preparations	Junyaprasert et al. (2001)
Chelates	Co-ordination chelates of Ca or Fe with ethylene-diamine tetra-acetic acid or peptides or sugars or amino acids	Ca or Fe chelates with peptides plant or animal protein hydrolysates	Stability, enhanced absorption, and bioavailability in vitro and in vivo systems	Walters et al. (2018)
Co-crystallites	Preparation of supersaturated sucrose solution followed by addition of core Release of substantial heat after solution reaches the sucrose crystallization temperature	Vitamin B_{12} co-crystallized with sucrose in the presence of gum acacia	Improved stability, simple, convenient, scalable technique	Bajaj and Singhal (2021)

(continued)

Table 7.1 (continued)

Delivery system	Process	Example	Benefits	Reference
Inclusion complexes	Preparation of complexes by mixing or grinding, or spray drying Vitamin complexation in the cavity	Cholecalciferol, ascorbic acid, and α-tocopherol inclusion complex with α, β, γ-cyclodextrin	Enhanced solubility and stability of vitamins	Braithwaite et al. (2017)

7.6 Summary

In scenarios where community-based food programmes are followed and where means are scarce, the conventional techniques of food processing that reduce antinutritional factors and increase nutrients can come to the rescue. Also, the conventional food processing techniques are age-old ones and only require awareness and wide-scale adoption. These techniques use local foods with minimal change in diets. They are hence culture-centric and can have better acceptability than the addition of "foreign" fortified foods in the diet of indigenous populations. Novel food processing techniques, such as microwave processing, fortification with microencapsulationed micronutrients, need to prove techno-economics for wider acceptance. An understanding of both conventional and novel food processing techniques and various nutrient delivery systems (food-to-food fortification, etc.) indicates that combination methods may be helpful in tackling the issue of nutrient deficiency in populations across various countries and communities.

References

Agrahar-Murugkar D (2020) Food to food fortification of breads and biscuits with herbs, spices, millets, and oilseeds on bio-accessibility of calcium, iron, and zinc and impact of proteins, fat and phenolics. LWT 130:109703. https://doi.org/10.1016/j.lwt.2020.109703

Augustin MA, Sanguansri L (2017) Microencapsulation technologies. In: Roos YH, Livney YD (eds) Engineering foods for bioactives stability and delivery. Springer New York (Food Engineering Series), New York, NY, pp 119–142. https://doi.org/10.1007/978-1-4939-6595-3_4

Bajaj SR, Singhal RS (2019) Effect of extrusion processing and hydrocolloids on the stability of added vitamin B12 and physico-functional properties of the fortified puffed extrudates. LWT. http://agris.fao.org/agris-search/search.do?recordID=US201900145784. Accessed 6 Nov 2019

Bajaj SR, Singhal RS (2021) Enhancement of stability of vitamin B12 by co-crystallization: a convenient and palatable form of fortification. J Food Eng 291:110231. https://doi.org/10.1016/j.jfoodeng.2020.110231

Bhagwat S et al (2014) Food fortification as a complementary strategy for the elimination of micronutrient deficiencies: case studies of large-scale food fortification in two Indian States. Asia Pac J Clin Nutr 23(1):S4–S11. https://doi.org/10.6133/apjcn.2014.23.s1.04

Braithwaite MC et al (2017) A novel multi-tiered experimental approach unfolding the mechanisms behind cyclodextrin-vitamin inclusion complexes for enhanced vitamin solubility and stability. Int J Pharm 532(1):90–104. https://doi.org/10.1016/j.ijpharm.2017.08.109

Chadare FJ et al (2019) Conventional and food-to-food fortification: an appraisal of past practices and lessons learned. Food Sci Nutr 7(9):2781–2795. https://doi.org/10.1002/fsn3.1133

Chinma CE et al (2021) Effect of germination on the physicochemical, nutritional, functional, thermal properties and in vitro digestibility of Bambara groundnut flours. LWT 140:110749. https://doi.org/10.1016/j.lwt.2020.110749

Chizoba Ekezie FG et al (2017) Microwave-assisted food processing technologies for enhancing product quality and process efficiency: a review of recent developments. Trends Food Sci Technol 67:58–69. https://doi.org/10.1016/j.tifs.2017.05.014

Company HJH (1959) The Heinz handbook of nutrition: a comprehensive treatise on nutrition in health and disease. Blakiston Division, McGraw-Hill

Cornejo F et al (2015) Effects of germination on the nutritive value and bioactive compounds of brown rice breads. Food Chem 173:298–304. https://doi.org/10.1016/j.foodchem.2014.10.037

da Silva FLF et al (2017) Comparison between boiling and vacuum cooking (sous-vide) in the bioaccessibility of minerals in bovine liver samples. Food Res Int 100:566–571. https://doi.org/10.1016/j.foodres.2017.07.054

Ding H, Fu TJ, Smith MA (2013) Microbial contamination in sprouts: how effective is seed disinfection treatment? J Food Sci 78(4):R495–R501. https://doi.org/10.1111/1750-3841.12064

Dordevic V et al (2015) Trends in encapsulation technologies for delivery of food bioactive compounds. Food Eng Rev 7(4):452–490. https://doi.org/10.1007/s12393-014-9106-7

Fact sheets—Malnutrition (2021) https://www.who.int/news-room/fact-sheets/detail/malnutrition. Accessed 23 Jun 2021

Fardet A (2015) A shift toward a new holistic paradigm will help to preserve and better process grain products' food structure for improving their health effects. Food Funct 6(2):363–382. https://doi.org/10.1039/c4fo00477a

Gabaza M et al (2018) Baobab fruit pulp and mopane worm as potential functional ingredients to improve the iron and zinc content and bioaccessibility of fermented cereals. Innov Food Sci Emerg Technol 47:390–398. https://doi.org/10.1016/j.ifset.2018.04.005

Gibson RS, Hotz C (2001) Dietary diversification/modification strategies to enhance micronutrient content and bioavailability of diets in developing countries. Br J Nutr 85(2):S159-166. https://doi.org/10.1079/bjn2001309

Gibson RS, Perlas L, Hotz C (2006) Improving the bioavailability of nutrients in plant foods at the household level. Proc Nutr Soc 65(2):160–168. https://doi.org/10.1079/pns2006489

Gopi S, Balakrishnan P (2020) Evaluation and clinical comparison studies on liposomal and non-liposomal ascorbic acid (vitamin C) and their enhanced bioavailability. J Liposome Res 1–9.https://doi.org/10.1080/08982104.2020.1820521

Gupta C et al (2015) Iron microencapsulation with blend of gum arabic, maltodextrin and modified starch using modified solvent evaporation method—milk fortification. Food Hydrocolloids 43:622–628. https://doi.org/10.1016/j.foodhyd.2014.07.021

Hardwick W (1994) Handbook of brewing. CRC Press

Harguindeguy M, Fissore D (2020) On the effects of freeze-drying processes on the nutritional properties of foodstuff: a review. Drying Technol 38(7):846–868. https://doi.org/10.1080/07373937.2019.1599905

Hassani A, Procopio S, Becker T (2016) Influence of malting and lactic acid fermentation on functional bioactive components in cereal-based raw materials: a review paper. Int J Food Sci Technol 51(1):14–22. https://doi.org/10.1111/ijfs.12965

Henry CJK, Heppell N (2002) Nutritional losses and gains during processing: future problems and issues††. Proc Nutr Soc 61(1):145–148. https://doi.org/10.1079/PNS2001142

Icard-Verniere C et al (2015) Contribution of leafy vegetable sauces to dietary iron, zinc, vitamin A and energy requirements in children and their mothers in Burkina Faso. Plant Foods Hum Nutr 70(1):63–70. https://doi.org/10.1007/s11130-014-0462-5

Jain M (2013) Combating iron deficiency anaemia through food-to-food fortification: recipe development, iron bioavailability and effect of supplementation. Int J Food Nutr Sci 2(1):93

Joye IJ, Davidov-Pardo G, McClements DJ (2014) Nanotechnology for increased micronutrient bioavailability. Trends Food Sci Technol 40(2):168–182. https://doi.org/10.1016/j.tifs.2014.08.006

Junyaprasert VB et al (2001) Effect of process variables on the microencapsulation of vitamin A palmitate by gelatin-acacia coacervation. Drug Dev Ind Pharm 27(6):561–566. https://doi.org/10.1081/DDC-100105181

Kruger J et al (2020) What is food-to-food fortification? A working definition and framework for evaluation of efficiency and implementation of best practices. Compr Rev Food Sci Food Saf 19(6):3618–3658. https://doi.org/10.1111/1541-4337.12624

Kumari S et al (2020) Does "activating" nuts affect nutrient bioavailability? Food Chem 319:126529. https://doi.org/10.1016/j.foodchem.2020.126529

Liu Y et al (2021) Processing of four different cooking methods of *Oudemansiella radicata*: effects on in vitro bioaccessibility of nutrients and antioxidant activity. Food Chem 337:128007. https://doi.org/10.1016/j.foodchem.2020.128007

Martínez-Navarrete N et al (2002) Iron deficiency and iron fortified foods-a review. Food Res Int 35(2):225–231. https://doi.org/10.1016/S0963-9969(01)00189-2

Nair MK, Augustine LF, Konapur A (2015) Food-based interventions to modify diet quality and diversity to address multiple micronutrient deficiency. Front Public Health 3:277. https://doi.org/10.3389/fpubh.2015.00277

Najdi Hejazi S, Orsat V (2017) Optimization of the malting process for nutritional improvement of finger millet and amaranth flours in the infant weaning food industry. Int J Food Sci Nutr 68(4):429–441. https://doi.org/10.1080/09637486.2016.1261085

National Family Health Survey (2016). Available at: http://rchiips.org/NFHS/nfhs4.shtml. Accessed 20 Aug 2018

Ndiaye C et al (2020) Effect of edible plant materials on provitamin A stability and bioaccessibility from extruded whole pearl millet (P. typhoides) composite blends. LWT 123:109109. https://doi.org/10.1016/j.lwt.2020.109109

Nestares T et al (2003) Effect of different soaking solutions on nutritive utilization of minerals (calcium, phosphorus, and magnesium) from cooked beans (*Phaseolus vulgaris* L.) in growing rats. J Agric Food Chem 51(2):515–520. https://doi.org/10.1021/jf020693y

Nkhata SG et al (2018) Fermentation and germination improve nutritional value of cereals and legumes through activation of endogenous enzymes. Food Sci Nutr 6(8):2446–2458. https://doi.org/10.1002/fsn3.846

Ohanenye IC et al (2020) Germination as a bioprocess for enhancing the quality and nutritional prospects of legume proteins. Trends Food Sci Technol 101:213–222. https://doi.org/10.1016/j.tifs.2020.05.003

Ojha KS, Tiwari BK, O'Donnell CP (2018) Chapter six—effect of ultrasound technology on food and nutritional quality. In: Toldrá F (ed) Advances in food and nutrition research. Academic Press, pp 207–240. https://doi.org/10.1016/bs.afnr.2018.01.001

Ozturk B (2017) Nanoemulsions for food fortification with lipophilic vitamins: production challenges, stability, and bioavailability. Eur J Lipid Sci Technol 119(7):1500539. https://doi.org/10.1002/ejlt.201500539

Pena-Rosas JP et al (2019) Fortification of rice with vitamins and minerals for addressing micronutrient malnutrition. Cochrane Database Syst Rev 2019(10). https://doi.org/10.1002/14651858.CD009902.pub2

Perito MA et al (2020) Factors influencing consumers attitude towards biopreservatives. Sustainability 12(24):10338. https://doi.org/10.3390/su122410338

Platel K, Eipeson SW, Srinivasan K (2010) Bioaccessible mineral content of malted finger millet (*Eleusine coracana*), wheat (*Triticum aestivum*), and barley (*Hordeum vulgare*). J Agric Food Chem 58(13):8100–8103. https://doi.org/10.1021/jf100846e

Progress Towards the Sustainable Development Goals (2016) United nations economic and social council. https://unstats.un.org/sdgs/files/report/2016/secretary-general-sdg-report-2016--EN.pdf

Rao S et al (2014) Dietary diversification for prevention of anaemia among women of childbearing age from rural India. Public Health Nutr 17(4):939–947. https://doi.org/10.1017/S1368980013001006

Rigaux C et al (2016) A mechanistic and probabilistic model estimating micronutrient losses in industrial food processing: vitamin C and canned green beans, a case-study. LWT Food Sci Technol 69:236–243. https://doi.org/10.1016/j.lwt.2016.01.051

Roman S, Sanchez-Siles LM, Siegrist M (2017) The importance of food naturalness for consumers: results of a systematic review. Trends Food Sci Technol 67:44–57. https://doi.org/10.1016/j.tifs.2017.06.010

Salehi-Abargouei A et al (2016) Dietary diversity score and obesity: a systematic review and meta-analysis of observational studies. Eur J Clin Nutr 70(1):1–9. https://doi.org/10.1038/ejcn.2015.118

Salvi D, Gosavi NS, Karwe MV (2016) High pressure cold pasteurization. In: Reference module in food science. Elsevier.https://doi.org/10.1016/B978-0-08-100596-5.21075-5

Scholl TO et al (1994) Maternal growth during pregnancy and the competition for nutrients. Am J Clin Nutr 60(2):183–188. https://doi.org/10.1093/ajcn/60.2.183

Shah N, Singhal RS (2017) Fermented fruits and vegetables. In: Current developments in biotechnology and bioengineering. Elsevier, pp 45–89.https://doi.org/10.1016/B978-0-444-63666-9.00003-0

Sharma S, Saxena DC, Riar CS (2016) Analysing the effect of germination on phenolics, dietary fibres, minerals, and γ-amino butyric acid contents of barnyard millet (*Echinochloa frumentaceae*). Food Biosci 13:60–68. https://doi.org/10.1016/j.fbio.2015.12.007

Sharma N et al (2018) Effect of high pressure soaking on water absorption, gelatinization, and biochemical properties of germinated and non-germinated foxtail millet grains. J Cereal Sci 83:162–170. https://doi.org/10.1016/j.jcs.2018.08.013

Shiferaw Terefe N, Augusti MA (2020) Fermentation for tailoring the technological and health related functionality of food products. Crit Rev Food Sci Nutr 60(17):2887–2913. https://doi.org/10.1080/10408398.2019.1666250

Smith G (2015) Micronutrient fortification of food: issues for Asia. J Nutr Sci Vitaminol 61:S183-185. https://doi.org/10.3177/jnsv.61.S183

Sruthi NU, Rao PS (2021) Effect of processing on storage stability of millet flour: a review. Trends Food Sci Technol 112:58–74. https://doi.org/10.1016/j.tifs.2021.03.043

Steinkraus KH (1997) Classification of fermented foods: worldwide review of household fermentation techniques. Food Control 8(5–6):311–317. https://doi.org/10.1016/S0956-7135(97)00050-9

Tamang JP (2009) Himalayan fermented foods: microbiology, nutrition, and ethnic values. CRC Press. https://books.google.co.in/books?hl=en&lr=&id=EimHj9veADgC&oi=fnd&pg=PP1&dq=himalayan+fermented+foods&ots=bUYaAkTp_c&sig=g9ybrGMsjB-8NVB6tExdj1XdCMU. Accessed 20 Apr 2015

Tharifkhan SA et al (2021) Improvement of nutrient bioavailability in millets: emphasis on the application of enzymes. J Sci Food Agric. https://doi.org/10.1002/jsfa.11228

Verni M, Rizzello CG, Coda R (2019) Fermentation biotechnology applied to cereal industry by-products: nutritional and functional insights. Front Nutr 6.https://doi.org/10.3389/fnut.2019.00042

Vir SC (2019) Chronic child undernutrition (stunting) in India: an overview of the problem, determinants and ongoing efforts for improving the situation. SSCA 17(1):221–234

Walters ME, Esfandi R, Tsopmo A (2018) Potential of food hydrolyzed proteins and peptides to chelate iron or calcium and enhance their absorption. Foods 7(10):172. https://doi.org/10.3390/foods7100172

Wee JJY et al (2020) Influence of sucrose reduction on powder and reconstitution properties of powdered cocoa malted beverage. Powder Technol 360:221–230. https://doi.org/10.1016/j.powtec.2019.09.051

Zaccari F et al (2015) In vitro bio-accessibility of β-carotene, Ca, Mg and Zn in landrace carrots (*Daucus carota*, L.). Food Chemi 166365–166371.https://doi.org/10.1016/j.foodchem.2014.06.051

Chapter 8
Undernutrition Among the Adult Tribal Populations of India: Review and Meta-analysis

P. Venkatramana and S. A. A. Latheef

Abstract Tribes comprise 8.61% of the Indian population as per the 2011 Census and occupy second place in the indigenous population of the world. Undernutrition is a significant health problem in adult tribal populations of India. Undernutrition causes minerals (iron and iodine) and nutrient deficiency and predisposes to infections. If undernutrition is persistent from childhood, it increases the risk of non-communicable diseases. Anthropometric measurements are used to determine undernutrition or chronic energy deficiency. In this study, a total sample size of 29,953 individuals (male = 19,354 and female = 10,599) was included from various studies published from the years 2001 to 2020 in India, involving 85 tribes from across 50 studies. For review and meta-analysis, mean BMI from a total of 125 male populations from 45 studies and 61 female populations from 36 studies and 128 hundred male populations from 48 studies, and 55 female populations from 55 studies for the incidence studies on undernutrition, were included. Based on the mean BMI comparison, it was concluded that 0.8% had Grade III, 3.2% Grade II, and 24.8% Grade I chronic energy deficiency (CED) in men. Among tribal women, the incidence of CED Grades III, II, and I was 1.6%, 3.2%, and 29.50%, respectively. The CED Grade I was a common CED category among both sexes, but its incidence was higher among women than men. Comparison of mean BMI between both genders in meta-analysis revealed heterogeneity. In both sexes, the incidence of undernutrition was more than 50% but was higher in women than men. Among men and women across tribes' heterogeneity was observed in the incidence of undernutrition. Studies showed a significant prevalence of hypertension and typed 2 diabetes mellitus among the undernourished tribal participants.

Keywords Tribes · Body mass index · Chronic energy deficiency · Undernutrition · Meta-analysis

P. Venkatramana (✉)
Department of Anthropology, School of Social Sciences, Indira Gandhi National Open University, New Delhi, India
e-mail: pvenkatramana@ignou.ac.in

S. A. A. Latheef
Department of Genetics, Osmania University, Hyderabad, India

A. Grover et al. (eds.), *Sustainable Health Through Food, Nutrition, and Lifestyle*,
Advances in Geographical and Environmental Sciences,
https://doi.org/10.1007/978-981-19-7230-0_8

8.1 Introduction

Tribes are those communities scheduled by the President of India as per Article 324 of the Indian Constitution. Backwardness, geographical isolation, distinctive culture, primitive traits, and shyness of contact with the community are features that are taken into consideration for defining any community as a tribe (Ministry of Tribal Affairs, Annual report 2019–2020). Tribes in India are known as *Vanavasi*, *Vanyjyati*, *Anusuchit Jan Jati*, *Girijan*, *Adimjati*, and *Pahari* (Das and Bose 2015). In India, 705 ethnic groups are recognized as Scheduled Tribes; they constitute 10.45 crore or 8.6% of the Indian population and are spread in 2.8% of urban and 11.3% of rural areas as per Census (2011). Odisha, with 62 tribes, is the State with the largest number of tribes. The largest tribal population is concentrated in Madhya Pradesh (15 million), and 82.3% of the tribal population is spread in ten states (Madhya Pradesh, Maharashtra, Rajasthan, Odisha, Gujarat, Jharkhand, Andhra Pradesh, West Bengal, Chhattisgarh, and Karnataka). In about 809 blocks or 90 districts, more than 50% of the tribal population is distributed (Ministry of Tribal Affairs, Annual report 2019–2020; Report of the Expert Committee on Tribal Health RECTH 2013).

One hundred and eleven tribes are inhabiting 31 states/union territory (UT), each counting more than 5% of the tribal population of respective states or UT. Tribes are harboured in 15% of country land, occupying plains, forests, and hills. Among 705 tribes, 75 tribes in 18 states and one union territory are declared as particularly vulnerable tribal groups based on a subsistence of economy, extremely low literacy, declining or a stagnant population, and a pre-agricultural level technology. Census (2011) results showed sex ratio of tribes was 990, 59% lettered (male: 68.5% and female: 49.4%), 68% delivered in hospitals and attended by 71.5% skilled health personnel, 24.1% in urban and 45.3% in rural areas were below the poverty line, 74.7% defecated in the open, had worker population ratio of 54.2%, 51.3% under-employed, 4.4% unemployed, had a total fertility rate of 2.5, the life expectancy of 63.9 years [Ministry of Tribal Affairs Annual report (2019–2020)] and 45.3% were underweight (National Family Health Survey—4). Tribes in India belong to proto-Australoid, Negrito, and Mongoloid races and speak languages of Indo-European, Dravidian, Tibeto-Chinese, and Austro-Asiatic families. Different social, cultural, and economic conditions can be observed in Indian tribes. They are engaged in food gathering and hunting, pastoral and cattle herding, shifting cultivation, folk artists, industrial labour, wage labour, and settled agriculture (Das and Bose 2015).

About 30% of all cases of malaria and 50% of malaria-related deaths, 703 cases of tuberculosis per 100,000, 18.5% new leprosy cases, hypertension (5% of men and 9% of women),1–40% of sickle cell disease, and thalassemia, 0.7–15.6% glucose-6-phosphate dehydrogenase deficiency, 65% of anaemia in women, low intake of nutrients and foodstuffs than recommended dietary allowance, higher incidence of angular stomatitis, intestinal parasite infections, and goitre were observed in tribal communities of India (RECTH 2013; Kshatriya 2014).

A balanced diet consumption of proper nutrients is required to maintain the physiology of the human body. Consumption of improper nutrition (excess or

fewer nutrients) leads to malnutrition. Excess nutrition or overnutrition causes non-communicable diseases, while undernutrition is responsible for communicable diseases and other nutrition-associated complications, diseases, and deaths (Bhattacharya et al. 2019). Tribal communities constitute a sizeable population in India (Census 2011), and the prevalence of high undernutrition has been reported among them (Das and Bose 2015; Goswami 2016). The authors of published studies who conducted investigations on nutritional status among tribes of India experienced the incomplete coverage of a large number of tribes (Bisai and Bose 2008; Banik et al. 2009; Mukhopadhyay 2010; Chakraborty et al. 2011; Das and Bose 2012, 2015; Goswami 2012, 2013, 2014, 2016) owing to the huge number of 705 tribes in India. Investigations on nutritional status will help formulate strategies to address the undernutrition among tribes (Goswami 2015). Earlier authors reviewed studies on tribes covering Odisha (Goswami 2016), and reviews were reported until 2015 (Das and Bose 2012, 2015). After the year 2015, studies reported on nutritional status in general, and undernutrition in particular among tribal communities in India remains to be reviewed. The meta-analysis by examining previous research data provides precise, consolidated, presence of heterogeneity and quantitative view of the evidence than any individual study to the pooled analysis (Haidich 2010). In this meta-analysis, we have investigated whether BMI and incidence of undernutrition differ between or within the genders across tribal populations.

8.2 Material and Methods

Relevant studies on undernutrition among tribal communities were searched using terms like "body mass index and tribes in India" and "undernutrition and tribes of India" in Google search engine and PubMed. Searching was also done using references given in the published articles. Studies reported in English, both original and review articles, were included. Abstracts and a mixed population of tribes were excluded from the study. Meta-analysis was performed using MedCalc software ver 15.

8.3 Results and Discussion

Details of tribes include gender-wise mean body mass index (BMI), the incidence of undernutrition, and reference are provided in Table 8.2. In this meta-analysis, a total sample size of 29,953 individuals (male = 19,354 and female = 10,599) was included from studies published from the years 2001 to 2020 in India. This study covered a total of 85 tribes from across 50 studies. The included studies were reported from the states/union territories of Andhra Pradesh, Telangana, Andaman and Nicobar, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Gujarat, Himachal Pradesh, Jharkhand, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya,

Odisha, Rajasthan, Tamil Nadu, Uttarakhand, and West Bengal. Studies reporting sample mean BMI and standard deviation were included in the present study, constituting 125 male populations from 45 studies and 61female populations from 36 studies. Studies on undernutrition included 128 male populations from 48 studies and 55 female populations from 55 studies. The lower number of studies in women than men may be due to cultural reasons such as not allowing men investigators to record measurements, conditions prevalent at the time of investigation, and availability of participants.

The combined mean BMI in males was 19.51 ± 1.43 kg/m^2, whereas, in females, it was 19.88 ± 2.01 kg/m^2, but the difference was not statistically significant ($P = 0.485$). The mean BMI ranged from 15.86 to 40.05 in men and from 15.93 to 41.49. World Health Organization (WHO classified human populations based on BMI Kg/m^2 into different categories such as normal (18.5–24.9), chronic energy deficiency (CED) Grade I: (17–18.4), CED Grade II: (16–16.9), CED Grade III (< 16) and overweight ($\geq$ 25).

The results on review and meta-analysis are presented gender-wise, which is shown below.

8.3.1 Men

Based on mean BMI, 0.8% had Grade III, 3.2% Grade II, and 24.8% Grade I chronic energy deficiency in men. The analysis of data suggests that undernutrition is mostly common in tribal men of Maharashtra, Bihar, Jharkhand, Madhya Pradesh, and Odisha. Based on mean BMI among the male tribal population (Bhasin and Jain 2007), Garasia of Rajasthan showed 0.8% of CED Grade III level undernutrition. The same author showed CED Grade II in Damor, Kathodi, and Bhil population of Rajasthan and Adak et al. (2006b) in Worli tribal population of Maharashtra. The following populations showed CED grade I undernutrition. They are Oraon (Mainlander) of Andaman and Nicobar (Sahani et al. 2018); Sugali and Valmiki of Andhra Pradesh (Reddy et al. 2020; Kusuma et al. 2004); Kathodi, Andh, Gond, Kathodi, Korku, Mahadeokoli, Sonr, Sahariya and Bhil of Maharashtra (Adak et al. 2006b; Gautam and Adak 2006), Santal, HO, Tharu of Bihar (Charkabarty et al. 2008), Oraon of Ranchi and Gumla of Jharkhand (Banik 2008; Banik et al. 2009; Chakraborty et al. 2011), Baiga (Chakma et al. 2009), Bhumia (Jaiswal 2013), Bhil, Korku, Saharia, and Sonr (Adak et al. 2006a) of Madhya Pradesh; Tadvi of Gujarat (Kapoor et al. 2012); Bathudi, Bhuyan, Gond, Santal, Savara, and Desia Khond of Odisha (Bose and Chakraborty 2005; Goswami 2016; Chakrabarty et al. 2008; Kapoor et al. 2012) and Mina and Sahariya of Rajasthan (Bhasin and Jain 2007; Kapoor et al. 2012). Sixty-seven per cent of tribal men had normal weight, and 0.016% were overweight.

8.3.2 Women

In tribal women, the incidence of Grades III, II, and I was 1.6%, 3.2%, and 29.50%, respectively. Sixty per cent of tribal women had normal weight, and 3.2% were overweight. Kothadi of Rajasthan (Bhasin and Jain 2007) showed Grade III CED; Garsia and Bhil of Rajasthan (Bhasin and Jain 2007) Grade II CED; and the following populations showed grade I CED (Bhuyan Juang and Bathudi) (Goswami 2012, 2013, 2016; Kanrar and Goswami 2020; Kshatriya and Acharya 2016; Bose and Chakraborty 2005) of Odisha; Damor and Sahariya of Rajasthan (Bhasin and Jain 2007); Mudugar of Kerala (Sreelakshmi et al. 2012); Kora, Oraon, Munda, Sabers, Santal, Bhumij, and Kora Mudi of West Bengal (Kshatriya and Acharya 2016; Ghosh and Bharati 2006; Bhandari et al. 2019; Das and Bose 2010; Bisai et al. 2008; Ghosh 2007). These observations suggest tribal women of Rajasthan, Odisha, and West Bengal have significant CED. Comparison of CED between genders showed that Grade I CED is common in both genders of Indian tribes as observed earlier (Adak et al. 2006b; Gautam and Adak 2006), but its incidence is higher in women than men. It is interesting to note that CED Grades based on mean BMI were observed in both sexes of Odisha and absent in men but common in women of West Bengal.

To observe whether any significant difference exists in the mean BMI between both genders, we conducted an analysis and calculated Cochran's Q and I^2 index. The forest plot of the mean BMI difference between both sexes is shown in Fig. 8.1. Cochran's Q (507.42, $p < 0.0001$) and I^2(90.15%, 95%) CI (87.88–91.99) suggested substantial heterogeneity in the mean BMI between both genders.

WHO (1995) categorized human populations into different levels of undernutrition based on the per cent of undernutrition or CED as follows: 5–9% (low, warning sign, monitoring required), 10–19% (medium, poor situation), 20–39% (high, serious situation) and ≥ 40 (very high, critical situation). Using this criterion, we have analysed the incidence of undernutrition in male and female tribal populations separately. Incidence data is available in 128 male populations and 55 female populations (Table 8.1). The incidence of undernutrition ranged from 0.9 to 100% in men and from 1.7 to 94.87% in women. The combined mean incidence of undernutrition in men was 44.42%, and in women, it was 45.86% but not statistically significant ($P = 0.073$). To investigate whether heterogeneity exists within men and women in different tribal populations, we performed a meta-analysis and presented it in Figs. 8.2 and 8.3. Cochran's Q (male = 3728.47, $p < 0.0001$; female = 2142.18, $p < 0.0001$), I^2(male = 96.59%, 95%) CI (96.26–96.90); female = 97.48%, 95% CI 97.13–97.79) suggested considerable heterogeneity within men and women in different tribal populations. The reason for heterogeneity in mean BMI and incidence of undernutrition in the tribal populations may be due to socio-economic status, nutritional status, the impact of environment and genetic factors, sample size difference, habitat, and availability of the participants (Das and Bose 2015; Rao et al. 2015; Adak et al. 2006b). In the forest plot of men, due to clubbing of studies, author names in the y-axis are not visible. This is due to reporting of several tribal populations by many authors in the same study (Fig. 8.2).

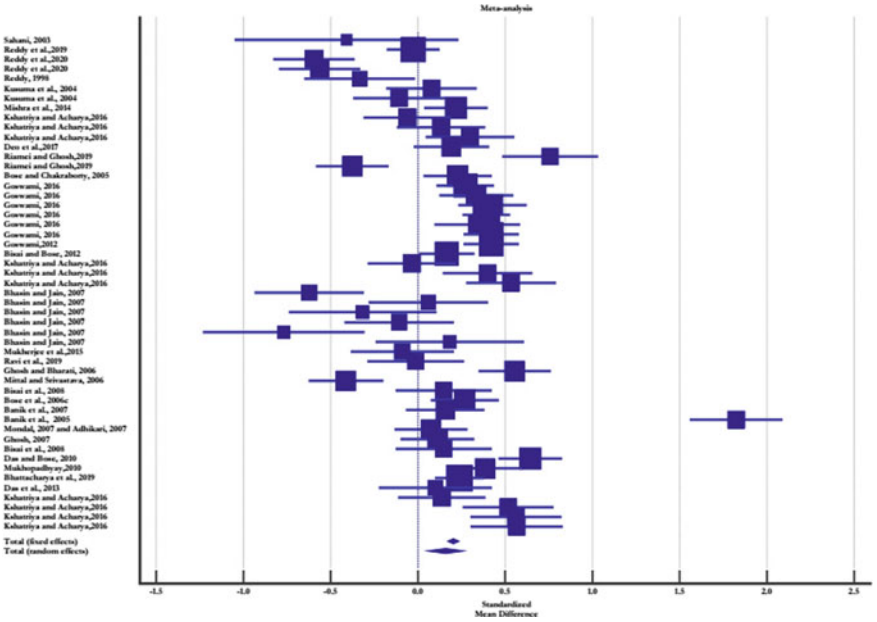


Fig. 8.1 Forest plot showing standardized mean difference of BMI between genders

Table 8.1 Incidence of undernutrition in both genders of tribal population

Category (%)	Male (n = 128) n and %	Female (n = 55) n and %	Total (n = 179) n and %
5–9 (Low)	6 (4.68)	1 (1.96)	7 (3.91)
10–19 (Medium)	5 (3.9)	3 (5.88)	8 (4.46)
20–39 (High)	42 (32.81)	15 (29.41)	57 (31.84)
≥ 40 (Very high)	70 (54.68)	33 (64.70)	103 (57.54)

Those not reported in the table are normal

In both sexes, more than 50% have very high undernutrition demonstrating nutritional stress and serious situation. Incidence of undernutrition was higher among women than men, like in earlier studies (Goswami 2016; Rao et al. 2015; Singh et al. 2014; Banik et al. 2007), but a statistically significant difference was not observed between both genders in the different levels of undernutrition ($P = 0.656$). The incidence of undernutrition found in this study was higher than undernutrition among Indian tribes observed in the National Nutrition Monitoring Bureau report of 2009 (male = 40% and female = 49%) and the National Family Health survey-4 (total male = 20.2% and total female = 22.9%) conducted in 2015–2016. The results of

Table 8.2 Body mass index and prevalence of undernutrition (< 18.5 kg/m^2) in tribes of India

S. No	Tribe	Location	Body mass index *n* (mean)			Chronic energy deficiency			References
			Male	Female	Total	Male *n* (%)	Female *n* (%)	Total *n* (%)	
Andaman and Nicobar									
1	Jarawas		25 (18.9)	16 (19.8)	NA	25 (44.0)	16 (31.25)	41 (39.02)	Sahani (2003)
2	Onge		26 (19.7)	35 (21.2)	NA	26 (12.9)	35 (29.2)	NA	Rao et al. (2006)
3	Car Nicobarese		165 (21.98)	NA	NA	165 (6.6)	NA	NA	Kapoor et al. (2012)
4	Car Nicobarese		108 (21.70)	NA	NA	108 (0.9)	NA	NA	Sahani et al. (2018)
5	Great Andamanese		11 (22.80)	NA ara>	NA	NA	NA	NA	Sahani et al. (2018)
6	Jarawas		42 (19.50)	NA	NA	42 (33.30)	NA	NA	Sahani et al. (2018)
7	Onge		27 (21.6)	NA	NA	27 (7.4)	NA	NA	Sahani et al. (2018)
8	Munda (immigrant)		99 (20.1)	NA	NA	99 (20.4)	NA	NA	Sahani et al. (2018)
9	Oraon (immigrant)		110 (19.4)	NA	NA	110(36.60)	NA	NA	Sahani et al. (2018)
10	Kharia (immigrant)		99 (19.70)	NA	NA	99 (28.3)	NA	NA	Sahani et al. (2018)

(continued)

Table 8.2 (continued)

S. No	Tribe	Location	Body mass index *n* (mean)			Chronic energy deficiency			References
			Male	Female	Total	Male *n* (%)	Female *n* (%)	Total *n* (%)	
11	Paniyan (immigrant)		50 (19.5)	NA	NA	99 (26.0)	NA	NA	Sahani et al. (2018)
12	Munda (mainlander)		98 (18.6)	NA	NA	98 (47)	NA	NA	Sahani et al. (2018)
13	Oraon (mainlander)		199 (17.9)	NA	NA	199 (66.8)			Sahani et al. (2018)
Andhra Pradesh and Telangana									
14	Yanadi	Nellore	285 (21.26)	398 (22.37)	683 (21.91)	285 (25.61)	398 (18.84)	683 (21.66)	Reddy et al. (2019)
15	Yanadi	Rayalaseema	134 (18.74)	163 (20.08)	NA	134 (44.0)	163 (28.2)	297 (35.35)	Reddy et al. (2020)
16	Sugali	Rayalaseema	137 (18.34)	160 (19.90)	NA	137 (59.1)	160 (33.1)	297 (45.11)	Reddy et al. (2020)
17	Sugali	Cuddapah	NA	NA	NA	705 (51.06)	717 (49.09)	1422 (50.07)	Reddy and Rao (2000)
18	Yerukula	Chittoor	72 (18.65)	84 (19.45)	NA	72 (55.55)ara>	84 (35.7)	NA	Reddy (1998)
19	Chenchu	ITDA, Srisailam	NA	NA	NA	209 (41.0)	431 (42.0)	NA	Rao et al. (2015)

(continued)

Table 8.2 (continued)

S. No	Tribe	Location	Body mass index *n* (mean)			Chronic energy deficiency			References
			Male	Female	Total	Male *n* (%)	Female *n* (%)	Total *n* (%)	
20	Khondh	Visakhapatnam	115 (19.02)	113 (18.28)	NA	NA	NA	NA	Kusuma et al. (2004)
21	Valmiki	Visakhapatnam	111 (17.42)	111 (17.40)	NA	NA	NA	NA	Kusuma et al. (2004)
Arunachal Pradesh									
22	Nyishi	Papum Pare	543 (21.30)	NA	NA	543 (10.50)	NA	NA	Bharali et al. (2017)
Assam									
23	Boro-Kachari		98 (19.8)	NA	NA	98 (11.22)	NA	NA	Khongsdier (2001)
24	Lalung		49 (19.2)	NA	NA	49 (34.69)	NA	NA	Khongsdier (2001)
25	Mech Kachari		50 (20.5)	NA	NA	50 (6.0)	NA	NA	Khongsdier (2001)
26	Miri		50 (19.6)	NA	NA	50 (34.0)	NA	NA	Khongsdier (2001)
27	Dibongiya Deori	North Lakhimpur	98 (20.0)	NA	NA	98 (21.43)	NA	NA	Gogoi and Sengupta (2002)
28	Mishing	Tinsukia	179 (22.93)	153 (21.74)	332 (22.38)	NA	NA	NA	Mishra et al. (2014)
29	Karbi	Kamrup	NA	300 (21.53)	NA	NA	NA	NA	Ritu and Bhattacharyya (2015)

(continued)

Table 8.2 (continued)

S. No	Tribe	Location	Body mass index *n* (mean)			Chronic energy deficiency			References
			Male	Female	Total	Male *n* (%)	Female *n* (%)	Total *n* (%)	
Bihar									
30	Bhuiya		196 (18.66)	NA	NA	196 (47.95)	NA	NA	Chakrabarty et al. (2008)
31	Munda		98 (18.55)	NA	NA	98 (48.97)	NA	NA	Chakrabarty et al. (2008)
32	Santal		347 (18.21)	NA	NA	347 (62.24)	NA	NA	Chakrabarty et al. (2008)
33	Oroan		199 (17.94)	NA	NA	199 (66.84)	NA	NA	Chakrabarty et al. (2008)
34	Ho		50 (17.75)	NA	NA	50 (70.0)	NA	NA	Chakrabarty et al. (2008)
35	Tharu		50 (19.57)	NA	NA	50 (28.0)	NA	NA	Chakrabarty et al. (2008)
Chhattisgarh									
36	Bhaina		NA	100 (20.6)	NA	NA	100 (27.0)	NA	Singh et al. (2014)
37	Bhatra	Bastar	NA	290 (19.98)	NA	NA	290 (27.78)	NA	Verma (2020)
38	Dhurwa	Bastar	NA	207 (19.70)	NA	NA	207 (31.83)	NA	Verma (2020)

(continued)

Table 8.2 (continued)

S. No	Tribe	Location	Body mass index *n* (mean)			Chronic energy deficiency			References
			Male	Female	Total	Male *n* (%)	Female *n* (%)	Total *n* (%)	
Gujarat									
39	Tadvi		91 (18.13)	NA	NA	93 (5.0)	NA	NA	Kapoor et al. (2012)
40	Dhodia		121 (20.5)	120 (20.7)	240 (20.6)	121 (28.1)	120 (29.2)	240 (28.8)	Kshatriya and Acharya (2016)
41	Kukna		120 (20.3)	120 (19.9)	240 (20.1)	120 (28.3)	120 (40.0)	240 (34.2)	Kshatriya and Acharya (2016)
42	Chaudhari		120 (19.8)	121 (18.9)	241 (19.4)	120 (40.0)	121 (48.8)	241 (44.4)	Kshatriya and Acharya (2016)
Himachal Pradesh									
43	Gaddi	Bharmour	2070 (21.0)	1930 (20.5)	4000(20.8)	2070 (5.30)	1930 (10.0)	4000 (7.6)	Kapoor et al. (2014)
44	Gaddi	Dharmashala	1788 (21.8)	2212 (20.9)	4000 (21.4)	1788 (4.9)	2212 (10.1)	4000 (7.8)	Kapoor et al. (2014)
Jharkhand									
45	Oraon	Ranchi	290 (18.48)	NA	NA	290 (53.10)	NA	NA	Banik et al. (2009)
46	Oroan	Ranchi	290 (18.48)	NA	NA	290 (53.10)	NA	NA	Banik (2008)

(continued)

Table 8.2 (continued)

S. No	Tribe	Location	Body mass index *n* (mean)			Chronic energy deficiency			References
			Male	Female	Total	Male *n* (%)	Female *n* (%)	Total *n* (%)	
47	Saraks	Ranchi	158 (20.27)	NA	NA	158 (27.85)	NA	NA	Banik et al. (2009)
48	Oron	Gumla	205 (18.0)	NA	NA	205 (63.9)	NA	NA	Chakraborty et al. (2011)
Kerala									
49	Mannan		182 (20.1)	183 (19.1)	365 (19.6)	NA	NA	NA	John and Ramadas (2008)
50	Irular	Palakkad		214 (19.1)	NA	NA	NA	NA	Sreelakshmi et al. (2012)
51	Mudugar			16 (17.6)	NA	NA	NA	NA	Sreelakshmi et al. (2012)
52	Malassar			83 (19.0)	NA	NA	NA	NA	Sreelakshmi et al. (2012)
53	Eravalar			33 (20.1)	NA	NA	NA	NA	Sreelakshmi et al. (2012)
Madhya Pradesh									
54	Saharia		168 (19.11)	NA	NA	168 (49.0)	NA	NA	Kapoor et al. (2012)
55	Saharia		NA	NA	NA	168 (48.7)	196 (36.7)	NA	Kapoor et al. (2009)

(continued)

Table 8.2 (continued)

S. No	Tribe	Location	Body mass index *n* (mean)			Chronic energy deficiency			References
			Male	Female	Total	Male *n* (%)	Female *n* (%)	Total *n* (%)	
56	Baiga		434 (17.5)	426 (18.3)	NA	434 (21.6)	426 (26.4)	NA	Chakma et al. (2009)
57	Bhumia		161 (17.9)	165 (18.1)	NA	161 (21.4)	165 (26.0)	NA	Jaiswal (2013)
58	Kol		200 (18.75)	NA	NA	200 (46.0)	NA	NA	Adak et al. (2006a)
59	Bhil		401 (18.28)	NA	NA	200 (61.09)	NA	NA	Adak et al. (2006a)
60	Gond		904 (18.57)	NA	NA	904 (51.0)	NA	NA	Adak et al. (2006a)
61	Korku		101 (18.17)	NA	NA	101 (57.42)	NA	NA	Adak et al. (2006a)
62	Korwa		51 (20.83)	NA	NA	51 (7.84)	NA	NA	Adak et al. (2006a)
63	Majhi		50 (19.4)	NA	NA	50 (26.0)	NA	NA	Adak et al. (2006a)
64	Oraon		99 (19.5)	NA	NA	99 (28.28)	NA	NA	Adak et al. (2006a)
65	Sahariya		204 (18.12)	NA	NA	204 (60.78)	NA	NA	Adak et al. (2006a)

(continued)

Table 8.2 (continued)

S. No	Tribe	Location	Body mass index *n* (mean)			Chronic energy deficiency			References
			Male	Female	Total	Male *n* (%)	Female *n* (%)	Total *n* (%)	
66	Sonr		56 (17.64)	NA	NA	56 (73.21)	NA	NA	Adak et al. (2006a)
67	Baiga			NA	NA	527 (47.70)	678 (54.4)	1250 (51.40)	Jain et al. (2015)
Maharashtra									
68	Chikhaldara		198 (19.4)	210 (18.6)		NA	NA	NA	Ingole et al. (2014)
69	Andh		50 (17.13)	NA	NA	50 (82.0)	NA	NA	Adak et al. (2006b)
70	Bhil		200 (18.02)	NA	NA	200 (88.0)	NA	NA	Adak et al. (2006b)
71	Bhil		401 (18.24)	NA	NA	401 (61.09)	NA	NA	Gautam and Adak (2006)
72	Gond		100 (18.33)	NA	NA	100 (78.0)	NA	NA	Adak et al. (2006b)
73	Gond		904 (18.57)	NA	NA	904 (51)	NA	NA	Gautam and Adak (2006)
74	Kol		200 (18.75)	NA	NA	200 (46)	NA	NA	Gautam and Adak (2006)
75	Kathodi		50 (17.03)	NA	NA	50 (100)	NA	NA	Adak et al. (2006b)

(continued)

Table 8.2 (continued)

S. No	Tribe	Location	Body mass index *n* (mean)			Chronic energy deficiency			References
			Male	Female	Total	Male *n* (%)	Female *n* (%)	Total *n* (%)	
76	Korku		50 (18.0)	NA	NA	50 (90.0)	NA	NA	Adak et al. (2006b)
77	Korku		101 (18.17)	NA	NA	57.42	NA	NA	Gautam and Adak (2006)
78	Mahadeokoli		100 (18.17)	NA	NA	100 (85.0)	NA	NA	Adak et al. (2006b)
79	Warli		50 (16.82)	NA	NA	50 (96.0)	NA	NA	Adak et al. (2006b)
80	Oraon		99 (19.55)	NA	NA	99 (28.28)	NA	NA	Gautam and Adak (2006)
81	Sonr		56 (17.64)	NA	NA	56 (73.21)	NA	NA	Gautam and Adak (2006)
82	Majhi		50 (19.40)	NA	NA	50 (24.0)	NA	NA	Gautam and Adak (2006)
83	Korwa		51 (20.83)	NA	NA	51 (7.84)	NA	NA	Gautam and Adak (2006)
84	Sahariya		204 (18.12)	NA	NA	204 (60.78)	NA	NA	Gautam and Adak (2006)
85	Katkari	Raigad	191 (19.9)	219 (19.2)	410 (19.5)	191 (36.64)	219 (48.85)	410 (43.17)	Deo et al. (2017)

(continued)

Table 8.2 (continued)

S. No	Tribe	Location	Body mass index *n* (mean)			Chronic energy deficiency			References
			Male	Female	Total	Male *n* (%)	Female *n* (%)	Total *n* (%)	
Manipur									
86	Tangkhul Naga	Ukhrul	NA	346 (21.23)	NA	NA	346 (16.20)	NA	Mungreiphy and Kapoor (2010)
87	Zhou	Churachandpur	NA	NA	NA	NA	533 (8.06)	NA	Khual and Limbu (2019)
88	Rongmei Naga (urban)		78 (24.66)	176 (22.43)	NA	78 (4.35)	176 (1.70)	NA	Riamei and Ghosh (2019)
89	Rongmei Naga (rural)		167 (22.96)	197 (24.16)	NA	167 (2.99)	197 (4.57)	NA	Riamei and Ghosh (2019)
Meghalaya									
90	Pnars Khasi		49 (19.85)	NA	NA	49 (14.3)	NA	NA	Khongsdier (2001)
91	War Khasi		575 (20.06)	NA	NA	575 (35.0)	NA	NA	Khongsdier (2002)
Odisha									
92	Bathudi	Keonjhar	226 (18.4)	183 (17.9)	NA	226 (52.7)	183 (64.5)	409 (57.9)	Bose and Chakraborty (2005)
93	Lodha	Mayurbhanj	204 (19.56)	NA	NA	204 (48.5)	NA	NA	Goswami (2014)
94	Lodha	Mayurbhanj, Keonjhar and Anugu	264 (19.3)	306 (18.7)	NA	264 (53.8)	306 (58.8)	NA	Goswami (2016)

(continued)

Table 8.2 (continued)

S. No	Tribe	Location	Body mass index *n* (mean)			Chronic energy deficiency			References
			Male	Female	Total	Male *n* (%)	Female *n* (%)	Total *n* (%)	
95	Kharias	Mayurbhanj	157 (19.11)	NA	NA	157 (50.3)	NA	NA	Goswami (2014)
96	Kharias	Mayurbhanj, Keonjhar and Anugu	157 (19.11)	191 (18.2)	NA	157 (50.3)	191 (56.5)	NA	Goswami (2016)
97	Santal	Keonjhar	332 (19.6)	NA	NA	332 (26.2)	NA	NA	Bose et al. (2006a)
98	Paroja		50 (17.3)	NA	NA	153 (80)	NA	NA	Chakrabarty et al. (2008)
99	Bhuiya		50 (19.4)	NA	NA	50 (30.0)	NA	NA	Chakrabarty et al. (2008)
100	Bhuyan	Keonjhar and Anugul	303 (18.2)	324 (17.0)		303 (58.7)	324 (77.7)		Goswami (2012)
101	Bhuyan	Mayurbhanj, Keonjhar and Anugul	303 (18.2)	324 (17.0)	NA	303 (58.7)	324 (77.7)	NA	Goswami (2016)
102	Gond		99 (18.11)	NA	NA	99 (64.6)	NA	NA	Chakrabarty et al. (2008)
103	Khond		100 (19.17)	NA	NA	100 (35.0)	NA	NA	Chakrabarty et al. (2008)
104	Munda		50 (19.11)	NA	NA	50 (34.0)	NA	NA	Chakrabarty et al. (2008)

(continued)

Table 8.2 (continued)

S. No	Tribe	Location	Body mass index *n* (mean)			Chronic energy deficiency			References
			Male	Female	Total	Male *n* (%)	Female *n* (%)	Total *n* (%)	
105	Santal		106 (18.28)	NA	NA	106 (63.2)	NA	NA	Chakrabarty et al. (2008)
106	Savara		200 (18.46)	NA	NA	200 (53.0)	NA	NA	Chakrabarty et al. (2008)
107	Savar	Keonjhar	300 (19.3)	300 (18.9)	NA	300 (38.0)	300 (49.3)	NA	Bisai and Bose (2012)
108	Desia Khond		144 (17.63)		NA	144 (92.0)	NA	NA	Kapoor et al. (2012)
109	Juang	Keonjhar	414 (19.4)	423 (18.3)	NA	414 (51.9)	423 (62.9)	837 (57.5)	Goswami (2013)
110	Juang	Mayurbhanj, Keonjhar and Anugu	414 (19.4)	423 (18.3)	NA	414 (51.9)	423 (62.9)	NA	Goswami (2016)
111	Juang	Keonjhar	414 (19.4)	423 (18.3)	NA	NA	NA	NA	Kanrar and Goswami (2020)
112	Bhumija	Baleswar	66 (18.9)	73 (18.4)	66 (48.5)	73 (54.8)		NA	Goswami (2010)
113	Mankirdia	Mayurbanj	124 (19.3)	136 (18.6)		124 (48.38)	136 (59.55)	NA	Goswami (2015)
114	Mankirdia	Mayurbhanj, Keonjhar and Anugu	124 (19.3)	136 (18.6)		124 (48.4)	136 (59.5)	NA	Goswami (2016)

(continued)

Table 8.2 (continued)

S. No	Tribe	Location	Body mass index *n* (mean)			Chronic energy deficiency			References
			Male	Female	Total	Male *n* (%)	Female *n* (%)	Total *n* (%)	
115	Santal		121 (20.2)	119 (20.3)	240 (20.3)	121 (28.1)	119 (31.1)	240 29.6	Kshatriya and Acharya (2016)
116	Bhumij		116 (20.9)	122 (19.7)	238 (20.3)	116 (19.0)	122 (37.0)	238 (28.2)	Kshatriya and Acharya (2016)
117	Bathudi		119 (19.5)	121 (18)	240 (18.6)	119 (39.5)	121 (62.8)	240 (51.3)	Kshatriya and Acharya (2016)
Rajasthan									
118	Mina		89 (18.12)	76 (19.11)	NA	89 (66.29)	76 (38.15)	165 (53.33)	Bhasin and Jain (2007)
119	Mina		160 (17.55)	NA	NA	160 (68.0)	NA	NA	Kapoor et al. (2012)
120	Bhil		66 (16.59)	66 (16.49)	132	66 (95.45)	66 (81.81)	132 (88.63)	Bhasin and Jain (2007)
121	Garasia		50 (15.86)	39 (16.24)	89	50 (98)	39 (94.87)	89 (96.62)	Bhasin and Jain (2007)
122	Sahariya		81 (17.55)	76 (17.80)	157	81 (97.53)	76 (71.05)	157 (84.71)	Bhasin and Jain (2007)
123	Damor		41 (16.12)	37 (17.33)	78	41 (87.80)	37 (69.44)	78 (79.48)	Bhasin and Jain (2007)
124	Kathodi		43 (16.22)	43 (15.93)	86	43 (93.02)	43 (93.02)	86 (93.02)	Bhasin and Jain (2007)

(continued)

Table 8.2 (continued)

S. No	Tribe	Location	Body mass index *n* (mean)			Chronic energy deficiency			References
			Male	Female	Total	Male *n* (%)	Female *n* (%)	Total *n* (%)	
Tamil Nadu									
125	Kaani (Forest)		NA	NA	NA	106 (41.5)	74 (45.9)	NA	Mohankumar and Velvizhi (2018)
126	Kaani (Rural)		NA	NA	NA	93 (6.4)	62 (4.5)	NA	Mohankumar and Velvizhi (2018)
Uttarakhand									
127	Bhotia		182 (19.48)	NA	NA	182 (20.0)	NA	NA	Kapoor et al. (2012)
128	Raji		NA	NA	NA	63 (90.4)	NA	NA	Kapoor et al. (2009)
129	Tharu	Udham Singh Nagar	87 (21.18)	89 (21.52)	176 (21.35)	87 (26.4)	89 (18.0)	176 (22.20)	Mukherjee et al. (2015)
130	Jaunsari	Dehradun	100 (21.85)	100 (21.90)	NA	100 (32.0)	100 (35.0)	NA	Ravi et al. (2019)
West Bengal									
131	Munda	Kolkata	153 (18.7)	234 (17.7)		153 (49.0)	234 (67.9)		Ghosh and Bharati (2006)
132	Oraon	New Mal	200 (18.8)	150 (19.7)		200 (47.0)	150 (31.7)		Mittal and Srivastava (2006)

(continued)

Table 8.2 (continued)

S. No	Tribe	Location	Body mass index *n* (mean)			Chronic energy deficiency			References
			Male	Female	Total	Male *n* (%)	Female *n* (%)	Total *n* (%)	
133	Kora Mudi	Paschim Medinipur	87 (18.6)	123 (18.3)		87 (51.7)	123 (55.3)		Bisai et al. (2008)
134	Kora Mudi	Bankura	250 (18.7)	250 (18.3)		250 (48.0)	250 (56.4)	500 (52.2)	Bose et al. (2006b)
135	Santal	Paschim Medinipur	197 (20.9)	213 (19.3)		197 (31.5)	213 (41.8)		Bose et al. (2006a)
136	Dhimal	Naxalbari	159 (19.5)	146 (19.1)		159 (27.0)	146 (46.4)	305 (36.4)	Banik et al. (2007)
137	Dhimal	Naxalbari	159 (19.54)	150 (19.20)		159 (27.0)	150 (46.4)	305 (36.4)	Banik et al. (2005)
138	Lodha	Paschim Medinipur	157 (19.5)	199 (19.3)		157 (45.2)	199 (40.7)		Mondal (2007), Adhikary (2007)
139	Santal	Bankura	400 (18.5)	400 (18.7)		400 (55.0)	400 (52.5)		Ghosh and Mallik (2007)
140	Bhumij	Paschim Medinipur	161 (18.7)	185 (18.4)		161 (48.4)	185 (58.9)		Ghosh (2007)
141	Kora Mudi	Paschim Medinipur	87 (18.6)	123 (18.3)		87 (51.7)	123 (55.3)		Bisai et al. (2008)
142	Lodha		157 (19.47)			157 (45.2)			Bose et al. (2008)
143	Bhumij		161 (18.65)			161 (48.4)			Bose et al. (2008)
144	Santal	Purulia	196 (19.54)	317 (18.08)		196 (30.61)	317 (63.40)		Das and Bose (2010)

(continued)

Table 8.2 (continued)

S. No	Tribe	Location	Body mass index *n* (mean)			Chronic energy deficiency			References
			Male	Female	Total	Male *n* (%)	Female *n* (%)	Total *n* (%)	
145	Santal	Birbhum	168 (20.46)	183 (19.48)	351 (19.75)	168 (30.5)	183 (38.5)		Mukhopadhyay (2010)
146	Munda	Pachim Medinipur	106 (19.35)			106 (35.8)			Bose et al. (2011)
147	Oraon	Alipurduar	387 (19.33)	393 (18.66)	780 (18.99)	387 (40.1)	393 (51.7)	780 (45.9)	Bhattacharya et al. (2019)
148	Oraon	Pachim Medinipur	104 (19.46)			104 (37.5)			Bose et al. (2011)
149	Hill Kharia		68 (19.2)	92 (17.9)		68 (41.2)	92 (60.9)		Das and Bose (2014)
150	Birhor	Purulia	72 (20.50)	75 (20.19)	147 (20.30)	72 (19.4)	75 (33.3)		Das et al. (2013)
151	Santal		123 (19.9)	122 (19.5)	245 (19.7)	123 (30.1)	122 (45.1)	245 (37.6)	Kshatriya and Acharya (2016)
152	Kora		114 (18.9)	121 (17.6)	235 (18.3)	114 (41.2)	121 (62.0)	235 (51.9)	Kshatriya and Acharya (2016)
153	Oraon		112 (19.6)	124 (18.1)	236 (18.1)	112 (34.8)	124 (62.9)	236 (49.6)	Kshatriya and Acharya (2016)
154	Saber	Purulia	NA	NA	NA	215 (47.0)			Das et al. (2019)
155	Sabars	Bankura	111 (19.43)	115 (18.04)					Bhandari et al. (2019)

NA Not Available

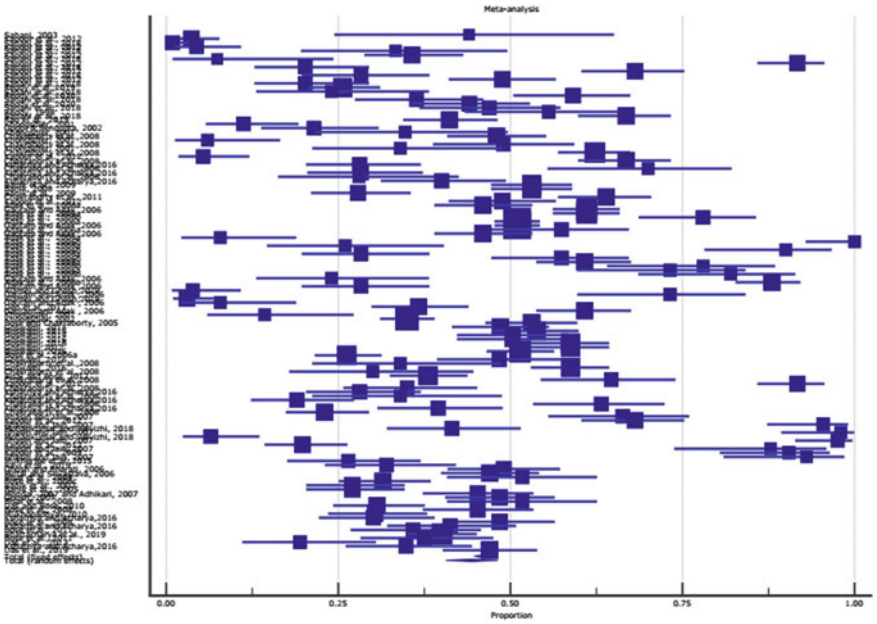


Fig. 8.2 Forest plot showing incidence of undernutrition in tribal men

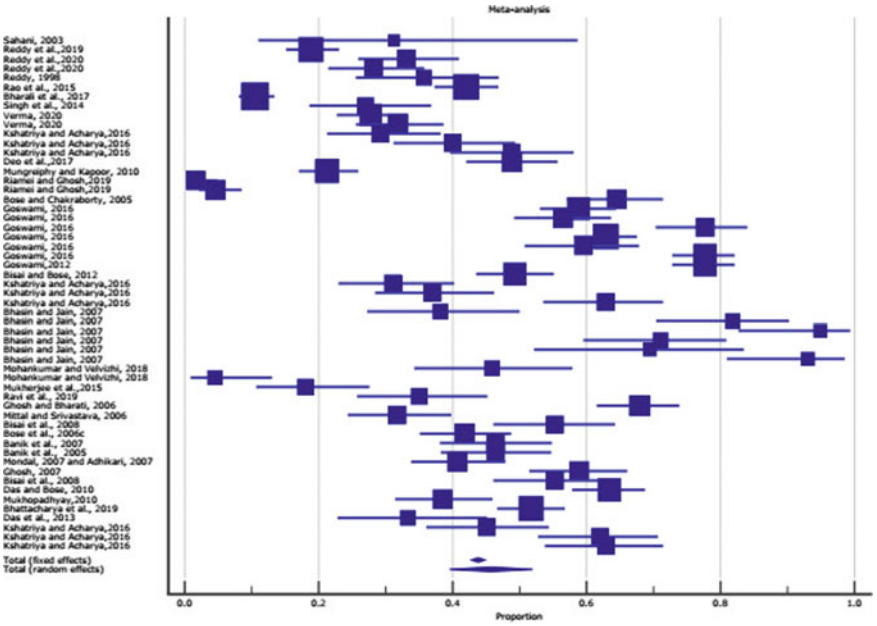


Fig. 8.3 Forest plot showing incidence of undernutrition in tribal women

the analysis of the present study suggested that rather than using combined measures, employing meta-analysis is a good tool for the assessment of heterogeneity.

8.3.3 Assessment of Nutritional Status Using BMI

Various tools are used for the assessment of the nutritional status of the population, such as anthropometry (BMI, waist–hip ratio, skinfold thickness, mid-upper arm circumference, and waist circumference), clinical, biochemical, and dietary survey. The clinical examination requires clinical expertise, biochemical investigations are expensive and dietary surveys need data of several days to obtain the information on the dietary intake. Anthropometric measurements such as BMI can be measured in a large number of participants without causing any pain to the participants, cost-effective, can correlate with fat and fat-free mass, reflect adiposity, socio-economic status of adults, and standard of living, are useful in diverse ethnic groups and its use is validated for the assessment of nutritional status in tribal studies and epidemiological studies of India (Bhattacharya et al. 2019; Bharali et al. 2017; Goswami 2015; Goswami 2012; Das and Bose 2010; Bisai and Bose 2009: Khongsdier 2001). BMI < 18.5 is established as a practical tool for the measurement of CED/undernutrition (Bisai and Bose 2009; Chakraborty et al. 2011). This may be the reason for using BMI in all the studies included in this particular study. Some authors used upper arm circumference (Bhattacharya et al. 2019; Das and Bose 2014; Bisai and Bose 2009; Banik et al. 2009; Bose et al. 2006a) along with BMI in some studies thoughts age-specific cut-off values have to be available for its wider use (Bhattacharya et al. 2019). Other than upper arm circumference, other anthropometric tools are in evaluation status.

8.3.4 Causes of Undernutrition

Causes of undernutrition among tribal communities include uncertain food supply, geographical isolation, inadequate healthcare facilities, seasonal availability of food, environmental conditions, cultural practices, traditional beliefs, infections, socio-economic status, personal and environmental unhygienic conditions, lack of knowledge and practices, religious practices, lack of education, political situation, reduced intake of nutrients, impaired metabolism, high physical activity, < 30 years, usage of smokeless tobacco, number of children in the family, migration from rural to urban areas, shift in the occupation, dependence on primitive agriculture practices, poor communication, rural residence, consumption of alcohol, ignored and underprivileged tribes, cultural barriers, impact of modernization, improper food intake, lack of safe drinking water, non-coverage of national and nutritional services and prevalence of genetic and nutritional disorders (Rokade et al. 2020; Bhattacharya et al. 2019; Mohandas et al. 2019; Ghosh 2016; Goswami 2016; Rao et al. 2015; Singh

et al. 2014;Kshatriya 2014;Goswami 2013; Bisai and Bose 2008; Bhasin and Jain 2007; Adak et al. 2006b).

8.3.5 Consequences of Undernutrition

Undernutrition or CED has been shown to be associated with behavioural changes, suppressed immunity, increased morbidity, and reduced productivity and performance. Giving birth to low-weight babies, adverse pregnancy outcomes, and effects on lactation and breastfeeding were observed among undernourished tribal women (Kshatriya 2014; Bose and Das 2010; Bisai and Bose 2008).

8.3.6 Morbidity Associated with Undernutrition

A few authors attempted to study the morbidity among undernourished tribal communities. Among War Khasi, Khongsdier (2002) observed lower mean BMI in all age groups of those who reported illness than those without it. Investigating tribes of Nicobar Islands, Madhya Pradesh, Gujarat, Uttarakhand, Rajasthan, and Orissa, Kapoor et al. (2012) have observed 17.96 and 33.5% of underweights had a prevalence of hypertension based on systolic and diastolic blood pressure. Kshatriya and Acharya (2016) have observed a higher prevalence of hypertension among undernourished tribes of Kora, Bathudis, and Oraons. A higher prevalence of type 2 diabetes among rural than urban (9.3 vs. 4.2%) underweight Gaddi tribes of Himachal Pradesh was reported (Kapoor et al. 2014).

8.3.7 Recommendations

1. More studies on the nutritional status of Indian tribes should be conducted as till 2020, only 85 tribes were covered.
2. Strategies among undernourished tribes should be started.
3. Eight per cent of the budget should be assigned for tribal welfare in tune with the size of tribal populations.
4. Per capita expenditure on health should be increased, and lion share should be spent on primary health care.
5. Infrastructure in tribal areas should be developed, and diversion of funds meant for tribal welfare to other programmes should be stopped.
6. Tribal field health stations should be started where tribal populations are located.
7. Application of mobile and telemedicine services should be explored for tribal health services.
8. Database relating to data of all tribes should be developed.

9. Scheduled tribe experts from tribal populations should be made members of the tribal advisory committee, and tribal students should be trained in healthcare programmes and integrated into the national health services (Narain 2019).
10. Periodic health education programmes should be conducted in tribal areas to raise their health awareness.
11. Health insurance programme to cover all tribal populations should be Started (RECTH 2013).
12. Programmes should be initiated to support livelihood programmes.
13. Grain banks managed by self-help groups should be established to address seasonal food security (World Bank 2014).
14. More investment should be made/done on power, roads, and irrigation in tribal areas to revamp small-hold agriculture.
15. Watershed programmes should be started in tribal areas to benefit the agriculture in tribal areas.
16. Encourage planting fruit trees in homestead lands, and degraded forests to diversify the livelihood and prevent seasonal vulnerabilities.
17. Start massive public works in tribal areas where agricultural productivity is less.
18. Provide training to develop the skill among tribal youth and provide ration cards and national rural employment guarantee to support tribal people.
19. Ensure the availability of subsidized food grains to the poor through the public distribution system.
20. Station-integrated child development services where the maximum people can have access (Saxena CPRC-IIPA Working paper).

References

Adak DK, Gautam RK, Bharti S, Gharmi AK (2006a) Body mass index and chronic energy deficiency of adult males of Central Indian populations. Hum Boil 78:201–218

Adak DK, Gautam RK, Gharami AK (2006b) Assessment of nutritional status through body mass index among adult males of 7 tribal populations of Maharashtra. India Ma1 J Nutr 12:23–31

Adhikary M (2007) Assessment of anthropometric characteristics, body composition and nutritional status of Lodha women of Samraipur, Paschim Midnapur, West Bengal, India. M. Sc. Dissertation (unpublished). Vidyasagar University, West Bengal, India

Banik SD (2008) Nutritional status of adult men from the Oraon tribe in Ranchi District of Jharkhand, India. Mal J Nutr 14:91–99

Banik SD, Bow K, Bisai S (2005) Anthropometric and physiometric assessment of adult Dhimals of Naxalbari, West Bengal. Indian J Biol Sci 11:26–39

Banik SD, Bose K, Bisai S, Bhattacharya M, Das S, Jana A, Purkait P (2007) Chronic energy deficiency among adult Dhimals of Naxalbari, West Bengal: comparison with other tribes of Eastern India. Food Nutr Bull 28:348–352

Banik SD, Barman RK, Maity S, TanwiSukul T, Roy V (2009) Ethnic variation in anthropometric characteristics and nutritional status—a comparative study among adult male Oraons and Saraks of Ranchi district, Jharkhand, India. Anthropologie XLVII(1–2):95–106

Bhandari S, Ghosh M, Bose K (2019) Socio-Demographic characteristics and prevalence of under nutrition among adult Sabars of Bankura district, West Bengal, India. Int J Adv Life Sci Res 2:01–10

Bharali N, Mondal N, Singh KHN (2017) Prevalence of undernutrition, overweight and obesity among Nyishi tribal women of Arunachal Pradesh, Northeast India. Hum Biol Rev 6(1):63–78

Bhasin MK, Jain S (2007) Biology of the tribal groups of Rajasthan, India:1. Body mass index as an indicator of nutritional status. Anthropologist 9(3):165–175

Bhattacharya A, Pal B, Mukherjee S, Roy SK (2019) Assessment of nutritional status using. anthropometric variables by multivariate analysis. BMC Public Health 19:1045

Bisai S, Bose K (2008) Body mass index and chronic energy deficiency among adult tribal populations of West Bengal: a review. Tribes Tribals 2:87–94

Bisai S, Bose K (2009) Undernutrition in the Kora Mudi tribal population, West Bengal, India: a comparison of body mass index and mid-upper-arm circumference. Food Nutr Bull 30:63–67

Bisai S, Bose K (2012) Critical nutritional stress among adult tribal populations of West Bengal and Orissa, India. Nat Proc. https://doi.org/10.1038/npre.2012.7068.2

Bisai S, Bose K, Khatun A, Ganguli S, Das P, Dikshit S, Pradhan S, Mishra T (2008) Nutritional stress in Kora Mudis of two districts in West Bengal. India: a comparative statement. In: Basu SK, Banik SD (eds) Environment and education. Protection and policy issues, vol 2. APH Publication Corporation, New Delhi, pp 379–389

Bose K, Chakraborty F (2005) Anthropometric characteristics and nutritional status based on body mass index of adult Bathudis: a tribal population of Keonjhar District, Orissa, India. Asia Pacific J Clinical Nutr 14(1):80–82

Bose K, Chakraborty F, Mitra K, Bisai S (2006a) Nutritional status of adult Santal men in Keonjhar district, Orissa, India. Food Nutr Bull 27:353–356

Bose K, Ganguli S, Mamtaz H, Mukhopadhyay A, Bhadra M (2006b) High prevalence of undernutrition among adult Kora Mudi tribals of Bankura district, West Bengal, India. Anthropol Sci 114:65–68

Bose K, Bisai S, Mondal PS, Ghosh M (2008) Body mass index and chronic energy deficiency among adult male Lodhas and Bhumijs: a comparison with other tribal populations of West Bengal, India. J Pub Health 16:117–121

Bose K, Debsharma B, Das S (2011) Is body adiposity index a good measure of nutritional status? A study among two adult tribal populations of Paschim Medinipur, West Bengal, India. Science J Sociol Anthropol 1:1–7

Census (2011). https://censusindia.gov.in/2011-common/censusdata2011.html. Accessed 9 Sept 2021

Chakma T, Meshram PK, Rao PV, Singh SB, Kavishwar A (2009) Nutritional status of Baiga—a primitive tribe of Madhya Pradesh. Anthropologist 11:39–43

Chakrabarty S, Pal M, Bharati S, Bharati P (2008) Body form and nutritional status among adult males of different social groups in Orissa and Bihar states in India. HOMO—J Comp Hum Biol 59:235–251

Chakraborty R, Bose K, Koziel S (2011) Use of mid-upper arm circumference in determining undernutrition and illness in rural adult Oraon men of Gumla District, Jharkhand, India. Rural Remote Health 11:1754

Das S, Bose K (2012) Nutritional deprivation among Indian tribals: a cause for concern. Anthropol Notebooks 18:5–16

Das S, Bose K (2014) Anthropometric assessment of nutritional status of adult Hill Kherias of Purulia district, West Bengal. In: Sinha AK, Sharma K (eds) Human ecology in an era of globalization and urbanization. Anthropological dimension. Serials Publications PVT. Ltd, New Delhi, pp 381–90

Das S, Bose K (2015) Adult tribal malnutrition in India: an anthropometric and socio- demographic review. Anthropol Rev 78:47–65

Das S, Bose K (2010) Body mass index and chronic energy deficiency among adult Santals of Purulia district, West Bengal, India. Int J Hum Sci 7:488–503

Das S, Mahata M, Bose K (2013) Nutritional profile of adult Birhors of Purulia: a particularly vulnerable tribal group of, West Bengal, India. Asian Acad Res J Mult 1(5):262–276
Das K, Mukherjee K, Chanak M, Pal S, Sayak Ganguli S, Sankar Bagchi SS, Bose K (2019) Co-existence of high levels of undernutrition and hypertension among Sabar Males of Purulia, West Bengal, India: a paradox. Int J Adv Life Sci Res 2:38–47
Deo MG, Pawar PV, Kanetkar SR, Kakade SV (2017) Prevalence and risk factors of hypertension and diabetes in the Katkari tribe of coastal Maharashtra. J Postgrad Med 63:106–113
Gautam RK, Adak DK (2006) Nutrition and Genetic variation among Central Indian tribes. In: Tribal health proceedings of national symposium. Regional Medical Research Centre for Tribals, ICMR, pp 141–153
Ghosh M (2007) Nutritional status of adult Bhumij males of Kharagpur, Paschim Medinipur. Paper presented in seminar on approaching development, Department of Anthropology, Vidyasagar University, 5: 22 cited in Bisai S, Bose K (2008) Body mass index and chronic energy deficiency among adult tribal populations of West Bengal: a review. Tribes Tribals 2:87–94
Ghosh J (2016) Nutritional status of tribal women: an epidemiological study among Santal-Munda tribes of North 24th Parganas district of West Bengal, India. Int J Sci Res 5:229–232
Ghosh R, Bharati P (2006) Nutritional status of adults among Munda and Pod populations in a semiurban area of Kolkata City, India. Asia Pac J Pub Health 18:12–20
Ghosh S, Malik SL (2007) Sex differences in body size and shape among Santhals of West Bengal. Anthropologist 9:143–149
Gogoi G, Sengupta S (2002) Body mass index among the Dibongiya Deoris of Assam, India. J Hum Ecol 13:271–273
Goswami M (2010) Nutritional status of the Bhumija of Baleswar, Orissa. Indian Anthropologist 40(1):55–70
Goswami M (2012) Body mass index and chronic energy deficiency of adult Bhuyans: a vulnerable tribal group of Keonjhar and Anugul districts of Odisha, India. Ind J Phys Anthrop Hum Genet 31:39–47
Goswami M (2013) Prevalence of under-nutrition among the Juangs. A study on a particularly vulnerable tribal group of Odisha, India. Antrocom Online Jo Anthropol 9 (1):61–66
Goswami M (2014) Body mass index and Chronic energy deficiency among adult male Lodhas and Kharias of Mayurbhanj, Odisha. Comparison with other tribal populations of Eastern India. Antrocom Online J Anthropol 10:359–364
Goswami M (2015) Anthropometric characteristics and chronic energy deficiency of the Mankidias—a PTG of Northern Odisha, India. Stud Tribes Tribals 13:88–93
Goswami M (2016) The health scenario of the tribes of Odisha—a review. Ind J Phys Anthrop Hum Genet 35:237–244
Haidich AB (2010) Meta-analysis in medical research. Hippokratia 14(1):29–37
Ingole AB, Tantarpale VT, Kulkarni KM (2014) Haemoglobin percentage and body mass indices observed in tribes of Chikhaldara Dist. Amravati. Int J Life Sci 2:75–78
Jain Y, Kataria R, Patil S, Kadam S, Kataria A, Jain R, Kurbude R, Shinde S (2015) Burden and pattern of illnesses among the tribal communities in central India: a report from a community health programme. Indian J Med Res 141:663–672
Jaiswal A (2013) Health and nutritional status of a primitive tribe of Madhya Pradesh: Bhumia. Global J Hum Soc Sci Hist Archaeol Anthropol 13:14–19
John P, Ramadas S (2008) Body mass index: an indicator of nutritional status among adult Man nan tribes of Idukki District, Kerela. Acad Rev 15:60–65
Kanrar P, Goswami M (2020) Socio-demographic profile, reproductive health and nutritional status among the Juangs—a particularly vulnerable tribal group of Odisha, India. Orient Anthropol 20:135–149
Kapoor AK, Tyagi R, Kapoor S (2009) Nutritional status and cardio-respiratory functions among adult Raji males, a hunter and gatherer tribe of the Indian Himalayas. Anthropol Sci 117:1–7
Kapoor AK, Saluja K, Verma D, Kapoor S (2012) Predictors of hypertension among adult tribal males of India. Intern J Trop Dis Health 2:241–256

Kapoor D, Bhardwaj AK, Kumar D, Raina SK (2014) Prevalence of diabetes mellitus and its risk factors among permanently settled tribal individuals in tribal and urban areas in northern state of sub-Himalayan Region of India. Int J Chronic Dis Article ID 380597:9

Khongsdier R (2001) Body mass index of adult males in 12 populations of Northeast India. Ann Hum Biol 28:374–383

Khongsdier R (2002) Body mass index and morbidity in adult males of the War Khasi in Northeast India. Eur J Clin Nutr 56:484–489

Khual GK, Limbu DK (2019) Prevalence of obesity and hypertension among the Zou Mothers of Manipur, Northeast India. Orient Anthropol 19:111–120

Kshatriya GK (2014) Changing perspectives of tribal health in the context of increasing lifestyle diseases in India. Environ Soc Sci 1:1–7

Kshatriya GK, Acharya SK (2016) Triple burden of obesity, undernutrition, and cardiovascular disease risk among Indian tribes. PLoS ONE 11(1):e0147934

Kusuma YS, Bontha V, Babu BV, Naidu JM (2004) Prevalence of hypertension in some cross-cultural populations of Visakhapatnam district, south India. Ethn Dis 14:250–259

Ministry of Tribal Affairs, Government of India Annual Report (2019–2020). https://tribal.nic.in/downloads/Statistics/AnnualReport/AREnglish1920.pdf. Accessed 9 Sept 2021

Misra RJ, Mini GK, Thankappan KR (2014) Risk factor profile for non-communicable diseases among Mishing tribes in Assam, India: results from a WHO STEPs survey. Indian J Med Res 140:370–378

Mittal PC, Srivastava S (2006) Diet, nutritional status and food-related traditions of Oraon tribes of New Mal (West Bengal), India. Rur Rem Health 6(1):1–11

Mohandas S, Amritesh K, Lais H, Vasudevan S, Ajithakumari S (2019) Nutritional assessment of tribal women in Kainatty, Wayanad: a cross-sectional study. Indian J Community Med 44:S50–S53

Mohankumar JB, Velvizhi M (2018) Body mass index of Kaani tribes from Kanyakumari district in Tamil Nadu, India. Scho J Food Nutr 1:1–3

Mondal PS (2007) Nutritional status of adult Lodha males of Shyamraipur, Paschim Medinipur. Paper presented in seminar on Approaching development in Department of Anthropology, Vidyasagar University. Abstract no. 06, p 23

Mukherjee K, Harashawaradhana VPN, Alam A, Rawat B (2015) Body mass index and chronic energy deficiency among adults of Tharu Population, Uttarakhand, India. Int J Biomed Res 6:475–478

Mukhopadhyay A (2010) Anthropometric characteristics and undernutrition among adult Santal tribe of Birbhum District, West Bengal, India. Anthropol Sci 118:57–60

Mungreiphy NK, Kapoor S (2010) Socioeconomic changes as covariates of overweight and obesity among Tangkhul Naga tribal women of Manipur, north-east India. J Biosoc Sci 42:289–305

Narain JP (2019) Health of tribal populations in India: how long can we afford to neglect? Indian J Med Res 149:313–316

Rao VG, Sugunan AP, Murhekar MV, Sehgal SC (2006) Malnutrition and high childhood mortality among the Onge tribe of the Andaman and Nicobar Islands. Public Health Nutr 9:19–25

Rao KM, Kumar R, Krishna KS, Bhaskar V, Laxmaiah A (2015) Diet and nutrition profile of Chenchu population - a vulnerable tribe in Telangana and Andhra Pradesh, India. Indian J Med Res 141:688–696

Ravi KS, Singla M, Ansari MS (2019) Body mass index in adult Jaunsari tribe population of Dehradun district of Uttarakhand. J Anat Soc India 68:138–142

Reddy BN (1998) Blood pressure and adiposity: a comparative study of socioeconomically diverse groups of Andhra Pradesh, India. Am J Human Biol 10:5–21

Reddy PYB, Rao A (2000) Body mass index (BMI) among the Sugalis-A tribal population of Cuddapah district, Andhra Pradesh. J Human Ecol 11(5):409–410

Reddy BM, Latheef SAA, Pranavchand R (2019) The burden of non-communicable disease risk factors and haematological indicators of infections among the rural, semiurban and Urban inhabitants of the Yanadi tribal population of South India. J Indian Anthrop Soc 54:137–169

Reddy RK, Rao PC, Reddy TR, Reddy K (2020) Health and nutritional Status of Sugali and Yanadi tribes of Rayalaseema Region, Andhra Pradesh. Biomed Res Health Adv 2:28–32

Report of the expert committee on Tribal Health (2013) Tribal Health in India Bridging the gap and a roadmap for the future. Ministry of Health and Family Welfare and Ministry of Tribal Affairs, Government of India. http://nhm.gov.in/nhm_components/tribal_report/Executive_Summary.pdf. Accessed 9 Sept 2021

Riamei G, Ghosh S (2019) Nutritional status in relation with age and place of residence among the adult Rongmei Naga of Manipur. NEHU J 28:31–39

Ritu G, Bhattacharyya M (2015) Nutritional status among adult Karbi women of Kamrup district, Assam. Int Res J Social Sci 4:17–20

Rokade S, Mog M, Mondal NA (2020) Nutritional status among tribal women in Maharashtra, India: spatial variations and determinants. Clin Epidemiol Global Health 8(4):1360–1365

Sahani RK (2003) Nutritional and health status of the Jarawas: a preliminary report. J Anthropol Surv India 52:47–65

Sahani RK, Gautam RK, Golnabi AH, Vedwan N (2018) Comparative study of chronic energy deficiency among adult males of Andaman and Nicobar Islands and their counterparts. Anthropol Rev 81:1–17

Saxena NC Hunger, under-nutrition and food security in India. Working paper no.44. https://www.files.ethz.ch/isn/128320/CPRC-IIPA%2044.pdf. Accessed 9 Sept 2021

Singh HS, Ghritlahre M, Das S (2014) Nutritional status among females of Bhaina Tribe of Bilaspur, Chhattisgarh, India: an anthropological insight. J Anthrop 897893:7

Sreelakshmi PR, Vijayakumar K, Anish TS, Shrinivasa BM, Sheela S (2012) Anaemia and body mass index of non-pregnant tribal women of reproductive age group in Palakkad district of Kerala, India. Ind J Prev Soc Med 43:35–41

Verma DK (2020) Intertribal variation with respect to BMI: a study on tribal women of Bastar, Chhattisgarh, India. Adv Soc Sci Res J 7:564–579

World Bank (2014) India: food security and nutrition in tribal areas. Washington, DC, World Bank. https://openknowledge.worldbank.org/handle/10986/20007License:CCBY3.0IGO. Accessed 9 Sept 2021

World Health Organization (1995) Physical status: the use and interpretation anthropometry (Technical Report Series No. 856). World Health Organization

Chapter 9
The Food and Nutrition Status in India: A Systematic Review

Shahnaz Basheer, V. V. Ashique, and Aakriti Grover

Abstract With undernutrition, overnutrition, and micronutrient deficiencies afflicting the country, India experiences a triple burden of malnutrition. Recent decades have seen modest progress when it comes to health in India, but progress has been uneven and inequitable. This study reviews food and nutrition status in India. The diversity in food is enabled by variety in nutrition, which is only possible with serious crop diversification. The nutrient uptake is majorly cereal-centric as food production, availability, and access are impacted by the agricultural policy that has placed a significant thrust on food grain production spurred by the green revolution and supported by the institutions. India is not only affected by malnutrition amongst the poor but also amongst all socio-economic groups. India ranks 101 out of 116 countries based on the Global Hunger Index 2020. The Global Nutrition Report 2018 clearly mentions that India is home to 46.6 million stunted children and 25.5 million wasted children. India ranks 103 out of 119 qualifying countries per the Global Hunger Index 2018. Malnutrition was the predominant risk factor for death in children younger than five years of age in every state of India in 2017 (GBD), accounting for 68.2% (95% UI 65.8–70.7) of the total under-5 deaths and the leading risk factor for health loss for all ages, responsible for 17.3% (16.3–18.2) of the entire disability-adjusted life years (DALYs). In India, nutrition status has deteriorated over decades because of ineffective policy interventions and inadequate food systems, which are neither affordable nor sustainable. There are severe gaps in India's nutrition statistics, and even the most important nutrition trends are far from explicit; practical action in this field requires regular and reliable large-scale surveys that would make it possible to monitor the nutrition situation at the district levels at intervals.

S. Basheer (✉) · V. V. Ashique · A. Grover
Department of Geography, School of Earth Sciences, Central University of Tamil Nadu, Thiruvarur, India
e-mail: shahnazbphd19@students.cutn.ac.in

A. Grover
School of Global Affairs, Dr. B.R. Ambedkar University, Delhi, India

A. Grover et al. (eds.), *Sustainable Health Through Food, Nutrition, and Lifestyle*,
Advances in Geographical and Environmental Sciences,
https://doi.org/10.1007/978-981-19-7230-0_9

Keywords Food · Nutrition · Malnutrition · Nutritional status · Health · NFHS · Nutritional policies

9.1 Introduction

India had a population of 1.21 billion in 2011 (Census of India 2011), which increased to 1.39 billion in a decade (2021) (World population prospects 2019). In order to meet its food and development needs, India's population places immense pressure on its land and natural resources. Food production and the socio-economic status of rural people determine the growth of agriculture and rural prosperity (Kumar 2017). By measuring the health of its citizens, a nation evaluates its health quality; people, regardless of their income level, face various health problems due to underdeveloped economies (Dambal 2017). Malnutrition is a dual issue in the country, both overweight and underweight. In India, malnutrition affects people from all socio-economic backgrounds, not just those below the poverty line. However, India is home to nearly one-quarter of the world's poor and undernourished population (Kumar 2017).

Amongst the critical drivers of urban malnutrition, urbanization is responsible for profound shifts in urban food systems (namely, the prevalence of cheap ultra-processed food and beverages), urban diets (convenient and processed food), and urban lifestyles (Nguyen et al. 2021; Popkin et al. 2020). Globally, approximately 55% of the population lives in cities; by 2030, that number is expected to rise to 60%, and by 2050, it is expected to reach 68% (Revision of World Urbanization Prospects 2018). The triple burden of malnutrition is just one of the many challenges facing urban dwellers regarding health and nutrition., i.e. the coexistence of undernutrition and micronutrient deficiencies and overweight/obesity is increasingly affecting public health in urban areas and worldwide (Ruel et al. 2017).

Over the past few decades, India's health has improved, although uneven and inequitable progress has been made (Nguyen et al. 2021). Poverty disproportionately affects the prevalence of maternal and child undernutrition (Young et al. 2020). It is especially striking to see how poor urban dwellers fare when it comes to undernutrition and other health conditions (Goli et al. 2013), and sometimes even worse than in rural areas (Usmani and Ahmad 2018). On many healthcare outcomes, India has witnessed positive strides, but the state of nutrition and health security needs improvement. While India made significant progress toward meeting the Millennium Development Goals (MDGs) during the MDG era, there is still a need for more sustained efforts to achieve progress, particularly in food security (Food and Nutrition Security Analysis, India 2019). Between 1993–1994 and 2011–2012, the average daily per capita consumption of both energy and protein decreased in rural India, while in urban areas, there was no consistent trend, and the decline has happened despite the increase in household income (Food and Nutrition Security Analysis, India 2019). India will not meet many of its MDG targets. The problems of low birth weight and maternal anaemia are still worryingly significant. The undernutrition

leading to poor growth and stunting continues to take its toll on succeeding generations of children (Gopalan 2013). The study attempted to gain an understanding of the food and nutrition situation in India.

9.2 Food and Nutrition

The multifaceted food systems are dependent on agriculture, food, eating, and health and well-being. As consumers, people are the central focus of a resilient food system. As a result of this system, environmental integrity, economic independence, and social well-being are maintained and reinforced. Sobal et al. (1998) take a holistic perspective on the food and nutrition system; it can help design more comprehensive policies and programmes that include elements from the food chain, cycle, and web models. It is essential to recognize that the food and nutrition system works in a context that is further subdivided into biophysical and social environments. A healthy lifestyle requires energy, protein, and nutrient requirements that are fulfilled by food security, which results in access to adequate, secure, and nutritious food for everyone, regardless of their socioeconomic status.

Overall progress notwithstanding, hunger remains an everyday challenge for almost 795 million people worldwide, including 780 million in the developing regions (McGuire, FAO, IFAD and WFP 2015). More than a hundred million people are afflicted by diseases triggered (Food Aid for Health and Development, WFP and WHO 1997) or exacerbated by insufficient and unbalanced nutrient intakes and aggravated by unsafe food and drinking water. People everywhere have the opportunity, throughout their lives, to achieve and maintain their highest attainable level of health, according to the WHO's universal health goal of health for all (Nutrition for Health and Development, WHO 2000), and this is impossible in the presence of hunger, starvation, and malnutrition.

According to Capone et al. (2014) by 2050, in order to meet the world's food needs, the world agricultural system could provide food for a rapidly growing population while also offering economic opportunities for the rural poor population whose livelihoods rely on agriculture, and reducing carbon emissions. Overpopulation and food consumption are the two major causes of the increase in food demand. However, malnutrition (undernutrition, overnutrition, and malnutrition of micronutrients) and insecurity of food are the most significant global crises. In addition to these, the globally inflexible food system can be attributed to its damaging social, economic, and environmental effects (Capone et al. 2014). A significant determinant of nutritional status is consuming high-quality and nutritious foods in sufficient quantities (Battersby 2019).

A person's health is not only dependent upon physical well-being but also on personal and psychological well-being and good nutrition (Upadhyay and Tripathi 2017). Nutrition is defined as the food at work in the body; nutrition involves all that happens to food from the moment it is ingested until it is being used in the body for different functions (Srilakshmi 2006). In nutrition, an individual's physiological state

is based on what occurs when nutrients intake matches nutritional needs, as well as the capacity of the body to digest and absorb nutrients (Zulkarnaen 2019). The state of dietary disparity is referred to as malnutrition, and the two causes that cause malnutrition could be overnutrition and undernutrition (Huysentruyt et al. 2021). Thus, malnutrition and its adverse consequences depend upon altered intake, functional changes, and finally, anthropometric effects (Jeejeebhoy et al. 1990; Christensson et al. 2002).

Both "malnutrition" and "under-nutrition" frequently refer to nutritional circumstances indicative of people belonging to developing countries' low-income and poor socio-economic groups, but under- and overnutrition occur concurrently within different population groups in many developing countries (Söderström et al. 2014). India seems to have the questionable characteristic that low-birth-weight incidence is growing (LBW). The primary underlying type of undernutrition is micro-nutrient malnutrition. It is also referred to differently because it can therefore co-exist with inadequate macronutrient intake (i.e. overweight and obesity, more below) and has health effects different from those correlated with stunting (Gómez et al. 2013).

There are numerous factors determining the nutritional status of a person, and it varies; knowing all the factors distressing nutritional status, such as evaluating malnutrition and managing and assisting solutions for the nutritional issues (Fogel 2004). Factors influencing the nutritional status, which are the affordability of food and its delivery system, food intake, source of consumption expenditure, family size, illiteracy, socio-cultural and religious values, sanitation facilities, and health services (Somalia et al. 2017).

9.3 Nutritional Profile of India

Over the last two decades, India's population has grown tremendously, surpassing 1.3 billion people. Despite India's phenomenal industrial and economic growth and despite being able to produce sufficient food to feed its population, a large number of people, particularly women and children, lack access to food. The Indian States are practically equal to small countries, each with its socio-economic level, ethnic groups, eating habits, health infrastructure, and communication systems. Consequently, the population's nutritional status varies considerably between states due to a variety of factors.

According to its annual report, the FAO estimates there are 189.2 million undernourished people in India (The State of Food Security and Nutrition in the World 2020). Approximately 14% of India's population (189.2 million) is undernourished, and Between 15 and 49 years old, 51.4% of women are anemic. The report finds that 34.7% of children under five are stunted, and around 20% have wasted. India ranks 101 out of 116 countries based on the Global Hunger Index 2020, which measures three major indicators such as wasting and stunting among children under 5 years, undercarriage mortality rate, and prevalence of undernutrition. The prevalence of underweight amongst children aged 1–5 years in states ranging from Meghalaya to

Gujarat is 13 to 77%; in Goa, 20% of children are stunted, while 83% in Gujarat. Almost the same states in the country have the highest prevalence of stunting and underweight, i.e., the States with the highest prevalence of underweight also have the highest prevalence of stunting. Across India, stunting and being underweight does not usually coincide with wasting, other than in Madhya Pradesh and Arunachal Pradesh, which have the worst nutritional situation nationwide. Nutritional status is markedly improved in children under five years of age by reducing the prevalence of underweight. With more than half of the adults in Karnataka, Gujarat, Madhya Pradesh, and Orissa having a BMI under 18.5 kg/m^2, these states have the highest rates of adult malnutrition. Child and adult malnutrition patterns are similar, with extremely poor nutritional status occurring in Gujarat, Orissa, Arunachal Pradesh, Karnataka, Maharashtra, Madhya Pradesh, and Andhra Pradesh. In most states, being underweight, stunting, and wasting are considered severe public health problems.

In the context of nutrition, India has some of the worst anthropometric indicators in the world, both for adults and children, and even though most sub-Saharan African countries are currently poorer, the growth is slower, and infant and child mortality rates are higher than in India, India's undernutrition levels remain higher than those of most of these countries (Deaton et al. 2008). Recent decades have seen health improvements in India, but progress has been uneven and inequitable (Nguyen et al. 2021). The poor bear a disproportionate burden of maternal and child malnutrition (Nguyen et al. 2021; Young et al. 2020). There has been an increase in undernutrition and other health conditions among the urban poor, especially those living in poverty (Goli et al. 2013; Nguyen et al. 2021), and sometimes even worse than in rural areas (Usmani and Ahmad 2018). On many healthcare outcomes, India has witnessed positive strides, but the state of nutrition and health security in the country really needs improvement. Despite India's extensive progress toward the Millennium Development Goals (MDGs) during the MDG era, it was noted in the 2016 India MDG Country Report that more sustained efforts are required to accelerate progress, particularly regarding food and nutrition (Food and Nutrition Security Analysis, India 2019). Between 1993–1994 and 2011–2012, the average daily per capita consumption of both energy and protein decreased in rural India, while in urban areas, there was no consistent trend and the decline has happened despite the increase in household income (Food and Nutrition Security Analysis, India 2019).

The Global Burden of Diseases assesses the incidence, prevalence, mortality, years of life lost (YLLs), years lived with disability (YLDs), and disability-adjusted life-years (DALYs) due to 369 diseases and injuries, for both sexes, for 204 countries and territories. According to GBD, the malnutrition was the leading cause of death in children younger than five years old in every state of India in 2017, accounting for 68.2% (https://gdc.unicef.org/resource/burden-child-and-maternal-malnutrition-and-trends-its-indicators-states-india-global) of all deaths and it is the leading risk factor for health loss in most age groups, causing 17.3% of total disability-adjusted life years (DALYs). India recorded a 21.7% the prevalence of low birth weight in 2017, a 39.3% prevalence of stunting, a 15.7% prevalence of child wasting, a 32.7% prevalence of child underweight, 59.7% of children having anaemia, 54.4% of women 15–49 years of age having anaemia, and 11.5% of children having overweight. If

in India, if the projections up to 2017 continue for each indicator in the National Nutrition Mission (NNM) 2022, there would be an excess prevalence of low birth weight, stunting, underweight, 11.7% of anaemia in youth, and 13.8% of anaemia in women compared to the 2022 target. The trends up until 2017 would result in an excess prevalence of wasting of 10.4%, overweight of 14.5%, and exclusive breastfeeding of 10.7% for the additional indicators in the WHO/UNICEF 2030 targets (India State-Level Disease Burden Initiative Malnutrition Collaborators 2019).

In addition to other challenges urban dwellers face regarding health and nutrition, malnutrition carries a double burden, i.e., the coexistence of undernutrition (Caroline et al. 2019) and micronutrient deficiencies and overweight/obesity is globally, and especially in urban areas, public health has become a significant issue (Ruel et al. 2017). Urbanization is a strong driver of the double burden of malnutrition because it causes remarkable shifts in urban food systems (particularly the availability of cheap ultra-processed food and beverages), in urban diets (convenient and processed foods), and lifestyles (lower levels of physical activity related to the labour-saving technologies, more sedentary work, more leisure, and motorized transportation) (Popkin et al. 2020; Nguyen et al. 2021).

There are serious gaps in India's nutrition statistics and even the most basic nutrition trends are far from clear; effective action in this field requires regular and reliable large-scale surveys that would make it possible to monitor the nutrition situation at the district levels at intervals (Deaton et al. 2009). When individuals seek nutrition or health care, India's health system must reorient and retool itself to ensure prevention, early detection, and effective management of dual nutrition and disease burdens (Ramachandran and Kalaivani 2018).

9.4 An Overview of the Factors Maintaining Malnutrition in India

Amongst young children, malnutrition is regarded as the most significant risk factor for illness and death and is associated with 52.5% of all deaths (Muller and Krawinkel 2005; Black et al. 2003, 2008; Caulfield et al. 2004). The following factors increase the risk of malnutrition in children: low birth weight, feeding problems, diarrhoea, recurrent illness, measles, pertussis, and chronic disease (Rikimaru et al. 1998; Ighogboja 1992; Tomkins and Watson 1989). Children under five years of age are most at risk, and social factors also play a role in malnutrition. Other causes of malnutrition include inadequate antenatal care, not deworming children regularly, low birth weight, diarrhoea episodes, and delayed development. Despite the fact that the latter three conditions can be a consequence of malnutrition, a lack of health services can exacerbate malnutrition (Tette et al. 2015).

There is a number of factors that influence a child's nutrition level. For example, socio-economic factors such as income, ethnicity, geographic location, sanitation, hygiene, and parental and child-level factors play an important role in nutrition

levels. In general, parents, particularly mothers, strive to provide their children with every means of getting proper health care and to ensure their health status is appropriate for their potential (Ettinger 2004). It is becoming increasingly evident that a mother's education can provide better access to knowledge about proper feeding practises and better hygiene (Moestue et al. 2007; Webb and Block 2004). According to some studies, mother's employment is beneficial as it provides them with a sense of empowerment, while others claim it is detrimental as it limits the time they have to spend with their children. Mother's health awareness and education are powerful factors for improving their children's nutrition. It has been shown that domestic violence has harmful effects on physical and psychological health, but there is little information regarding domestic violence and malnutrition (Ghosh 2020).

9.5 Nutrition Programmes and Policies in India

The majority of the programmes and policies are aimed at providing additional nutrients to target groups to fulfil the gap between food intake and requirements. In the "National Policies and Strategies" category, work is being done to accelerate progress toward the World Food Summit of 1996.

According to the Director-General's Foreword in The State of Food Insecurity in the World 2001, where this challenge is currently at:

> In the poorest countries, most people are affected by hunger, greatly magnifying the dimensions of other correctable defects in efforts to meet basic human needs. Once problems are understood at the community level, resources can be focused first on the direct relief and essential service interventions that ensure people have the health and energy to participate in their development (National Policies and strategies, FAO 2001).

It is critical to address nutrition at multiple levels, as it is a multisectoral issue, and it is important to address the problem of nutrition both directly by addressing particularly vulnerable groups and indirectly by using various development policy tools that will create conditions for better nutrition. Nutrition activities in India were aimed at increasing food production during the First and Second Five-Year Plans, initiating nutritional surveys of complementary feeding, and preventing food adulteration (Kapil et al. 1992). India has a number of nutrition supplementation programs Fig. 9.1 shows the timeline of India's nutrition supplementation programs. In these programmes, the Mid-day Meal Programme (1961) was revised in the year 2014 and the National Goitre Control Programme (NGCP) (1962) in 1992 the programme was renamed as National Iodine Deficiency Disorder Control Programme. The governments in various states are implementing numerous other supplementary programmes also.

A National Prophylaxis Programme against Nutritional Blindness due to Vitamin A Deficiency (NPPNB due to VAD) was launched in 1970 specifically to address nutritional blindness due to keratomalacia (WHO 2005). In the 1950s and 1960s, there was an unacceptable level of xerophthalmic blindness in the country. So, it

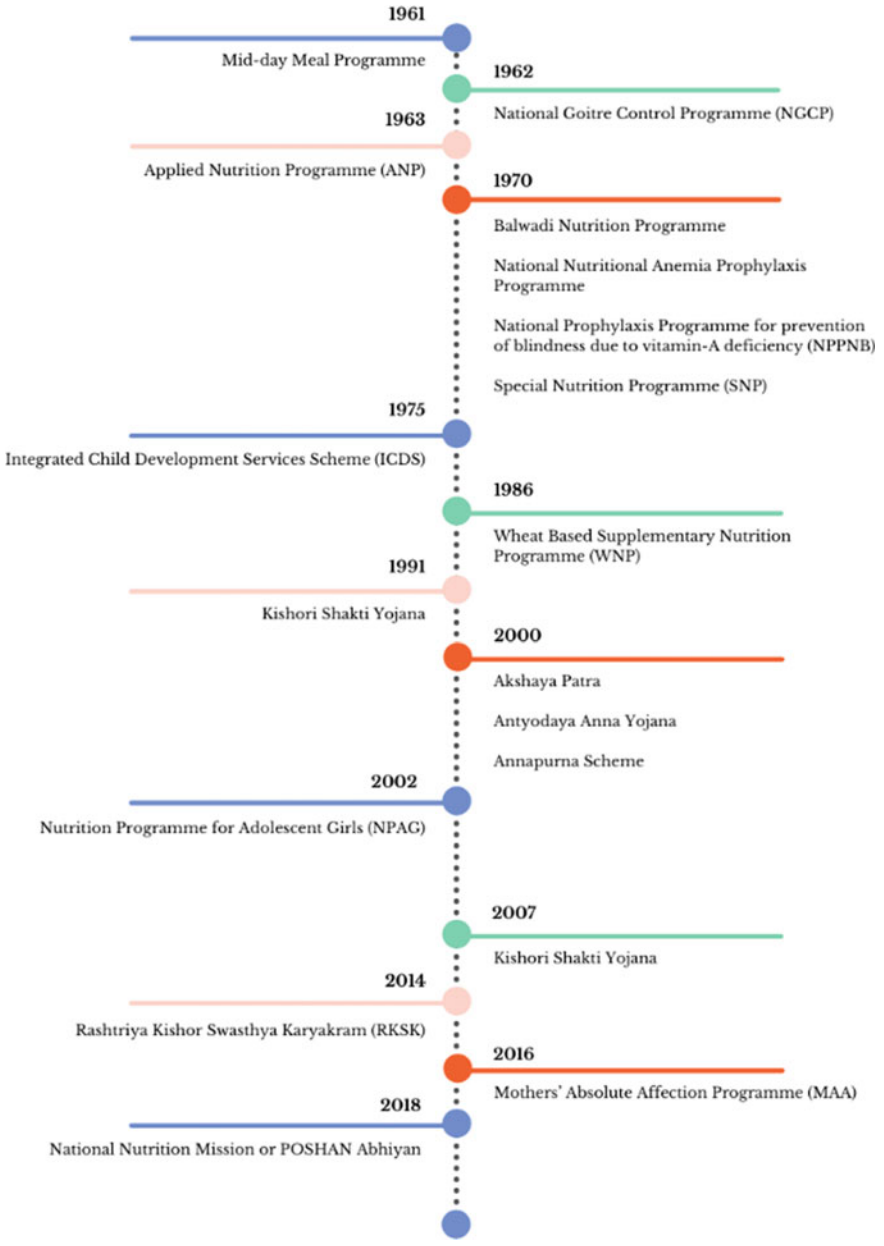


Fig. 9.1 National nutritional programmes

was necessary to implement this urgent remedy. At first, the program was launched in 11 states only, and later it was extended to all the states of the country. In 1976, the National Institute of Nutrition (NIN), Hyderabad conducted evaluation studies in two states and found the programme to be effective (Kapil et al. 1992). The country is at a point in which universal vitamin A supplementation must be converted into a targeted program very soon (Kapil and Sachdev 2013).

In 1993, the Government of India adopted the National Nutrition Policy (NNP) under the auspices of the Department of Women and Child Development. The NNP aimed to eradicate malnutrition by achieving optimum nutrition for everyone with a multi-sectoral approach. According to the revised NNP (1993), the Direct and Indirect interventions for the nutrition policy instruments were Direct Intervention (Short Term) such as nutrition intervention for especially vulnerable groups, fortification of essential foods, popularisation of low-cost nutritious food, control of micronutrient deficiencies amongst vulnerable groups and the indirect Policy Instruments are Long Term Institutional and Structural Changes which includes Food Security, Improvement of Dietary pattern through Production and Demonstration, Policies for Effecting Income Transfers to improve the entitlement package of the rural and urban poor, Land Reforms, Health and Family Welfare, Bask Health and Nutrition Knowledge, Prevention of Food Alteration, Nutrition surveillance, Monitoring of Nutrition Programmes, Research, Equal Remuneration, Communication, Minimum Wage Administration, Community Participation, Education lit Literacy, Improvement of the Status of Women.

The National Food Security Act (NFSA)-2013 indicates food and nutritional security for people through a life cycle approach to agriculture by providing access to affordable, quality food at reasonable prices so they can live a dignified life, and other related matters thereto. On an all-India basis, NFSA has been implemented in all states/UTs, and an estimated 80 crore people have covered under it for highly subsidized food grains out of 81.34 crore people (https://nfsa.gov.in/portal/nfsa-act).

The POSHAN Abhiyaan or National Nutrition Mission-2018 is the Government of India's nutritional programme to improve nutrition outcomes for children, pregnant women, and breastfeeding mothers, and it aims to ensure a malnutrition-free India. The broad themes of the programme were: antenatal care, optimal breastfeeding (early and exclusive), complementary feeding, anaemia, growth monitoring, girls'—education, diet, right age of marriage, hygiene and sanitation, eating healthy—food fortification (https://www.niti.gov.in/poshan-abhiyaan).

Agricultural efforts should be geared towards a crop-neutral focus; greater diversification of production will help alleviate poverty and improve diet diversity. For policies and programmes to be implemented adequately, the government should allocate appropriate resources. To ensure that nutrition reaches all, must be a joint effort between state governments and the Centre. Nutritional disparities within the domestic sphere must be mapped.

9.5.1 National Family Health Surveys in India

A health information system is an essential component of any health system but is weak in low-income countries like India because of poor data quality, which can make it difficult to inform health policy (WHO 2007; AbouZahr and Boerma 2005; Boerma and Stansfield 2007; Stansfield et al. 2006). The National Family Health Survey (NFHS) is a multi-round, large-scale survey conducted on representative samples of Indian households nationwide. NFHS was first launched by the Ministry of Health and Family Welfare (MoHFW), Government of India, in 1991, in New Delhi. As the nodal agency for survey coordination and technical guidance, the MoHFW has designated the International Institute for Population Sciences (IIPS) Mumbai. The survey and the sample size of NFHS are summarized in Table 9.1. The NFHS has been designed to achieve two specific goals, such as providing the Ministry of Health and Family Welfare and other agencies with essential health and family welfare data and providing information about important emerging health and family welfare issues. The first survey of NFHS was conducted in 1992–93; the following rounds were conducted in 6–9-year intervals. Women were surveyed in all rounds of surveys, NFHS-3,4, and 5 also included never-married women. The ever and/or currently married women interviewed in all rounds of surveys were of reproductive age; women up to 49 years of age were selected as respondents in all rounds of NFHS. The lower age limit for NFHS-1 was 13 years, which was raised to 15 years during subsequent rounds. Male representation across surveys has been inconsistent. Only in four rounds have men represented, and men aged 15–54 years were interviewed in NFHS-3 and 4.

In all rounds of NFHS, questions about women's employment status and fertility preferences were asked. In rounds 2,3,4 and 5 of the NFHS, questions were asked regarding health services quality, sexually transmitted infections (STI), HIV/AIDS, and women's autonomy. In NFHS-2,3,4,5 height and weight measurements for women and men were taken. In later rounds of the surveys, different biomarkers were evaluated. As part of NFHS-2, anaemia was assessed among children 6–35 months of age and ever-married women 15–49 years old. Also, an anaemia test was done for men in NFHS-3,4, and 5.

NFHS-1 collected a piece of detailed information on infant and child nutrition in India, where chronic undernutrition and acute malnutrition are high. Nearly half of children under the age of four are underweight and stunted. The wasting amongst children is also quite prevalent and, it affects more than one out of six children. As a child's age varies significantly, undernutrition is lowest during the first six months of life when most are breastfed. There are relatively low levels of undernutrition amongst young children in Kerala, even though more than a quarter are underweight and stunted. As with infant mortality, wasting is most evident in Bihar and Orissa, which also have amongst the lowest levels of undernutrition in the country (IIPS 1995).

The second round of NFHS provides the important aspects of nutrition, health, and healthcare. In India, 47% of children under the age of three are underweight. There

Table 9.1 Survey and sample size for National family health surveys in India, 1992–2020

Survey	Years	States covered	Reports	No. of households in the sample	Information
NFHS-1	1992–93	24 + NCT Delhi	National & State Level	88,562	Population, health, and nutrition, with an emphasis on women and young children
NFHS-2	1998–99	26 + NCT Delhi	National & State Level	91,196	The quality of health and family planning services, domestic violence, reproductive health, anaemia, the nutrition of women, and the status of women
NFHS-3	2005–06	29 + NCT Delhi	National & State Level	109,041	Population, health, and nutrition, slum, and non-slum areas, household indicators, women and men
NFHS-4	2015–16	All states + NCT Delhi	National, State & District Level	568,200	Population, health, and nutrition, malnutrition, anaemia hypertension, HIV, high blood glucose levels, household indicators, women and men, biomarkers
NFHS-5	2019–20	All states + NCT Delhi	National, State & District Level	610,000	Population, health and family welfare, nutrition, and others

Source IIPS (1995), IIPS and ORC Macro (2000), Arnold et al. (2009), IIPS and ICF (2017, 2020)

is 46% of children were stunted and 16% were wasted. Compared to urban areas, undernutrition is more prevalent in rural areas and is particularly prevalent amongst children from disadvantaged socio-economic backgrounds. The majority of children aged 6–35 are anaemic. Children whose mothers are not anaemic have anaemia at different levels in different parts of India. In Kerala and Nagaland, 44% have anaemia, whereas 80–84% have it in Haryana, Rajasthan, Bihar, and Punjab. Nearly two-thirds (35%) of women are undernourished. Nutritional deficiencies are more prevalent among women in rural areas, young women, and women in economically disadvantaged groups. In Orissa and West Bengal, the percentage of undernourished women is highest, while it is lowest in Arunachal Pradesh, Sikkim, and Delhi. Obesity is a considerable problem among several groups of women in India. Women with anaemia are least likely in Kerala, Manipur, Goa, and Nagaland, where 23–28% are anaemic and the highest anaemia prevalence in Assam, Bihar, Meghalaya, Orissa, West Bengal, Arunachal Pradesh, and Sikkim, where 61–70% are anaemic. There is a potential threat of iodine deficiency disorders in India (IIPS and ORC Macro 2000).

The NFHS-3 shows in every state of India, the nutritional problems are severe. The children under the age of five years who are underweight range from 20% in Sikkim and Mizoram to 60% in Madhya Pradesh. Furthermore, more than half of young children in Jharkhand and Bihar are underweight. The states with the highest percentages of underweight (40%) children are Meghalaya, Chhattisgarh, Gujarat, Uttar Pradesh, and Orissa. Despite the relatively low prevalence of underweight in Mizoram, Sikkim, and Manipur, more than one-third of children are stunted. Madhya Pradesh is the most prevalent state of wasting (35%), followed by Jharkhand (32%), and Meghalaya (31%). Seven in ten children in India aged 6–59 months are anaemic. The prevalence of nutritional deficiency is high amongst women (36%) and men (34%). Generally, the geographic distribution of anaemia among men and women is similar (Arnold et al. 2009).

According to the fourth round of NFHS, 38.4% of children under five years are stunted, 21% are wasted, and 35.8% are underweight. Twenty-six per cent of women and 18% of men were overweight or obese. There is 58.6% of children aged 6–59 months are anaemic. A total of 53.1% of all women aged 15–49 and 22.7% of men aged 15–49 are anaemic (IIPS and ICF 2017).

In the latest round of the NFHS-5, Children under the age of 5 were more likely to be stunted, wasted, and underweight at 36.5%, 19.3%, and 32.1%, respectively. Amongst overweight and obese women there is 24%, and amongst overweight or obese men, it is 22.9%. Anaemia prevalence in children aged 6–59 months is 67.1%. A majority of women (57%) aged 15–49 are anaemic, and a quarter of all men (25%) are anaemic (IIPS and ICF 2020).

Since the NFHS is one of the largest data sets in the world in terms of health measures, it offers a unique source for observing many aspects of health, especially women's health and children's health. Indicators related to population, health, family welfare, nutrition, and others are essential for measuring the progress toward Sustainable Development Goals in the country. Based on the surveys, it is apparent that there are several issues for consideration in improving their use of these surveys.

9.6 Progress Towards Global Nutrition Targets

Considering the current pace of progress, in most countries, the global nutrition targets won't be met by 2025. Over 194 countries, there is a considerable variation in the availability of nutrition-related data and the progress made toward the global nutrition targets. By 2025, only seven countries will achieve four of the six nutrition targets for maternal, infant, and young child nutrition. As a result of the Covid-19 pandemic, global nutrition targets are being impeded. The global population has been pushed into extreme poverty by an estimated 155 million people, during the pandemic of Covid-19 (Cesare et al. 2021). In order to facilitate the achievement of Sustainable Development Goals, nutrition plays a key role; a healthy and sustainable diet and food security are prerequisites for meeting the proposed targets of quality nutrition for all and protection of the environment (Grosso et al. 2020).

In India, most households are middle class or poor; a small number are wealthy. In terms of nutrition, the country's economic condition was not good during independence. Nevertheless, India has developed socially, economically, and globally in the years since. However, much more needs to be accomplished. The World Health Assembly recently published the Global Nutrition Report of 2020. The 2020 Report examines how nations have progressed in achieving the global nutrition targets for 2025. These targets include anaemia, low birth weight, exclusive breastfeeding, childhood wasting, and childhood overweight, amongst others. It marks the progress of a total of 194 countries. Of these, India is amongst the 88 countries that are not on track for achieving their 2025 targets. According to the report, India is not on track to meet its nutrition targets for 2025.

Several surveys on nutrition are conducted intermittently in India, but it is unclear which of these will provide the required data to track the World Health Assembly Targets (John et al. 2015). The insufficient investments in welfare programmes and economic slowdown that have marked the last few years, combined with the growing food security amongst poor households, have brought India to a state where the Government of India has to take drastic measures to stem the tide. As well, the first phase of NFHS-5 shows the situation just before the COVID-19 lockdown, which means child nutrition has deteriorated further over the last year, necessitating urgent action (www.theigc.org).

9.7 Conclusion

Overall, the findings clearly demonstrate the decline in India's nutritional status over the decades and call for policy interventions and immediate adjustments to the food system. Nutrition and health services, as well as our population, are not in a position to provide such routine periodic assessment and appropriate counselling for early detection and effective management of undernutrition and overnutrition as well as their health consequences (Ramachandran and Kalaivani 2018).

Public health issues like micronutrient deficiency and inadequate nutrition continue to be significant concerns. The need for frequent nutritional data is fundamental, to educating the public about nutrition through the media. Boosting growth through fortification can also be economically, practically, and flexibly achievable. There is a need to improve and proper implementation of the current nutritional programmes.

References

AbouZahr C, Boerma T (2005) Health information systems: the foundations of public health. Bull World Health Organ 83(8):578–583

Arnold F, Parasuraman S, Arokiasamy P, Kothari M (2009) Nutrition in India. In: National Family Health Survey (NFHS-3), India, 2005–06. International Institute for Population Sciences, Mumbai; ICF Macro, Calverton, Maryland, USA

Battersby J (2019) Urban food systems governance and poverty in African Cities. pp 1–26.https://doi.org/10.4324/9781315191195

Black RE, Morris SS, Bryce J (2003) Where and why are 10 million children dying every year? Lancet 361(9376):2226–2234. https://doi.org/10.1016/S0140-6736(03)13779-8

Black RE, Allen LH, Bhutta ZA, Caulfield LE, de Onis M, Ezzati M et al (2008) Maternal and child undernutrition: global and regional exposures and health consequences. Lancet 371(9608):243–260. https://doi.org/10.1016/S0140-6736(07)61690-0

Brand C, Bricas N, Conaré D, Daviron B, Debru J, Michel J, Soulard C-T (ed) (2019) Designing urban food policies concepts and approaches, urban agriculture. Springer, Switzerland

Boerma JT, Stansfield SK (2007) Health statistics now: are we making the right investments? Lancet 369(9563):779–786. https://doi.org/10.1016/S0140-6736(07)60364-X

Capone R, Bilai HE, Debs P, Cardone G, Driouech N (2014) Food system sustainability and food security: connecting the dots. J Food Secur 2(1):13–22

Caulfield LE, de Onis M, Blossner M, Black RE (2004) Undernutrition as an underlying cause of child deaths associated with diarrhea, pneumonia, malaria, and measles. Am J Clin Nutr 80(1):193–198

Census of India (2011) Primary Census Abstract (PCA) directorate of census operations Kerala. https://censusindia.gov.in

Cesare Di M, Ghosh S, Osendarp S, Mozaffarian D (2021) A world free from malnutrition: an assessment of progress towards the global nutrition targets. https://globalnutritionreport.org/reports/2021-global-nutrition-report/assessing-progress-towards-the-global-nutrition-targets/

Christensson L, Unosson M, Ek AC (2002) Evaluation of nutritional assessment techniques in elderly people newly admitted to municipal care. Eur J Clin Nutr 56:810–881. https://doi.org/10.1038/sj.ejcn.1601394

Dambal S (2017) Malnutrition in India: an overview. Int J Med Pharm Sci (IJMPS) 7(6):41–52. www.tjprc.org

Deaton A, Drèze J (2008) Income, health, and well-being around the world: evidence from the gallup world poll. J Econ Perspect 22(2):53-72

Deaton A, Drèze J (2009) Nutrition in India: facts and interpretations, working paper no. 170. Econ Political Wkly 44(7):42–65

Ettinger AS (2004) Children's health, the Nation's wealth: assessing and improving child health. Environ Health Perspect 112(14)

Fogel RW (2004) Health, nutrition, and economic growth. Econ Dev Cult Change. 52(3). University of Chicago and National Bureau of Economic Research. https://doi.org/10.1086/383450

Food and Nutrition Security Analysis, India (2019) Ministry of statistics and programme implementation and the world food programme by the Government of India and World Food Programme. http://www.indiaenvironmentportal.org.in/files/file/Food%20and%20Nutrition%20Security%20Analysis.pdf

Ghosh S (2020) Factors responsible for childhood malnutrition: a review of the Literature. Curre Res Nutr Food Sci 8(2):360–370. https://doi.org/10.12944/CRNFSJ.8.2.01

Goli S, Doshi R, Perianayagam A (2013) Pathways of economic inequalities in maternal and child health in urban India: a decomposition analysis. PLoS ONE 8(3):e58573. https://doi.org/10.1371/journal.pone.0058573

Gómez MI, Barrett CB, Raney T, Pinstrup-Andersen P, Meerman J, Croppenstedt A, Lowder S, Carisma B, Thompson B (2013) Post-green revolution food systems and the triple burden of malnutrition. In: ESA Working Paper No. 13–02, Agricultural Development Economics Division Food and Agriculture Organization of the United Nations. www.fao.org/economic/esa

Gopalan C (2013) The changing nutrition scenario. Indian J Med Res 138(3):392–397

Huysentruyt K, Brunet-Wood K, Bandsma R, Gramlich L, Fleming-Carroll B, Hotson B, Byers R, Lovelace H, Persad R, Kalnins D, Martinez A, Marchand V, Vachon M, Hulst JM (2021) On behalf of the Canadian malnutrition task force-pediatric working group. Canadian nationwide survey on pediatric malnutrition management in tertiary hospitals. Nutrients 13:2635. https://doi.org/10.3390/nu13082635

Ighogboja SI (1992) Some factors contributing to protein-energy malnutrition in the middle belt of Nigeria. East Afr Med J 69(10):566–571

India State-Level Disease Burden Initiative Malnutrition Collaborators (2019) The burden of child and maternal malnutrition and trends in its indicators in the states of India: the global burden of disease study 1990–2017. Lancet Child Adolesc Health 3:855–870. https://doi.org/10.1016/S2352-4642(19)30273-1. https://gdc.unicef.org/resource/burden-child-and-maternal-malnutrition-and-trends-its-indicators-states-india-global

International Institute for Population Sciences (IIPS) (1995) National family health survey (MCH and family planning), India 1992–93. IIPS, Mumbai

International Institute for Population Sciences (IIPS) and ICF (2017) National family health survey (NFHS-4), 2015–16: India. IIPS, Mumbai

International Institute for Population Sciences (IIPS) and ICF (2020) National family health survey (NFHS)-5, India and state factsheet compendium. IIPS, Mumbai

International Institute for Population Sciences (IIPS) and ORC Macro (2000) National family health survey (NFHS-2), 1998–99: India. IIPS, Mumbai

Jeejeebhoy KN, Detsky AS, Barker JP (1990) Assessment of nutritional status. J Parent Enternal Nutr 14:193–196

John A, E Knebel, L Haddad, Menon P (2015) An assessment of data sources to track progress towards global nutrition targets in India. POSHAN Research Note 6. International Food Policy Research Institute (IFPRI), New Delhi. http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/129722

Kapil U, Sachdev HP (2013) Massive dose vitamin A programme in India need for a targeted approach. Indian J Med Res 138(3):411–417

Kapil U, Chaturvedi S, Nayar D (1992) National nutrition supplementation programmes. Indian Pediatr 29:1601–1613. https://www.indianpediatrics.net/dec1992/1601.pdf

Kumar P (2017) Food and nutrition security in India: the way forward. Agric Econ Res Rev 30(1):1–21. https://doi.org/10.5958/0974-0279.2017.00001.5

McGuire S, FAO, IFAD, WFP (2015) The state of food insecurity in the world 2015: meeting the 2015 international hunger targets: taking stock of uneven progress. Adv Nutr 6(5):623–624. https://doi.org/10.3945/an.115.009936

Moestue H, Huttly S, Sarella L, Galab S (2007) 'The bigger the better'-mothers' social networks and child nutrition in Andhra Pradesh. Public Health Nutr 10(11):1274–1282

Muller O, Krawinkel M (2005) Malnutrition and health in developing countries. CMAJ 173(3):279–286. https://doi.org/10.1503/cmaj.050342

National Nutrition Policy (1993) Government of India Department of Women & Child Development Ministry of Human Resource Development New Delhi. https://wcd.nic.in/sites/default/files/nnp_0.pdf

National Policies and strategies, FAO (2001) https://www.fao.org/ag/AGN/nutrition/nationalpolicies_en.stm

Nguyen PH, Scott S, Headey D, Singh N, Tran LM, Menon P et al (2021) The double burden of malnutrition in India: trends and inequalities (2006–2016). PLoS ONE 16(2):e0247856. https://doi.org/10.1371/journal.pone.0247856

Popkin BM, Corvalan C, Grummer-Strawn LM (2020) Dynamics of the double burden of malnutrition and the changing nutrition reality. Lancet 395(10217):65–74. https://doi.org/10.1016/S0140-6736(19)32497-3

Ramachandran P, Kalaivani K (2018) Nutrition transition in India: challenges in achieving global targets. Proc Indian Natn Sci Acad 84(4):821–833

Rikimaru T, Yartey JE, Taniguchi K, Kennedy DO, Nkrumah FK (1998) Risk factors for the prevalence of malnutrition among urban children in Ghana. J Nutr Sci Vitaminol (Tokyo) 44(3):391–407. https://doi.org/10.3177/jnsv.44.391

Ruel MT, Garrett JL, Yosef S, Olivier M (2017) Urbanization, food security, and nutrition. In: de Pee S, Taren D, Bloem MW (eds) Nutrition and health in a developing world, part VII, vol 705–735. New York. https://doi.org/10.1007/978-3-319-43739-2_32

Sobal J, Khan LK, Bisogni C (1998) A conceptual model of the food and nutrition system. Soc Sci Med 47(7):853–863. https://doi.org/10.1016/s0277-9536(98)00104-x

Söderström L, Rosenblad A, Adolfsson ET, Saletti A, Bergkvist L (2014) Nutritional status predicts preterm death in older people: a prospective cohort study. Clin Nutr 33(2):354–359. https://doi.org/10.1016/j.clnu.2013.06.004

Somalia, Mogadishu, Mohamud A, Ibrahim WM (2017) Study on risk factors for poor nutritional status among <5 children in Yaqshid district Mogadishu-Somalia. Dissertation. https://www.researchgate.net/publication/323831532_Study_on_risk_factors_for_Poor_Nutritional_Status_among_5_children_in_Yaqshid_district_Mogadishu-Somalia

Srilakshmi B (2006) Nutrition science, Revised 2nd edn. New Age International (P) Limited Publishers, New Delhi, India

Stansfield SK, Walsh J, Prata N, Evans T (2006) Information to improve decision making for health. In: Jamison DT, Breman JG, Measham AR, Alleyne G, Claeson M, Evans DB et al (eds). Disease control priorities in developing countries, 2nd edn. The International Bank for Reconstruction and Development and The World Bank, Washington

Tette EM, Sifah EK, Nartey ET (2015) Factors affecting malnutrition in children and the uptake of interventions to prevent the condition. BMC Pediatr 15:189. https://doi.org/10.1186/s12887-015-0496-3

Tomkins A, Watson F (1989) Malnutrition and infection; a review. In: UN ACC/SCN. vol. Nutrition policy discussion paper. Administrative committee on coordination-subcommittee on nutrition, Geneva

The state of food security and nutrition in the world, UNICEF. https://www.unicef.org/reports/state-of-food-security-and-nutrition-2020

United Nations, Department of Economic and Social Affairs, Population Division (2018) World population prospects 2018: highlights (ST/ESA/SER.A/423)

Upadhyay R, Tripathi KD (2017) How can we assess the nutritional status of an individual? J Nutr Food Sci 7(6):1–2. https://doi.org/10.4172/2155-9600.1000640

Usmani G, Ahmad N (2018) Health status in India: a study of urban slum and non-slum population. J Nurs Res Pract 2(1):09–14

Webb P, Block S (2004) Nutrition information and formal schooling as inputs to child nutrition. Econ Dev Cult Change 52(4):801–820

WHO (2000) Nutrition for health and development: a global agenda for combating malnutrition. In: Sustainable development and healthy environments (SDE) for health and development. https://apps.who.int/iris/handle/10665/66509

WHO (2005) Vitamin and mineral requirements in human nutrition, 2nd edn. World Health Organization. https://apps.who.int/iris/handle/10665/42716

WHO (2007) Everybody's business strengthening health systems to improve health outcomes: WHO's framework for action. World Health Organization. https://apps.who.int/iris/handle/10665/43918

World population prospects (2019) Highlights, United Nations department of economic and social affairs, ministry of statistics and programme implementation UN. https://doi.org/10.18356/13bf5476-en. https://www.un.org

World urbanization prospects (2019) United Nations, department of economic and social affairs, population division. World urbanization prospects: the 2018 revision (ST/ESA/SER.A/420). New York, United Nations

Young MF, Nguyen P, Tran LM, Avula R, Menon PA (2020) Double-edged sword? Improvements in economic conditions over a decade in India led to declines in undernutrition as well as increases in overweight among adolescents and women. J Nutr 150(2):364–372. https://doi.org/10.1093/jn/nxz251

Zulkarnaen Z (2019) The influence of nutritional status on gross and fine motor skills development in early childhood. Asian Soc Sci 15(5):1–75

Chapter 10
Spirituality in Sustainable Mental Health Protection: Evidence from Vocational Training of Information Technology Professionals

Muhammad Kamran and Tomasz Ochinowski

Abstract This chapter reviews theory existing research and presents the authors' analysis of in-depth interviews with information technology (IT) professionals on the relationship between spirituality and mental health protection. The participants of the study are representatives of a specific professional group burdened with many stereotypes concerning their psychological functioning, often considered to be far from sustainable mental health. Extant research shows evidence of a negative correlation between spirituality and mental health diseases such as anxiety, depression, suicide, and schizophrenia. The chapter is focused on (a) operationalization of spirituality as a biologically rooted phenomenon in the light of David Hay's conception, (b) identifying the relationship between spirituality and sustainable mental health, (c) analysis of this relationship by exploiting qualitative research design, i.e., in-depth biographical interviews from IT professionals. The results show that IT professionals treat a high sense of spirituality as a personal competence, which makes them be more involved in their work and feel happy in their personal lives, which results in sustainable mental health protection on an existential level. Moreover, spirituality is narratively understood as a biographical phenomenon, which plays an important role to provide courage to face new challenges, providing a feeling of satisfaction, and creating empathy to others in the professional life of IT experts. Spiritual evidently can create happiness in the personal and professional lives of IT professionals and develops more patience in tough times, which are also some of the signs of good mental health. Based on our results, we propose organizations introduce professional training programs to enhance spirituality in IT professionals for sustainable mental health.

Keywords Spirituality · Mental health · Happiness · Information technology professionals

M. Kamran (✉)
Wyższą Szkołę Gospodarki Euroregionalnej im. Alcide De Gasperi, Jozefow, Poland
e-mail: muhammad.kamran@wsge.edu.pl

T. Ochinowski
Faculty of Management, University of Warsaw, Warsaw, Poland
e-mail: Ochinto@wz.uw.edu.pl

A. Grover et al. (eds.), *Sustainable Health Through Food, Nutrition, and Lifestyle*,
Advances in Geographical and Environmental Sciences,
https://doi.org/10.1007/978-981-19-7230-0_10

10.1 Introduction

Over time, spirituality has gradually become an essential factor in the mental health profession (Brown et al. 2013; Kao et al. 2020; Garssen et al. 2021; Moreira-Almeida and Bhugra 2021; Oxhandler et al. 2021). Studies revealed that spirituality plays a substantial role in people's lives, beliefs, and actions, thereby affecting human well-being (Hadzic 2011). Additionally, there is ample evidence in the literature regarding the impact of spirituality on well-being and mental health, mainly positive, but the picture of spirituality–mental health relations seem to be complex (Hodges 2002; Townsend et al. 2002). Although the literature supports the existence of the relationship between spirituality and mental health and well-being, however, this relationship still needs to be explored scientifically.

In the contemporary professional literature, mental health is defined as a lack of mental disorders such as schizophrenia, depression, and bipolar disorder and as positive feelings such as peace, happiness, and satisfaction (Cohen and Koeing 2004). Exploring the effect of spirituality on mental health is greatly linked with behavioral sciences, psychiatry, and psychology (Miller and Thoresen 2003). The role of spirituality in individual mental health is strongly affected by how the person reacts to the realities of life. Moreover, studies confirm that the way people survive and tolerate the hardships in their lives has an impact on their ability to recover from that negative event (Moreira-Almeida et al. 2006). To encounter such adversities, spirituality can facilitate how to efficiently deal with the problems in life, develop a healthy and productive lifestyle, and overcome negative emotions such as anger, frustration, fears, and anxiety (Hadzic 2011).

The main objective of this chapter is to establish and explain the possible patterns of relationships between spirituality and sustainable mental health in everyday life. Our cognitive goal is a strict qualitative one. We are going to increase the understanding of the relationships between spirituality and sustainable mental health. To achieve this goal, we have divided this chapter into two parts. In the first part of this chapter, we will identify the relationship between spirituality and sustainable mental health based on the literature. In the second part, we will discuss the concept of spirituality as a natural phenomenon, operationalizing it in the light of David Hay's biological approach. We will analyze the relationship between spirituality as a biologically rooted phenomenon and sustainable mental health management by exploiting our previous qualitative research design, i.e., in-depth biographical interviews from Pakistani IT professionals.

10.2 Spirituality and Sustainable Mental Health

The word "spirituality" has advanced in significance for social and behavioral science over the past fifty years, but there is still a lack of literature on the conceptual and operational definition of spirituality (Hill et al. 2000; Kamran and Ochinowski 2018).

Spirituality is traditionally related to religion in the western world and is treated as a specific way of performing religious practices (Rolheiser 1998). In current exploration, the understanding of spirituality is an assumption; spirituality is abstract in nature as well as a natural human phenomenon (Kamran 2019).

Therefore, "spirituality is a concept with ancient roots yet contemporary relevance to mental health," as an international group of Canadian, Australian, and Scottish scholars set out the topic succinctly a few years ago (Michaelson et al. 2019). It is obvious today for researchers, journalists, philosophers, and even preachers that the problem of spirituality goes far beyond any religious discourse. Of course, the religious contexts present interesting challenges as well as stimulating controversies which inspire further research on spirituality.

An existential stream in World thought[1] seems to propose the broadest, cross-cultural background for academic discussions (including interpretations of various studies) about spirituality acceptable to researchers with different world views and methodological orientations. At the same time, an existential approach highlights these aspects of spirituality as a natural phenomenon that seems especially important for mental health issues.

Robert C. Solomon (2002: 33), in his *Spirituality for the Skeptic*…assumed that.

> Perhaps it is, as Camus tells us, that we should live "without appeal". To live without hope, in this sense, does not mean life without meaning, nor does it imply living in despair or without a sense of the future - even an optimistic sense of the future. Insofar a faith implies that there is some agent of whom we should expect something (for instance, an answer to our prayers, even our daily bread), the aim of naturalized spirituality is precisely to get beyond such expectations. Nevertheless, I would not want to live without love, reverence, and trust, although, I admit, I have sometimes tried to do so.

The mentioned view is also acceptable to believers steeped in diverse traditions. Inside Christianity, for example, the same ideas as Solomon (2002) were presented after Camus presents it understanding of the essence of spirituality was developed by Paul Tillich (1948/2016), a representative thinker of the so-called religious form of existentialism (Thompson 2007: 72).

The existential framework helps researchers and reflective practitioners of mental health care to also take into consideration the extreme emotional factors inherent to human beings, like grief and loss resulting in severe and lasting trauma. They constitute a specific context of relations between spirituality and sustainable mental health.

Neil Thompson (2007:72), the co-author of *Spirituality, Values and Mental Health: Jewels for the Journey*—just like above-mentioned Solomon (2002), who was referring to the thoughts of Camus, stressing that:

> Recognizing that we are finite beings can be a challenge of meaning in its own right. Albert Camus, an absurdist writer whose thoughts have much in common with existentialism, asks

[1] Existential philosophy is traditionally associated with its Western creators as Kierkegaard, Sartre, or Camus. However, it is worth mentioning, for example, Habachi (1965), the Lebanese representative of existentialism. Moreover, Tillich (1963) has consistently pointed out the importance of the existential approach in intercultural dialogue on the example of interreligious issues.

> the basic question of why do we go on? Why do we not end it here and now – that is, commit suicide? (Camus 2005). This was not a plea of despair but, rather, a recognition that the challenge of finding "the meaning of life" constitutes an essential part of human existence/experience. If we cannot find meaning, what is there left except death?

After this citation, Thompson (2007:72) immediately adds:

"This is closely linked to the Buddhist notion of "impermanence" that is also a feature of other Eastern philosophies. The idea of impermanence is not a source of despair but rather of celebration. The recognition that, because our life is of limited duration, we need to make sure that we make the best use of it while we can, that we do not waste the precious resources of life and humanity that are available to us. This has spiritual implications.

As can be seen, an existential thought, which includes intercultural intuitions too, offers an intellectual tool to look at the issues of this chapter in the context of extreme threats such as the threat of death. Then when the sustainable mental health becomes a matter of not only everyday well-being but also means increasing the chances of survival for yourself or your relatives or helping dying people."

It is also worth emphasizing that from an existential perspective, the core issue of spirituality turns out to be the search for "the meaning of life."

The existential vision of the spirituality phenomenon is undoubtedly useful when this chapter is emerging just before the fourth wave of the COVID-19. Both aspects of spirituality that the existentialist perspective has highlighted turn out to be very current. They allow a new look at empirical research and concepts regarding the spirituality–mental health relationship and bring out the universal elements (of these relations), to which the pandemic makes it more sensitive. From this perspective, it is worth taking into consideration research on empirical indicators of spirituality, which have been developing mainly since the beginning of the 2000s. Moreover, it is important not to forget also about earlier conclusions on the issues, which today are referred to as spiritualty–sustainable mental health relations. These "old" concepts may turn out to be very fresh now, just because of the global pandemic experiences. Both contemporary research results and "old" conceptions or findings could throw new light and reveal their new meanings now. Among these new meanings, there may be those that will turn out to be relatively universal and useful in the period.

Broadly speaking, the indicatively treated phenomenon of spirituality, as one can see in the contents of the research, is constituted by such elements as (1) individual's specific relationship toward others, and to reality in general (2) feeling of transcendence, (3) re-evaluating ethical and moral values, and (4) searching for the meaning of life (Charzyńska and Heszen-Celińska 2020).

Diverse research devoted to the mentioned theme, framed by an existential thought and analyzed from the perspective of the new reality created by the pandemic, presents a colorful palette of spirituality–sustainable mental health issues.

Psychiatric studies in the field of mental health have long since broken past the limitations of the traditional way of thinking about spirituality spawned from the one-sided interpretation of Freud's intellectual heritage. In that traditional approach, religious beliefs and practices and the notions of perceiving non-physical reality by

the individual in general (including phenomena interpreted as spiritual in contemporary works) have been linked to hysteria, neurosis, psychotic states and were treated mainly as pathological delusions.

The contemporary research in mental health areas shows the crucial role played by spirituality (but still investigating it rather marginally) in promoting emotional wellness. It is specifically valuable in developing personal life satisfaction as well as building self-esteem, improving marital and family relations, and rising levels of coping with clinical problems. What is especially important from the existential perspective in treating clinical problems is that such of them can be reduced by individual spiritual resources, as negative stress, excessive consumption of alcohol, pharmacological and substances addiction, depression, and suicide. Spirituality strengthening the individual feeling of psychic comfort revives hope and gives meaning to mundane experiences. Practitioners in palliative medicine see spirituality as a coherent element of their patients' treatments, especially in the face of the end of life. Psychiatrists and Psychanalysts in the USA who develop spiritually sensitive practices may achieve APA annual Oskar Pfister Award, which honors outstanding contributions in the field of psychiatry and religion (Verghese 2008; Koening 2009; Dein et al. 2010; Peteet 2019; Kao et al. 2020; Rosmarin et al. 2020).

Members of the mentioned above international research team, Valerie Michaelson, Nathan King and William Pickett from Canada, Jo Inchley and Dorothy Currie from the UK, and Fiona Brooks from Australia (2019), are among these scholars who no longer treat spirituality as a homogeneous phenomenon. They examined the intercorrelation between the four domains of the spirituality of adolescents from their countries. They also took into account the demographic variables. The researchers indicated that the inner connection between the domains of spirituality differentiated by them, "self," "others," "nature," and "transcendence" may play a crucial role in the protection of the so-called spiritual health. As one can see, sustainable mental health in all probability requires sustainable spirituality. The exact meaning of it is a matter for future studies. The work of Michaelson et al. (2019) paves a path to them.

However, on the other hand, it is rather difficult to recognize precisely whether spirituality plays a role of a real resource or rather constitutes a liability in particular cases of mental health problems. Earlier cited, Rosmarin et al. (2020: 1) give the following examples of such situations based on recent research:

> Spirituality can co-opt the presentation of psychotic and obsessive symptoms, complicating treatment. Worse still, emotional distress resulting from spiritual crisis, persistent doubts, or faith struggles (e.g., disillusionment with organized religion following clergy sexual abuse scandals, anger towards God) can functionally contribute to mental health problems. In one study, more than 40% of pre-treatment suicidality could be accounted for by spiritual struggles.

So, spirituality concerning mental health still looks like an opportunity and challenge at the same time, which awaits serious studies to be fully undertaken by professionals of the psychiatry fields. This requires, among other conditions, the intensification of the cooperation of psychiatrists with non-medical experts on spirituality (Rosmarin et al. 2020).

Psychologists appear to be the most natural "subjects" of such cooperation with psychiatrists. The basic form of such an endeavor is the mutual sharing of the concepts and research findings worked out by colleagues from "neighboring fields." Of course, it means cooperative psychiatric and psychological mental health investigations.

An interesting case illustrates this idea as an example, the application of the concept of spirituality proposed by the Spanish-American psychologist Jorge N. Ferrer (Jakovljevic et al. 2019) by the cross-interdisciplinary Croatian research team. Miro Jakovljevic (psychiatrist), Asim Kurjak (practitioner in obstetrics and gynecology hospital department), Ana Jerkovic (from university faculty of business and economics), Aziz Hasanovic (Islamic community activist), and Mijo Nikic (academic expert in philosophy and religious studies) have analyzed relations between religion, spirituality, and mental health on the global level, in the face of nationalism. They published their proposals in the *Psychiatria Danubina* journal. Ferrer's ideas served them to differentiate between the healthy and the narcissistic (unhealthy) spirituality.

This distinction is based on the concept of narcissism, which is known very well through the classic psychoanalytic works of Zygmunt Freud and Heinz Kohout. More recently, it is associated mainly with pathology; a famous American psychiatric manual DSM-5 described as Narcissistic Personality Disorder. The mentioned diagnostic category develops Kohout's proposal that "the Self, rather than drive conflict, is primary to human psychology and that the Self should be at least a co-equal principle to drive conflict" in theory and practice of psychologies (Schipke 2017: 5). Ferrer (2002, 2011), a representative person of so-called transpersonal psychology, used the concept of narcissism to explain the core of spirituality as a psychological phenomenon.

According to Jakovljevic:

> Spirituality is a basic transformative process that involves shedding of narcissism, self-centeredness, self-separation, self-preoccupation, and so on. Spiritual narcissism represents a spiritual distortion and misuse of spiritual practice, energy, or experience, manifesting as ego-inflation with grandiosity fuelled by spiritual energies, self-absorption with a preoccupation by own spiritual status and achievements, and spiritual materialism with the appropriation of spirituality to strengthen the egoic way of life (Jakovljevic et al. 2019:386).

Only healthy, of course, means not narcissistic in a pathological sense, spirituality may contribute positively to real, sustainable mental health on the global level.

Jakovljevic et al. (2019) notice that healthy spirituality is linked with individual and collective resilience too. And yet it was resilience that became a de facto synonym of sustainable mental health during the CVID-19 pandemic, as numerous studies show it, testing sometimes the relations between resiliency and spirituality too (Büssing et al. 2021; Davis et al. 2021; Pérez-Rojo et al. 2021; Shibi et al. 2021; Vos 2021).

As one of the authors of this chapter has previously written about it (Ochinowski 2017), the term "resilience" was borrowed from engineering science, where it stands for the physical resistance of materials, expressed by a rapid return to their original state after deformation. Initially, the term was used by clinical child psychologists, then, the concept was gradually adopted by theorists and practitioners working

with adults. Generally speaking, "resilience" refers (although not all authors follow this understanding of the term) to a flexible approach to stress, easily returning to normal functioning after an experienced event was perceived as a failure, following a sudden misfortune, or after encountering adversity, including traumatic experiences (Seligman 2011; Stix 2011).

Lifton (1993b) was one of the founders of the resilience theme in behavioral science. Lifton's narration about resilience is rooted in his long-term studies of the experiences and behavior of people who have found themselves in extreme life-threatening situations. Lifton (1987, 1993a) proposed a psycho-formative concept to interpret the consequence of traumatic stress experiences. He emphasizes, among other things, the essential role of giving meaning to life-threatening events and bringing about the consideration of immortality. Lifton detects an interpersonal dimension where meaning is to revalue former relationships with people, to personally answer the questions of "what is good or evil," and whether there are any reliable emotional ties or personal bonds (Ochinowski 2021).

As one can see, without doubt, Lifton brings to the question of resilience clear threads related to spirituality and related to the search for meaning in particular. American scholar criticizes, at the same time, the idea of "spiritual survival" in the face of the extreme threats of a human being. People need "affirmations of everyday human life" in these situations (Lifton 1987: 274).

Martin Seligman (2011), an American founder of so-called positive psychology in behavioral science, directly connected the issues of resilience and spirituality. He develops a concept of "psychological fitness" as a relatively stable basis of human resilience. According to Seligman, "psychological fitness" consists of six components: overall satisfaction; strengths, operationalized by cross-cultural character strengths (including spirituality among them); emotional fitness; social fitness; the so-called family fitness (partner and family relationships generating support) and—last but not least—"spiritual fitness." The last one is described as a set of values and beliefs that gives a person support outside the family, institutional, and societal sources of a sense of security (Ochinowski 2017). Seligman's "spiritual fitness" operationalizes mainly by questions about the sense of meaning (Seligman 2011; Weitzman 2021).

Summing up, the results of the research and the implications of the concepts of healthy spirituality as a natural phenomenon in its relation to sustainable mental health, framed by intuitions of existential thinkers, clearly indicate the core role of searching for meaning for the discussed relation.

This issue has been highlighted by the experience of the current pandemic (see, e.g., also spiritual fortitude phenomenon, which was tested under COVID-19 circumstances, Zhang et al. 2021), but the role of the search for the meaning of life is universal and seems to be useful for building sustainable mental health in post-pandemic time too.

Even some years before the pandemic, Polish sports psychologists Kuk and Guszkowska (2019) developed a proposal for identifying spirituality only by the "search for meaning" indicator, based on numerous studies (including their own). In

this case, spirituality is healthy and has a strict positive effect on mental health, as empirical data shows it.

The rest of the chapter is a small continuation of this approach. As it was emphasized in the latest summary of the exploration of the problem of the spirituality–mental health relationship by Rosmarin et al. (2020: 1), already cited above, spirituality, first of all, opens "new vistas for mental health researchers enhancing our understanding of the human condition." If so, qualitative studies should be developed too.

It is also postulated to analyze spirituality in the context of homogeneous cultures (Hadzic 2011) and, as we have mentioned already, not to avoid the context of everyday life (Lifton 1987; King et al. 2013).

Taking these postulates into account, the next part of the chapter presents a reinterpretation (in the context of sustainable mental health) of previous, qualitative research on the role of spirituality in the biographies of IT professionals, using the example of the analysis of the biographic narrations of Pakistani experts (compare Mahmood et al. 2021). Among the results of the research based on the multidimensional, biological model of spirituality by David Hay, only the data, which were related to the search for meaning, were reinterpreted.

10.3 Spirituality as a "Search for Meaning" Among IT Professionals Concerning Sustainable Mental Health. A Narrative Study

10.3.1 Spirituality as a Biologically Rooted Phenomenon: David Hay's Conception

David Hay started his career in the school of Education at Nottingham University UK, where he reconnected with Sir Alister Hardy, a British Zoologist. Hardy established the Religious Experience Research Unit at Oxford in 1969. Hardy appealed to spirituality as the inherent potential that exists in humans and growing with the practice of natural selection (Hardy 1965). According to Hardy, spirituality is natural as well it is essential to humanity, like breathing. David Hay's research study of more than 20 years afterward the study of Hardy and he argument few facts that there is a biological root for spiritual awareness (Hay 1998). Because of Hay's work, the University of Nottingham had appointed him as a reader in spiritual education. David Hay published numerous books and articles, including Exploring Inner Space: Scientists and Religious Experience (1987); Religious Experience Today: Studying the Facts (1990); The Spirit of the Child (2006, with Rebecca Nye), and Something There: The Biology of the Human Spirit (2006). David Hay and Rebecca Nye propose the concept of relational consciousness as an equivalent of spirituality in the book "Spirit of the Child" (Hay and Nye 2006).

According to them, spiritual sensitivity is divided into dimensions and indicators. The key dimension of spiritual sensitivity, as described in the book, are awareness sensing, mystery sense, and value sense. The first dimension of "awareness sensing" is comprised of three sub-indicators, namely "here and now," "tuning," and "focusing." Secondly, "mystery sensing" includes "wonder and awe," and "imagination." Lastly, "value sensing" consists of "delight and despair," "ultimate goodness," and "meaning." In this chapter, to capture spirituality in respondents, we have exclusively considered "meaning" which is closely linked with mental health. "Meaning" is of vital importance among other sub-indicators and dimensions of spirituality. It is an idea about discovering one's inner self, looking for an identity and responsibilities. However, the concept does not relate to the conventional religious phenomenon. It is about a situation when a person feels himself "at one" with the universe while praising the natural beauties and sceneries. This is the point when a person experiences spirituality based on direct intuition, which is something linked with feelings rather than facts (Hay and Nye 2006). Hence, "meaning" is about discovering oneself, identifying the purpose, connection with a higher being, moral sense, and self-transcendence.

10.3.2 Research Objective

The main objective of this chapter is to establish and explain the possible patterns of relationships between spirituality and sustainable mental health in everyday life. To answer this question, we use some part of our previous research that explains the existence of spirituality in professional biographies of IT professionals (Kamran 2019; Kamran and Ochinowski 2017). This research was based on a qualitative analysis of interviews of IT professionals. In the current chapter, we have interpreted our results in the context of sustainable mental health.

In our research, we invited as reviewers some IT professionals from Pakistan, and they were all Muslims. We invited our reviewers not as "subjects," but according to the philosophy of narrative qualitative research as judges/experts in the era of the biographic meaning of spirituality, especially in professional life. The main criteria were that they fulfill the standard of judges/experts. We want to extract possible patterns of the meaning of spirituality as biographies of representative persons of the profession that is ordinary not associated with spirituality, at the same time, living in a homogeneous, very strong religious culture is sometimes treated as a stereotype in western culture.

10.3.3 Research Methodology

The present study employs a narrative qualitative research method that is inductive and is in line with the objectives of the study. Since the idea of spirituality is abstract

in nature, therefore, it cannot be explored straightforwardly. This is because each individual has a diverse understanding of this concept. Hence, a qualitative research method serves the purpose of exploring this abstract concept. In this study, we have used biographical interviews to deeply explore the participant's insight and knowledge of spirituality in vocational training. The interview questions were open-ended and concerned different stages of life like childhood, basic education, professional education, personal life, and professional life.

An interview is "a conversation between people in which one person has the role of a researcher" (Arksey and Knight 1999). Interviews can be structured, semi-structured, or unstructured. In the case of structured interviews, respondents are asked about the pre-scheduled standard information (Arksey and Knight 1999). The present study utilized semi-structured interviews to collect the data from eight experts. As we mentioned before, the participants were from the IT profession with more than 10 years of IT-specific experience. We treated them as a "vehicle" of narrative voices, so the unit of analysis was a sentence, not a person, who was interviewed.

Audio-recorded interviews were conducted online with participants with a time span of 90–150 min. The interviews took over 20 weeks, and in many ways, the transformation was desired. On average, 2–5 h were needed per interview, as well the transcript stretched from 12 to 27 pages. The interviews were conducted on Skype.

As mentioned before, the unit of analysis was a sentence, and the total number of sentences was 2710 (50,989 words). It covers 136 normalized pages of transcription.

10.3.4 Data Analysis Techniques

The interviews transcript and the results of the study were shared with the participants for verification. For analysis, verbatim transcriptions of interviews were generated, which were further read by three independent researchers is used. Moreover, themes were generated from the transcription in form of nodes in NVivo 11 software. This software is used to code the audio recording and analyze the transcription of the interviews thematically and generate categories of spirituality. At last, data analysis was done by content analysis manually and using NVivo.

10.4 Analysis and Results

Meaning has not been found in certain phases of the experts' lives, such as during childhood, early education, and professional education. They have expressed the presence of "meaning" in personal lives after a childhood in the forms of "discovering oneself" and "identification of the purpose of life." Experts described the "purpose of life" to be helpful for the community, loyal to friends, family, and the country, and live life ethically. Moreover, the "meaning" is also found concerning "awareness

connection with the higher being" and "moral sense," which they referred to as giving back to the community and staying positive. Thus, it can be said that having "meaning" in life makes a person purposeful, responsible, and beneficial to society and loved ones.

Regarding the presence of spirituality in professional life, experts described "meaning" to be in the form of helping the community by developing automated computer software and constructive use of technology for mankind. Furthermore, experts also expressed "meaning" in terms of having a good relationship with colleagues at the workplace and being responsible for avoiding negative use of technology. Therefore, it is observed that IT professionals report the existence of a positive relationship between spirituality and sustainable mental health in their everyday professional life. Moreover, the literature clearly shows the existence of "meaning" with morality which could implicate a moral dilemma that may affect in decreasing of psychological comforts, but this problem does not emerge from the narrations of our experts. According to Hay's concept, "meaning" belongs to a wider set of indicators that make up the dimension of "value sensing" in spirituality. Comparing the role of "meaning" with other Hay's categories and subcategories of spirituality in biographical narrations of IT Pakistani professionals, we can indicate that "value sensing" is the central spiritual dimension that creates patience and happiness in their personal and professional lives.

Therefore, sustainable mental health could be built also in professional life through spiritual resources, also by professionals, whose work is not colloquially associated nor with spirituality nor with the sustainable version of mental health.

10.5 Discussion and Conclusion

The results of the study show the positive relationship between spirituality and sustainable mental health, which are consistent with previous studies (Garssen et al. 2021; Moreira-Almeida and Bhugra 2021; Oxhandler et al. 2021). The issue has been adopted in our case to the professional era of IT professionals' biographies. Conducting the profession of IT expert, no-doubt, a profession which is both a symbol of "modern time" (using the famous metaphor from Charlie Chaplin's movie) and a typical "profession of future" it is also possible to build your sustainable mental health by developing a sense of meaning. The results of the study show that "meaning" exists in the professional life of our experts. It has been known from the classic research by Victor Frankl that meaning is very important to the mental health of children and adults. At the present stage of our research, it is difficult to say whether our experts lack "meaning" experiences in the early stage of their life or their lack of memory of such experiences. In any case, it can be an important signal to pay attention to the meaning of "meaning" in the education of IT professionals and, more broadly, in the course of education in general. Future research will also show whether

our qualitative findings will also be confirmed in IT professionals' narratives representing a worldwide view other than Muslim culture and is representative of other professions.

10.6 Limitations of the Research

As spirituality is a new field of discussion in the field of mental health from an information technology training perspective, therefore, the present study may not be able to investigate this underexplored area holistically. One of the important dimensions of spirituality that the present study lacks is its link with culture. Further research on spirituality and mental health among IT professionals can be carried out from a cross-culture perspective. This investigation will further explore whether the presence of spirituality in IT professionals has any link with the culture where these professionals belong to.

10.7 Implications of the Research

David Hay's concept of spirituality is very little explored with respect to its link with the training of IT professionals. This connection is very little explored in this study, and its findings are of great importance in terms of their practical contribution. The results can be used to improve the quality of vocational training through incorporating elements of spirituality in the training programs. Moreover, this may further enhance the knowledge and skills of the trainees and develop their responsibility for the sustainable mental health of their clients.

References

Arksey H, Knight PT (1999) Interviewing for social scientists: an introductory resource with examples. Sage

Brown DR, Carney JS, Parrish MS, Klem JL (2013) Assessing spirituality: the relationship between spirituality and mental health. J Spirituality Mental Health 15(2):107–122

Büssing A, Rodrigues Recchia D, Dienberg T, Surzykiewicz J, Baumann K (2021) Awe/gratitude as an experiential aspect of spirituality and its association to perceived positive changes during the COVID-19 pandemic. Front Psychiatry 12:642716

Camus A (2005) The myth of Sisyphus. Penguin, London

Charzyńska E, Heszen-Celińska I (2020) Spirituality and mental health care in a religiously homogeneous country: definitions, opinions, and practices among polish mental health professionals. J Relig Health 59:113–134

Cohen AB, Koenig HG (2004) Religion and mental health. In: Spielberger C (ed) Encyclopedia of applied psychology, vol 3. Elsevier Academic Press, Oxford, UK, pp 255–258

Davis EB, McElroy-Heltzel SE, Lemke AW, Cowden RG, VanderWeele TJ, Worthington EL Jr, Glowiak KJ, Shannonhouse LR, Davis DE, Hook JN, Van Tongeren DR, Aten JD (2021) Psychological and spiritual outcomes during the COVID-19 pandemic: a prospective longitudinal study of adults with chronic disease. Health Psychol 40(6):347–356

Dein S, Christopher CH, Cook CH, Powell A, Eagger S (2010) Religion, spirituality and mental health. Psychiatrist 34:63–64

Ferrer JN (2002) Revisioning transpersonal theory—a participatory vision of human spirituality. State University of New York Press, Albany

Ferrer JN (2011) Participatory spirituality and transpersonal theory: a ten-year retrospective. J Transpersonal Psychol 43(1):1–34 https://www.ciis.edu/EWP/EWP%20Documents/EWP%20PDFs/participatory%20spirituality.pdf. 14 Aug 2021

Garssen B, Visser A, Pool G (2021) Does spirituality or religion positively affect mental health? Meta-analysis of longitudinal studies. Int J Psychol Relig 31(1):4–20

Habachi R (1965) Commencements de la creature. Èditions du Centurion, Paris; Polish version (1982) U źródeł człowieczeństwa, translated by Sukiennicka, W. IW PAX, Warszawa

Hadzic M (2011) Spirituality and mental health: current research and future directions. J Spirituality Mental Health 13(4):223–235

Hardy AC (1965) The living stream: a restatement of evolution theory and its relation to the spirit of man. Collins

Hay D (1998) Why should we care about children's spirituality? Pastoral Care Educ 16(1):11–16

Hay D, Nye R (2006) The spirit of the child. Jessica Kingsley Publishers

Hill PC, Pargament KI, Hood RW Jr, McCullough ME, Swyers JP, Larson DB et al (2000) Conceptualizing religion and spirituality: points of commonality, points of departure. J Theory Soc Behav 30(1):51–77

Hodges S (2002) Mental health, depression, and dimensions of spirituality and religion. J Adult Dev 9:109–115

Jakovljevic M, Kurjak A, Jerkovic S, Hasanovic A, Nikic M (2019) Spirituality, religiosity and nationalism from the perspective of public and global mental health. Psychiatr Danub 31(4):382–391

Kamran M (2019) Spiritual dimensions in vocational training of information and communication technology professionals. Ph.D. thesis is written under the supervision of Prof Tomasz Ochinowski at the Faculty of Management, University of Warsaw, Poland. http://www.wz.uw.edu.pl/files/aktualnosci_pliki/PhD_Thesis_Summary_Muhammad_Kamran.pdf

Kamran M, Ochinowski T (2018) Spirituality in vocational training of information and communication technology professionals in the light of David Hay's conception. Chin Bus Rev 17(3):144–154. https://doi.org/10.17265/1537-1506/2018.03.004

Kao LE, Peteet JR, Cook CC (2020) Spirituality and mental health. J Study Spirituality 10(1):42–54

King M, Marston L, McManus S, Brugha T, Meltzer H, Bebbington P (2013) Religion, spirituality, and mental health: results from a national study of English households. Br J Psychiatry 202(1):68–73

Koening HG (2009) Research on religion, spirituality, and mental health: a review. Can J Psychiat 54(5):283–291

Kuk A, Guszkowska M (2019) Changes and predictors of the sense of meaning in life in polish university students participating in psychological workshops communication—forgiveness–love. J Relig Health

Lifton RJ (1987) The future of immortality and other essays for a nuclear age. Basic Books, New York

Lifton RJ (1993a) From Hiroshima to the Nazi doctors. In: Wilson JP, Raphael R (eds) The evolution of psychoformative approaches to understanding traumatic stress syndromes. international handbook of traumatic stress syndromes. Plenum Press, New York, London, pp 11–23

Lifton RJ (1993b) The protean self: human resilience in an age of fragmentation. Basic Books, New York

Mahmood QK, Jafree SR, Sohali MM, Akram MB (2021) A cross-sectional survey of Pakistani Muslims coping with health anxiety through religiosity during the COVID-19 pandemic. J Relig Health 60:1462–1474
Michaelson V, King N, Inchleyc J, Curriec D, Brookse F, Pickett W (2019) Domains of spirituality and their associations with positive mental health: a study of adolescents in Canada, England, and Scotland
Miller WR, Thoresen CE (2003) Spirituality, religion, and health: an emerging research field. Am Psychol 58(1):24
Moreira-Almeida A, Bhugra D (2021) Religion, spirituality, and mental health: setting the scene. Spirituality Mental Health Across Cult 11
Moreira-Almeida A, Lotufo Neto F, Koenig HG (2006) Religiousness and mental health: a review. Braz J Psychiatry 28:242–250
Ochinowski T (2017) Character strengths as a tool of resilience-oriented vocational training for managerial staff in a life-long learning perspective. In: Kozina G, Juznik Rotar L, Tomic D (eds) Economic and social development 19th international scientific conference on economic and social development. Book of proceedings. Development and Entrepreneurship Agency, Varazdin, pp 371–377
Ochinowski T (2021) What historiographical questions arise when a small biographical narrative meets the great psychological narratives? The case of Polish Jesuit Władysław Gurgacz (1914–1949) in front of Stalinist court, Klio Polska. Studia i Materiały z Dziejów Historiografii Polskiej. Polish Clio. Studies and materials on Polish historiography, 2021, 13
Oxhandler HK, Pargament KI, Pearce MJ, Vieten C, Moffatt KM (2021) The relevance of religion and spirituality to mental health: a national survey of current clients' views. Soc Work
Pérez-Rojo G, López J, Noriega C, Martínez-Huertas JA, Velasco C, Carreter I, López-Frutos P, Galarrag L, Pillemer K (2021) Older people's personal strengths during the first wave of the COVID-19 pandemic. Psicothema 33(3):423–432
Peteet JR (2019) Spirituality and mental health: implications for ethics, medicine, and public health. Ethics Med Public Health 9:75–79
Rolheiser R (1998) Seeking spirituality: guidelines for a Christian spirituality for the twenty-first century. Hodder & Stoughton
Rosmarin DH, Pargament KI, Koenig HG (2020) Spirituality and mental health: challenges and opportunities. Lancet Psychiatry. https://doi.org/10.1016/S2215-0366(20)30048-1[14.08.2021]
Schipke T (2017) Narcissism, ego, and self: Kohut—a key figure in transpersonal psychology. J Transpersonal Psychol 49(1):3–21
Seligman MEP (2011) Fluorish. Free Press, New York
Shibi N, Rashid T, Sher A (2021) COVID-19: psychological tips for all. JUMDC 12(2):80–84
Solomon RC (2002) Spirituality for the Skeptic: the thoughtful love of life. Oxford University Press, New York
Stix G (2011) The neuroscience of true grit: when tragedy strikes, most of us ultimately rebound surprisingly well. Where does such resilience come from? Sci Am 3:29–33
Thompson N (2007) Loss and grief: spiritual aspects. In: Coyte ME, Gilbert P, Nicholls V (eds) Spirituality, values and practice in mental health care: jewels for the journey. Jessica Kinsley Publishing, London
Tillich P (1948) The protestant era. The University of Chicago Press, Chicago; Polish version (2016) Era protestancka, translated by Prokopski JA and Łomanowska- Barańska. Wydawnictwo Marek Derewiecki, N Kęty
Tillich P (1963) Christianity and the encounter of the world religions. Columbia University Press, New York, London
Townsend M, Kladder V, Ayele H, Mulligan T (2002) Systematic review of clinical trials examining the effects of religion on health. South Med J 95:1429–1434
Verghese A (2008) Spirituality and mental health. Indian J Psychiatry 50(4):233–237
Vos J (2021) The psychology of Covid-19: building resilience for future pandemics. SAGE Publications, London

Weitzman S (2021) Strategic spirituality: positive psychology, the army, and the ambiguities of "spirituality fitness." J Am Acad Relig 89(1):240–271

Zhang H, Hook JN, Van Tongeren DR, Davis EB, Aten JD, McElroy-Heltzel S, Davis DE, Shannonhouse L, Hodge AS, Captari LE (2021) Spiritual fortitude: a systematic review of the literature and implications for Covid-19 coping. Spirituality Clin Pract 1–15.https://doi.org/10.1037/scp0000267[14.08.2021]

Chapter 11
Physical Activity as a Vital Element of the Development of the Concept of Healthy Cities (SDGs 3 and 11) with a Role of Local Governments (SDG 17)

Izabella Łęcka and Nicolai Henri de Kuyper

Abstract The main task of the chapter is to present the concepts of healthy cities, healthy active cities healthy cities and villages, and related concepts such as Green Cities, Slow Cities, and healthy smart cities (refer to SDG 11). All sectors of the economy are essential for implementing these schemes, and local governments have a unique leadership position in protecting and promoting the health and well-being of residents (refer to the SDG 17). The concept to enable all citizens, regardless of their socioeconomic status, to be physically active in day-to-day life (refer to the SDG 3) can probably be realized through solutions that are most easily accessible to all, such as bike-sharing and outdoor activities gyms if local governments enable their implementation. Next, we discuss the following two examples of research performed on these city physical activity solutions, including studies conducted in Polish cities: (a) The development of bike-sharing stations (BSS) and how and why people use them in two Polish cities: Warsaw and Bialystok. (b) Outdoor gym (OG) perception and governance: similarities and differences on a global scale; complemented by a case study in Warsaw.

Keywords Lifestyle · Physical activity · Healthy city

I. Łęcka (✉)
Associate Professor, University of Warsaw, Warsaw, Poland
e-mail: ilecka@uw.edu.pl

N. H. de Kuyper
University of Maastricht, Maastricht, The Netherlands
e-mail: nick_dekuyper@hotmail.com

A. Grover et al. (eds.), *Sustainable Health Through Food, Nutrition, and Lifestyle*,
Advances in Geographical and Environmental Sciences,
https://doi.org/10.1007/978-981-19-7230-0_11

11.1 Introduction

In this chapter, we would like to highlight three issues that are gaining in importance and popularity in the world:

1. The belief that it is necessary to instill the idea of physical activity (and exercises) in all people, regardless of age and gender, guarantees life expectancy, especially years of healthy life.
2. Adaptation of cities (although not only cities, because the countryside often takes on the features of an urban environment, and its inhabitants have similar aspirations to the citizens of urban agglomerations) to act as an activator of lifestyle changes of inhabitants to a more proactive one. Infrastructural changes in cities and educational changes of its inhabitants are effective only when they are available to everyone, regardless of their socioeconomic status. This chapter refers to physical activities in public open spaces (bike-sharing systems BSS and outdoor gyms OG).
3. Linking the above aspects of city (and rural) life with the Sustainable Development Goals (especially SDGs 3, 11, and 17) recommended by the United Nations for 2016–2030, whose goals will likely be the basis for the subsequent global goals after 2030.

Why is the combination of the above-mentioned aspects important? Because an increase in the physically active population could influence health (individual and public health), the environment (environment-friendly transportation), and the economy (Ahmed and Babakir-Mina 2021), including the development of a resource-saving, sharing economy, as well as a push for local governments to develop public–private partnerships (e.g., to collaborate more with outdoor gym manufacturers or private sponsorships to promote active healthy life) (WHO 2018a).

Physical activity (PA) includes activities such as walking, running, cycling, playing, dancing, gardening, occupational-related and leisure-related activities. WHO defines PA as *any bodily movement produced by skeletal muscles that require energy expenditure* (WHO 2021). Exercise typically happens to be differentiated from PA as it is planned, repetitive, and structured with the main objective of improving health, fitness, and strength.

Regular PA leads to physical health benefits, ranging from simply improving physical fitness and being in a better mood, to counteracting obesity, reduction of risk of coronary heart disease (CHD), coronary vascular disease (CVD), diabetes, depression or anxiety, and other mental health problems (Götschi et al. 2016; WHO 2020a, 2021). In addition, it strengthens memory, creativity, maintains social ties, and, as a result, improves the quality of life. Some research suggests a biological gradient based on PA intensity, with some evidence for global positive longer-term changes in the metabolome of highly active individuals (Kelly et al. 2020).

On the contrary, physical inactivity (PI) increases the risk of heart and circulatory diseases, diabetes, depression, etc. This can be considered an individual problem and, on the public, health level. Research by Alvarez-Alvarez et al. (2018) indicated that

a lack of PA accounts for 27% of diabetes and 30% of ischemic heart disease (IHD) and 21–25% of breast and colon cancers. Generally, insufficiently active people have a 20% to 30% increased risk of death than those who are sufficiently active (Götschi et al. 2016). Unfortunately, a quarter of the world's adult population (1.4 billion adults) is insufficiently active (WHO 2020a). A lack of sufficient PA among adolescents should be of concern, as healthy lifestyle patterns can be traced back to childhood and adolescence (Veselska et al. 2011). At the same time, prolonged physical inactivity in elderly persons tends to lead to a gradual decrease from all the components of physical fitness and significantly worsens the quality of life, and shortens the life expectancy (Lobo 2011; Cruceanu et al. 2014).

In this situation, the WHO target is to lead to at least a 15% relative reduction in the global prevalence of PI in adults and adolescents by 2030 (WHO 2018b). So, the question is how much exercise is needed to get the benefits of PA. Research shows that every effort counts, but at the same time, every increase in activity translates into an increase in the amount of health gain (except for the situation when the effort is not adjusted to individual capabilities at a given time). Even so, the WHO provides detailed PA recommendations from birth to death for specific age cohorts.

Box 11.1 Global Physical Activity Guidelines and Benefits of Exercise

According to WHO guidelines, adults aged 18–64 years should do at least 150–300 min of moderate-intensity aerobic PA, or at least 75–150 min of vigorous-intensity aerobic PA, or an equivalent combination of moderate- and vigorous-intensity activity throughout the week. They should also do muscle-strengthening exercises at an average or greater intensity that involve all major muscle groups two or more days a week. The amount of time spent being sedentary should be limited. Replacing sedentary time with physical PA of any intensity (including light intensity) provides health benefits (WHO 2021). The American College of Sports Medicine (Garber et al. 2011) identified exercises that use large muscle groups that should be performed 3 to 5 days a week, with 15 to 90 min per session. According to the recommendations of the American College of Cardiology/American Heart Association (ACC/AHA) (Nelson et al. 2007), for the elderly, even with chronic diseases, at least 30 min of moderate-intensity exercise five days a week, or at least 20 min of intense activity, should be included because proper exercise builds muscle strength, maintains bone density, independence, and vitality with age (Paterson et al. 2007; Nelson et al. 2004).

There is no doubt that PA (especially the one understood as daily life activity) depends on age, gender, climate, profession, individual preferences, and cultural codes (WHO 2018b), but is also different for specific socioeconomic groups. At the same time, it was observed that lower socioeconomic status is associated with lower PA (Mota et al. 2009; Richter et al. 2009; Piko and Keresztes 2008; Veselska et al.

2011). In the North countries after the industrial revolution, sports were generally exclusively for the privileged social classes but with time had been gradually extended to the working classes. Over time, most PA in high-income countries occurs during leisure time, while in low-income countries still during work, chores, or transport (Mathers et al. 2009).

Veselska et al. (2011) confirmed the results of other researchers that adolescents with high socioeconomic status engage in regular PA more often than their peers with middle- or low-socioeconomic status and report higher self-esteem. These attitudes will translate into attitudes toward PA in later years. Globally, 81% of adolescents aged 11–17 years were insufficiently PA in 2016. Adolescent girls were less active than adolescent boys, with 85% versus 78%, not meeting WHO recommendations (WHO 2021). In those cases, walking and cycling combine PA with ordinary life (Norwood et al. 2014; Grigoletto et al. 2021). If, for example, there is also an outdoor gym (OG) in the vicinity, then a greater tendency of citizens to perform daily PA becomes visible because they are seen serving PA at a site designated for such activity.

Therefore, it is essential to encourage, educate, and provide an infrastructure that enables interesting PA so that it becomes a lifelong habit for everyone, regardless of their socioeconomic status. One mission of the WHO is: To ensure that all people have access to safe and enabling environments and to diverse opportunities to be physically active in their daily lives, as a means of improving individual and community health and contributing to the social, cultural, and economic development of all nation. […] Increasing physical activity requires a systems-based approach – there is no single policy solution (WHO 2018b). Sustainable and comprehensive programs should be developed and implemented to increase PA among all individuals at local, regional, national, and international levels to bring about positive change and improve global health (Fletcher et al. 2018). Many governments, non-governmental organizations (NGOs), institutions, and companies undertook action to promote PA through wide-ranging public programs to raise public awareness (Lobo 2011). To achieve results, it is vital to start with bottom-up initiatives, as population-level initiatives can be used to change the knowledge, attitudes, or beliefs of specific population groups in local communities (Wandersman and Florin 2003). Health is an all-sector activity, and local governments are uniquely positioned to protect and promote health and wellness. It is not just about the healthcare sector but also about efforts to support the economic development of the country and the revitalization and development of towns and villages (Edwards and Tsouros 2006).

Box 11.2 Toronto Charter for Physical Activity

Assistance in the communication of various stakeholders is initiated (supported by WHO) by the International Society for Physical Activity and Health and The Toronto Charter for Physical Activity (2010) and complementary Non-Communicable Disease Prevention: Investments that Work for Physical Activity document (2011). This collaboration made a call for action- and an

advocacy tool to create sustainable opportunities for physically active lifestyles for all. Organizations and individuals interested in promoting PA can use this Charter to influence and unite decision-makers at national, regional, and local levels to achieve a shared goal. Among the nine guiding principles for a population-based approach to PA, the last one (No. 9) is: Facilitate healthy personal choices by choosing to be physically active, an easy choice. The suggestions of actions in the Charter related to planning and environment directly affect the PA described in this chapter, as they recommend:

1. Evidence-based urban design that supports walking, cycling, and recreational PA.
2. Urban design that provides opportunities for sport, recreation, and PA by increasing access to public space where people of all ages and abilities can be physically active in urban and rural settings.

Cycling and OG facilities fit perfectly with the above suggestions. They are an effective way to increase the population's PA levels and can be applied to different population groups (Hammami et al. 2020). However, the choice of exactly BSS and OG facilities refers to the Charter's number 9 rulemaking the physically active option the easy choice. Both ideas are available to all people regardless of their economic status, age, gender, and current health condition. As a rule, they also fit into the socially sensitive concept of sharing economy, which has been gaining in importance last few years around the world.

The first important feature of the sharing economy is access to resources, not ownership. Based on the sharing economy, the party reporting a specific need for a given product does not have to purchase it but only gains access to the resource. Access is often free, but it can also be for a fee. The very concept of the sharing economy is relatively new and not yet precisely described by academia. In English, apart from sharing economy, 14 basic definitions have been identified so far (Görög 2018), which partly explains why the concept does not have a clear framework. It is also known as the collaborative economy, gig economy, on-demand economy, or peer economy (Petropoulos 2017). Schor (2011) calls the phenomenon of the sharing economy a social innovation driven by the ethos of sustainable development.

11.2 Health and Cities in Definitions

11.2.1 Healthy Cities

According to the definition of Healthy Cities, it is a process of creating a better, healthier city for its inhabitants, with the joint effort of many stakeholders and a

grassroots initiative of citizens. The WHO European Network comprises 100 flagships WHO Healthy Cities and 1500 cities and municipalities under 30 national Healthy Cities networks in Europe (WHO 2020b). There are examples of countries on all continents working on implementing Healthy Cities or possibly Healthy Cities and villages in their area if the country has a low degree of urbanization (WHO 2018c).

> A healthy city is one that continually creates and improves its physical and social environments and expands the community resources that enable people to mutually support each other in performing all the functions of life and developing to their maximum potential [….] This entails: explicit political commitment; leadership; institutional change; and intersectoral partnerships. The Healthy Cities approach recognizes the determinants of health and the need to work in collaboration across public, private, voluntary and community sector organizations. (WHO 2017).

The Healthy Cities program was introduced in 1988 by the World Health Organization (WHO) to implement the 'Health for All' strategy at the local level, by improving the health conditions in cities, their natural environment, and the health of their inhabitants (WHO 2020c).

The Healthy City vision (Fig. 11.1) is concerned about the top of governance and equity processes within a city (as a Healthy City is a concept of process and not an outcome). The essential aspects are characterized as 'People and Place' from the sharing economy perspective. People: prioritized investment in people focusing on improving equity and inclusion through enhanced empowerment. Place: Physical, social, and cultural environment that enables and drives health and well-being for all (WHO 2020d).

Fig. 11.1 Areas of concern in the process of ensuring health and well-being for the individual and society. *Source* WHO (2020d)

Extending the concept to Healthy Active Cities introduces PA as a necessary daily routine. *A healthy, active city continually creates and improves opportunities in the built and social environments and expands community resources to enable all its citizens to be physically active in day-to-day life. The promotion of active living in the city also needs to focus on various settings, including schools, workplaces, healthcare settings, neighbourhoods and homes and recreation and sports facilities* (Edwards and Tsouros 2008, p. 3). In most member cities, reported measures were taken to promote active life, primarily related to walking and cycling**.**

In 1991, The Polish Network of Healthy Cities was established, which transformed into the Association of Healthy Polish Cities two years later. In 2000, with an official certificate, the World Health Organization confirmed that the Association of Healthy Polish Cities meets the requirements set by WHO for the national networks of Healthy Cities in Europe. Currently, the Association of Healthy Polish Cities (2021) has 39 cities and municipalities with a total population of approximately 7 million, including Warsaw and Białystok (case studies below). The Association aims to implement the principles and strategies of health policy in the country, regions, and communes, to activate local government communities to jointly solve the problems of environmental protection and health of inhabitants in areas and communes, and to develop and support cooperation between other cities and national networks of Healthy Cities in the world.

11.2.2 Health Component in Other Types of Cities

The popular opinion is that now cities will have countless autonomous, intelligent information systems that will have a perfect knowledge of the habits of their inhabitants (Łęcka et al. 2018). According to Caragliu and Del Bo (2016), a city can be described as competent when human and social capital investments are visible. Traditional and modern information and communication technologies support sustainable economic growth while increasing the quality of life of its inhabitants. Smart cities are greener, safer, faster, and friendlier, and services are more flexible, efficient, and sustainable (Mohanty et al. 2016). Their management is supervised by constantly improved digital and telecommunications technologies (Mitchell 2007). Sometimes it causes anxiety and satisfaction, especially in the elderly population.

One of the critical factors for a smart city to become a 'Healthy' smart city is caring for sustainable, low-emission transport. The aim is to minimize the use of own means of transport (e.g., passenger cars) for the benefit of collective transport and the use of solutions in individual mobility. The latter could be beneficial for cities where users share the means of transportation in various forms, such as cars, bicycles, or scooters (O'Brien et al. 2014; Belanche et al. 2016; Benevolo et al. 2016; Zhang et al. 2015; Karanikola et al. 2018). Mobility-as-a-Service (MaaS) platforms combine the offering of various means of transport—public and shared—in one smartphone application.

Green City

Green Cities provide sustainable lifestyles and high environmental standards. They have an active approach toward addressing climate change and usually implement solutions such as bike lanes, community parks, recreation areas free from carbon dioxide emissions, and other environmentally friendly initiatives.

EBRD Green Cities initiative was established in 1990 in several countries from Central Europe to Central Asia. Cities in the EBRD regions suffer from insufficient infrastructure investment, the unresolved problem with solid waste management, and poor air quality connected with historical legacies of high energy and carbon intensity. In this group, Warsaw and Wałbrzych aspire to the title of Green City (EBRD Green Cities 2021).

Slow City

In Italy, the International Network of Good Living Cities—Cittàslow (Slow City)—was established in 1998. Its supporters appreciate the slowing down of the pace of life and the strengthening of relations with the local community and space. Currently, 278 cities from 30 countries belong to Cittàslow, creating a total of 20 regional networks (Cittaslow 2021). The dominant group is made up of Italian cities (87 cities) and the second-largest Polish cities (36 cities). Over time, the concept of Slow City became famous also outside Europe, including in the USA, Canada, China, Japan, and Australia. All cities with less than 50,000 inhabitants can join this organization to pass the qualification procedure. There is at least one place with an OG facility in each of the small towns in Poland. Still, there is no BSS because small towns are uneconomical (local governments must pay extra for them) unless a small city is located on the border of a more significant accumulation. Interestingly, the fascination with PA in large Polish cities (also with polluted air) is visible and that this is much less in small cities with clean air.

11.2.3 Health in SDGs

PA in the WHO concept, developed at the conference in Bangkok in 2016, refers to multiple SDGs (Fig. 11.2). The ones most directly related to PA are SDG 3 and SDG 11.

SDG 3: Ensure healthy lives and promote well-being for all ages; it is a very complex, multifaceted, and difficult to achieve goal worldwide. The COVID- 19 pandemic (UN 2021a, b. Goal 3) cast a shadow over implementing the tasks under Goal 3. The emphasis on PA was considerable, but the possibilities were much slighter.

Meanwhile, SDG 11 is related to the concept of sustainable cities and human settlements, where the focus is on access to housing and basic services, sustainable transport system, sustainable urbanization, access to public spaces, sustainable buildings, per capita environmental impact of cities, and policies toward climate change, resource efficiency and disaster risk reduction (UNEP 2021).

Fig. 11.2 Health dimension in the SDGs. *Source* WHO (2016)

Both these goals are united by SDG 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development (UN 2021a, b. Goal 17) relating to good management practices.

11.3 Physical Activity in Public Space

As PA, cycling works well in the daily routine as representing mode of low-cost transport, health-improving way of travel and offers environmental advantages for the city and the countryside. Most often, the bicycle is used for commuting to or returning from work, school, university, commuting to offices, as a connection with public transport (Janczewski 2019).

It seems reasonable for health and economic reasons to promote PA in public spaces to advance a culture of health (Giles-Corti et al. 2017). There is a growing belief that returning to walking and cycling is necessary to maintain the health of people and the planet. Many countries persuade their citizens to take this challenge seriously for many reasons, ranging from environmental, individual health, public health cost and performance, to ethical and philosophical (WHO 2018a). At the country level, promises are made; for example, the UK government declared to increase the rate of cycling in Britain twofold in the years 2013–2025 (Ahmed and Babakir-Mina 2021). Health arguments are facilitated by pro-bike campaigns in well-developed countries, with a solid individual transport saturation and the sedentary lifestyle of its inhabitants (Götschi et al. 2016).

In the discussion about the city, cyclists took a prominent place as co-organizers of a human-friendly city. Representatives of the cycling subculture, often through happenings, express their support for the idea of sustainable transport, construction of bicycle routes, calming car traffic, improving the safety of pedestrians and cyclists, and the development of public transport. These are the factors that make the city more human-friendly.

Many researchers focus on the pro-health nature of cycling (Oja et al. 2011; Bouchard 2012; Bauman et al. 2017; Ahmed and Babakir-Mina 2021). However, it should be noted that although cycling has been shown to reduce air pollution, there is evidence that cyclists may face exposure to air pollution if they travel on busy routes due to the uptake of fine and ultrafine particulate matter (Teschke et al. 2012). Additionally, some studies showed that the rate of death caused by collisions among cyclists of all ages except 15–30 is much higher than that of car drivers (de Hartog et al. 2010). In turn, '*risks from air pollution can be assumed to be small, with limited evidence for cycling-specific mechanisms. Based on a large body of evidence, planners, health professionals, and decision-makers can rest assured that benefits from cycling-related physical activity are worth pursuing. Safety improvements should be part of the efforts to promote cycling*' (Götschi et al. 2016).

Another global strategy that is deployed to tackle the burden of PI is the improvement of public spaces to make them more attractive for outdoor PA. Creating active environments is one of the key strategic objectives for PA promotion, as described under the Global Action Plan on Physical Activity 2018–30 (WHO 2018b). *Strengthening access to good-quality public and green open spaces, green networks, recreational spaces, and sports amenities by all people of all ages and diverse abilities in urban, peri-urban and rural communities* is deemed essential under this Global Action Plan for any nation aiming to promote health and well-being of its citizens (WHO 2018b).

The publicly available OG has seen a significant increase globally over the last decade and is increasingly becoming a feature of urban and park landscapes (Jansson et al. 2019). An OG is an area that consists of easy-to-use, durable, weather- and vandal-resistant fitness equipment. Most equipment can be used for many bodyweights strength, stretching, and aerobic exercises. OG use is sometimes planned but likely used by amateurs, undertaken spontaneously and irregularly, without a specific sports goal. People do use it with the goal of losing weight, modeling the figure, and improving physical fitness, but not necessarily (de Kuyper 2020). In the latter case, when OGs are used in a moderately active way, their use is closer to the definition of PA than strictly to sports exercises. OGs as a feature of the urban environment have become popular in many Asian countries, like Taiwan, China, Hong Kong, and South Korea (Chow 2013). Multiple studies have established that installing an OG in a park can significantly increase the number of park visitors that engage in physical activity (Cohen et al. 2012; Cranney et al. 2016). A recent systematic review by Jansson et al. (2019) that construed current evidence and future directions of OG use showed that OGs had been researched in multiple countries, including Australia, the USA, Canada, Uruguay, Chile, Colombia, and Brazil. It must be noted that European and African countries are underrepresented in academic OG

research, and whether this is reflected in the amount of OGs that are constructed remains unclear.

OGs are intended to provide novel exercise opportunities free of charge in a public setting for many people, usually the inhabitants living close to the device (Cohen et al. 2011). Typically, an OG has five to ten pieces of equipment installed to ensure a variety of exercise opportunities, but there is no blueprint for the 'perfect' OG. Equipment is made of weather-resistant material and is designed to make one singular movement, making its use straightforward. Some of the equipment can be used explicitly for resistance training exercises. When performed regularly, resistance training has been shown to improve lean body mass, insulin sensitivity, and glycaemic control, potentially improving glucose homeostasis, decreasing diabetes type 2 prevalence (Boulé et al. 2001). In Australia, for example, only 18.6% of adults participate in the recommended levels of resistance training (Bennie et al. 2016). Despite the benefits of this type of training, participation is low and that is partly due to a few unique barriers: Equipment for resistance training is typically only available in gyms that have an entrance fee, plus it requires knowledge of correct technique, appropriate exercises and instructions for safety and effectiveness. All these barriers are what the OG can potentially limit by being free of charge, including easy-to-use equipment with clear instructions. Resistance training is not the main goal of OGs, but it is a part of PA that is underestimated and undervalued. When OGs become part of an urban environment, next to inducing more PA, it introduces people to a type of training not often performed.

11.3.1 Bike-Sharing

BSS are short-term bike rental schemes that allow bikes to be picked up at any self-service bike station and returned at any other bike station of the same rental company. Individuals use bicycles as needed without the costs (although there usually are fees for relatively long use) and obligations related to owning a bicycle (Shaheen et al. 2010; Midgley 2011). The characteristics and analysis of BSS development have been the subject of many studies (Shaheen et al. 2010; Fishmann et al. 2013; O'Brien et al. 2014; Zhang et al. 2015; Götschi et al. 2016, de Chardon et al. 2017). Initially, one of the critical issues was estimating the potential demand for the service, especially in countries where this type of system is not yet implemented (Frade and Ribeiro 2014). Then the researchers' attention was drawn to, inter alia, their connection with the idea of sustainable urban transport (Zhang et al. 2015), smart city (Belanche et al. 2016), smart mobility (Benevolo et al. 2016), or sharing economy (Frade and Ribeiro 2014; Morozov 2019; Choi and Choi 2020).

In Poland, a country of rapid and generally successful economic transformation, the authors of the development of cycling through the BBS system have been

exploring this topic for several years. They were pioneering in the search for terms[1] and concepts in which this idea in Poland would fit, initially referring primarily to tourist attractiveness in large cities (Berg 2013; Łęcka 2015), with time more and more often referring to the sharing- economy (Bieliński et al. 2019; Krassowski and Młynarski 2020; Radzimski and Dzięcielski 2021).

It is helpful to look at the current state of bike-sharing in Poland, whereas it can set an example for countries with less developed economies. The Commission on Sustainable Development of the UN in a special document from 2011 devoted to this issue (Midgley 2011) and stated: *Given the different characteristics of developing country cities, there will be a need to develop new and innovative approaches to bicycle-sharing that will draw on current experiences in Europe and elsewhere. The best way to move forward would be to undertake a series of pilot projects, ideally supported by the development banks and bilateral aid. Ideally, these should be regional programmes that recognise local conditions.*

All sharing bikes are different from regular bikes to prevent theft and vandalism. They are typically bulky with robust, high-set frames that are different from the typical road- or mountain bikes. The colors of the bikes are usually bright with branding and often prominent as well, with many programs displaying the corporate logos of big sponsors on the frames. The latter provides another opportunity for local governments to push public–private partnerships in health by extracting finances that can be used to develop healthy urban systems in return for public advertisement.

The bike-sharing stations are essentially high-tech bike racks with an adjacent payment kiosk. Each station has several docks (anywhere from 10 to 100 or more, depending on local traffic volumes). Dockless systems are described as free-floating and recognized as the fifth generation of BSSs (Polish Network 2017; Li et al. 2018). Unfortunately, a dockless system poses some risks related to parking bikes in unauthorized places, affecting all road users' safety (Chen et al. 2018).

Usage fees are typically calculated in increments of 30 or 60 min. Price increases with timed usage have encouraged relatively short point-to-point trips and reduced long-distance riding with the same bike. The fourth generation of public bikes is shared in a closed group, free of charge (as a benefit) or an annual subscription.

According to OBIS (2011), the European countries where BSSs are created can be divided according to the criterion of cycling tradition into three groups:

(a) established cyclists (e.g., Austria, Germany, Sweden) where interest in BSS is moderate despite good infrastructure and tradition.
(b) new enthusiasts of bicycle transport (e.g., France, Italy, Spain, London), where despite the lack of tradition and underdeveloped infrastructure, new large rental stations are created.
(c) new EU partners (e.g., the Czech Republic, Poland), drawing on the experience of their predecessors.

[1] One of the first terms popular in Poland on BSS was *maintenance-free bicycle rental stations*, that is, a term referring to a technique and not an economic concept.

In 2021, there will be nearly 10 million bikes in the global BSSs on all continents. However, in Africa, they appeared only in two countries: Nigeria (Lagos and Ede from 2019, a total of 150 bikes) and South Africa (Stellenbosch from 2017, 20 bikes). Most shared bikes are used in the EU, USA, and China. We are currently witnessing the transition to the next generation of BSS. Some call the next fourth (Li et al. 2018), and others call the fifth (Polish Network 2017), but the main difference between them concerns the funding scheme. The current transition is going from public to private funds. This does not guarantee success, though. In China, a system based on investor financing, rental fees, loans, revenues from advertising, and users' deposits bankrupted in 2017 (Bieliński et al 2019).

Case studies from Poland

A large study by Bieliński et al. (2019) based on statistical data from bicycle docking stations in 56 cities in Poland and 3631 interviews with cyclists and residents of 9 cities in Poland showed that factors correlating with the effectiveness of Polish BBSs do not differ much from other regions in Europe. Poland's main findings show that BSS performance was positively related to cities' population, tourism, number of bike stations per capita, congestion, bicycle pathways' length, and higher temperature. BSS performance was negatively related to precipitation. Findings visibly suggest that tourism is significantly associated with the BBS effectiveness: Cities with more tourists per capita had higher trips per day per bike (Bieliński et al. 2019).

The first Polish BSS was launched in 2008 in Krakow. Still, the most significant development of bike-sharing systems was recorded ten years later in 2017–2019, when a total of 52 out of 108 currently operating systems were launched. In 2018 alone, 30 new public bicycle systems were introduced. In the beginning, bicycle systems were trained mainly in the largest cities in the country in terms of population (over 300,000 inhabitants), including Kraków, Wrocław, Poznań, Warsaw, Lublin Szczecin, and Bydgoszcz. In the following years, more and more of them were launched, also in smaller urban centers and communes (Wolny-Kucińska 2020). The largest provider is Nextbike Polska S.A. (60% of the bike-sharing market)—a company founded in Poland in 2011 (and in 2017 also in Finland), which operates in 43 locations. In the last pre-pandemic season 2019/2020, the statistics relating to the bike-sharing system in Poland were as follows: 26,632 bikes were in use in 96 systems (95 public and one commercial) in 108 towns. 2.6 million users used this service, and 98 of them per 1 bike shared. It is one of the largest BSS systems in Europe and the world. Unfortunately, the positive development of BSS in Poland was halted in 2020 (Ostre hamowanie 2020). The two largest agglomerations (Krakow and the Tri-City) remain without a city bike. In both cases, the premature closure of the service (during the term of the contract with the local government) resulted from economic reasons on the part of the operators.

Some resistance for BSSs happened because of the uprising of rental e- scooters. However, the capital city of Warsaw did not give up the services of either bike-sharing or e-scooters (5500 bikes vs. nearly 5000 e-scooters in the high season), and public consultations preceded the tender for the operator for the years after 2020. Five thousand surveys from residents and 700 e-mail comments were collected. Based

on consultations and the expertise and experience of other cities, the concept of a new system was created, which spelled out more clearly the rights and obligations of e-scooter users, thus restoring a good place for bikes.

> Warsaw has been dynamic from the very beginning. As part of the system initiated in 2012, initially consisting of 55 stations and 1000 bikes, 283,000 rentals and 47,500 new user registrations were made during the first season. In 2013, the American daily *USA Today* placed Warsaw BSS in tenth place on the list of cities with the best and most user-friendly rental networks, ahead of, among others, Washington, Buenos Aires, London, and New York (Lebetkin 2013).

The location of the most attractive BSS stations and the course of the most popular routes in the first years of operation of the systems in cities indicated mainly the commercial (and not the tourist-recreational) nature of bicycle rentals. A city bike for young people, primarily students, and recent university graduates was beneficial for connecting universities with student dormitories and the broadly understood entertainment and recreation center. The introduction of distance learning during the COVID-19 epidemic stopped this practice (Radzimski and Dzięcielski 2021). One of the confirmations of this thesis was obtained by conducting partially structured interviews on July 30, 2015, in Warsaw and August 7, 2015 (between 12.00–17.00) on a group of people directly using bicycle stations in the city center on those days: 105 people (Warsaw) (49 women and 56 men) and 70 respondents in Białystok (32 women and 38 men). It was shown that BSS was used in both cases by people aged 16 to over 55, half of whom declared higher education, which to some extent characterized the group of recipients. The respondents asked to choose the main reasons (with the possibility of multiple choice) why they use the public bike most frequently indicated a daily ride on a fixed route to work/university, but also a significant percentage were those who did not have their bicycle (Table 11.1) (Łęcka 2015).

Table 11.1 Respondents' answers to the question of why they use BSS

Answers	Warsaw 1.7 mln inhabitants (%)	Białystok 300 th. inhabitants (%)
I do not have a bike	34	24
It is cheaper to rent than to buy a bike	11.5	17
I like to rent a bike when I feel like going somewhere	20	48.5
I travel every day on a regular route from Work/university to my home	30.5	41.5
I rent it when I want to explore the city	20	27
I rent for trips outside the city	–	6
Other	19	31.5

Source Own study

Among those who did not have their bicycle (in general or in their place of temporary residence), there were people up to 30 years of age, with higher education, often students from other locations. Those who owned a bicycle declared that renting a bicycle allows them to avoid the risk of keeping their bicycle on the street for many hours of work or study. On the other hand, nearly one-third of the surveyed inhabitants of Białystok emphasized that bicycles are an effective alternative to expensive, in their opinion, public transport over short distances (small city area).

Spontaneous decisions to ride a bike appeared in all age groups in both cities. In Warsaw, a bicycle for short trips, with numerous changes, is an attractive form of visiting the city for people aged 18–55, with higher education; however, as it was verified, they show poor knowledge of the city plan and the location of the docks. Among the inhabitants of Białystok, a similar opinion was expressed mainly by young respondents aged 18–30, with higher education, good knowledge of the map, and the zone's range with BSS stations. They are also often subjected to a quick decision about a recreational bicycle ride for pleasure (nearly half of the respondents). In the case of a medium-sized city like Białystok, such a spontaneous decision is possible even in a relatively short time. In the case of much larger Warsaw, a trip outside the city is instead a day trip.

The thoughts that emerged in the course of 175 interviews (using the storytelling method) allowed for some general summary (Łęcka 2015):

1. In cities, rented bicycles more often play the role of an everyday solution than a recreational vehicle;
2. The most used stations/routes are located near the university and are used by students on the routes of their daily activities;
3. BSSs are mainly used by people aged 18–30 with higher and secondary education. Older people would also like to rent a bicycle but are discouraged by the electronic registration system and possible difficulties operating the bicycle docks. In worn-out systems (where attendance is high), damaged docks are the reason why physically weaker people (young people, women, the elderly) are unable to unfasten, and especially refasten, a vehicle. As a result of constant use, bicycles quickly deteriorate and sometimes complicate the journey more than it makes it easier; but it does change for the better with time;
4. There is a different method of financial settlement in each city. Some systems favor more educated people who can understand the complexities of billing faster. Moreover, not all stations are served by the same IT system, even within the same city;
5. More often, a borrowed bicycle is an inspiration to start exploring the city or the surrounding area in small and medium-sized cities, especially in places where an 'agglomeration bicycle' or 'communal bicycle' is being built. In large cities, too much distance between stations and too short a time free of charge discourages most participants from using the bike for tourism. At the same time, weekend bicycle traffic is visible on tourist routes using their two-wheelers.

Some ongoing complaints arising from the current materials of the non-profit organization Mobile City (Ostre hamowanie 2020):

- Too slow growth of bicycle infrastructure in cities understood as a coherent, convenient and safe network of bicycle connections and paths;
- Cyclists' concerns about safety and a general sense of danger related to the dominance of cars in the road space and bad driving habits (speeding, road piracy, improper parking, failure to give way);
- Mental causes. Identifying the bicycle with low financial status in some social groups.

Unfortunately, the same concerns were emphasized by Berg (2013) a few years ago with respondents from Krakow, a city of very dynamic domestic and foreign tourism. This, unfortunately, means that the improvement in bicycle infrastructure and culture is not yet satisfactory in Poland. Kraków, on the other hand, has not had its BSS since 2019, which seems unlikely.

11.3.2 Outdoor Gyms

The previous section was focused on bike-sharing, which has common grounds with OG considering the SDGs. First, they are built to promote and give access to healthy practices, PA, to citizens of all ages and socioeconomic statuses (SDG 3). Second, it aids the quest for cities to become healthy (SDG 11). And third, it originates from public funding but plays a role in pushing for improved public–private partnerships to improve the population's health (SDG 17). Generally speaking, there are no broader comprehensive studies on OG. So the primary objective of that integrative assessment is to overview the differences and similarities between OG-related governance and OG users' perceptions in different countries worldwide (de Kuyper 2020).

1. **Governing**. The amount of involvement of national governments is low, and only the Uruguayan government combined the installation of OGs with quantifiable policy goals, for example, to achieve an OG density of 1 OG per 16,000 people in the next three years (del Campo et al. 2017). Despite OG installment being a highly decentralized phenomenon, the rationale for funding and building the OGs come mostly from national levels. High physical inactivity (or low physical activity levels) among the entire national population were named as public health problems sparking OG construction in Brazil, Chile, Australia, and India. In Hong Kong and Taiwan, the predominant national rationale for building OGs was the preparative response to an aging population, focusing on keeping seniors active and thus improving their health (Chow 2013). A range of public–private partnerships happened, of which experts have the idea that this could further benefit the installation of OGs in the future. One example of such a partnership is Australia, where all OG placement is done by local governments but with strict processes in the city of Newcastle. There the local university, city council, and private investors are working together to form an 'ecofit' trial, aiding each other

through funding, research, and policy (de Kuyper 2020). This collaborative OG-related effort, and other forms, is present in 7 out of 10 countries included in the analysis.

2. **User profile and OG perception**. When looking at which age groups were included in OG studies, it stands out that seniors were dominant in most Asian countries, which is in line with the rationale of building it for an aging population. In other continents, this was not the case. Anyway, inherently the OG is a structure for all ages, so one can argue whether or not advertisement or policy should be aimed at seniors specifically or not. A difference in gender ratio between survey and observational OG studies in the same countries was observed. This tells that OG perception (measured through surveys) might not correspond with the perception of the actual daily OG users. It is thus advised to further develop OG research, to get a better, more comprehensive overview of what the role of the OG is in the public sphere. Such an issue was demonstrated in Canada, where after 106 h of observation in 2 parks with OGs they saw a use rate of only 2.7% (Copeland et al. 2017). They also performed a survey, and 26% of the respondents, who were the most probable OG users because they lived close to the OGs, said that they used the OG at least monthly and often accompanied by a family member. Relatively low use rates like in this Canadian study were also seen in the USA and Australia, i.e., in developed countries. This could mean that OG awareness is the number one priority to improve OG use as it becomes part of an urban environment.

One more interesting result came from Santiago, Chile, where people were observed to use the OGs at nighttime as a social hub. People said it acted as a 'natural surveillance device,' keeping the neighborhood safer during nighttime (Mora 2012).

3. **Recommendations**. From all the recommendations that were distilled from different papers and personal communication, 8 main recommendations were given: (1) Need for collective fitness programs at OGs; (2) Need for more OGs, better location, and better equipment selection; (3) Improve the role of a local and national government, and their cooperation in OG-related programs; (4) Enhance OG maintenance and security; (5) Need for more OG research; (6) Need for more collaborative OG-related efforts; (7) More advertising and marketing of local OGs; (8) Use results of OG research in the future development. The recommendations given differed per country and even within the countries, so it shows that depending on the local situation (political, geographical, population perception, financial) it should be determined how to implement or improve OGs.

Case study of three OGs in Warsaw

One study that surveyed Polish people showed that they find physical activity distinctly essential to lead a healthy life (Łęcka et al. 2018). In the same study, it was mentioned that there had been lots of social actions that made Poles focus on physical exercises and that 'gyms in the open-air grow like mushrooms in public space' (Łęcka et al. 2018). This may show that Polish people are dealing with a desire

Fig. 11.3 Empty OG in the Polish post-socialist village of Słoneczniki, former State Agricultural Farm in Northern Poland. Municipality Morąg with 50% co-financing from the Physical Culture Development Fund. Ministry of Sport and Tourism. Photo by Izabella Łęcka (July, 2021)

to be physically active but not translate this to actual activity (Fig. 11.3). Despite the recent proliferation of OGs, which also clearly has been happening in Warsaw, there is no clear rationale to be found from a governmental perspective. Even more so, Polish people tend to agree (53%) that their local government is not doing enough to physical activity, but at the same time, Poland has seen the third highest increase in Europe in engaging in sports or physical activity in a park or outdoors (European Commission 2018). Warsaw residents have been exposed to an explosion of OGs since 2017 since the city has made a significant investment in OGs, constructing approximately 100 of them in that year, next to the improved opportunities for active commuting using more bike paths, rental bikes, and large urban parks (de Kuyper 2020). Combined with the fact that OG research in a European context is almost non-existent, the latter presented a good rationale for choosing Warsaw as a study site for the case study.

A survey was performed among 53 adults OG users at three sites and 64 adults online. Most young adult people responded to the survey, as 80 (68.4%) of the respondents were between 18 and 34 years old. The on-site survey was answered more by men, whereas more women answered the online survey. The most significant and likely most important difference between the on-site and online respondents was seen in the frequency of OG use, as the on-site respondents were far more likely to use the OG at least once a week ($\chi^2 = 28.56$, $p < 0.001$). The hypothesis is that the two groups' apparent differences in OG perception can be explained by the frequency of OG use, with higher frequency correlating to more positive perception (de Kuyper 2020). Health-related reasons were chosen most often, significantly 'improved fitness/cardio' (48.2%) and 'improved health' (45.6%). After that, the location was the most cited reason for OG use, with 'close to home' (37.2%) mentioned slightly more than 'to do an outside workout' (29.8%). OGs are free to use also a popular reason (36.8%). Somewhat less than half of the respondents

Fig. 11.4 OG near POLIN museum in Warsaw Śródmieście. Several people are occupying the street workout area of the OG while not using the actual equipment but stretching and making a handstand, for example. One person is using the leg swinger. Photo by Izabella Łęcka (July 2020)

socialize with other OG users, indicating that OGs are not perceived as a social hub in Warsaw.

The general outlook of one OG in Warsaw's Śródmieście (Warsaw City Center) district in July 2020 was populated, with people performing a variety of PA and social activities (Fig. 11.4). In 28 h of observation, 240 'parties' (i.e., groups of people) and 406 persons were observed among three selected OG sites. Of all observed OG users (note that it was the researcher's estimation), 59.1% were male, 27.8% were kids, 52% were adults, and 12.8% were seniors. Next to PA, leisure time, in this case, family time spent at the OG was observed in 19 out of 240 observed parties (7.9%), and in those cases, for example, parents came to the OG to play with their kids or the adults did a workout while the kids were present. The average duration of stay was 15 min and a large proportion of OG users only stayed between 1 and 5 min (35.5%). Twenty-eight of 240 observed parties (11.7%) were people that came to the OG for a dedicated workout as they were either already running before, did an extensive warming-up, or brought attributes (like a skipping rope or a stretching band). The OG facilitated these people to improve their needs for active behavior.

11.4 Bike-Sharing and Outdoor Gyms in COVID-19 Times

It is unclear how the COVID-19 pandemic affected the PA of inhabitants of cities and regions around the world, e.g., Hammami et al. (2020), Byers et al. (2021), Rodrigues-Krause et al. (2021). Research on PA of adults in Poland, before and during the COVID-19 pandemic, was conducted in 2020 using an online survey questionnaire. A total of 688 residents of Poland aged 18–58 (28.61 ± 9.5) participated in the study. A statistically significant decrease in the frequency of PA was noted in the group of men ($P < 0.01$) and the age group of 39–58 old. The analysis of the duration of a

single PA before and during the pandemic has shown a statistically significant reduction in the workout duration among both men and women and across all age groups ($P = 0.05$). There was a statistically significant increase in the frequency of women undertaking flexibility exercises, for example, yoga ($P < 0.01$), as well as a decrease in marching and walks ($P < 0.01$). Men did strength exercises less frequently ($P < 0.01$) (Zaworski et al. 2020).

While the world slowly reopens amid the COVID-19 pandemic, OGs, start filling up with people again. Moreover, the idea itself becomes more popular. It is not only a free space for everyone to exercise. It is an open and healthier space, unlike the once exclusive indoor gyms, where people heavily breathe and expel body fluids. An example of South Korea where an indoor fitness center situation caused a coronavirus cluster can be a warning. That is why, next to public gyms, luxurious open-air facilities are also being built for elite subscribers (Taylor 2020).

The COVID-19 epidemic also changed the scope of operation of BSSs, sometimes accelerating the station's closure (reduced traffic due to lockdowns and curfew), and sometimes, on the contrary, causing its intensification (safe commuting to work, resignation from public transport). Today, social initiatives promoting bicycles and cyclists, such as 'Critical Mass' or 'Cyclical Dialogues' remind us of the old days, making the topic of the development of bicycle infrastructure constantly attract the attention of local authorities. These initiatives ceased as the result of the COVID-19 epidemic. In Poland, the popularity of bike-sharing is much greater than in other countries of the former Eastern Bloc, today belonging to the EU. And yet, stations whose opening took place shortly before the COVID-19 pandemic have been closed in Poland, especially those in smaller cities and larger ones that did not receive the expected financial support from the local government. The problem is that BSSs, especially those run by municipalities or non-profit organizations, may not be fully funded by the users. Programs must also receive grants from local transport authorities and private companies or special EU funds. For similar financial reasons, the closure of stations in Spain and the USA took place in smaller towns several years ago and was rarely associated with lockdowns during the COVID-19 pandemic (The Meddin Bike-sharing World Map 2012).

In the case of bike-sharing, the health protection factor is also essential. City dwellers during a pandemic are more willing to choose city bikes as the primary means of transport. System operators ensure that they sanitize their bikes regularly during their daily checks and servicing. In Poland, the average time of renting a bike has increased significantly, which indicates that users decide to go on further trips and are thus resigning from using public transport. Also, they prefer to pay for an extra time above the initial 20 free minutes, not to increase the risk of touching more bikes when changing vehicles. The extended operation time of the system by an additional month gives residents more transport and recreational alternatives during the year (Nextbike 2021).

References

Ahmed HM, Babakir-Mina M (2021) Population-level interventions based on walking and cycling as a means to increase physical activity. Phys Act Health 5(1):55–63. https://doi.org/10.5334/paah.87

Alvarez-Alvarez I, Zazpe I, de Rojas JP et al (2018) Mediterranean diet, physical activity and their combined effect on all-cause mortality: The Seguimiento Universidad de Navarra (SUN) cohort. Prev Med 106:45–52. https://doi.org/10.1016/j.ypmed.2017.09.021

Association of Healthy Polish Cities (2021) https://www.szmp.pl/. Accessed 10 July 2021

Bauman A, Crane M, Drayton BA, Titze S (2017) The unrealised potential of bike share schemes to influence population physical activity levels—a narrative review. Prev Med Suppl Promot Phys Act Public Spaces Adv Cult Health 103:7–14. https://doi.org/10.1016/j.ypmed.2017.02.015

Belanche D, Casaló LV, Orús C (2016) City attachment and use of urban services: benefits for smart cities. Cities 50:75–81. https://doi.org/10.1016/j.cities.2015.08.016

Benevolo C, Dameri RP, D'Auria B (2016) Smart mobility in smart city. In: Torre J, Braccini AM, Spinelli R (eds) Empowering organizations, lecture notes in information systems and organization. Springer International Publishing, Cham, pp 13–28. https://doi.org/10.1007/978-3-319-23784-8_2

Bennie JA, Pedisic Z, van Uffelen JGZ (2016) The descriptive epidemiology of total physical activity, muscle-strengthening exercises and sedentary behavior among Australian adults—results from the National Nutrition and Physical Activity Survey. BMC Public Health 16(1):73. https://doi.org/10.1186/s12889-016-2736-3

Berg T (2013) Infrastruktura rowerowa jako czynnik rozwoju turystyki rowerowej w Krakowie (Cycling infrastructure as a factor in the development of cycling tourism in Cracow) dissertation, Jagiellonian University. Available in Repository.uj.pl

Bieliński T, Kwapisz A, Ważna A (2019) Bike-sharing systems in Poland. Sustainability 11:2458. https://doi.org/10.3390/su11092458)

Boulé NG, Haddad E, Kenny GP (2001) Effects of exercise on glycemic control and body mass in type 2 diabetes mellitus: a meta- analysis of controlled clinical trials. JAMA 286(10):1218–1227. https://doi.org/10.1001/jama.286.10.1218

Bouchard C, Blair SN, Haskell W (eds) (2012) Physical activity and health, 2nd edn. Human Kinetics, New York. https://doi.org/10.5040/9781492595717

Byers T, Gormley K-L, Winand M (2021) COVID-19 impacts on sport governance and management: a global, critical realist perspective. Manag Sport Leisure 1–9. https://doi.org/10.1080/23750472.2020.1867002

Caragliu A, Del Bo CF (2016) Do smart cities invest in smarter policies? Learning from the past, planning for the future. Soc Sci Comput Rev 34(6):657–672. https://doi.org/10.1177/0894439315610843

Chen F, Turoń K, Kłos M, Czech P, Pamuła W, Sierpiński G (2018) Fifth- generation bike-sharing systems: examples from Poland and China. Sci J Silesian Univ Technol Series Transp 99:05–13. https://doi.org/10.20858/sjsutst.2018.99.1

Choi Y, Choi EJ (2020) Sustainable governance of the sharing economy: the Chinese bike-sharing industry. Sustainability 12:1195. https://doi.org/10.3390/su12031195

Chow HW (2013) Outdoor fitness equipment in parks: a qualitative study from older adults' perceptions. BMC Public Health 13:1216. https://doi.org/10.1186/1471-2458-13-1216

Cittaslow (2021) International network of cities where living is good. https://www.cittaslow.org/. Accessed 10 July 2021

Cohen DA, Setodji C, Evenson KR, Ward P, Lapham S, Hillier A, McKenzie TL (2011) How much observation is enough? Refining the administration of SOPARC. J Phys Act Health 8:1117–1123. https://doi.org/10.1123/jpah.8.8.1117

Cohen DA, Marsh T, Williamson S, Golinelli D, Mckenzie TL (2012) Impact and cost- effectiveness of family fitness zones: A natural experiment in urban public parks. Health Place 18(1):39–45. https://doi.org/10.1016/j.healthplace.2011.09.008

Copeland JL, Currie C, Walker A, Mason E, Willoughby TN, Amson A (2017) Fitness equipment in public parks: frequency of use and community perceptions in a small urban centre. J Phys Act Health 15(5):344–352. https://doi.org/10.1123/jpah.2016-0277

Cranney L, Phongsavan P, Kariuki M, Stride V, Scott A, Hua M, Bauman A (2016) Impact of an outdoor gym on park users' physical activity: a natural experiment. Health Place 37:26–34. https://doi.org/10.1016/j.healthplace.2015.11.002

Cruceanu A, Łęcka I, Muntele I (2014) The health state our most precious asset? A short review. Netw Intell Stud 2(4):193–208

de Chardon CM, Caruso G, Thomas I (2017) Bicycle sharing system 'success' determinants. Transp Res Part A Policy Pract 100:202–214. https://doi.org/10.1016/j.tra.2017.04.020

de Hartog JJ, Boogaard H, Nijland H (2010) Do the health benefits of cycling outweigh the risks? Environ Health Perspect 118(8):1109–1116. https://doi.org/10.1289/ehp.0901747

del Campo VC, Tutte V, Bermudez G, Parra DC (2017) Impact on area-level physical activity following the implementation of a fitness zone in Montevideo, Uruguay. J Phys Act Health 15:883–887

de Kuyper NH (2020) An integrated assessment of outdoor gym perception and governance: similarities and differences on a global scale. Complemented by a case study in Warsaw. Dissertation, University of Maastricht

EBRD Green Cities (2021) https://www.ebrdgreencities.com/. Accessed 2 July 2021

Edwards P, Tsouros AD (2006) Promoting physical activity and active living in urban environments: the role of local governments. WHO Regional Office Europe. https://apps.who.int/iris/handle/10665/326536. Accessed 20 June 2021

Edwards P, Tsouros AD (2008) A healthy city is an active city: a physical activity planning guide. WHO Regional Office Europe. https://www.euro.who.int/data/assets/pdf_file/0012/99975/E91883.pdf

European Commission (2018) Special Eurobarometer 472: sport and physical activity. Survey conducted by TNS opinion & social at the request of the European Commission, Directorate-General for Education, Youth, Sport and Culture

Fishman E, Washington S, Haworth N (2013) Bike share: a synthesis of the literature. Transp Rev 33:148–165. https://doi.org/10.1080/01441647.2013.775612

Fletcher G, Landolfo C, Niebauer, (2018) Promoting physical activity and exercise: JACC health promotion series. J Am Coll Cardiol 72:3053–3070

Frade I, Ribeiro A (2014) Bicycle sharing systems demand. Proc Soc Behav Sci 111:518–527

Garber CE, Blissmer B, Deschenes MR (2011) American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. Med Sci Sports Exerc 43(7):1334–59. https://doi.org/10.1249/MSS.0b013e318213fefb

Giles-Corti B, Kerr J, Pratt M (2017) Supplement: promoting physical activity in public spaces to advance a culture of health (2017): S1-S104

Görög G (2018) The definitions of sharing economy: a systematic literature review. Management 13(2):175–189

Götschi T, Garrard J, Giles-Corti B (2016) Cycling as a part of daily life: a review of health perspectives. Transp Rev 36:45–71. https://doi.org/10.1080/01441647.2015.1057877

Grigoletto A, Mauro M, Maietta P (2021) Impact of different types of physical activity in green urban space on adult health and behaviors: a systematic review. Eur J Invest Health Psychol Educ 11(1):263–275. https://doi.org/10.3390/ejihpe11010020

Hammami A, Harrabi B, Mohr M, Krustrup P (2020) Physical activity and coronavirus disease 2019 (COVID-19): specific recommendations for home-based physical training. Manag Sport Leisure: 1–6.https://doi.org/10.1080/23750472.2020.1757494

Janczewski J (2019) Współdzielenie środków transportu w podróżach miejskich (Sharing means of transport in Urban Areas). Zarządzanie Innowacyjne w Gospodarce i Biznesie 2(29):189–206. https://doi.org/10.25312/2391-5129.29/2019_12jj

Jansson AK, Lubans DR, Smith JJ, Duncan MJ, Haslam R, Plotnikoff RC (2019) A systematic review of outdoor gym use: current evidence and future directions. J Sci Med Sport 22(12):1335–1343. https://doi.org/10.1016/j.jsams.2019.08.003

Karanikola P, Panagopoulos T, Tampakis S et al (2018) Cycling as a smart and green mode of transport in small touristic cities. Sustainability 10:268. https://doi.org/10.3390/su10010268

Kelly RS, Kelly MP, Kelly P (2020) Metabolomics, physical activity, exercise and health: A review of the current evidence. Biochim Biophys Acta Mol Basis Dis1;1866(12):165936. https://doi.org/10.1016/j.bbadis.2020.165936

Krassowski M, Młynarski G (2020) Pozorny kryzys własności. Współdzielony rower miejski - koniec konsumpcji czy utopia współdzielenia? (Apparent property crisis. Shared city bike—the end of consumption or the utopia of sharing?). Przeglad Kulturoznawczy 4(46):529–544. https://www.ejournals.eu/PrzeKulturoznawczy/2020/Numer-4-462020/art/17617/

Lebetkin M (2013) Best bike-sharing cities in the world, USA Today, www.usatoday.com/story/travel/destinations/2013/10/01/best-cities-bike-sharing/2896227. Accessed 10 Oct 2015

Łęcka I (2015) Poprawa atrakcyjności turystycznej miast dzięki bezobsługowym stacjom wypożyczania rowerów (Improving the tourist attractiveness of cities thanks to maintenance-free bicycle rental stations). Biuletyn KPZK 256:112–132

Łęcka I, Ortega AR, Cruceanu A (2018) Cultural path in the smart city concept. Perception of health among the inhabitants of Warsaw, Bucharest and Toluca. Dodicesimo Seminario Internationale di Geografia Medica. Guerra Edizioni Edel, Perugia, pp 133–140

Li X, Zhang Y, Sun L, Liu Q (2018) Free-floating bike-sharing in Jiangsu: users' behaviors and influencing factors. Energies 11:1664

Lobo A (2011) Physical activity and health in the elderly. Bentham Science Publishers, University of Porto, Portugal

Mathers C, Stevens G, Mascarenhas M (2009) Global health risks: mortality and burden of disease attributable to selected major risks. World Health Organization, Geneva. https://apps.who.int/iris/handle/10665/44203

Midgley P (2011) Bicycle-sharing schemes: enhancing sustainable mobility in urban areas. United Nations, Department of Economic and Social Affairs 8: 1–12

Mitchell W (2007) Intelligent cities. E-J Knowl Soc 5:3−8. https://www.uoc.edu/uocpapers/5/dt/eng/mitchell.pdf

Mohanty SP, Choppali U, Kougianos E (2016) Everything you wanted to know about smart cities: The internet of things is the backbone. IEEE Consum Electron Mag 5(3):60–70

Mora R (2012) Moving bodies: open gyms and physical activity in Santiago. J Urban Des 17(4):485–497. https://doi.org/10.1590/S1980-6574201700030005

Morozov E (2019) From airbnb to city bikes, the 'sharing economy' has been seized by big money. The Guardian International edition. https://www.theguardian.com/commentisfree/2018/nov/27/airbnb-city-bikes-sharing-economy-big-money. Accessed 10 July 2021

Mota J, Ribeiro JC, Santos MP (2009) Obese girls differences in neighborhood perceptions, screen time and socioeconomic status according to level of physical activity. Health Educ Res 24:98e104

Nelson ME, Layne JE, Bernstein MJ (2004) The effects of multidimensional home- based exercise on functional performance in elderly people. J Gerontol A Biol Sci Med Sci 59(2):154–160

Nelson ME, Rejeski WJ, Blair SN (2007) Physical activity and public health in older adults: recommendation from the American College of Sports Medicine and the American Heart Association. Circulation 116(9):1094–1105. https://doi.org/10.1161/CIRCULATIONAHA.107.185650

Nextbike (2021) https://nextbike.pl/sezon-rowerowy-2021-startuje-w-kolejnych-miejscowosciach/. Accessed 3 July 2021

Non-communicable disease prevention: investments that work for physical activity (2011) https://ispah.org/wp-content/uploads/2019/08/Investments_English.pdf. Accessed 23 June 2020

Norwood P, Eberth B, Farrar S, Anable J, Ludbrook A (2014) Active travel intervention and physical activity behaviour: an evaluation. Soc Sci Med 113:50–58. https://doi.org/10.1016/j.socscimed.2014.05.003

O'Brien O, Cheshire J, Batty M (2014) Mining bicycle sharing data for generating insights into sustainable transport systems. J Transp Geogr 34:262–273. https://doi.org/10.1016/j.jtrangeo.2013.06.007

OBIS, Optimising bike sharing in European Cities Handbook (2011) http://www.obis.pswe.org/palio/html.wmedia?_Instance=obis&_Connector=data&_ID=1006&_CheckSum=-50536827. Accessed 20 Oct 2015

Oja P, Titze S, Bauman A (2011) Health benefits of cycling: a systematic review. Scand J Med Sci Sports 21(4):496–509. https://doi.org/10.1111/j.1600-0838.2011.01299.x

Ostre hamowanie roweru miejskiego. Bikesharing w Polsce 2019/2020, Epizod czy początek kryzysu? (Sharp braking of the city bike. Bike-sharing in Poland 2019/2020, Episode or the beginning of the crisis?). http://mobilne-miasto.org/wp-content/uploads/2020/03/Mobilne_Miasto_raport_bikesharing_final.pdf

Paterson D, Jones G, Rice, (2007) Aging and physical activity: evidence to develop exercise recommendations for older adults. Appl Physiol Nutr Metab 32:S69–S108

Petropoulos G (2017) An economic review of the collaborative economy. www.bruegel.org/2017/02/an--economic-review-of-the-collaborative-economy. Accessed 4 July 2020

Polish Network (2017) Nextbike. Bike sharing, five generations later: what's next? https://www.polisnetwork.eu/publicdocuments/download/2224/document/3c_brink.pdf. Accessed 4 Juy 2020

Piko B, Keresztes N (2008) Sociodemographic and socioeconomic variations in leisure time physical activity in a sample of Hungarian youth. Int J Public Health 53:306e10

Radzimski A; Dzięcielski M (2021) Exploring the relationship between bike-sharing and public transport in Poznań, Poland. Transp Res Part A Policy Pract 145:189–202. https://www.worldtransitresearch.info/research/8333/

Reinhardt-Rutland A (2011) Walking and cycling: local measures to promote walking and cycling as forms of traffic or recreation (PH41). NHS. http://www.bps.org.uk/bpslegacy/cp. Accessed 1 July 2021

Richter M, Erhart M, Vereecken CA (2009) The role of behavioural factors in explaining socioeconomic differences in adolescent health: a multilevel study in 33 countries. Soc Sci Med 69:396e403

Road safety report (2020) Poland. IRTAD OECD, https://www.itf-oecd.org/sites/default/files/poland-road-safety.pdf. Accessed 1 July 2021

Rodrigues-Krause J, dos Santos GC, Krause M (2021) Dancing at home during quarantine: considerations for session structure, aerobic fitness, and safety. J Phys Educ Recreation Dance 92(4):22–32. https://doi.org/10.1080/07303084.2021.1894272

Schor JB (2011) True wealth: how and why millions of Americans are creating a time- rich, ecologically light, small-scale, high-satisfaction economy. Penguin Group (USA)

Shaheen S, Guzman S, Zhang H (2010) Bikesharing in Europe, the Americas, and Asia, transportation research record. J Transp Res Board 2143:159–167. https://doi.org/10.3141/2143-20

Taylor E (2020) Are outdoor gyms the future of fitness? Vogue. https://www.vogue.com/article/equinox-outdoor-open-air-gym-covid-19. Accessed 2 June 2021

Teschke K, Harris MA, Reynolds CC (2012) Route infrastructure and the risk of injuries to bicyclists: a case-crossover study. Am J Public Health. https://ajph.aphapublications.org/doi/full/10.2105/AJPH.2012.300762

The Meddin Bike-sharing World Map (2012) https://bikesharingworldmap.com/#/all/2.7/0/51.5/. Accessed 5 July 2021

The Toronto Charter for Physical Activity: A Global Call for Action (2016) https://ispah.org/wp-content/uploads/2019/08/Toronto_Charter_English.pdf. Accessed 5 July2021

UN (2021a) Sustainable Development Goal 3, https://sdgs.un.org/goals/goal3. Accessed 5 July 2021a

UN (2021b) Sustainable Development Goal 17, https://sdgs.un.org/goals/goal17. Accessed 5 July 2021b

UNEP (2021) Sustainable Cities, https://www.unep.org/regions/asia-and-pacific/regional-initiatives/supporting-resource-efficiency/sustainable-cities. Accessed 5 July 2021
Veselska Z, Madarasova A, Reijneveld SA (2011) Socio-economic status and physical activity among adolescents. Public Health 125(11):763–768. https://doi.org/10.1016/j.puhe.2011.09.007
Wandersman A, Florin P (2003) Community interventions and effective prevention. Am Psychol 58(6–7):441–448. https://doi.org/10.1037/0003-066X.58.6-7.441
WHO (2016) Promoting health in the SDGs: report on the 9th global conference for health promotion, Shanghai, China, 21–24 November 2016: all for health, health for all. https://apps.who.int/iris/handle/10665/259183. Accessed 2 July 2021
WHO (2017) What is a healthy city?. https://www.euro.who.int/en/health-topics/environment-and-health/urban-health/who-european-healthy-cities-network/what-is-a-healthy-city. Accessed 2 July 2021
WHO (2018a) Healthier and happier cities for all. A transformative approach for safe, inclusive, sustainable and resilient societies. http://www.euro.who.int/data/assets/pdf_file/0003/361434/consensus-eng.pdf?ua=1. Accessed 2 July 2021
WHO (2018b) Global action plan on physical activity 2018b–2030: more active peoplefor a healthier world. https://apps.who.int/iris/bitstream/handle/10665/272722/9789241514187-eng.pdf?sequence=1&isAllowed=y. Accessed 2 July 2021
WHO (2018c) Kyrgyzstan becomes first country in central Asia to host a national healthy cities network meeting. https://www.euro.who.int/en/countries/kyrgyzstan/news/news/2018c/9/kyrgyzstan-becomes-first-country-in-central-asia-to-host-a-national-healthy-cities-network-meeting. Accessed 2 July 2021
WHO (2020a) Guidelines on physical activity and sedentary behavior. https://apps.who.int/iris/bitstream/handle/10665/336656/9789240015128-eng.pdf?sequence=1&isAllowed=y. Accessed 2 July 2021
WHO (2020b) European healthy cities network annual conference. https://www.euro.who.int/en/media-centre/events/events/2020b/12/who-european-healthy-cities-network-annual-conference. Accessed 2 July 2021
WHO (2020c) Phases of network, https://www.euro.who.int/en/health-topics/environment-and-health/urban-health/who-european-healthy-cities-network/phases-of-the-network. Accessed 2 July 2021
WHO (2020d) Healthy cities vision. https://www.euro.who.int/en/health-topics/environment-and-health/urban-health/who-european-healthy-cities-network/healthy-cities-vision. Accessed 2 July 2021
WHO (2021) Physical activity. https://www.who.int/news-room/fact-sheets/detail/physical-activity. Accessed 2 July 2021
Wolny-Kucińska A (2020) Rower podmiejski – koncepcja roweru publicznego w strefach zurbanizowanych miejskich obszarów funkcjonalnych na przykładzie Polski (Suburban bike - the concept of a public bike in urbanized urban functional areas on the example of Poland). Prace Komisji Geografii Komunikacji PTG 23(1):41–57. https://doi.org/10.4467/2543859XPKG.20.012.12114
Zaworski K, Kubińska Z, Dziewulska A, Walasek O (2020) Physical activity of poles in the care for their health potential before and during the COVID-19 pandemic. Disaster Med Publ Health Preparedness 1–4.https://doi.org/10.1017/dmp.2020.398
Zhang L, Zhang J, Duan Z et al (2015) Sustainable bike-sharing systems: characteristics and commonalities across cases in urban China. J Cleaner Prod 97:124–133. https://doi.org/10.1016/j.jclepro.2014.04.006

Chapter 12
Body Mass Index and Healthy Lifestyle Among Adolescent Girls: A Case Study on Delhi

Purva Bhalla and Praveen Kumar Pathak

Abstract *Introduction*: The adolescence stage for a girl is a period of physical, biological, and psychological preparation for safe motherhood. This is a very crucial period for adolescent girls as if their diet is not healthy, it will create a problem for the future generation. In modern western societies, an unhealthy lifestyle is causing many problems like unhealthy diet, physical inactivity, and substance abuse which acknowledge major health diseases. An unhealthy lifestyle contributes to sickness, which makes absenteeism from work. *Objectives:* The current study aims to understand the pattern of lifestyle and what are factors determine lifestyle choices among young females, and the association of lifestyle patterns and health/nutritional status. *Method:* Primary data on 300 young females (15–19 years) was collected from selected urban environs in Delhi using a multi-stage stratified sampling design. Detailed information about household characteristics, demographic and social characteristics, physical activity, dietary patterns, leisure time activities, and anthropometric characteristics of young females were collected. Appropriate Univariate (frequency distribution), multivariate statistics (multiple linear regression model), and ANOVA test have been applied to achieve the objectives of the present research. *Results and Conclusion:* Data suggests marked demographic and socioeconomic differentials in lifestyle patterns of young females in Delhi. Close to one-fifth of young females indulged in substance abuse. Results indicate that physical activity was positively associated with BMI among young females. Consumption of fast food and eating desert were positively associated with BMI. Findings called for a context-specific healthy lifestyle, and health promotion policies and programs must be tailored for adolescents.

Keywords Adolescent girl · Body mass index · Healthy lifestyle · Physical activity · Dietary pattern · Leisure time · Substance abuse

P. Bhalla (✉)
Delhi School of Economics, University of Delhi, New Delhi, India
e-mail: purvabhallamail@gmail.com

P. K. Pathak
Jamia Millia Islamia, Central University, New Delhi, India

A. Grover et al. (eds.), *Sustainable Health Through Food, Nutrition, and Lifestyle*,
Advances in Geographical and Environmental Sciences,
https://doi.org/10.1007/978-981-19-7230-0_12

12.1 Introduction

Adolescence is a period of rapid growth and development and is a critical period for the acquisition of health-related behaviors such as food preferences and physical activity. These behaviors are usually tracked throughout the life course and may contribute to nutrition-related NCDs in adulthood (Maehara et al. 2019).

The adolescent period marks the transition between childhood to adulthood. This stage is characterized by physical growth, emotional, psychological, and social transition. It brings a unique and more closeness with the world above an adolescent's immediate family. Changing social and psychological environments together with increasing urbanization presents numerous risks and challenges before adolescents' health and nutrition. Healthy lifestyle measure is an asset that may improve public health guidelines. It could also represent a paradigm shift in the way people think about lifestyle as a combination of several healthy behaviors. The nutritional status of adolescent girls is influenced by a variety of factors, including Lifestyle, environment, food intake, socioeconomic status, and demographic factors. Nutritional deficiencies lead to various health issues which are very difficult to cure/treatment. The increase in deficiency of both macro-and micronutrients has been co-related with behavioral issues (Venugopal et al. 2020).

Living a healthy lifestyle still remains a challenge to a good section of the population. A healthy lifestyle is related to different aspects of economic and social life, it ought to be examined among adolescent girls. This perspective suggests that participation in an exceedingly healthy way, with its behavioral stress, which generally involves selection regarding food, physical activity, risk factors like substance abuse, isn't essentially up to the individual. Socio-economic and demographic status, the level of adolescents and their parent's education, parental occupation, age, and social influences all have an effect on the choice of lifestyle (Ochieng 2006).

Health-related behavior in early life influences later risks for lifestyle-related disorders. World Health Organization has determined the age range between 10 and 19 years as adolescence and the age range between 15 and 24 as a youth. Youth is the maturation period with all the physical, mental, social changes and have distinctive problems as this period is the healthiest and riskiest for the adolescent. All individuals must live a healthy life which includes all the healthy behavior like physical activity, stress management, interpersonal relation, and a nutritious diet. If adolescents are not having a healthy diet and eat unhealthy food it will create risk in their adulthood. The World Health Organization aims that young people must have a healthy and nutritious diet which will definitely help in their future lifestyle (Hacihasanoglu et al. 2011).

Due to industrialization and urbanization, the standard of living continues to rise particularly in developing countries. This has led to weight gain and obesity, which are posing a threat to the health of adolescents. Obesity is perhaps the most prevalent form of malnutrition in developing countries, both among adults and children. Obesity, its attendant health consequences, and consequent health burden are expected to reach epidemic proportions in developing countries (Dua et al. 2014).

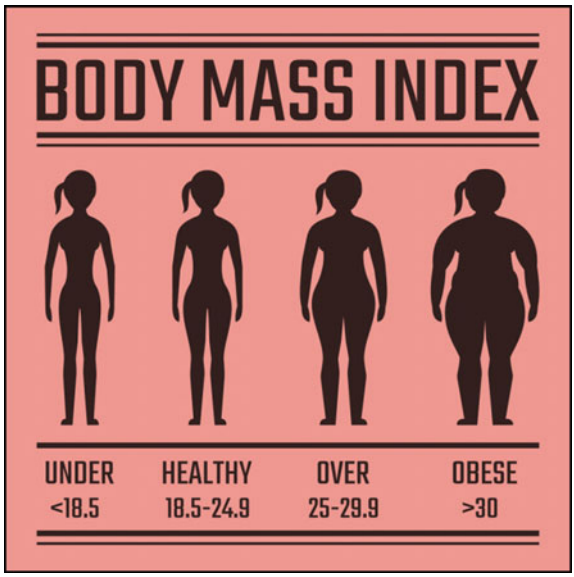


Fig. 12.1 Illustration of body mass index of the adolescent girls. *Source* Author's modification

According to WHO in 2020 "BMI is outlined as weight (in kilograms) divided by height (in centimeters) square. A person's height and weight can be easily measured so BMI has become a popular heuristic approximation for body fat in medical terms and clinical practice (Fig. 12.1). They outlined BMI based fat categories of underweight (BMI < 18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2) and obese ($\geq$ 30.0 kg/m^2)".

Healthy eating is defined as eating practices and behaviors that are consistent with improving, maintaining, and enhancing health. Meal patterns and food intake are markers for nutrient intake and diet quality. The key features of the eating patterns include snacking, fasting, skipping breakfast or any meal, dieting, eating sweets or chocolate, and fast food eating. The preference for eating habits or foods in humans is established by the influences from the socio-economic level of the household income, religion, tradition, regional characteristics, and educational level of parents. Many factors determine food preferences. Religion, sex, age, physical activity, psychological characteristics, dietary patterns old traditions social prestige, and economic factors affect food preferences in all cultures. Eating behavior and dietary factors as one of the risk factors are creating a lot of problems among adolescent females like obesity (Omidvar and Begum 2014).

Nutritional status throughout adolescence plays a very important role in human life. The worldwide economic development and urbanization have resulted in good changes within the weight status of adolescents. A decreasing trend within the prevalence of under-nutrition has been known in developing countries (Doustmohammadian et al. 2013).

Dietary factors are involved in the macronutrient composition of diets. This has been consistently investigated with regard to body weight and dietary fat content.

It has received the greatest attention. On a food group level, many food items or food groups have been proposed to be related to energy intake, and some of them to body weight, particularly salty snacks, sugar-sweetened beverages, junk food, and sweets. The proportion of children and adolescents who are overweight has increased dramatically in the past decade. Adolescent obesity increases the long-term risk of adult morbidity and mortality. Modernized lifestyle of excessive energy intake and inactive behavior partially explains the recent emergence of type 2 diabetes and obesity in adolescents (Patrick et al. 2004).

Behaviors, like television viewing, use of personal computer/laptop or the Internet, and engagement in moderate-to-vigorous physical activities or outside activities are one by one related to multiplied or diminished weight or change in weight. Watching television, particularly at night throughout adolescence, has been found to be related to poor physical stamina and obesity (Must and Tybor 2005). To the best of our knowledge, there exist limited research on the association of lifestyle patterns and health/nutritional status among adolescent girls in urban areas.

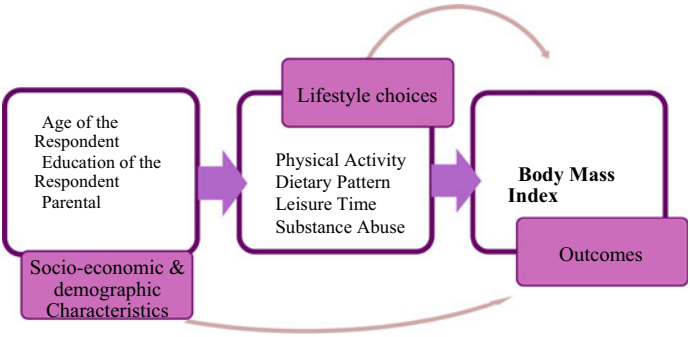
12.2 Rationale for the Study

Adolescent girls in today's society are extremely conscious of the perception of a perfect body. With the rising sense of ideal body structure during adolescence, young girls try to lose or gain body weight to achieve the perfect body. Various cross-sectional studies have been done on the behavioral and lifestyle aspects of adolescent girls, which are very important determining issues among adolescents. Moreover, in our society, there is a trend to value thinness and social discrimination against overweight people.

In today's era increase of non-communicable diseases is increasing at an alarming pace. Factors like blood pressure, obesity, alcohol consumption, physical inactivity, which are now active in adolescent children, are risk factors that are neglected today, and in future, they will cause a major issue. In Delhi, adolescent girls are facing a lot of problems like obesity, stress, underweight, alcohol use, and tobacco as they are busy with late-night parties, workload, exams stress, family issues, and personal life issues. They are mentally so stressed out that they don't perform any outdoor activity and those who have the time don't like going out and playing as they want to sit at home watch TV, play video games, chat with friends on the phone, mobile phone or connect with social media, and download their stuff (movies, etc.).

Adolescent lifestyle is so changed as they adapt the habit of fast food more than home food which is more nutritious than street food. Nutrition requirement is very important for adolescent girls not only for their present but also for their future. Malnutrition will make their body weak, and they will not be physically fit. The irregular dietary pattern also has a negative impact not only on their health status but also mental performance as they will not be able to cope with other students in studies and other activities. Skipping meals, as every girl wants to look slim as they see on television and social media, affects their lifestyle.

12.3 Conceptual Framework



Due to these socio-demographic factors (e.g.: age, sex, wealth, caste, neighborhood, parents, occupation, etc.), female health has been effected. As in this age group (15–19 years), their behavior in society, physical appearance, dietary habits, substance abuse, and leisure time will affect their health. In this particular age group, females need more attention, more concentration on studies, and even more psychological factors. Adolescence is a crucial period when the first intake of substance abuse takes place, which includes alcohol, tobacco, drugs, etc. Encouragement getting from their peer group, friends, cousins, boyfriend to indulge in these activities also create a lot of problem like missing their school/college, physically inactive. For this, even social media also play a crucial part as whatever adolescents see in films and television, they start following that lifestyle and behavior. They want to be like their role models. The influence of media is taking adolescent girls mindsets to a very different track which affects both their health as well as their lifestyle.

12.4 Data and Methodology

The present research investigated the pattern and association of lifestyle aiming at young females and their health/nutritional status in an urban context. In the present research, two variables were computed-Body Mass Index (BMI) and Unhealthy Diet and were derived from factor analysis. The purpose of making this variable was to see how many adolescent girls were indulged in unhealthy diets and how many were having healthy diets. The purpose of making this variable was to check the general nutritional status of adolescent girls (15–19 years).

Fig. 12.2 Illustration of healthy and unhealthy diet of adolescent girls. *Source* Author's modification

12.4.1 Data Source

Delhi is a metropolitan city, and people from all over India come and live here. West Delhi Zone as study area has been taken by calculating the district-wise data (Census of India 2011) of particular age group (15–19 years) of adolescent girls by age correction (Fig. 12.2). Looking at the proportion of 15–19 years adolescent girls across various a district in West Delhi, the number was closer to the overall Delhi. Primary data on 300 adolescent girls (15–19 years) age group was collected in November–December 2015. Data was collected from selected urban environs in Delhi (three Wards, namely Bhagwan Das Nagar, Jai Dev Park, and Madan Park of Punjabi Bagh Tehsil in West Delhi, Fig. 12.3) using multi-stage stratified random sampling. Equal sample size data of 100 households were randomly collected from all three wards. Within each ward list of households, data was collected from the electoral office. Detailed information related to socio-demographic characteristics, physical activity, dietary patterns, psychological characteristics, substance abuse, and anthropometric characteristics of young females were collected through semi-structured questionnaires. Finally, a sample of 300 adolescent girls was randomly selected for the purpose of the study (Fig. 12.4).

12.4.2 Data Analysis

Data collection is just the starting point in research. The way to manage data is the crucial factor in determining the success of a thesis, as this information forms the basis of quantitative research. All the analysis were carried out using the Statistical Package for Social Sciences statistical software package version 21.0 (SPSS).

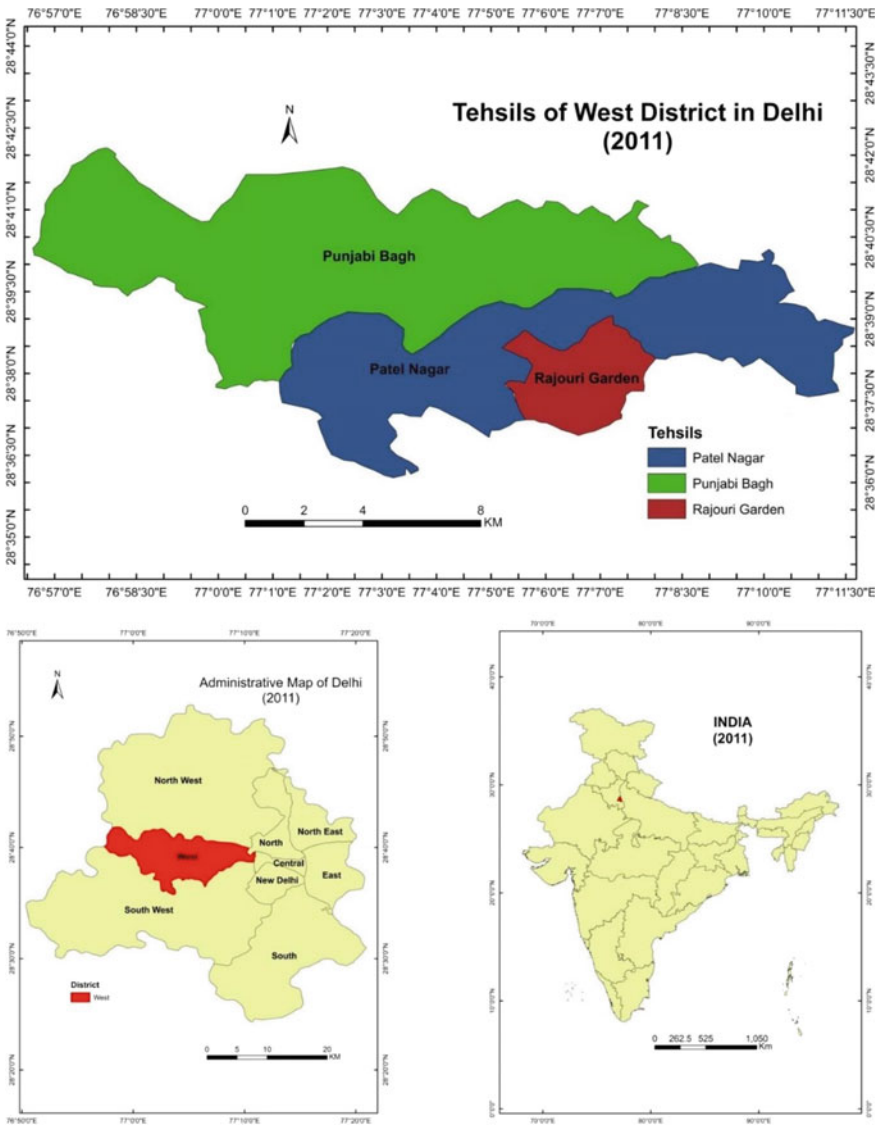


Fig. 12.3 Study area. *Source*: Census of India (2011)

12.4.3 Methodology

The methodological approach adopted in the research for this particular topic is the quantitative method. The quantitative method is used in the form of a detailed questionnaire survey. To explore the basic knowledge about the different methods

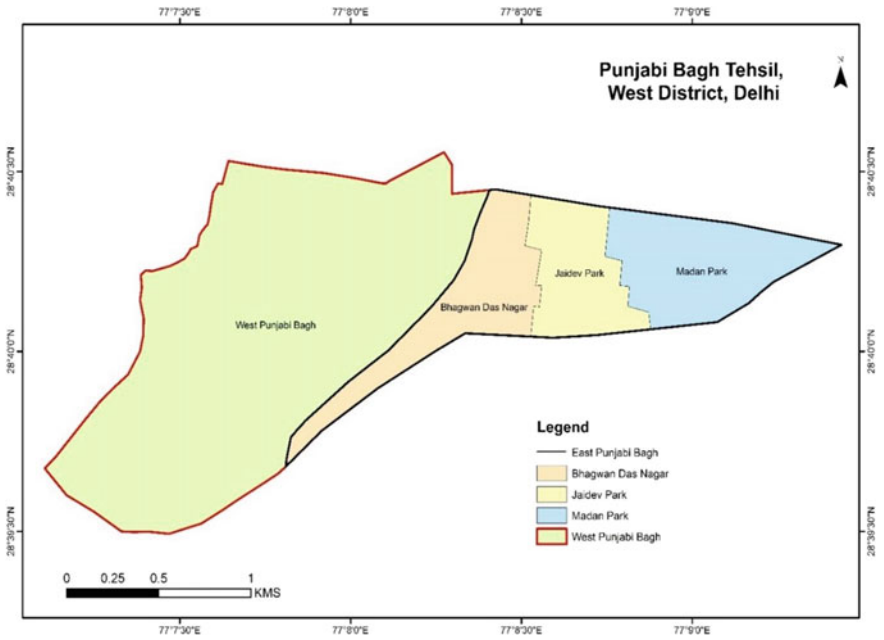


Fig. 12.4 Field area; Punjabi Bagh, West District, Delhi. *Source* Municipal Corporation of Delhi (2013)

of health practice and their lifestyle in which adolescent females of age group 15–19 years are taking part. The adolescent girls were divided into two age groups, i.e., younger adolescent girls (15–17 years) and older adolescent girls (18–19 years). It was absolutely important to conduct a quantitative survey as it facilitated information on the infrastructural and other facilities provided. Lifestyle, including physical activity, is considered one of the major determinants of health in a population, and regular physical activity is well documented to increase physical and mental health.

ANOVA test was applied to determine whether there were any statistically significant differences between the mean BMI (dependent variables) with physical activity, dietary pattern, substance abuse, psychological characteristics, and socio-demographic characteristics. The present research computed three variables—Body Mass Index (BMI), Unhealthy Diet, and Scale of Leisure Time Activity. Descriptive statistics are used to describe the socio-economic and demographic characteristics of the adolescent girls' population. Unhealthy diet, BMI, and leisure time activity were derived from the principal components. The main applications of factor analytic techniques are: (1) to reduce the number of variables and (2) to detect structure in the relationships between variables, that is, to classify variables. Therefore, factor analysis is applied as a data reduction or structure detection method. It is a useful tool for investigating variable relationships for complex concepts such as socio-economic status, dietary patterns, or psychological scales. Descriptive statistics are used to describe the socio-economic and demographic characteristics of the adolescent girls'

population. Unhealthy diet, BMI, and leisure time activity were derived from the principal components factor analysis). A multiple linear regression model was applied on mean BMI (dependent variables continuous) to see the relationship between two or more explanatory variables and a response variable by fitting a linear equation to observed data. Multiple regression (an extension of simple linear regression) is used to predict the value of a dependent variable (also known as an outcome variable) based on the value of two or more independent variables (also known as predictor variables). For example, multiple regression to determine if physical activity can be predicted based on father occupation, mother occupation, monthly family income, parental education, adolescent age, adolescent education, anemic, and body image (i.e., dependent variable be physical activity and the eight independent variables).

$$\text{Logistic regression(Li)} = \beta_0 + \beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 + \beta_6 + \beta_7 \ldots \beta_n.$$

Li (Physical Activity) $= \beta_0 +$ β_1 Parental Education $+$ β_2 Mother Occupation $+$ β_3 Father Occupation $+$ β_4 Family Monthly Income $+$ β_5 Age of Respondent $+$ β_6 Education of Respondent $+$ β_7 Body image.

12.5 Results

The socio-demographic characteristics of adolescent girls in Delhi were conducted (Table 12.1). It was pursued that 64% of the adolescent girls were from age 15–17 and 36% from the age of 18–19 years. It was observed that 52% of the adolescent girls were having higher secondary education and 25% of adolescent girls were in college doing their graduation, and the remaining 23% of adolescent girls were pursuing secondary education. The table shows the parental educational status of the respondent. Half of the adolescent girl's fathers were more educated than their mothers. Only one-fourth of mothers were more educated than fathers. It was observed that 40% of the adolescent girls' fathers were doing private jobs, 33% were engaged in their own business, and the rest 27% were doing government jobs. Maximum 39% of adolescent girls' mothers were housewives, 24% were doing government jobs, 20% were doing private jobs, and rests 17.3% were doing their own business.

The differentials in mean BMI of adolescent girls who performed physical activity (Fig. 12.5). As the data suggests that any statistical difference in adolescent girls means BMI and their physical activity status was not statistically significant. Adolescent girls who perform some physical activity had relatively lower mean BMI (20.9 $\pm$ 3.68 S.D.) than their counterparts who were having higher mean BMI (21.3 $\pm$ 3.43 S.D.).

The differentials in mean BMI of adolescent girls across selected lifestyle, socioeconomic and demographic characteristics (Table 12.2). Data suggests that the mean BMI of adolescent girls was 21.1. There was less difference in mean BMI value with food preference among adolescent girls, and it was not statistically significant.

Table 12.1 Selected socio-demographic characteristics of adolescent girls (15–19 years) in Delhi, 2015

Variables	Percent	Sample
Total	100	300
Age of the respondent		
15–17 years	64.3	193
18–19 years	35.7	107
Mean age		16.9(1.4*)
Adolescent education		
Secondary	23.0	69
Higher secondary	52.3	157
College	24.7	74
Parental education		
Both are equally educated	32.0	96
Father is more educated than mother	50.3	151
Mother is more educated than father	17.7	53
Father occupation		
Business	33.0	99
Government job	27.0	81
Private job	40.0	120
Mother occupation		
Business	17.3	52
Government job	24.0	72
Private job	19.7	59
Housewife	39.0	117

Source Author's calculation
Note *Standard deviation

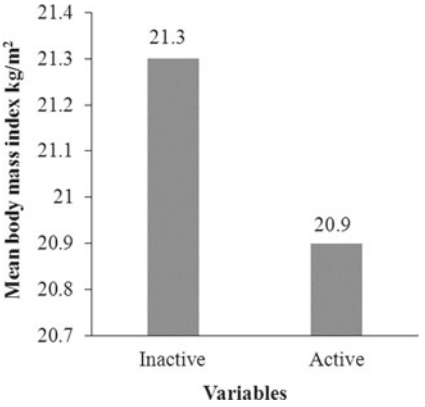


Fig. 12.5 Differentials in mean BMI of adolescent girls performed physical activity in Delhi, 2015. *Source* Author's calculation

For instance, adolescent girls who preferred a vegetarian diet (21.4 ± 3.8 S.D.) had a relatively higher mean BMI than others who consumed non-vegetarian (21.1 ± 3.9 S.D.) and eggetarian (20.7 ± 2.9 S.D.) diet, respectively. Secondly, there was no statistically significant difference between intake of fast food and mean BMI; those adolescent girls who ate fast food were having high mean BMI (21.1 ± 3.6 S.D.) than those who didn't eat fast food (20.9 ± 3.6 S.D.). There was a statistically significant difference among adolescent girls who ate dessert. Respondent girls who ate dessert had a relatively high mean BMI (21.1 ± 3.7 S.D.) than those who didn't eat dessert (19.9 ± 2.7 S.D.). Further, there was no significant association between milk preference and mean BMI and no consistent pattern among milk preferences.

However, there was no significant association between adolescent girls' BMI and economic status. There was a significant difference by mean BMI in household monthly family income, but no consistent pattern. Next, there was a significant association between the father's occupation and mean BMI. Adolescent girls, whose fathers were in government jobs, had a relatively high mean BMI (21.8 ± 3.2 S.D.) than those working in private jobs or doing business. Furthermore, there was no significant association between adolescent age and mean BMI. Young adolescents had relatively positively lower mean BMI than those who were older adolescents (21.2 ± 3.3 S.D.). Lastly, there was no significant difference between adolescent education and mean BMI. In education, as the education rises, mean BMI increases like those who were in higher secondary their mean BMI was 21.1 ± 3.5 S.D., and in college, mean BMI was 21.3 ± 3.7 S.D.

Multiple linear regression models predicting the body mass index of adolescent girls were also conducted (Table 12.3). Adolescent girls, who were performing any physical activity, had a positive association with mean BMI. For instance, a unit increase in the proportion of adolescent girls performing physical activities was associated with a 0.050 units increase in their mean BMI. Adolescent girls, who were eating an unhealthy diet, had a positive association with mean BMI. For instance, a unit increase in the proportion of adolescent girls eating an unhealthy diet was associated with a 0.042 units increase in their mean BMI. It was observed that adolescent girls, who were smoking, had a positive association with mean BMI. For instance, a unit increase in the proportion of adolescent girls smoking was associated with a 0.067 unit increase in their mean BMI. Adolescent girls consuming alcoholic drinks had a positive association with mean BMI. For instance, a unit increase in the proportion of adolescent girls consuming alcoholic drinks was associated with a 0.049 unit increase in their mean BMI. Adolescent girls who felt peer pressure had a positive association with mean BMI. For instance, a unit increase in the proportion of adolescent girls, who felt peer pressure, was associated with 0.024 units increase in their mean BMI. Adolescent girls who sometimes felt social isolation have a positive association with mean BMI. For instance, a unit increase in the proportion of adolescent girls, who sometimes felt social isolation, was associated with 0.011 units increase in their mean BMI. Adolescent girls who sometimes felt low social self-esteem had a positive association with mean BMI. For instance, a unit increase in the proportion of adolescent girls, who sometimes felt low social self-esteem, was associated with 0.064 units increase in their mean BMI (Fig. 12.6). Adolescent girls

Table 12.2 Differentials in mean BMI of Adolescent Girls (15–19 years) across selected lifestyle and socio-economic and demographic characteristics in Delhi, 2015

Variable	Mean	Standard deviation	*P*-value
Total	21.1	3.6	
Dietary pattern			
Food preferences			0.377
Vegetarian	21.4	3.8	
Non-vegetarian	21.1	3.9	
Eggetarian	20.7	2.9	
Intake of fast food			0.611
No	20.9	3.6	
Yes	21.1	3.6	
Eat dessert			0.011
No	19.9	2.7	
Yes	21.1	3.7	
Frequency of fasting			0.192
No fasting	21.5	3.8	
Weekly	20.3	4.6	
Monthly	20.0	1.8	
Yearly	20.7	3.5	
Eat low fat products			0.720
No	21.0	3.6	
Yes	21.7	3.6	
Milk preference			0.462
Full cream	21.6	4.2	
Toned milk	21.0	3.2	
Skimmed milk	20.7	2.7	
Powdered milk	20.7	3.6	
Sedentary lifestyle			
Time spend on mobile (per day)			0.384
Nothing	21.5	3.5	
Less than 2 h	20.6	2.8	
2–3 h	21.2	3.2	
More than 3 h	20.7	4.1	
Time spend on television (per day)			0.272
Nothing	20.2	3.1	
Less than 1 h	21.1	3.8	
1–2 h	21.4	3.4	

(continued)

Table 12.2 (continued)

Variable	Mean	Standard deviation	*P*-value
More than 2 h	20.2	3.4	
Time spend on laptop (per day)			0.154
Nothing	21.3	3.8	
Less than 2 h	20.2	2.8	
2–4 h	20.0	1.7	
More than 4 h	21.1	3.7	
Substance abuse			
Ever smoked			0.504
No	20.9	3.5	
Yes	21.3	3.7	
Consumption of any alcoholic drinks			
No	21.1	3.6	0.990
Yes	21.1	3.7	
Socio-economic demographic characteristics			
Monthly household income (Rs.)			0.014
Less than Rs. 50,000	21.3	3.6	
Rs. 50,000–Rs. 150,000	20.3	2.5	
More than Rs. 150,000	21.7	4.3	
Parental education			0.259
Both are equally educated	20.7	3.6	
Father is more educated than mother	21.1	3.7	
Mother is more educated than father	21.3	3.3	
Father occupation			0.001
Business	20.3	3.5	
Government job	21.8	3.2	
Private job	21.8	3.9	
Mother occupation			0.373
Business	20.8	3.1	
Government job	20.9	3.1	
Private job	20.7	2.6	
Housewife	21.5	4.4	
Adolescent age			0.539
15–17 years	20.9	3.7	
18–19 years	21.2	3.3	
Adolescent education			0.675

(continued)

Table 12.2 (continued)

Variable	Mean	Standard deviation	*P*-value
Secondary	20.8	3.8	
Higher secondary	21.1	3.5	
College	21.3	3.7	

Note One-way ANOVA test has been applied to examine statistically significant differences in mean BMI of adolescent girls across selected areas of lifestyle and socio-demographic characteristics. BMI was computed by these variables-height (centimeters) and weight (kilogram). The formula for BMI = weight (kg)/height (cm). Unhealthy diet as this indicator is a composite major conducted through the following terms. Unhealthy diet-fast food, eat dessert, skip a meal, and ever fasting. Healthy diet-eat vegetables and eat fruits

whose mothers were in business had a negative association with mean BMI. There was a change of one unit in adolescent girls whose mothers were in business 0.043 units had declined in mean BMI.

12.6 Discussion

The present study attempts to evaluate the association between lifestyle choices and health/nutrition among adolescent girls. Lifestyle choices are nutrition and health outcome principally examined through BMI. Lifestyle domains are dietary patterns, leisure time activity, substance abuse, and physical inactivity. Then each result shows that BMI varies by eating dessert, monthly family income, and father occupation. All these are largely associated with BMI. A study conducted by Duyff et al. (2015) in America reported that intake of dessert has played a vital role in cultural traditions and celebrations for thousands of years and continues to be enjoyed by the majority as an occasional treat. Sweets within the diet and their attainable effects on biomarkers of health challenge the view that eating after could also be related to increasing rates of obesity and health risks.

Diet habit like eating sweets was significantly associated with a high prevalence of overweight among school adolescent girls. Yerpude and Jogdand (2013) said that nutrition education should be given in schools regarding this to prevent the occurrence of lifestyle diseases in the future.

The socioeconomic status of a child is most ordinarily determined by combining parent's education level, occupational status, and financial level. Socioeconomic status has a very important role in individual perspectives, behavior, and activities. People of different social and economic backgrounds observe numerous social aspects differently, and their behavior is sure to be different. Body mass index could be a relative parameter of weight with respect to height. Students of higher socioeconomic status sometimes take a low-fat diet, exercise a lot, and have a better prevalence of fast to manage weight. Socioeconomic class variations within the prevalence of overweight and obesity were found to be negligible in childhood, however, marked

Table 12.3 Multiple linear regression models predicting body mass index of adolescent girls (15–19 years) in Delhi, 2015

Variables	Standardized coefficients	95% confidence interval		*P*-value
	Beta	Lower	Upper	
(Constant)		16.985	21.412	0.000
Physical inactivity				
Perform physical activity				
No (ref)	1.000			
Yes	− 0.046	− 1.187	0.512	0.435
Dietary pattern				
Intake of unhealthy diet				
Healthy diet (ref)	1.000			
Unhealthy diet	0.046	− 0.787	1.844	0.430
Psychological characteristics				
Peer pressure				
Not at all*	1.000			
Yes	0.037	− 0.700	1.345	0.535
Social isolation				
Never*	1.000			
Yes	0.019	− 0.845	1.149	0.764
Low social self-esteem				
Never	1.000			
Sometimes	0.086	− 0.391	2.325	0.162
Substance abuse				
Ever smoking*				
Frequency of smoking				
Never (ref)	1.000			
Others (daily, weekly, monthly, rarely)	0.042	− 0.635	1.276	0.510
Ever consume any alcoholic drinks*				
Frequency of alcoholic drinks				
Never (ref)	1.000			
Others (weekly, monthly, rarely)	0.017	− 0.808	1.051	0.797
Socio-demographic characteristics				
Parental occupation				
Either father or mother is more educated*	1.000			

(continued)

Table 12.3 (continued)

Variables	Standardized coefficients	95% confidence interval		*P*-value
	Beta	Lower	Upper	
Both are equally educated	− 0.037	− 1.179	0.612	0.534
Father occupation				
Business*				
Service	0.225	0.783	2.442	0.000
Mother occupation				
Service*	1.000			
Business	− 0.009	− 1.369	1.198	0.896
Not working	0.125	0.008	1.815	0.048
Adolescent age				
15–17 years (Ref)	1.000			
18–19 years	0.021	− 1.180	1.489	0.820
Adolescent education				
Secondary or higher secondary*	1.000			
College	0.005	− 1.426	1.513	0.953

Note $R^2 = 0.089$ Adjusted $R^2 = 0.044$ Ref = Reference * = Multi-collinearity

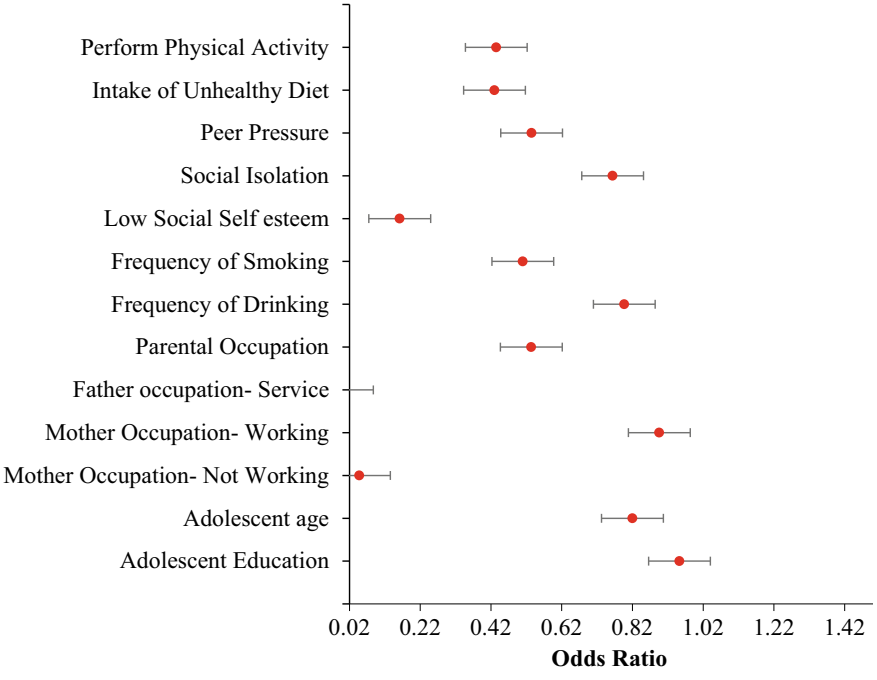


Fig. 12.6 Forest plot: regression analysis

by early adulthood with a larger proportion of overweight and obesity in lower social categories (Yadav and Choubey 2014). To identify the characteristics of adolescent girls, whether they have high BMI or low BMI, so that appropriate programs and invention plans are implemented. The burden of high BMI, low BMI depends on whether there is a systematic difference in background characteristics or not.

Dietary factors are involved macronutrient composition of diets. This has been consistently investigated with regard to body weight, and dietary fat content. It has received the greatest attention. On a food group level, many food items or food groups have been proposed to be related to energy intake, and some of them to body weight, particularly salty snacks, sugar-sweetened beverages, junk foods, and sweets. The proportion of children and adolescents who are overweight has increased dramatically in the past decade. Adolescent obesity increases the long-term risk of adult morbidity and mortality. Modernized, the lifestyle of excessive energy intake and inactive behavior partially explains the recent emergence of type 2 diabetes and obesity in youth (Patrick et al. 2004).

Behaviors, like television viewing, use of personal computer/laptop or the Internet, and engagement in moderate-to-vigorous physical activities or outside activities are one by one related to multiplied or diminished weight or change in weight. Watching television, particularly at night throughout adolescence, has been found to be related to poor physical stamina, obesity, and smoking. Several environmental factors are related to body weight in children. Physical inactivity is absolutely associated with obesity, whereas increased physical activity and diminished inactive behaviors protect against overweight throughout childhood and adolescence (Must and Tybor 2005). Self and peer perception of body image and substance abuse are closely associated with the physiological, social, and mental health of adolescents. To identify how these socio-economic and demographic characteristics affect adolescent girl's body mass index and which are the most influential among these all.

Health is affected by socioeconomic status. Financial gain is widely used because of the indicators of socioeconomic status. Knowing the risk factors of obesity of adolescent girls will enable in developing the right approaches for preventing this drawback. Low socioeconomic status is one of those risk factors. It has been shown a relationship between the low socioeconomic status and incidence of obesity in both adolescence and adulthood phases. So, socioeconomic status is one of the foremost necessary factors that should be addressed in obesity-reducing programs (Abtahi et al. 2016). Father's job is affecting adolescent girl's BMI because it is associated with adolescent obesity. If the father is earning smart, their standard of living will be sensible, and the family won't face the matter of malnutrition (Farzianpour et al. 2014).

Eating chocolate may have a positive effect on our body fat. Physical activity has been identified as a major contributor to the current obesity epidemic among children and adolescents. Physical activity was inversely and significantly associated with BMI among adolescent females (Sulemana et al. 2006).

The efficiency fitness index of the topic differed considerably from each other in the numerous body mass index class, with the topic of normal weight possessing a higher fitness than the overweight or obese subjects. Fitness capability, therefore,

weakened, was decreased progressively as the body mass index increased (Srivastav et al. 2013).

Fast food refers to food that will be served ready to eat. Fast food culture is a rising trend among the younger generation. Junk food, a kind of quick food, merely suggests an empty-calorie food. These foods have lack nutrients that are essential to staying healthy. Fast food causes adverse effects on health. Dietary habits are elementary factors that influence human lifestyle and quality of life. The dietary habits in young girls might confirm their quality of life in later middle or adulthood. Fast food culture is a rising trend among the younger generation (Jackson et al. 2004).

Multiple linear regression analysis predicts the Body Mass Index of Adolescents girls 15–19 years in Delhi. The present study examined how the dietary habits of adolescent girls have affected body mass index (BMI), which may be an indicator of future weight gain, and assessed the occurrence of overweight and obesity. Changes in adolescents' lifestyles may also affect eating habits and food choices (Al-Muammar et al. 2014).

12.7 Conclusion

The present study suggests a widespread sense as an association of lifestyle and health/nutritional status of adolescent girls with risk factors which include body mass index. The major health impacting behaviors and problems among the adolescent girls (15–19 years) include under-nutrition and over-nutrition, common psychological problems including stress, low self-esteem, anxiety, and increased consumption of tobacco alcohol. Adolescence is associated with nutritional issues, as overweight and obesity are serious health problems, so it cannot be neglected to change the lifestyle. Eating behavior is the biggest challenge among adolescent girls.

Prevention programs in each of those areas could be improved by using adolescents' peer crowd affiliation so as to focus on probably high-risk individuals. At the individual level, schools/colleges health and wealth services and primary health care should develop skills and techniques to encourage and support different adolescent groups to reduce alcohol use. A lot of support is required to boost a healthy lifestyle among socioeconomically underprivileged adolescent girls compared with a lot of privileged adolescents.

Most studies rely on self-reported data and cross-sectional study designs with descriptive statistics. Obtain an extra in-depth understanding of the predictive motives of participation in physical exercise is needed. In the study, only a particular area has been selected and does not represent the entire Delhi. Due to time constraints only, West Delhi has been chosen. The qualitative data could also be used, as it can bring into light those things which are either not possible to bring out through the questionnaire survey or things that an adolescent girl is prone to say only in an interview. Also, a lot could be understood by the tone of a person, which is quite impossible to understand in a questionnaire survey. Moreover, by observing the body

language, it becomes easier to say if the person is comfortable talking on the subject or she is saying it to be politically correct.

References

Abtahi M, Pouraram H, Djazayeri A (2016) Relationship between prevalence of overweight and obesity in adolescent girls, and socio-economic status of their families: a case study in Tehran. J Nutri and Health 2(1):4

Al-Muammar MN, El-Shafie M, Feroze S (2014) Association between dietary habits and body mass index of adolescent females in intermediate schools in Riyadh, Saudi Arabia. EMHJ-East Mediterr Health J 20(1):39–45

Census of India (2011) District census handbook of nine districts. Retrieved from http://www.censusindia.gov.in/2011census/dchb/DCHB.html

Doustmohammadian A, Keshavarz SA, Doustmohammadian S (2013) Nutritional status and dietary intake among adolescent girls. J Paramed Sci 4:72–77. https://doi.org/10.22037/jps.v4i0.4119

Dua S, Bhuker M, Sharma P (2014) Body mass index relates to blood pressure among adults. N Am J Med Sci 6(2):89. https://doi.org/10.4103/1947-2714.127751

Duyff RL, Birch LL, Byrd-Bredbenner C (2015) Candy consumption patterns, effects on health, and behavioral strategies to promote moderation: summary report of a roundtable discussion. Adv Nutr 6:139S-146S. https://doi.org/10.3945/an.114.007302

Farzianpour F, Reihani A, Hosseini SM, Yaganeh HS (2014) The effect of the family's socioeconomic factors on nutrition of elementary school children. Health 6:2657–2667. https://doi.org/10.4236/health.2014.619305

Hacihasanoglu R, Yildirim A, Karakurt P (2011) Healthy lifestyle behavior in university students and influential factors in eastern Turkey. Int J Nurs Pract 17:43–51. https://doi.org/10.1111/j.1440-172X.2010.01905.x

Jackson P, Romo MM, Castillo MA et al (2004) Junk food consumption and child nutrition: nutritional anthropological analysis. Rev Med Chil 132:1235–1242. https://doi.org/10.4067/s0034-98872004001000012

Maehara M, Rah JH, Roshita A, Suryantan J, Rachmadewi A, Izwardy D (2019) Patterns and risk factors of double burden of malnutrition among adolescent girls and boys in Indonesia. PLoS ONE 14(8):e0221273

Must A, Tybor DJ (2005) Physical activity and sedentary behavior: a review of longitudinal studies of weight and adiposity in youth. Int J Obes 29(2):S84–S96

Ochieng BM (2006) Factors affecting choice of a healthy lifestyle: implications for nurses. Br J Community Nurs 11(2):78–81. https://doi.org/10.12968/bjcn.2006.11.2.20445

Omidvar S, Begum K (2014) Dietary pattern, food habits, and preferences among adolescent and adult student girls from an urban area, South India. Indian J Fundam Appl Sci 4(2):465–473

Patrick K, Norman GJ, Calfas KJ (2004) Diet, physical activity, and sedentary behaviors as risk factors for overweight in adolescence. Arch Pediatr Adolesc Med J 158:385–390. https://doi.org/10.1001/archpedi.158.4.385

Srivastav S, Dhar U, Malhotra V (2013) Correlation between physical fitness and body mass index. Int J Curr Res Rev 5(23):42–48

Sulemana H, Smolensky MH, Lai D (2006) Relationship between physical activity and body mass index in adolescents. Med Sci Sports Exerc 38(6):1182–1186. https://doi.org/10.1249/01.mss.0000222847.35004.a5

Venugopal R, Srivastava P, Varoda A (2020) Impact of body mass index and age on mental health of adolescents girls. Int J Public Health Res Develop 11(01):849. https://doi.org/10.37506/v11/i1/2020/ijphrd/193941

World Health Organization (2020) Obesity: preventing and managing the global epidemic. Report of a WHO Consultation (WHO Technical Report Series 894) Geneva. Available. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight

Yadav RA, Choubey JB (2014) Study of the effect of socioeconomic status on body mass index and academic performance of college going girls. Indian J Sci Res 9(1):146–153. https://doi.org/10.5958/2250-0138.2014.00023.6

Yerpude PN, Jogdand KS (2013) A study on overweight promoting dietary factors among school children in an urban area of Andhra Pradesh. Nat J Med Res 3(2):156–158. Retrieved from http://njmr.in/uploads/3-2_156-158.pdf

Chapter 13
Can Doctor's Resource Allocation Improve Residents' Health?: Price, Quality, and Patient Mobility

Wenjian Cao and Weibin Peng

Abstract The COVID-19 has brought a significant blow to the global economy, and it is urgent to solve public health problems. This article analyzes the impact of the Chinese doctor's resource allocation, doctor quality, and price on the resident's health. Theoretically, it is found that increasing the number of doctors and reducing the number of patients will change the quality and price of doctors, thereby affecting the health of residents. The empirical analysis found that the lower health level of Chinese residents is the unbalanced regional distribution, fewer doctors, and doctor's lower quality. For urban and rural areas, the increase in the number of urban doctors squeezes out rural doctor's resources and reduces the overall health level. In terms of the three major regions in the east, middle and west, the number of patients and doctors and the price of medical treatment will affect the resident's health in the east. In addition, the quality and quantity of doctors will affect the health of residents in the central region. Besides, the quality of doctors will affect the health of residents in the west.

Keywords Doctor resources · Resident health · Doctor quality · Doctor prices · Patient flow

13.1 Introduction

The COVID-19 has brought a significant blow to the global economy, and it is urgent to solve public health problems. According to the United Nation's standards of population aging, China has entered an aging society at the end of the twentieth century, and the absolute number of the elderly population ranks first in the world

W. Cao
School of Economics and Management, Hunan Applied Technology University, Changde 415000, China

W. Peng (✉)
Institute of Population Development and Health Governance, Hangzhou Normal University, Hangzhou 311121, China
e-mail: pwb7129@hznu.edu.cn

A. Grover et al. (eds.), *Sustainable Health Through Food, Nutrition, and Lifestyle*, Advances in Geographical and Environmental Sciences,
https://doi.org/10.1007/978-981-19-7230-0_13

(Xie and Zhu 2020). China's demand for high-quality medical services is growing. However, the contradiction between supply and demand in the medical market is still very prominent due to the limitation of doctor's numbers and prices (AXQ et al. 2013). China's finance has given generous support to reform the medical and health system. To solve the long-term suppression of doctors' income, the government allows doctors to walk into the cave to obtain more additional payments (Yang 2006). In the six years from 2013 to 2018, China's medical costs almost doubled. The government has continuously increased medical insurance coverage and promoted medical services and the generalized system of preferences. But in 2016, The Lancet Researchers evaluated the progress of implementing the Sustainable Development Goals (SDG) health-related indicators, ranked the global health status, and proposed the "healthiest countries and regions." China ranks 92nd, why does China's medical financial expenditure continue to grow, but the doctor's resources are still not reasonable. Under the aging population background, how to allocate doctor's resources to improve resident's health levels?

By analyzing the impact of resource allocation of doctors in urban and rural areas on Residents' health, it is found that high-level education and more training opportunities can improve the supply of rural doctors on chronic diseases, thus improving the health level of rural residents (Li et al. 2015). After a new round of health system reform in 2009, government subsidies have become an essential source of income for rural doctors. The development of rural doctors also needs national financial compensation and the medical system (Hu et al. 2017). In addition, a doctor's salary is linked to the income of drugs prescribed, which leads to cooperation between doctors and drug suppliers, resulting in a sharp rise in the utilization rate of antibiotics in China, thus damaging health (Hsiao 2018). Although medical insurance has basically achieved universal coverage, the medical insurance reimbursement rate is very unfair, resulting in a large difference in the resident's medical costs (Hu et al. 2008).

In developing countries, the migration of doctor resources to developed countries has a significant inhibitory effect on people's health in developing countries (Hagopian et al. 2004). For example, in sub-Saharan Africa, the doctor's migration increased the mortality rate of adult AIDS by 20%. The increase in the AIDS mortality rate further strengthened the emigration of doctors in sub-Saharan Africa (Alok and Frédéric 2008). For developed countries, the flow of doctor resources is usually two way. In Germany, the decline in the number of doctors and doctor's retirement has reduced the doctor's resources, resulting in a shortage of medical resources. However, the foreign doctor's immigration has increased the German doctor's resources and made Germany more dependent on foreign doctors (Kopetsch 2009). The inflow of doctor resources increases the stock of doctors in the host country and reduces the stock of doctors abroad, which aggravates the imbalance of international doctor resource distribution and improves the health difference between countries.

In this paper, the Hotelling ring model is used to analyze the impact of doctor resource allocation on regional health differences and investigate the effect of doctor quality and price on Residents' health. The Hotelling model is usually used to analyze the relationship between quality and price and quality and competition (Siciliani and

Straume 2019). The model sets the doctor's utility function and introduces resident health function, which can explain the impact of doctor resource stock on Residents' health. This paper uses the 2018 CFPS database to measure resident's health and then analyzes the effect of doctor resource allocation on resident's health. It is found that the reason for the low health level of residents in China is that the distribution of doctor's resources is unreasonable, the number of doctors is too small, and the quality of doctors is low.

In the paper, the second part is the background and current situation; the third part is the model analysis; the fourth part is the empirical strategy; the fifth part is the data analysis; the sixth part is the result discussion; and the seventh part is the conclusion.

13.2 Background and Current Situation

13.2.1 Rural Doctors and Medical Security Development

The development of rural doctors in China can be divided into two stages. The first stage was from the 1960s to the 1970s to 2004. Under the planned economy system, the rural cooperative medical system and the barefoot doctor system were born in rural China. In 1975, there were 1.56 million "barefoot doctors" in China, with an average of 2.5 "barefoot doctors" for every 1000 rural residents. To standardize the construction of "barefoot doctors," China has implemented the regulations on rural doctor's management since January 1, 2004. The development of rural doctors has entered the second stage. The principles point out that rural doctors can only operate after training and professional examinations and obtaining licenses. So far, the rural areas of China have entered the development stage of the doctor system dominated by rural doctors. Before the reform and opening up in 1978, the rural cooperative medical system existed with cooperatives and people's communes, which solved people's medical treatment and enabled farmers to obtain affordable medical services. After the dissolution of cooperatives, barefoot doctors lost their direct source of income. After that, the state carried out market economic system reform, and medical services began to be priced through the market. Due to the strong monopoly of the pharmaceutical market and the weak state financial subsidies, China's medical prices rose rapidly from the 1990s to the beginning of the twenty-first century, making it more difficult for people to obtain medical services. Until 2003, the state launched the new rural cooperative medical system, trying to reduce the rural resident's pressure to seek medical treatment and reduce the medical service's price. Until 2020, the new rural cooperative medical system's coverage rate in China exceeded 95%, but the rural resident's medical service price is still very high.

13.2.2 Development of Urban Doctors in China

Western medicine has been introduced into China since 1840 and has experienced 280 years of development. Before the Republic of China, medical schools in China were generally undertaken by the church. After founding the people's Republic of China, there were 44 medical colleges in China (including three pharmacists), including 24 national, seven provincial, and 13 private. After 1952, the Ministry of Health merged and adjusted the institutions mentioned above, leaving 32 (including two pharmaceutical institutions) (Jin 1993). In 1989, 697,241 graduates were trained, 70 times more than before 1949. After decades of development, the quality of doctors in China has been significantly improved. Moreover, after 70 years of development, the number of doctors has increased significantly. In 2016, 63 kinds of master of medicine, 3202 masters of medicine programs, 64 types of doctor of treatment, and 1236 doctor of medicine programs. There are 270,173 undergraduate medical students, 425,334 specialist students, 298,242 adult undergraduate students, and 159,335 adult specialty students.

13.2.3 Current Situation of Doctor Resource Allocation

The regional disparity in urban and rural doctor's distribution in China's East, Central and West regions (Fig. 13.1) is found that the urban doctor resources in the eastern and central areas are on the rise, and the gap in the number of doctors is relatively stable. However, the Western region dropped sharply after reaching the eastern region's level from 2014 to 2017. Moreover, rural doctor's resources in the three regions are rising, but the rising speed is not fast. At the same time, the gap between the eastern and Western rural doctors is relatively stable. The number of medical practitioners in community health service institutions, township hospitals, village clinics (Fig. 13.2) among them, and the number of doctors in community health service institutions in the eastern region is larger than that in the central and Western areas. The gap between the three is widening. There was no significant difference in the number of medical practitioners between the township hospitals in the eastern and central regions. The Western region's number lags behind the central and Western regions, but its growth rate is faster than the central and east regions. The number of licensed doctors in village clinics in the central and east areas is similar, and there is no apparent gap between them; in contrast, the Western region lags behind the central and east areas, and the gap has not narrowed. To sum up, the number of grassroots doctors in the eastern part is higher than that in the east-central area. However, the number of village doctors in the central area is not significantly different from that in the eastern areas but higher than that in the Western region. The resource distribution of general practitioners and practitioners in China (Fig. 13.3) is found that the number of general practitioners is far less than that of medical practitioners. Moreover, the number of general practitioners in the eastern region is the largest,

and the gap between the eastern and central and Western regions is also widening. What is the impact of the unbalanced distribution of doctor resources on the health level of Chinese residents? How to promote the regional flow of doctor resources, improve the efficiency of doctor resource allocation?

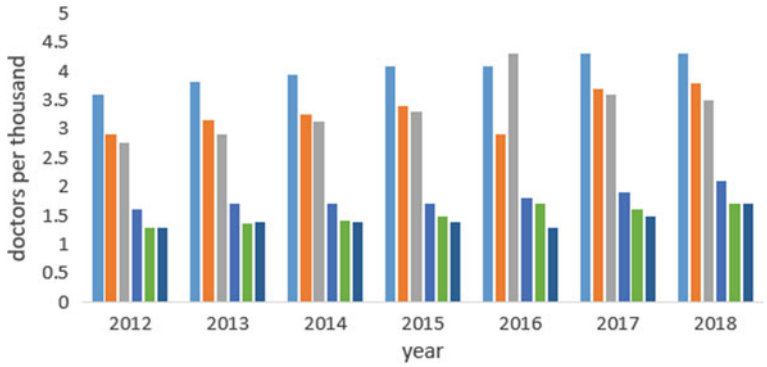


Fig. 13.1 Number of doctors per thousand people in urban and rural areas of eastern, western, and central regions: from left to right are eastern cities, central cities, western cities, eastern rural areas, central rural areas, and Western rural areas

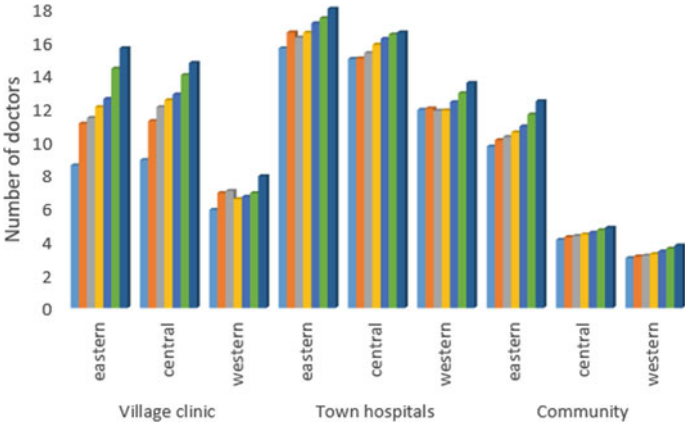


Fig. 13.2 Number of doctors in communities, urban hospitals, and village clinics in the eastern and western regions: from left to right is the number of doctors from 2012 to 2018

Fig. 13.3 Number of general practitioners and practitioner doctors per thousand people in the three regions of east, central and west: from left to right is general practitioners in the east, general practitioners in the middle, general practitioners in the west, practitioner doctors in the east, practitioner doctors in the middle, and practitioner doctors in the west

13.3 Model

13.3.1 Model Construction

This paper is based on the Pennerstorfer (2017) model. Although the Hotelling model has strong constraints, it can solve the difficulty of Hotelling's "corner solution" and allow doctors with equal spacing to obtain market equilibrium, eliminate technical problems, and make qualitative equilibrium analysis more simple (Steven 1979). Suppose that the spatial market is a circle with a circumference of 1, and N doctors are evenly distributed on the ring. The distance between each doctor is $1/n$. Each doctor is in offer q_i quality under price p_i of doctor services. Each patient only purchases one unit of medical services, evenly distributed in the density of L ring, its pursuit of utility maximization. The distance between the patient and the i-th doctor was D_i. The cost function is considered as a linear function, and U_i is the utility of the i-th patient.

$$U_i = v + b(q_i) + u(y) \tag{13.1}$$

$b_q > 0$, $b_{qq} > 0$ It means that the higher the doctor's quality, the better the effect on patients, Y is net income, $u_y > 0$, $u_{yy} < 0$ because income has money effect and time effect.

V is the net utility and $b(q_i)$ is the mass q_i. The effectiveness of the doctor's service to the patient (patient's health).

$$y = Y - p_i - t * d_i \tag{13.2}$$

Because patients are evenly distributed, the utility of choosing the i doctor is equal to that of selecting the i + th or i-th doctor. Suppose the patient's distance from the i-th doctor is d_i. Then the distance from the $i + 1$ $(i - 1)$ doctor to the adjacent doctor is $\frac{1}{n} - d_i$. Z the utility of the doctor $i + 1$ $(i - 1)$ on the left (right) of the patient going to the i-th doctor is equal to the utility of the doctor $i + 1$ $(i - 1)$.

$$v + b(q_i) + u(Y - p_i - t * d_{iz}) = v + b(q_{i+}) + u\left(Y - p_{i+1} - t * \left(\frac{1}{n} - d_{iz}\right)\right) \tag{13.3}$$

$$X_i(.) = L(d_{i-}, d_{i+}) \tag{13.4}$$

X_i is the demand function of doctors with quality q_i and price p_i.
Revenue function:

$$\pi_i = p_i * X_i(.) - C(X_i(.), q_i) \tag{13.5}$$

According to the consistency and symmetry as well as the first-order condition, the following results are obtained[1]:

$$p^* = \frac{t}{n} + C_X\left(\frac{L}{n}, q^*\right) \tag{13.6}$$

$$\left[p_i - C_X\left(\frac{L}{n}, q^*\right)\right] * \frac{Lb_q(q^*)}{t} - C_q\left(\frac{L}{n}, q^*\right) = 0 \tag{13.7}$$

From the above analysis, we can see that the service quality will affect the price, and the price and quantity are mutually affected. Moreover, increasing the cost of medical services will directly affect the price and service quality. Among them, $C_X > 0, C_{XX} > 0, C_q > 0, C_{qq} > 0$, C_{qX}, C_{Xq} is also more significant than 0, because the substitution effect between quantity and quality increases costs.

13.3.2 Impact of the Number of Doctors and Patients on Residents' Health

13.3.2.1 The Impact of the Number of Doctors on the Quality and Price of Doctors

$$\frac{\partial p^*}{\partial n} = \frac{-t}{n^2} - C_{XX}\left(\frac{L}{n}, q^*\right) * \frac{L}{n^2} + C_{Xq} * \frac{\partial q^*}{\partial n} \tag{13.8}$$

[1] Hypothesis $\frac{\mathrm{d}d_{iz+}}{\mathrm{d}p_i} + \frac{\mathrm{d}d_{iz-}}{\mathrm{d}p_i} = 1$.

The first is that the increase in doctor's number leads to fierce competition, making the price drop rapidly, that is $\frac{-t}{n^2}$. The second part is that the increase in the number of doctors leads to the change of marginal cost, and a part of the cost change will be passed on to consumers, namely C_{XX}, C_{Xq}. When the quality of medical service is sensitive to the number of doctors, and the cost function is more inclined to quality, the quality effect of the increase in the number of doctors will be greater than the effect of the decline in demand. It will make the price of medical services rise, lead to the problem of "difficult to see a doctor" and reduce the resident's health level. Or the effect of demand decline is greater than the effect of quality, which leads to a decrease in price and the improvement of resident's health.

$$\frac{\partial q^*}{\partial n} = \frac{L}{n^2} * \left[C_{XX} * \frac{L b_q(q^*)}{t} + C_{qX} \right] \tag{13.9}$$

In the above formula, on the one hand, increasing the number of doctors will increase the competition, thus forcing to improve the quality of doctors, $\frac{L}{n^2}$. On the other hand, the increase in the number of doctors will increase the marginal cost. Therefore, increasing the number of doctors will improve the quality of service because of the competition among doctors, to improve resident's health levels.

13.3.2.2 The Impact of Patient Turnover on Medical Quality and Price

$$\frac{\partial p^*}{\partial L} = C_{XX}\left(\frac{L}{n}, q^*\right) * \frac{1}{n} + C_{Xq} * \frac{\partial q^*}{\partial L} \tag{13.10}$$

In the above formula, if the number of patients is increased, on the one hand, the marginal cost of doctors will rise, which is C_{XX}. On the other hand, due to the increase in demand, the supply side usually increases the price C_{Xq}. Therefore, the increase in the number of patients will increase the medical price and reduce resident's health levels. This is one of the reasons why it is difficult to see a doctor in our country.

$$\frac{\partial q^*}{\partial L} = \frac{b_q(q^*)}{t} * \left[p_i - C_X\left(\frac{L}{n}, q^*\right) \right] - \frac{L b_q(q^*)}{t} * \frac{1}{n} * C_{XX} - \frac{1}{n} * C_{qX} \tag{13.11}$$

In the above formula, as the number of patients increases, the marginal cost rises, and the doctor's relative income will decrease $-C_{XX}$ and $-C_{qX}$; therefore, the quality of doctors' service has declined, resulting in the decline of Residents' health level. It reflects the problem of "difficult to see a doctor" in our country.

To sum up, the doctor's competition will force them to improve the service quality in regions with more doctor resources. Only when the quality effect is greater than the demand effect; will the doctor competition reduce service quality. However, in areas with more patients, the problem of "difficult to see a doctor" makes the doctor's price rise, the quality of doctor's service, and the resident's health decline.

13.3.3 Model Constraints

The above models have the following constraints:

First, doctors and patients are evenly distributed in a circle, which is not in line with reality. Medical practitioners are usually concentrated in urban centers, while general practitioners tend to be more evenly distributed, and rural doctors are usually concentrated in village clinics. Therefore, in the empirical analysis, we must analyze the impact of different doctors on Residents' health.

Second, the cost function of the number of doctors and the quality of doctors is inconsistent, and there is regional heterogeneity. Therefore, in the empirical analysis, we should analyze the regional heterogeneity.

13.4 Empirical Strategy

According to the theoretical model analysis, the number of doctors affects resident's health level through the influence of the doctor's medical price and quality. At the same time, the number of patients, that is, the patient's market size will also affect resident's health. Because the health indicators and individual characteristics of this paper use microdata, while the quality and number of doctors and transportation costs uses microdata, Therefore, the method of Zhang et al. (2019) is considered. Construct the following empirical model to test the impact of doctor resource allocation on Residents' health.

13.4.1 Impact of Regional Allocation of Doctor Resources on Residents' Health

$$H = \alpha_1 * n + \alpha_2 * p + \alpha_3 * q + \alpha_4 * t + \alpha_5 * L + \delta \tag{13.12}$$

n is the number of doctors' resources, p is the doctor's price, q is the quality of the doctor, t is the transportation cost, L is the number of patients, ε is the error term, and δ is the population characteristics, including the age and gender characteristics of the population. Then, according to China's national conditions, the region is divided into three areas, East, Central, West, and the impact of doctor resource allocation on Residents' health in each area.

13.4.2 The Impact of Doctor Resource Allocation on Residents' Health Under the Hierarchical Medical System

$$H = \alpha_1 * n_1 + \alpha_2 * n_2 + \alpha_3 * n_3 + \alpha_4 * n_4 + \alpha_5 * p + \alpha_6 * q + \alpha_7 * t + \alpha_8 * L + \delta \quad (13.13)$$

$$H_i = \alpha_1 * n_i + \alpha_5 * p + \alpha_6 * q + \alpha_7 * t + \alpha_8 * L + \varepsilon + \delta \quad (i = 1, 2, 3, 4) \quad (13.14)$$

The number of all levels of doctors and health were regressed together, and then the number of each level doctors was regressed separately. In Eqs. 13.13 and 13.14, n_1 is the number of doctors in the hospital, n_2 is the number of doctors in community health service center n_3 is the number of doctors in township hospitals n_4 is the number of doctors in village clinics. α_1 to α_4 are coefficients, the rest, the same as 13.

13.5 Data

13.5.1 Variables

13.5.1.1 Core Explained Variable

Health (H). According to the definition of health by the World Health Organization (WHO), this paper measures the resident's health from four aspects: physical health, mental health, social adaptation, and moral health. Physical health mainly includes exercise and BMI[2] the frequency of exercise measured physical exercise in a week. BMI = the absolute value of standard value—weight/height 2, in which the standard value is 22.5 for men, 20.5 for women, the unit of weight in kg, and the unit of height is meter. Mental health is measured by "satisfaction with their own life" and "confidence in their future." People with mental health are usually energetic and satisfied with their own life. Their future life is full of confidence; the index has "1–5" 5 levels; the higher the value, the more satisfied with their own life, the more confident. Good social adaptation includes the trust of neighbors and strangers. People who are well adapted to society will be full of trust in everything around them. The index has 11 grades of "0–10". The higher the value, the higher the trust. Moral health includes two indicators: whether they often feel lonely or not and whether they often feel depressed. According to the measurement, people with moral health will lead to tension and fear, and they usually feel lonely and depressed. In this indicator,

[2] Since other indicators are bigger and healthier, take the maximum value of this indicator and subtract the value of this indicator as to the final calculated value.

"4" means "less than 1 day," "3" means "1–2 days," "2" refers to "3–4 days," and "1" refers to "5–7 days".

In this paper, the indexes of this method are fixed, which is easy to compare and express. Among them, OA, OB, OC, OD, OE, OF, OG, and OH are health, BMI index, satisfaction with their own life, confidence in their future, trust in neighbors, trust in strangers, often feeling lonely and often depressed, and $\alpha = 360°/8 = 45°$. The calculation formula is as follows:

$$H = \frac{1}{2} * \sin 45° * (OA_1 * OB_1 + OB_1 * OC_1 + OC_1 * OD_1 + OD_1 * OE_1 + OE_1 * OF_1 + OF_1 * OG_1 + OG_1 * OH_1 + OH_1 * OA)_1 \quad (13.15)$$

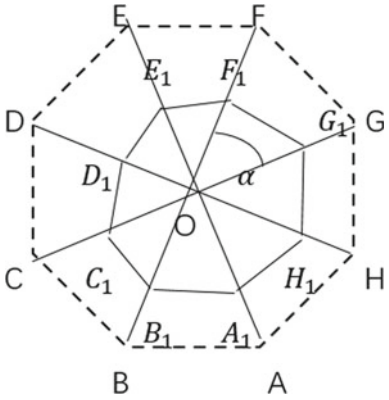


Figure 13.4 shows the Residents' health index of each province in 2018. It is found that Shanghai is the highest, while Hainan Province is the lowest. Among the three regions of East, Central, West, the central region is the highest, and the Western region is the lowest.

Doctor resources (n) (DR). It's measured by the number of doctors[3] (PDR) per thousand people in each province. The index is measured by the total number of doctors in each province/the number of permanent residents in the province, to eliminate the impact of population on the distribution of doctors. From the perspective of hierarchical medicine, the number of practitioners (HDR) and general practitioners[4] (GDR) should also be considered. The medical practitioners include hospital doctors, township hospital doctors, community health service station doctors, and village doctors. Hospital doctor resource (HDR) = hospital doctors/urban resident population, township hospital doctor resource (TDR) = township hospital doctor number/rural resident population, community health service station doctor resource

[3] Doctors include practicing doctors and assistant doctors, the same below.

[4] General practitioners include the number of doctors who have obtained general practitioner qualification certificates and registered as general practitioners.

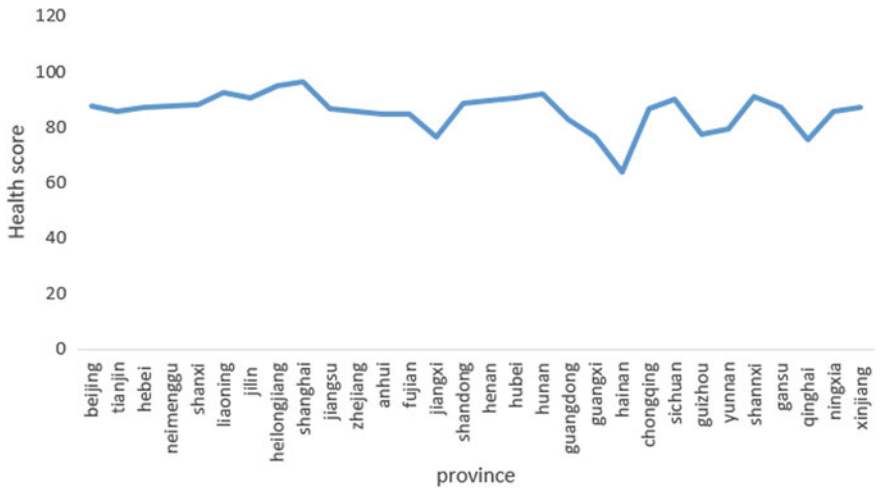


Fig. 13.4 Health index of residents in 30 provinces (except Tibet)

(CDR) = community health service station doctor number/urban resident population, village health office doctor resource (RDR) = village clinic doctor number/rural resident population. Although many village clinics and community health service station doctors are transforming to general practitioners in China, it is necessary to study the distribution of general practitioners alone because of the short development time of general practitioners and the imperfection of the general practitioner's system in China. General practitioner resources (GDR) = the number of general practitioners/the whole province's permanent population.

13.5.1.2 Control Variables

Transportation cost (T) (TC). It is measured by the number of railway and highway mileage per square kilometer. Doctor price (P) (OP), the price is measured by outpatient price. Generally, the higher the qualification and title of the doctor, the higher the outpatient price. The number of patients (L) (PN), the control variable is measured by the doctor's daily workload (diagnosis and treatment), which is a direct measure of the patient's number. Doctor quality (q) (DQ), the number of tertiary hospitals measured the control variables. In the hospital-grade evaluation system, the number of doctors with senior titles is an essential indicator of evaluation. Age (age), the control variables mainly come from the micro survey of the CFPS database. Gender characteristics (Gen), the control variables, expressed by "1" for men and "0" for women, were derived from the micro survey of the CFPS database.

13.5.2 Sample Selection

This paper's data are mainly from the 2017, 2018 China Statistical Yearbook, China Health Statistical Yearbook, and 2018 CFPS database. CFPS data, implemented by the China Social Survey Center of Peking University, reflects the changes in China's society, economy, population, education, and health. It collects sample data by tracking the status of individuals, families, and community residents. In this paper, samples of "unknown" or "not applicable"[5] were removed, and 20,006 samples from 30 provinces in China (except Tibet) in 2018 were selected.

13.5.3 Statistical Analysis

The statistical results of the data are in Table 13.1.

Table 13.1 Descriptive statistical results of variables

	Average	Maximum	Minimum	Standard deviation	Sample numbers
H	87.58355	674.0372	7.146914	1664.992	20,006
Sdr	2.555546	4.6	1.9	0.111578	20,006
Gdr	0.207555	0.593641	0.120912	0.007019	20,006
Hdr	0.014594	0.030310	0.010380	0.014737	20,006
Tdr	0.813994	1.460973	0.333333	0.032552	20,006
Cdr	0.24201	0.730811	0.102842	0.012674	20,006
Op	2.526671	5.448	1.878	0.309331	20,006
Tc	1.079536	2.15873	0.2787	0.116849	20,006
Pn	7.009988	14.4	4.2	6.037155	20,006
Dq	90.10547	190	13	2686.404	20,006
Age	45.15866	96	16	283.1645	20,006
Gen	0.472432	1	0	0.24924	20,006

[5] The "not applicable" sample of "out-of-pocket expenses for medical treatment" was also deleted.

13.6 Discussion

13.6.1 Impact of Medical Practitioner Resource Allocation on Residents' Health

The first column of Table 13.2 shows the results of ordinary least squares (OLS), which shows that doctor resources have a significant role in promoting Residents' health. The second column is the results of the two-stage least square method (2SLS). It shows that doctor resources have a significant role in promoting Residents' health. Still, its marginal value is more extensive than OLS, indicating that the doctor resource's impact on Residents' health is endogenous. The lag period of the number of doctors was used as the tool variable in the 2SLS regression. The results from the third to sixth columns in Table 13.2 show that rural doctor resources have a significant promotion effect on Residents' health. In contrast, urban doctor's resources have a significant inhibitory effect on Residents' health. After the 2SLS test, the regression results have no significant change, indicating that OLS has no endogenous problem. The growth of urban doctor resources will make Residents' health decline. From the perspective of control variables, the doctor price has a significant promoting effect on Residents' health, and the number of patients has a significant inhibitory effect on Residents' health. It shows that the main reason affecting the health of urban residents in China is that the number of patients is too large, and there are a large number of patients in urban areas, which makes it difficult for residents to see a doctor. For rural areas, the Residents' health index can be increased by 2.53587 units for each additional doctor per capita. Therefore, the transfer of urban doctors to rural areas will improve the efficiency of doctor resource allocation, reduce the urban resident's pressure, and improve the resident's health.

The results of OLS showed that doctor's resources had no significant impact on Residents' health, but 2SLS results showed that doctors' resources had an endogenous effect on Residents' health in the eastern region. After removing endogeneity, for every additional unit of doctors per capita in eastern China, the Residents' health index will increase by 10.6008 units. The doctor resources in Central China have a significant effect on promoting Residents' health, and there is no endogenous problem. The influence coefficient is 6.46256. The results of OLS showed that doctor's resources had a significant effect on Residents' health, but the effect was not significant after removing endogeneity. Therefore, the factor restricting the health of residents in the eastern and central regions is the shortage of doctors. In contrast, the number of doctors is not the main factor affecting the health of residents in the Western region.

Analyzing the impact of population characteristics on resident's health and finding that age has a significant role in promoting health (Tables 13.2 and 13.3), there is no endogenous problem. The older the age, the higher the level of health and the social pressure of the elderly is relatively small, and their mental health will be better; at the same time, the elderly have more time to exercise, and their physical quality will be higher. In gender characteristics, the number of women is higher,

Table 13.2 The impact of national doctor resource allocation and urban and rural doctor resource allocation on residents' health

	12 (ols) H (whole country)	12 (2sls) H (whole country)	12 (ols) H (urban)	12 (2sls) H (urban)	12 (ols) H (rural)	12 (2sls) H (rural)
	6.48103*** (1.14210)	13.17045*** (1.61240)	− 2.60136*** (0.29511)	− 3.05780*** (0.31583)	2.53587*** (0.24036)	2.45802*** (0.25365)
age	0.35015*** (0.01622)	0.35060*** (0.01623)	0.35977*** (0.01624)	0.36155*** (0.01624)	0.36418*** (0.01625)	0.36373*** (0.01625)
gen	− 24.6236*** (0.54396)	− 24.6125*** (0.54420)	− 24.5880*** (0.54337)	− 24.5796*** (0.54330)	− 24.5845*** (0.54291)	− 24.5861*** (0.54280)
tc	0.0573 (0.62673)	− 0.77787 (0.64885)	0.68840 (0.60429)	0.63220 (0.60437)	0.16070 (0.60803)	0.18674 (0.60852)
op	− 0.29039 (0.76256)	− 2.61052*** (0.89288)	1.97944*** (0.60460)	1.91398*** (0.60474)	0.03297 (0.64147)	0.10419 (0.64563)
pn	− 0.04901 (0.14082)	− 0.12707 (0.14521)	− 0.30308** (0.13629)	− 0.31247** (0.13629)	− 0.33633** (0.13629)	− 0.33367** (0.13629)
dq	− 0.00748 (0.00541)	− 0.00721 (0.00542)	− 0.00740 (0.00541)	− 0.00734 (0.00541)	− 0.00216 (0.00543)	− 0.00234 (1.47501)
cons	67.48055*** (2.34057)	58.41974*** (2.9607)	81.2299*** (1.52193)	81.83129*** (1.52894)	78.98414*** (0.13932)	76.59186*** (1.47519)
R^2	0.1147	0.1136	0.1167	0.1166	0.1180	0.1182
P value of LM test		0.0000		0.0000		0.0000

Note ***means significant at the 1% level; **indicates significant at the 5% level; and *indicates significant at the 10% level. The standard error is in brackets

and the resident's health level is higher. Among other control variables, the medical price has an inhibitory effect on the resident's health in eastern China. "Expensive medical service" is a factor affecting the health of residents in the eastern region; the quality of doctors in the central region has a significant role in promoting the health of residents in the central region, indicating that the quality of doctors is a factor affecting the health of residents in the central region; the traffic in the Western region has a restraining effect on Residents' health, which indicates that the spillover effect of traffic improvement on doctor resources in the Western region is less than the inhibitory effect of traffic improvement on pollution. Moreover, the rise of medical prices in the Western region will promote the resident's health, which indicates that environmental factors and the quality of doctors are the factors affecting the health of residents in the Western region.

Table 13.3 Impact of regional allocation of national doctor resources on residents' health

	12 (ols) H (east)	12 (2sls) H (east)	12 (ols) H (central)	12 (2sls) H (central)	12 (ols) H (west)	12 (2sls) H (west)
hdr	0.38459 (1.7773)	10.6008*** (2.86832)	6.46256** (2.63468)	6.86944** (3.11919)	19.67393** (9.24421)	− 18.88488 (26.2968)
age	0.38694*** (0.02619)	0.39852*** (0.02636)	0.40984*** (0.03077)	0.40976*** (0.03075)	0.22438*** (0.02796)	0.23036*** (0.02824)
gen	− 24.3521*** (0.88589)	− 24.4056*** (0.88740)	− 24.5218*** (1.02786)	− 24.5193*** (1.02718)	− 24.8562*** (0.92278)	− 24.9199*** (0.92434)
tc	2.65445* (1.45044)	0.02628 (1.56375)	0.61084 (2.28482)	0.53151 (2.30636)	− 11.6966** (5.86193)	− 28.68728*** (13.31)
op	2.31066* (1.29266)	− 2.07883*** (1.61560)	1.38234 (2.55755)	1.42137 (2.56077)	9.51677 (8.92056)	38.57472* (20.54914)
pn	− 0.26857 (0.22131)	0.31182 (0.25586)	− 1.67361 (1.19628)	− 1.56414 (1.27728)	− 0.84032 (1.54995)	− 6.19965* (3.74954)
dq	− 0.02845*** (0.00970)	− 0.01568 (0.01012)	0.19033*** (0.04477)	0.18825*** (0.04555)	− 0.02000 (0.18301)	− 0.02908 (0.01920)
cons	74.99183*** (4.83189)	56.04443*** (6.38196)	55.45255*** (13.73515)	54.00169*** (14.9647)	34.28489 (20.88965)	107.3407** (51.0137)
R^2	0.1197	0.1160	0.1219	0.1218	0.1146	0.1123
P value of LM test		0.0000		0.0000		0.0000

Note ***means significant at the 1% level; **indicates significant at the 5% level; and *indicates significant at the 10% level. The standard error is in brackets

13.6.2 Impact of General Practitioner Resource Allocation on Residents' Health

General practitioners are the main force of necessary medical treatment and disease prevention. In the first column of Table 13.4, it is found that increasing the number of general practitioners at the national level can significantly improve the health level of residents, and the second column still has a significant promoting effect after removing endogeneity. The third and fourth columns show that the number of general practitioners in the eastern region has no significant effect on resident's health. The possible reason is that the quality of general practitioners and specialists in the eastern region is relatively high. In contrast, the conversion of specialists to general practitioners will not significantly impact the resident's health. The first and second columns of Table 13.5 show that after the endogeneity test, general practitioner's resources in Central China have a significant role in promoting resident's health. The

Table 13.4 Impact of per capita resource allocation of general practitioners on residents' health in china and eastern regions

	12 (ols) H (whole country)	12 (2sls) H (whole country)	12 (ols) H (east)	12 (2sls) H (east)
gdr	9.00617** (4.50381)	13.8375** (5.61027)	2.70758 (5.16115)	5.92662 (6.40037)
age	0.35007*** (0.01623)	0.35025*** (0.01623)	0.38695*** (0.02613)	0.38748*** (0.02612)
gen	− 24.6361*** (0.54434)	− 24.6361*** (0.54424)	− 24.3516*** (0.88583)	− 24.3534*** (0.88540)
tc	0.75441 (0.61754)	0.64624 (0.62462)	2.74326** (1.37660)	2.73122** (1.37600)
op	2.21088*** (0.60837)	2.15062*** (0.61053)	2.38432** (1.05748)	2.27544** (1.06470)
pn	− 0.40970*** (0.15817)	− 0.47782 (0.16896)	− 0.38308 (0.21689)	− 0.39476* (0.22681)
dq	− 0.00815 (0.00542)	− 0.00831 (0.00542)	− 0.02949*** (0.00950)	− 0.03016*** (0.00953)
cons	77.70005*** (1.47501)	75.65665*** (1.47523)	75.73056** (3.53324)	75.76081*** (3.53169)
R^2	0.1135	0.1134	0.1198	0.1197
P value of LM test		0.0000		0.0000

Note ***means significant at the 1% level; **indicates significant at the 5% level; and *indicates significant at the 10% level. The standard error is in brackets

third and fourth columns show that the general practitioners in the Western region have no significant inhibitory effect on Residents' health.

13.6.3 Impact of Resource Allocation of Hierarchical Doctors on Residents' Health

Under the social background of urban–rural dual differentiation in China, the resource allocation of hierarchical doctors has a significant impact on Chinese resident's health. The impact of doctor's resource allocation at all levels on Residents' health under the hierarchical medical system (Tables 13.6 and 13.7). The first column of Table 13.6 shows that the number of doctors in township hospitals has no significant inhibitory effect on Residents' health. In contrast, doctors at other levels have a significant promoting effect. The second and third columns show that the number of hospital doctors greatly impacts resident's health. For every increase in the number of hospital doctors per capita, the Residents' health index will increase by 527.2778. The first column of Table 13.7 shows that the number of doctors in township hospitals has no significant effect on Residents' health. In contrast, the second column shows

Table 13.5 Impact of per capita resource allocation of general practitioners on residents' health in central and west regions

	12 (ols) H (central)	12 (2sls) H (central)	12 (ols) H (west)	12 (2sls) H (west)
gdr	126.7633*** (32.1469)	107.2048** (39.51114)	− 6.34531 (27.04913)	− 41.17386 (28.73407)
age	0.40828*** (0.03074)	0.40872*** (0.03073)	0.22764*** (0.92297)	0.22873*** (0.02794)
gen	− 24.4570*** (1.02720)	− 24.4731*** (1.02668)	− 24.8887*** (0.92297)	− 24.8881*** (0.92252)
tc	1.47193 (2.22676)	1.53344 (2.22642)	− 20.54112*** (4.27794)	− 21.40733*** (4.28374)
op	10.61618*** (3.56520)	9.09583** (3.98629)	24.55048*** (5.64303)	25.51938*** (5.64782)
pn	− 3.94500*** (0.97241)	− 3.86274 (0.97655)	− 3.68539*** (0.9787)	− 4.26118*** (0.99211)
dq	0.24896*** (0.04315)	0.24501*** (0.04337)	− 0.02530 (0.01839)	− 0.02892 (0.01841)
cons	34.18824** (15.04963)	41.02377*** (17.05321)	73.1501*** (13.1282)	81.41651*** (13.32361)
R^2	0.1233	0.1233	0.114	0.1138
P value of LM test		0.0000		0.0000

Note ***means significant at the 1% level; **indicates significant at the 5% level; and *indicates significant at the 10% level. The standard error is in brackets

that the number of doctors in township hospitals has a significant effect on Residents' health after removing the endogeneity of 2SLS, indicating that the number of doctors in township hospitals has an endogenous effect on Residents' health.

13.7 Conclusion

There is a big gap in the regional allocation of doctor resources in China. The theoretical model finds that the allocation of doctor resources affects the quality of doctors and the price of medical treatment. In addition, the difference in the number of doctors will affect the flow of patients, thus affecting the health of residents. The empirical study finds that the reasons for the low health level of Chinese residents are the unbalanced regional allocation of doctor resources, the small number of doctors, and the low quality of doctors. From the perspective of urban and rural dualistic analysis, the increase in the number of urban doctors crowding out the resources of rural doctors, which is not conducive to the improvement of the overall health level. The number of patients, the number of doctors, and the price of medical treatment will affect the health of residents in the eastern region, the quality and quantity of doctors

Table 13.6 Impact of doctor resource allocation on Residents' health under hierarchical medical care

	14 H	15 (ols) H_1	15 (2sls) H_2	15 (ols) H_3	15 (2sls) H_4
htr	527.2778** (254.7634)	1139.852*** (176.8316)	1139.852*** (176.8316)		
tdr	− 1.83749 (2.23181)				
cdr	14.31544* (7.36443)			32.92475*** (5.03107)	32.92475*** (5.03107)
rdr	6.31369*** (1.64837)				
age	0.34566*** (0.01623)	0.34935*** (0.01621)	0.34935*** (0.01621)	0.34691*** (0.01621)	0.34691*** (0.01621)
ger	− 24.5948*** (0.54367)	− 24.6134*** (0.54308)	− 24.6134*** (0.54308)	− 24.6478*** (0.54364)	− 24.6478*** (0.54364)
tc	− 1.29160* (0.75697)	0.07148 (0.62026)	0.07148 (0.62026)	0.44152 (0.60824)	0.44152 (0.60824)
op	− 0.56783 (0.91454)	− 1.73213** (0.87509)	− 1.73213** (0.87509)	− 0.77117 (0.73881)	− 0.77117 (0.73881)
pn	− 0.26488 (0.28592)	0.10088 (0.14669)	0.10088 (0.14669)	− 1.20367*** (0.18833)	− 1.20367*** (0.18833)
dq	0.00941 (0.00736)	− 0.00255 (0.00547)	− 0.00255 (0.00547)	0.01375** (0.00616)	0.01375** (0.00616)
Cons	72.46718*** (3.53822)	69.57459*** (1.94860)	69.57459*** (1.94860)	82.25944*** (1.59113)	82.25944*** (1.59113)
R^2	0.1163	0.1152	0.1152	0.1154	0.1154
P value of LM test			0.0000		0.0000

Note ***means significant at the 1% level; **indicates significant at the 5% level; and *indicates significant at the 10% level. The standard error is in brackets

will affect the health of residents in the central region, and the quality of doctors will affect the health of residents in the Western region. By analyzing the allocation of doctor resources in the medical system, it is found that the increase in the number of doctors in hospitals has the greatest impact on resident's health. At the same time, increasing the number of doctors in primary hospitals will also improve the health level of residents. Therefore, adjusting the allocation of doctor resources in the three major regions and urban and rural areas can improve the marginal effect of doctor resources and improve the health status of residents.

Table 13.7 Impact of the allocation of doctors' resources in township hospitals and village clinics on the health of residents

	15 (ols) H_1	15 (2sls) H_2	15 (ols) H_3	15 (2sls) H_4
tdr	1.97786 (1.88098)	7.79521*** (2.01415)		
rdr			8.66182*** (1.34227)	10.07901*** (1.3793)
age	0.34980*** (0.01623)	0.35028*** (0.01623)	0.34584*** (0.01623)	0.34522*** (0.01622)
ger	− 24.6456*** (0.54445)	− 24.6734*** (0.54449)	− 24.6036*** (0.54385)	− 24.5982*** (0.54376)
tc	0.73549 (0.62169)	− 0.06802 (0.66533)	− 1.60662** (0.72716)	− 2.03452** (0.73336)
op	2.50619*** (0.62169)	2.95801*** (0.62422)	2.79817*** (0.6076)	2.87107*** (0.60772)
pn	− 0.27936** (0.13933)	− 0.36696*** (0.13975)	− 0.02331 (0.14072)	0.01371 (0.14094)
dq	− 0.01018* (0.00588)	− 0.01723*** (0.00594)	− 0.00205 (0.00548)	− 0.00111 (0.00549)
Cons	76.52017*** (1.91299)	72.74985*** (1.96916)	71.71537*** (1.74889)	70.71951*** (1.76285)
R^2	0.1133	0.1129	0.1151	0.1151
P value of LM test		0.0000		0.0000

Note ***means significant at the 1% level; **indicates significant at the 5% level; and *indicates significant at the 10% level. The standard error is in brackets

Acknowledgments Qu acknowledges funding from the Zhejiang soft science research program (project on. 2020C35G2150457).

References

Alok B, Frédéric D (2008) HIV pandemic, medical brain drain, and economic development in sub-Saharan Africa. World Bank Econ Rev 2:2

AXQ, Bll, CCRH, (2013) Too few doctors or too low wages? labor supply of health care professionals in China. China Econ Rev 24(1):150–164

Hagopian A, Thompson MJ, Fordyce M, Johnson KE, Hart LG (2004) The migration of physicians from sub-Saharan Africa to the United States of America: measures of the African brain drain. Hum Resour Health 2(1):1–10

Hsiao YWC (2018) The Chinese health system at a crossroads. Health Aff 27(2):460–468

Hu S, Tang S, Liu Y, Zhao Y, Escobar ML, De FD (2008) Reform of how health care is paid for in China: challenges and opportunities. Lancet 372(9652):1846–1853

Hu D, Zhu W, Fu Y, Zhang M, Zhao Y, Hanson K et al (2017) Development of village doctors in China: financial compensation and health system support. Int J Equity Health 16(1):9

Kopetsch T (2009) The migration of doctors to and from Germany. J Public Health 17(1):33–39
Li T, Lei T, Xie Z et al (2015) Determinants of basic public health services provision by village doctors in China: using non-communicable diseases management as an example. BMC Health Serv Res 16(1):42
Pennerstorfer D (2017) Can competition keep the restrooms clean? Price, quality and spatial competition. Regional science and urban economics
Siciliani L, Straume OR (2019) Competition and equity in health care markets. J Health Econ 64:1–14
Steven CS (1979) Monopolistic competition with outside goods. Bell J Econ 141–156
Xie X, Zhu X (2020) Aging population, technological innovation and economic growth. China Soft Sci (06):42–53+76
Yang J (2006) Wage reforms, fiscal policies and their impact on doctors' clinical behaviour in China's public health sector. Policy Soc
Zhang X, Wan G, Zhang J, He Z (2019) Digital economy, inclusive finance and inclusive growth. Econ Res 54(08):71–86

Chapter 14
The Role of Urban Gardening in Global Cities: Three Case Studies in Berlin, Rome and Tokyo

Mariko Ikeda, Yui Akiyama, and Sandro Wiesenberg

Abstract In recent years, there has been a growing awareness in cities of the importance of a healthy lifestyle through food. In Tokyo, urban gardening using the rooftops of live venues and other buildings has emerged in the city center, and new public spaces have been established. In Berlin and Rome, many urban gardens have been established in the 2010s as a temporary use of vacant and unused land, and a new food space has been formed in a way that is related to the urban lifestyle. These new urban gardening projects are managed from the bottom up, and they have the potential to become an effective tool for shaping lifestyle and food spaces in cities. This study reconsiders the role of "new urban gardening", which has gained prominence in the wake of COVID-19. For this purpose, this paper gives a brief historical overview of urban gardening in Germany, Italy and Japan and then describes three case studies of new urban gardens in Berlin (Prinzessinnengarten), Rome (Hortus Urbis) and Tokyo (Jūsangatsu Farm). The paper concludes that the role of urban gardens in global cities around the world as public spaces for citizens' well-being, for food production, as meeting places and as places of learning has become more pronounced in recent years and even more so during the corona pandemic.

Keywords Urban gardening · Public space · Bottom up · Health · Urban lifestyle · Rooftop

M. Ikeda (✉)
Faculty of Art and Design, University of Tsukuba, Tennoudai 1-1-1, Tsukuba, Ibaraki, Japan
e-mail: ikeda.mariko.gt@u.tsukuba.ac.jp

Y. Akiyama
Graduate School of Comprehensive Human Sciences, University of Tsukuba, Tennoudai 1-1-1, Tsukuba, Ibaraki, Japan

S. Wiesenberg
Faculty of Management and Information Sciences, Tsukuba Gakuin University, Azuma 3-1, Tsukuba, Ibaraki, Japan

A. Grover et al. (eds.), *Sustainable Health Through Food, Nutrition, and Lifestyle*,
Advances in Geographical and Environmental Sciences,
https://doi.org/10.1007/978-981-19-7230-0_14

14.1 The Reevaluation of Urban Public Spaces and the Growing Interest in Food

Since the 2010s, a new public-participatory governance and its potentials in urban areas have been explored, as exemplified by the 2030 Agenda for Sustainable Development adopted at the UN Summit in 2015. Furthermore, the New Urban Agenda was endorsed by the UN General Assembly in 2016, declaring a well-planned and well-managed urbanization as a powerful tool for sustainable development for both developing and developed countries (United Nations 2017). This agenda has called for a reassessment of public space as necessary to form healthy cities (Mehaffy et al 2019). Furthermore, UN-Habitat's Global Public Space Toolkit (UN-Habitat 2015) stresses that public space has not been given sufficient attention despite its importance in promoting sustainable urban development. And there is also the potential of public space as a driving force for urban renewal of informal urban areas in developing countries (Ono 2020).

However, the importance of these public spaces has been sought mainly from the perspective of sustainability or disaster resilience of urban areas, and the perspectives connected to culture, neighborhood community building, education and food in urban society have not yet been evaluated sufficiently. Furthermore, modern urban planning, which emerged at the end of the nineteenth century, has regarded urban land use as different from agricultural use, and food was often not addressed as an urban issue (Honzawa and Dohi 2018). Only in recent years, cities have been considered as playing a strategic role in developing sustainable food systems and promoting healthy diets by the Milan Urban Food Policy Pact (2015) as well as the New Urban Agenda. Especially, smallholder food producers are seen as important for feeding cities in a sustainable way. Recent research underlines the importance of urban agriculture and suggests that besides its environmental benefits, it could produce as much as 10% of the global output of pulses, root crops, tubers and vegetable crops (Clinton et al. 2018).

On the other hand, the COVID-19 pandemic with its lockdowns has led to a renewed interest of citizens in urban gardening and urban farming in many cities. People are appreciating gardening not only as a way to grow their own food in close proximity (Chandran 2020; Cherry 2021) but also as a way to improve their general well-being (Inoue 2021). Several studies show the positive effects of urban green spaces and urban gardening to health and well-being, such as providing a stress-relieving refuge, contributing to a healthier lifestyle and creating social opportunities (Genter et al. 2015; WHO Regional Office for Europe 2016; Soga et al 2017).

Furthermore, during the pandemic, there has been a growing awareness of health through food, which is particularly evident in large cities. For example, in Berlin, the use of restaurants and cultural activities was severely restricted or not allowed at all, while gardening activities were still possible with some limitations (Koll 2020). Therefore, in Germany, urban gardens continued to be used by city dwellers to relax and to grow their own food during the pandemic. However, in Italy, where the number of people doing home gardening increased under the lockdown, parks and

public gardens were closed during the worst coronavirus outbreak (Reuters 2020). In Japan, sales of gardening-related products at home centers nationwide rose by 20% in 2020 compared with the same month in 2019, and in particular, sales of materials to start gardening increased markedly in 2020 (METI 2020). In addition, rooftops of live music venues and other spaces began to be used for gardening in a bottom-up manner (Hiratsuka 2020), creating a new kind of public space.

In Berlin and Rome, new urban gardens were established in the last two decades, often as temporary uses of vacant and unused land, creating new "food spaces" related to modern health-conscious urban lifestyles. A common feature of these new citizen farms is that they are created and operated in a grassroots manner, and despite the differences in the legal systems surrounding land in each country and the difference between unused vacant land (Berlin and Rome) and rooftops (Tokyo), they have the potential to become an effective tool for shaping food and lifestyle spaces in cities. However, academic research on this topic is still scarce.

In light of the above, the purpose of this study is to analyze the role of new citizen farms for a sustainable food production and a healthy lifestyle in global cities, where the importance of such spaces has begun to be reevaluated in the wake of COVID-19. For this aim, we will briefly summarize the historical development and the institutional changes of traditional citizen farms (allotment gardens) in Germany, Italy and Japan and then describe the new systems of citizen farms in Berlin, Rome and Tokyo and their backgrounds based mainly on document analyzes and to a smaller extent on interviews with the operators.

14.2 Allotment Gardens in Germany

The first allotment gardens (*Kleingarten*) in Germany were established at the beginning of the nineteenth century in the northern parts of the country to give the population the opportunity to grow their own fruits and vegetables. The establishment of gardens had become necessary due to a significant increase in population as well as poverty and was initiated by regional sovereigns and later adopted by churches, factory owners and city administrations (SenStadt 2012). Furthermore, in the 1860s, a movement was initiated to provide spaces for children to play in a healthy environment which had become rare in the increasingly industrialized cities of the nineteenth century. Since allotment gardens (*Kleingarten*) were perceived as having great sociopolitical importance and as being important factors in urban planning, they were put under legal protection and regulation in the Kleingarten Act of 1919 which designated allotment gardens as permanent green spaces (SenStadt 2012).

A similar system of allotment gardens can be found in England where the loaning of farmland by churches and other organizations began in the middle of the nineteenth century out of a desperate need for food self-sufficiency leading to the establishment of a legal system with the 1908 Small Holdings and Allotment Act (Nilsen 2014). In both countries, the development of urban gardens was triggered by the demand for food self-sufficiency and as a refuge from overcrowded cities with polluted air.

Urban planners often regarded such gardens as a way to insert "lungs" into a city (Ibid).

After World War II, allotment gardens became important as temporary living spaces and food suppliers for German city dwellers whose houses were damaged or destroyed by the ravages of war. Later, the gardens were mainly used for recreation, but the function of citizen's farms as public green spaces for city residents was widely recognized, and they were included in policies regarding well-being and city planning. Today, Germany has a total number of 891,000 *Kleingarten* spaces, occupying an area of 44,000 ha, to a large extent located in cities in the eastern part of the country (BDG 2021).

Case study 1: Prinzessinnengarten (Berlin)

As of 2012, there were 73,600 allotment gardens in 926 designated areas throughout the city of Berlin occupying an area of more than 3000 ha or 3.5% of Berlin's total area (SenStadt 2012). Despite the large number of allotment gardens, the demand for urban gardens is greater than the supply, and all allotment gardens have a waiting list for newcomers. Therefore, following earlier developments in cities such as New York City, urban gardens outside the allotment garden system have been established in Berlin mainly since the 2000s, and today, there are around 200 community gardens, which consist of intercultural gardens and neighborhood gardens spread all over the city (Berlin Online ND).

One of the most prominent of Berlin's community gardens is the Prinzessinnengarten which was founded in 2009 at Moritzplatz in the Kreuzberg district on a city-owned brownfield site in the middle of Berlin. This community garden with an area of almost 6000 m^2 not only contains countless raised beds but also open workshops, bee colonies, a garden café, a learning kitchen for processing local harvests and space for markets and networking meetings for people interested in topics of participatory and sustainable urban design (Fig. 14.1). The Prinzessinnengarten was conceived from the beginning as a mobile urban garden by Nomadisch Grün, the operating organization founded by Marco Clausen and Robert Shaw.

Clausen (2015), one of the founders of Prinzessinnengarten, explained the role of this urban garden by noting that "this new garden movement works on the ground to address issues such as biodiversity, healthy eating, recycling, environmental justice, climate change and food sovereignty". Furthermore, these issues were not only brought to the foreground by planting vegetables, but also by teaching this way of gardening to a younger generation. After establishing the Prinzessinnengarten, its founders went on to share their experiences in speeches and publications as well as through advising other institutions, especially schools, in creating their own urban gardens. Kitzinski (2015), who has conducted several interviews with the founders and other participants, concludes that the Prinzessinnengarten regards itself mainly as an educational institution to promote sustainable projects beyond its own space.

However, despite the success of Prinzessinnengarten with the local community, maintaining the urban garden was not always an easy task. The city administration was holding on to its original plans to sell the property to a private investor,

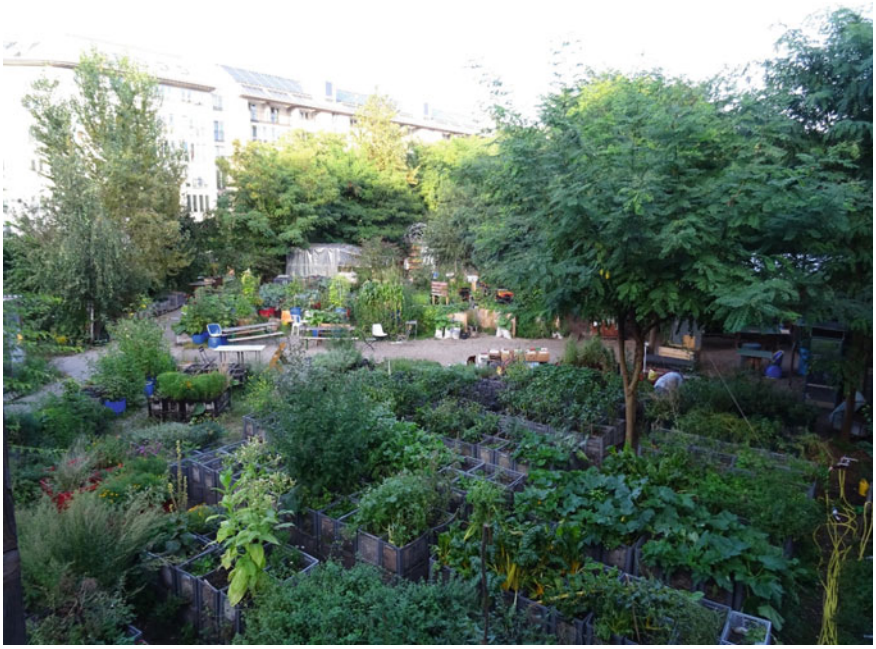


Fig. 14.1 Prinzessinnengarten in Kreuzberg, Berlin (Photo by author, September 2017)

and only through a petition with more than 30,000 signatures, the sale of the property was prevented in December 2012. The property was then transferred to the district administration, and the community garden was able to continue its operations (Prinzessinnengarten ND).

In December 2019, the lease agreement ended, and the operators (Nomadisch Grün) had already decided in 2018 to move to a new space on an unused area of a cemetery in the district of Neukölln, located close to the Tempelhof Airfield. However, the non-profit organization, Common Grounds, which had emerged from activities connected to the petition in 2012, was eager to continue using the Kreuzberg-site as an urban garden, but funding of 100,000 Euro was necessary for a new lease contract. The district administration supported the organization's efforts by making an application for funding to the city administration which made a positive decision only at the last moment. For the first time since its establishment, the Prinzessinnengarten had secured official funding by the administration (Clausen 2019).

While new operators continue Prinzessinnengarten at its original location in the middle of the city, the operators of Nomadisch Grün have moved their activities to a new location in Neukölln after 10 years in Kreuzberg. This new site is very large with its 7.5 ha, and the community garden is located in the middle of a natural space that has grown for 100 years. Aptly described in the title of a paper by Wendler (2018), the original founders of Prinzessinnen garten stay true to their original intentions as

a space for "grassroots experimentation, alternative learning and innovation" at their new site. Education plays an important role via open workshops for teachers and other educators "to share knowledge and practices about sustainable food production, soil management, material use, waste management and biodiversity" (Koehorst 2021).

Citizen farms in Japan

The first allotment gardens, or citizen farms (*shimin nōen* in Japanese), in Japan were established in 1924 in the city of Kyoto and then spread to bigger cities such as Osaka and Tokyo (Association for Japan Allotment Garden ND). According to Higuchi (1999), the idea to establish urban gardens in Japan was influenced by Germany's *Kleingarten,* but in practice, they were modeled after the English allotment gardens, emphasizing food production over leisure. However, in the years during and right after the war, the allotment gardens gradually disappeared. Moreover, in 1952, the Farmland Law was enacted which prohibited the ownership and use of agricultural land by non-farmers. In the 1960s, as urbanization rapidly progressed, the need for vegetable gardens increased among urban residents, while at the same time, the area of underused farmland grew. However, due to the lack of a legal framework, allotment gardens could not be established on this fallow land (Higuchi 1999).

Despite this legal issue, farmers and citizens in urban areas began to cooperate and establish allotment gardens in the 1970s. For this purpose, the Chigusadai Gardening Circle was founded in 1973, and an admission fee system was introduced. In this system, a farmland owner established an allotment garden, and the users of the allotment garden paid an admission fee to the owner. This system did not violate the Farmland Law, and the number of allotment gardens increased in the following years (Association for Japan Allotment Garden ND).

In 1989, the Association for Japan Allotment Garden established the Japanese Kleingarten Research Association, modeling its allotment gardens after the German *Kleingarten.* In the same year, the Ministry of Agriculture, Forestry and Fisheries enacted the Special Exemption Law of the Farmland Law and in 1990, the "Law to promote the Development of Citizen's Farms" which made it possible to lend farmland, exempt taxes and set up facilities on farmland in urbanized areas (Association for Japan Allotment Garden ND; Higuchi 1999).

Until the year 2010, the number of allotment gardens grew constantly and has been relatively stable since then. According to the Ministry of Agriculture, Forestry and Fisheries, as of March 31, 2020, there were 4169 citizen farms in total with 185,000 plots nationwide, occupying an area of 1296 ha (MAFF 2020). About half of the plots (96,518) are concentrated in the Kanto region, the heavily urbanized area of Tokyo and its surroundings. Compared to Germany, the total area of allotment gardens in Japan is less than half of Berlin's 3000 ha of allotment gardens alone.

As a result of legal regulations, a high concentration of the population, space restrictions and high land prices urban gardening is less common in Japanese cities compared to Germany. However, the demand for urban gardens is much greater than the supply so new types of citizen farms have been established in recent years that try to meet the demand of modern city dwellers. For example, the Tamazutsumi Experience Farm, a rental farm in the Setagaya Ward in Tokyo, has started experimental

use of urban farmland in some areas and has increased the number of its rentable plots (10 m^2 for 100,000 Yen per year) by 8 plots in 2021, bringing the total to 35 plots (Nippon News Network 2021).

Case study 2: Jūsangatsu Farm (Tokyo)

If we take the city center of Tokyo as an example, we can see that, except for parks and temples and shrines, the area of green space and vacant lots is limited. The number of allotment gardens in Tokyo is small compared to the number of them that have developed since the twentieth century in European capital cities such as Berlin or London.

The interest of residents in the Tokyo metropolitan area in agriculture is evident in the expansion of the market for materials needed to establish balcony farms and in the media exposure (Furusho 2020). In addition, as an extension of home vegetable gardens, the use of balconies as vegetable gardens has spread rapidly during the pandemic. In Tokyo, green spaces of various scales, from private balcony farms to more open gardens on urban farmland, have been customized and spread in a way to suit different lifestyles.

In recent years, rooftop gardens have become a common feature of new large-scale commercial constructions in Tokyo due to legal requirements by the city administration to compensate for lost soil surface. However, several smaller locations have established private or public gardens on rooftops for different reasons. For example, there is the mixed-use building GYRE in Tokyo's Shibuya Ward with a grocery store which uses the rooftop for growing organic food and for producing seeds which are sold in the shop. Close by there is a hair salon which has started to use the rooftop more than 10 years ago to grow vegetables which are then used to cook meals for the staff.

In 2020, during the state of emergency due to the new coronavirus, a group of people started an urban farm on the roof of the LIQUIDROOM, a live music venue in the middle of Tokyo. Like in most countries during that time, music clubs were not allowed hold concerts or other events. The project was initiated by the members and friends of the record label Jūsangetsu, which is managed by the musicians of the band GEZAN. Already since 2014, the same group has been organizing the pay-what-you-can "All Senses Festival", and in 2019, they started serving visitors meals made with vegetables donated by farmers. Through these practices, GEZAN and Jūsangetsu were trying to reconsider the "values" surrounding food and music (Hiratsuka 2020).

According to the organizer, the music festival aims to bring the food producers together with the people who are eating these foods, wishing that the experience of eating and the experience of the live performance would change for the people. The idea behind this is to rethink the act of "eating" rather than just mechanically pouring food into one's stomach. The festival is based on this idea and has generated sympathy among many farmers. Some of them donated as much as 1200 kg of rice (Hiratsuka 2020).

Furthermore, the organizer compares this system to recent developments in music distribution where on Websites such as Bandcamp, the consumers (listeners) can

directly buy the music from the producers (musicians). In the same way, producers and consumers get in direct contact at the music festival not only through the music but also through the served food. Therefore, the intention of this garden is to bring people together through food and music.

However, there were further reasons for the organizers to start a rooftop garden in the middle of the city. One of them is the low self-sufficiency rate of food in Japan and the possibility of a food crisis in future. The sense of danger increased during the pandemic and one of the organizer states that "I was aware of the danger, and I wanted to be able to produce food for our own consumption at that time" (Hiratsuka 2020).

Since the organizers have nationwide connections, they could have established their garden somewhere in the countryside, but they insisted on making it happen in the city. Through this, they wanted to show that even in the overcrowded cities of Japan people can produce their own food because there is an abundance of unused rooftops (Hiratsuka 2020). Therefore, one more intention was to initiate a change inside the city itself to produce more food locally.

Urban farming in Italy

In Italy, during World War II, as part of the *orticelli di guerra* (war vegetable gardens) campaign, urban farms (*orti urbana*) were created, making all public green spaces available for people to grow vegetables and legumes. However, until recently, urban gardens have not received much attention, and it was around 2010 that urban farms started to gain momentum. Citizens' groups and associations voluntarily established citizen farms as a way to start organic farming and to promote social interaction.

Italian law defines an urban garden as "a small land allocation owned by a local public enterprise and used for non-profit home cultivation (including home consumption) or recreational horticulture" (Coldiretti ND). Based on data by Coldiretti, the main organization of agricultural entrepreneurs in Italy, Italy's urban gardens on municipally owned land tripled from 1.1 million m^2 in 2011 to 3.3 million m^2 at the end of 2014. This is partly due to the economic crisis which is forcing one in four Italians in urban areas to grow their own food but also due to a desire to consume healthy products and due to a passion for cultivation (Borsa Italiana 2016).

In the following years, urban farms continued to grow at record levels. According to Istat (2021) data for 2017, Italy's "urban farmers" phenomenon is led by the Emilia Romagna region, which includes the city of Bologna, with a record 704,000 m^2 of urban farms. This is followed by Lombardy with Milan (193,000 m^2), Tuscany with Florence (170,000 m^2), Piedmont with Turin (144,000 m^2) and Veneto with Venice (106,000 m^2). Since then, the interest of municipalities and local administrations in urban gardens as a strategy to promote the emergence of a more active and conscious citizenship has been growing in Italy. For this aim, local administrations have made city lands available to citizens for urban garden initiatives (Borsa Italiana 2016).

According to Zappata Romana (ND), the main reasons for city dwellers to cultivate land are to eat healthy, real food, to spend more time in contact with nature and to save money. Other perspectives mentioned include helping economically poor families, educational value, maintaining green spaces in abandoned urban areas and

contributing to environmental and biodiversity issues, pointing to it as a very powerful tool for social inclusion and the growth of new active communities.

Case study 3: Hortus Urbis (Rome)

Currently, there are about 200 common green spaces in the city of Rome. Their locations were first mapped by STUDIO UAP, an office that undertakes work on environmental development projects in Italy's capital. During the research for their environmental development work, Luca D'Eusebio of STUDIO UAP discovered as many as 70 fields and wildernesses scattered throughout Rome that the local people had cultivated without permission to create fields and parks. To address and understand this phenomenon, Studio UAP mapped the existing community gardens and edible gardens in Rome and launched the Website zappataromana.net in 2010. Since then, Zappata Romana has played a central role for civic farm activities in the city of Rome. It can be said that the map by Zappata Romana has transformed the fragmented reality of many vegetable gardens and shared gardens into a landscape consistent with a different and new urban consciousness.

Urban gardens were not regulated at all in Rome until the summer of 2014, when regulations for community gardens were issued by the local government. Zappata Romana considered these regulations as an important achievement for the city although they were not seen as sufficient which is commented on by Patti (2016) with "community gardens emerged as a response to the inefficiency and the unwillingness of the city of Rome to improve the conditions of public spaces".

Hortus Urbis is one of the projects in which Zappata Romana is directly involved. Originally, the land was inhabited by ancient Roman plants. Today, it is a citizen farm in the Appia Antica Park, with about 225 m^2 of fields and 16 flower beds. The garden is maintained by volunteer gardeners and is an educational garden for children between the ages of 3 and 10, with a variety of food education events. Not only children but also adults are participating in the farm experience. For example, one of the volunteers started to work in the garden after retirement, and he is now an indispensable part of "Hortus Urbis", teaching various aspects of vegetable farming to children and their parents who visit the garden on weekends. The number of participants continues to grow, and organizer Luca D'Eusebio remarked in an interview that "for modern urbanites, the Hortus Urbis workshop may be like a weekend therapy. I want as many people as possible to realize how important this kind of experience is for our children's future and for us as adults in our daily lives".

Zappata Romana states on its Website that a community garden in Rome is "first of all a public space with social, cultural and environmental purposes" run by a group of citizens with the goal "to improve and beautify their neighborhood" (Zappata Romana ND). It has been pointed out that community gardens have many social and environmental functions for the citizens of Rome (Certomà 2016): They are valuable as general commons that generate other public benefits, such as participation, socialization, intergenerational relations, environmental stewardship, exchange of knowledge, recovery of traditions and culture, and they are also a places that represent active citizenship in the sense that abandoned spaces are being rebuilt and reused by citizens. Certomà (2016) further notes that although there are various forms of

citizen farms in Rome, they share the same purpose. For citizens in Rome, a civic garden is not just a place to engage in gardening, but a well-kept public space where social relations, place attachment and political engagement can take place and it can be "a catalyst for community activities" and it even "can become the heart of a community, introducing new ways of urban lifestyle" (Zappata Romana ND).

As a result of the corona pandemic, there has been a characteristic change in the civic gardens of Rome. During the lockdown, the interest of citizens in the use of urban gardens has increased. From the start of the lockdown until April 2021, usage requests increased by 30%. In addition, half of the new requests came from young people aged 20–30 (Zappata Romana ND). Since the use of gardens during the corona pandemic was allowed, albeit with some restrictions, it is inferred that the number of people who wanted to have a place to stay outdoors has increased. It can be said that this phenomenon represents the role of citizen gardens in the city and the demands of citizens.

Luca D'Eusebio believes that urban gardening is a response to the challenges of our time, including food policy, environmental issues, urban resilience and biodiversity conservation: "I think the birth of these communal farms is a valuable movement that proves that we do not have to wait for the government to tell us what to do, but we can take action and create an environment that is not left to others. Through Zappata Romana, I want to appeal to people today that the human act of plowing a field with a sickle actually has an important meaning".

14.3 Conclusion

Citizens gardens emerged under different circumstances in the three cities discussed in the case studies. In Berlin, the Prinzessinnengarten was initiated with a focus on education. In Rome, a general neglect of public spaces by the administration led to new citizens farms for community activities and education as well. In Tokyo, the overall lack of green space and the dense population made people create gardens on rooftops and balconies. However, during the COVID-19 pandemic, the importance of these public spaces for urban food production as well as spaces for increasing well-being has gained more prominence.

The challenges addressed by these urban community gardens have been there for years and even decades, but the coronavirus pandemic has brought many of the issues to the foreground. It has revealed the world's dependencies on a global flow of commodities and has created a demand in local food production and food production through bottom-up initiatives. Urban gardens have been seen as contributors to the creation and maintenance of communities and people's well-being. In the pandemic, their role has increased in local communities as people were restricted in movement, and many indoor activities had become impossible. Gardens with their positive influence on stress had an even greater importance in these times of increased stress.

The constantly increasing number of urban gardens in cities around the world is already an indicator for their important role as public spaces for citizens' well-being, for food production, as meeting places and as places of learning (Fig. 14.2). The case studies from Berlin, Rome and Tokyo have clarified this in more detail. Furthermore, if we consider urban gardens under the aspects of the social dimension of urban sustainable development (Dempsey et al. 2009), the analyzed community gardens are contributing with several positive factors to social sustainability. These factors are education and training, participation, health, quality of life and well-being, community social networks, social interaction, sense of community and belonging and cultural traditions. It is therefore increasingly important to consider urban gardening as a key factor for urban sustainability and sustainable development in the twenty-first century.

Fig. 14.2 Community point in the temporary use of urban garden "Himmelbeet" in Wedding, Berlin (Photo by author, September 2017)

References

Association for Japan Allotment Garden (ND) Japan. http://www.jardins-familiaux.org/nations/jp/eng/jp_e_start.html. Accessed 12 Aug 2021

BDG (Bundesverband Deutscher Gartenfreunde) (2021) Zahlen und Fakten. https://www.kleingarten-bund.de/de/bundesverband/zahlen-und-fakten/. Accessed 12 Aug 2021

Berlin Online (ND) Gemeinschaftsgärten in Berlin. https://www.berlin.de/gemeinschaftsgaertnern/gemeinschaftsgaerten/gemeinschaftsgaerten-in-berlin/artikel.879232.php. Accessed 10 Oct 2021

Borsa Italiana (2016) A vegetable garden in the city, a realistic dream. https://www.borsaitaliana.it/notizie/italian-factory/tendenze/034orti.en.htm. Accessed 25 Sep 2021

Certomà C (2016) 'A new season for planning': urban gardening as informal planning in Rome. Geogr Ann: Series b, Hum Geogr 98(2):109–126. https://doi.org/10.1111/geob.12094

Chandran R (2020) The coronavirus lockdowns are making city dwellers realise how crucial urban farms can be in feeding the urban population. https://news.trust.org/item/20200407082542-5652d. Accessed 12 Aug 2021

Cherry N (2021) Urban gardening has taken root, and it's time for cities to encourage new growth. https://kinder.rice.edu/urbanedge/2021/03/31/pandemic-urban-gardening-has-taken-root-and-it-is-time-cities-encourage-new-growth. Accessed 12 Aug 2021

Clausen M (2015) Urban agriculture between pioneer use and urban land grabbing: the case of "Prinzessinnengarten" Berlin. Cities Environ (CATE) 8(2), Article 15

Clausen M (2019) Prinzessinnengarten am Moritzplatz in letzter Sekunde gerettet. https://prinzessinnengarten.net/prinzessinnengarten-am-moritzplatz-in-letzter-sekunde-gerettet/. Accessed 25 Aug 2021

Clinton N, Stuhlmacher M, Miles A et al (2018) A global geospatial ecosystem services estimate of urban agriculture. Earth's Future 6:40–60. https://doi.org/10.1002/2017EF000536

Coldiretti (ND) Coldiretti. https://www.coldiretti.it. Accessed 10 Jun 2021

Dempsey N, Bramley G, Power S et al (2009) The social dimension of sustainable development: defining urban social sustainability. Sust Dev 19(5):289–300. https://doi.org/10.1002/sd.417

Furusho E (2020) Sakata no tane no gyōseki ga "Uwabure nōkō" to miru riyū (Reasons for Sakata Seed's earnings to be strongly on the rise). https://shikiho.jp/news/0/384385. Accessed 8 Aug 2021

Genter C, Roberts A, Richardson J et al (2015) The contribution of allotment gardening to health and wellbeing: A systematic review of the literature. Br J Occup Ther 78(10):593–605

Higuchi M (1999) Analysis of the present condition of an allotment garden in Japan: a case study of the Minuma Fureai Garden in Kawaguchi City. Jpn J Hum Geogr 51(3):291–304

Hiratsuka M (2020) Korona-ka no toshin ni totsujo arawareta jūsangatsu nōen (The sudden appearance of the Jūsangatsu Farm in the heart of the city during the coronavirus pandemic). https://www.timeout.jp/tokyo/ja/music/interview-gezan-mahitothepeople. Accessed 14 Aug 2021

Honzawa A, Dohi M (2018) The policy linkage of the municipal and provincial government brought by the Food Policy Council in Toronto, Ontario. J City Plann Inst Jpn 53(3):372–377. https://doi.org/10.11361/journalcpij.53.372

Inoue H (2021) Aaban faamingu de, korona-ka no toshiseikatsu wo uerubiingu ni (Urban farming for wellbeing in city life under corona). https://mainichi.jp/premier/politics/articles/20210611/pol/00m/010/007000c. Accessed 21 Aug 2021

Istat (2021) Istituto nazionale di statistica. https://www4.istat.it. Accessed 3 Jun 2021

Koehorst M (2021) Converting and conserving urban green spaces for educational community gardening. https://panorama.solutions/en/solution/converting-and-conserving-urban-green-spaces-educational-community-gardening. Accessed 24 Sep 2021

Kitzinski D (2015) Der Prinzessinnengarten in Berlin Kreuzberg: Wechselwirkungen zwischen Alltagsleben und Quartier. Master's thesis, TU Berlin. https://anstiftung.de/downloads/send/15-forschungsarbeiten-urbane-gaerten/235-der-prinzessinnengarten-in-berlin-kreuzberg-wechselwirkungen-zwischen-alltagsleben-und-quartier

Koll G (2020) Der Gemeinschaftsgarten in Zeiten einer Pandemie. https://www.mittendran.de/der-gemeinschaftsgarten-zeiten-einer-pandemie. Accessed 10 Oct 2021
MAFF (Ministry of Agriculture, Forestry and Fisheries) (2020) Shimin nōen no jōkyō (Status of citizen farms). https://www.maff.go.jp/j/nousin/kouryu/tosi_nougyo/s_joukyou.html. Accessed 12 Aug 2021
Mehaffy MW, Elmlund P, Farell K (2019) Implementing the New Urban Agenda: the central role of public space. Urban Des Int 24:4–6
METI (Ministry of Economy, Trade and Industry) (2020) Preliminary report on the current survey of commerce. https://www.meti.go.jp/statistics/tyo/syoudou/result/pdf/202006S.pdf. Accessed 12 Aug 2021
Milan Urban Food Policy Pact (2015) Milan Urban Food Policy Pact. https://www.milanurbanfoodpolicypact.org/wp-content/uploads/2020/12/Milan-Urban-Food-Policy-Pact-EN.pdf. Accessed 12 Aug 2021
Nilsen M (2014) The Working man's green space: allotment gardens in England, France, and Germany, 1870–1919. University of Virginia Press, Charlottesville
Nippon News Network (2021) Korona-ka de "tsuchiijiri" ninki – shoshinsha-muke mo (Gardening popular during coronavirus crisis, also with beginners). https://www.news24.jp/articles/2021/05/14/07872515.html. Accessed 12 Aug 2021
Ono H (2020) Residents' interaction in public space of informal settlements: understanding the spatial formation and management of informal settlements in Nairobi. J Archit Plann, AIJ 85(779):2695–2702. https://doi.org/10.3130/aija.85.2695
Patti D (2016) Zappata Romana—Connecting urban gardening communities. https://cooperativecity.org/2016/12/01/zappata-romana/. Accessed 28 Aug 2021
Prinzessinnengarten (ND) „Wachsen lassen!" – Die Kampagne. https://prinzessinnengarten.net/de/der-garten-und-die-stadt/kampagne-wachsen-lassen. Accessed 25 Sep 2021
Reuters (2020) Italy closes all parks in further tightening of coronavirus lockdown. https://www.reuters.com/article/uk-health-coronavirus-italy-crackdown-idUKKBN21739M. Accessed 25 Sep 2021
SenStadt (Senatsverwaltung für Stadtentwicklung und Umwelt) (2012) Das bunte Grün: Kleingärten in Berlin. https://www.berlin.de/sen/uvk/_assets/natur-gruen/stadtgruen/kleingaerten/kleingartenbroschuere.pdf. Accessed 26 Aug 2021
Soga M, Cox DTC, Yamaura Y et al (2017) Health benefits of urban allotment gardening: Improved physical and psychological well-being and social integration. Int J Environ Res Public Health 14(1):71. https://doi.org/10.3390/ijerph14010071
UN-Habitat (2015) Global public space toolkit: from global principles to local policies and practice. Nairobi
United Nations (2017) New Urban Agenda. https://uploads.habitat3.org/hb3/NUA-English.pdf. Accessed 26 Aug 2021
Wendler J (2018) Grassroots experimentation: Alternative learning and innovation in the Prinzessinnengarten, Berlin. In: Evans J, Karvonen A, Raven R (eds) (2018) The experimental city, 1st edn. Routledge, London. https://doi.org/10.4324/9781315719825
WHO Regional Office for Europe (2016) Urban green spaces and health: a review of the evidence. http://www.euro.who.int/__data/assets/pdf_file/0005/321971/Urban-green-spaces-and-health-review-evidence.pdf. Accessed 26 Aug 2021
Zappata Romana (ND) Community gardens. http://www.zappataromana.net/en/edible_garden. Accessed 25 Oct 2021

Chapter 15
Distributional Analysis and Access to Fresh Fruits and Vegetable Shops in Residential Neighborhoods of Birnin Kebbi Metropolis, Nigeria: Implications for Informal Land Use Planning

Samson Olaitan Olanrewaju, Peter Fadeyi, and Taibat Lawanson

Abstract In Nigeria, fresh fruits and vegetable shops (FFAVS) belong to the informal land use category with a gap of poor spatial and administrative management. Due to these lapses, Nigeria cities, particularly Birnin Kebbi, have been unable to standardize and maximize the operations of these shops—for the achievement of access, nutritional quality, and spatial balance. Using desk studies, spatial data, questionnaire administration and personal communication with food marketers, residents, and other stakeholders in different neighborhoods of Birnin Kebbi Metropolis, it was discovered that, due to petty buying informed patronage, there are more FFAVS in the high-density areas compared to medium and low. Despite this, only about 5% of the residents can access FFAVS within a 5–10 min' walk—thereby informing exclusion. With $X^2 = 124.20$, $p = 0.03$; there is a relationship between the type of fresh fruits and vegetables consumed by residents and those available in the FFAVS. However, about 75% of the respondents reported that goods obtained from the FFAVs, which are relatively expensive, would have at the time of purchase reduced in appearance. Unfortunately, products in FFAVs stands, even informal grocery stores, are not evaluated for safety by the Community Health Department of the metropolitan government. This paper, therefore, among others, recommends the establishment of a multidisciplinary department for the management of the location, activities, and operations of the FFAVS in the metropolis.

Keywords Nutrition · Healthy city · Informal land use · Birnin Kebbi

S. O. Olanrewaju (✉)
Department of Urban and Regional Planning, Osun State University, Osogbo, Nigeria
e-mail: samson.olanrewaju@uniosun.edu.ng

P. Fadeyi
Kebbi State Geographical Information System, Birnin-Kebbi, Nigeria

T. Lawanson
Department of Urban and Regional Planning, University of Lagos, Lagos, Nigeria

A. Grover et al. (eds.), *Sustainable Health Through Food, Nutrition, and Lifestyle*,
Advances in Geographical and Environmental Sciences,
https://doi.org/10.1007/978-981-19-7230-0_15

15.1 Introduction

In the last two decades, Africa has witnessed tremendous urban growth of 3.5% per year, and this rate is expected to hold on till 2050 (Africa Development Bank 2020). Currently, with an estimated urban population growth rate of about 4.3% and the individual growth rate of her cities within the range of 5–10%, Nigeria is no doubt an urbanization hub in the continent (Alhaji and Lawal 2017).

The current trend of Nigeria's urban dynamics has continued to cause pressures of all variants in her urban centers. Resultants of these include infrastructural deficits and decay, unbalanced wealth and skill distribution, and lack of access to resources. As a result, urban residents are faced with various social, environmental, psychological, and economical challenges. One of such is food insecurity. The narrative of food insecurity in Nigeria's urban areas includes reduction in food supply from rural areas due to different human and natural factors, increase in food demand in urban areas, and its associated high price and increasing distance between food markets and urban residences. Yet, cities can only be optimized when they are healthy, while food is central to the achievement of healthy cities.

Food, including fresh fruits and vegetables (FFAV), is an important substance, both for survival and maintenance of good health. In recent times, food has evolved to be a system, and its discussion has metamorphosed to include topical issues like access, processing, security, and its contributions to both national and global development. It is also, now, used as indicators of measuring development, quality of life, poverty, and health (Gani and Chand 2007). For urban planners, food is a key element in the functioning of territories and as important as habitat and mobility (Pothukuchi and Kaufman 2000). Despite its importance, nations and indeed the global community have continued to strive to meet the baseline of food (both in nutritional quality and quantity) needed for their sustenance. Currently, nearly 690 million people, representing about 8.9% of the global population, are hungry while an estimated 2 billion people in the world do not have regular access to safe, nutritious and sufficient food—a good number of these are in the cities (United Nations 2021).

Birnin Kebbi Metropolis, although a secondary city in Nigeria, possesses urbanization characteristics that are similar to others in the country. It also shares similar challenges of a typical urban area—although in this case, at a relatively low level like other secondary cities in the country. The high rate of urbanization in the metropolis, emergence of new neighborhoods and its outward development has caused an increase in demand for food, and at a longer distance from the central food market (locally referred to as Bayan Kara)—which is at the city center. To meet the fresh fruit and vegetable demands of these neighborhoods, FFAVS have continued to emerge. How are these shops distributed within the residential neighborhoods of Birnin Kebbi Metropolis? What is their interaction with the central food market? How accessible are the shops—in terms of quality, price, and distance? Do proximity of shops influences nutritional quality and diet in the metropolis? What are planning options for managing and optimizing this category of land use? These are the questions that this paper will put into perspective as it examines the distributional

analysis and access to fresh fruits and vegetable shops in residential neighborhoods of Birnin Kebbi Metropolis, Nigeria.

15.2 The Concern

Cities are not only engines of growth, they are centers of prosperity and opportunities and a reflection of human advancement. They are also catalysts for wealth creation, employment generation, and human progress (UN-Habitat 2016). Unfortunately, cities, particularly those in Africa and more specifically in Nigeria, have not emerged from conscious planning but either from a mere elevation of rural areas or upgrading of peripherals of existing cities. It is indeed a function of population explosion rather than industrialization and conscious urban development. This has left the cities with low productivity, declining health status, and growing poverty, which are indicators of unfulfilled aspirations.

Studies on urban health have revealed the nexus between food and of urban productivity, urban livelihood, lifestyles, and poverty. Lack of access to nutritional food can cause urban crises and national emergencies. The productivity of urban residents is tied to the status of their health, which is also connected to the safety and quality of food available to urban residents. Studies by Raja et al. (2010) revealed a relationship between proximity to grocery stores and body mass index. Overweight and obesity, which are new forms of malnutrition, are concentrated in cities and towns (Cecilia 2021). Billions of dollars have been expended by governments to address various health challenges emanating from food-related diseases and other ones. The growing number of urban poor—that are more vulnerable to food crises—in developing countries, like Nigeria, has continued to threaten not only the health of urban residents, but the health of the cities themselves. Realizing these have made food, in all its dimensions, become urban issue (Cecilia 2021), and concern for international policies including the Sustainable Development Goals.

Food issues have, since the beginning of the new millennium, been placed back on the urban agenda of developers (Pothukuchi and Kaufman 2000). This is because of the interconnectedness of food, health, and cities. Urban Planners' interest in discussion of food, health, and city is more on the perception of food and its system as not only being challenged by urbanization, but that cities will become sick and unable to attain their full potential, if food systems, in all its dimensions, are not managed. This, therefore, present urban environment is an essential framework for showcasing faults and new food practices (Sonnino 2009; Morgan 2015). Hence, the need for a coordinated food system—a network of complex interactions between actors and system process, policies, and regulatory framework (Julie and Caroline 2021). One of the entrants of the food system into the society is the distribution point—which may be food markets, community retails stores, and other informal stands.

Food markets, unlike other general markets, are concerned with the sale of food items including legumes, grains, fresh fruits, and vegetables. They also offer complimentary services like processing of these items. Food markets differ in sizes based on their service radius, thus some are regional, local, even neighborhood. Community food retailing, especially fruits and vegetables, plays a vital role in ensuring food security and promoting healthy lives—thereby ensuring healthy cities. However, as urban areas continue to grow horizontally to meet the spatial needs of their growing population, there is a widened distance between markets and urban residents. Inconsistencies and uncertainties in income (which encourages petty buying) coupled with lack of access to preservation facilities such as refrigerators and electricity, in a way, also affect market choices of urban poor. To fill these gaps, several food retailing stands, including fresh fruits and vegetable stands (FFAVs), have served as close alternatives to residents.

The recent outbreak of COVID-19 pandemic and its containment policies which include reduction of face-to-face interaction and the discouragement of public gatherings, further, amplify the importance of community food stores, both in the agricultural value chain and access to food. However, in Nigeria, because of their operation, majority, if not all, of these community food stores belong to the informal category (Hart 2008). Also, because of their location and method of access to land, they are of informal land use (Lord 2020). Sadly, informal land use has been excluded from various urban land use policies and management systems in Nigeria and other countries in West Africa (Yankson and Bertrand 2012; Jelili et al. 2017), thereby posing the challenge of sustainable management of these stands while achieving access to food.

To achieve food security and promote urban health in cities, food distribution channels, including fresh fruits and vegetable stands, need to be located to encourage proximity and access. Meanwhile, it requires conscious land use planning to ensure coherence between these types of land use and others in the urban fabric. Also, that food distribution channels in Africa—particularly retail outlets, are predominantly operated through informal land use; there is a need to functionalize and integrate this land use type with others in the formal category. This, therefore, require an understanding of the character of these land use type—which is one of the objectives of this study.

15.3 Study Area and Research Methodology

Birnin Kebbi Metropolitan area is the administrative cum political headquarter of Kebbi State, and an important traditional settlement in Northern Nigeria. With the population of less than one million individuals, the metropolitan area is one of the secondary cities in the core north of the country. Leveraging on its international boundary with Niger Republic and Republic of Benin, the town has direct commercial linkages with both major towns and rural areas in these countries, and other nearby countries such as Senegal, Cameroon, Libya, and Chad Republic. These interactions

not only influence the economy and spatial development of the metropolis, it also defines its agricultural food chain and fresh fruit supply. Also, the long ranged Kebbi–Sokoto–Gusau–Kaduna Highway aids the trans-community supply of fresh fruit from different rural communities along the highway and others in the Northwestern region of the country to the metropolitan area. Hence, despite being an agricultural state in itself, the metropolitan area enjoys the supply of fresh fruit and vegetable supply from rural communities in its neighboring states and countries.

The metropolitan area with an estimated population of 381,000 persons covers one local government area—Birnin Kebbi Local Government Area. Although, sometimes, adjoining communities like Zauro and Ambursa are considered as part of the town—for urban planning administration by Kebbi Urban Development Authority—still the metropolitan area is considered to be an identifiable urban extent within the metropolis. Supported by other small agglomeration of trades in strategic places in the metropolis, the town is served with two major markets—Central Market (locally called BabanKasuwa and Fresh Fruit Market (referred to as Kara). These markets are not only centrally located but are in proximity to each other—hence encouraging travels to central places. All forms of trading activities take place in the former, while the latter specializes in fresh fruits, vegetables, and related products.

The high rate of urbanization witnessed in the metropolitan area, like others in the country, has led to sporadic outward development in the peripheral area of the town. This dimension of urban development in the town increased the commuting distance between the fresh fruit market and residences—thereby reducing access to FFAVS and at the same time increasing the cost of FFAV (including travel cost and distance). FFAVS owners/operators, therefore, position themselves to solve this problem as well as earn a livelihood by locating within these neighborhoods for their trades. The success of the intrusion FFAVs with respect to the objectives of access and nutritional quality shall also be examined in this paper.

For this study, a multistage sampling technique was utilized. The residential areas of the metropolis were populated, and these areas were further classified into densities using their occupancy characteristics—in this case, areas dominated with houses of > 4 persons per room is classified as high, those with 3–4 persons were classified as medium, and those with 1–2 were classified as low-density areas. Further, six residential areas from the three densities—low, medium, and high—were purposively selected considering factors such as distance to the market, the prevalence of residential areas, and a true reflection of density characteristics. The residential areas were selected in the other of 3:2:1, respectively, for high, medium, and low densities, respectively (see Table 15.1).

In each of the selected residential area, FFAV shops were identified, characterized and their coordinates obtained with the aid of Imagine Q-GIS system. These were further transferred to ARC GIS 10.3 environment for development of maps and spatial analysis. Nearest neighbor analysis and buffer analysis were done to describe the distribution of FFAVS shops as well as calculate area of influence of the shops. To carry out the buffer analysis, a service ring of 300 m radius (10 buildings, as a plot in Nigeria has an average dimension of 30 m by 30 m) was delineated around each FFAV stands. The service radius of these FFAVS was first compared with each other,

Table 15.1 Selected area of the study

Density type	Residential area
Low	Gesse Phase I&2
Medium	Rafin Atiku, Bayan Kara
Low	Badariya (Mopol Barrack), Badariya (Church Area), Badariya (Cola-Junction)

Source Authors Work, 2021

and later within the area. Overlapping the service radius of two FFAVS indicates a strong influence at the center, but reduced coverage. The more the overlap, the higher the influence of the FFAVS at the center, but the less the coverage within the area. Also, higher overlap indicates cluster of FFAVs within a particular area in the neighborhood. Land use information of each FFAVS such as setback were subjected to descriptive statistics.

A ring of 300-m radius was delineated around each of the FFAVS and questionnaire administered to a representative from each of the houses within this ring. Another set of questionnaire was administered to operators of identified FFAVS. In all, 150 questionnaires, comprising 120 copies for residents and 30 copies for FFAV operators were administered. The information obtained from FFAVS operators include locational factors, method of land acquisition, source of fresh fruits and vegetables, methods of preservation, duration of sale, and replenishing of products. From residents, information obtained, among others, include patronage of FFAVS, accessibility with respect to distance, cost of products and perceived nutritional quality of FFAVs. These were subjected to descriptive statistics such as percentages.

15.4 Results and Discussion

This section presents the discussion that was made during the study. Its presentations follow the pattern outlined in the research questions.

A. **Incidence, Spatial Distribution and Interaction of Fresh Fruit and Vegetables Shops in the Residential Neighborhoods of Birnin Kebbi Metropolis, Nigeria**

There are more than 50 residential neighborhoods in the town—popular among them are the ones considered for this study. Despite variations in the density characteristics of neighborhoods in the metropolis, there appear to be similarities in their tolerance of a particular type of street trading—particularly street hawking. More related to culture and religion, street hawking is not encouraged in the residential neighborhoods; hence, a low incidence of this type of trade in the residential areas of the town, a situation that has given rise to the thriving of corner shops (locally referred to as Shago) at different locations. This is also leveraged upon by FFAVS, which is located at strategic and usually central places in the neighborhoods.

As at the time of this study, a total number of 30 FFAVS were identified in the selected neighborhoods (Fig. 15.1). There are 17 FFAVS in the high density area, 7 in the medium and 5 in the low density areas. Also, a FFAVS is identified along the linkage road between the medium and high density area. Therefore, the incidence of FFAVS is observed to differ with the density characteristics of the neighborhoods. Particularly, there are more FFAVS in the high density area compared to medium, while there are more shops in each of high and medium when compared to low density area. This observed difference in incidence may not be divorced from a relatively high tolerance of informality and informal land use evident in easy access to land, lack of coordinated physical planning, which is usually prevalent in high density areas. Another factor, as confirmed by the FFAVs operators, is patronage, which is more in the high density areas compared to both medium and low residential areas—possibly due to the inconsistency of income of high density residents and its associated petty buying.

With the nearest neighbor ratio (NNR) = 1.33, $p = 0.008$, FFAVS are dispersed within high residential areas. Similarly, spatial pattern was observed in the medium residential areas (NNR = 1.56, $p = 0.007$). The dispersal of FFAVS in the low and medium density areas of the metropolis indicates high penetration of these shops in the area. FFAVS are located at vantage locations (such as road junctions, interjections, nodes, and clustered areas) in these neighborhoods. Notably, as shown in Fig. 15.1, no FFAVS was observed in the Bayan-Kara area of the metropolis. Bayan-Kara, a

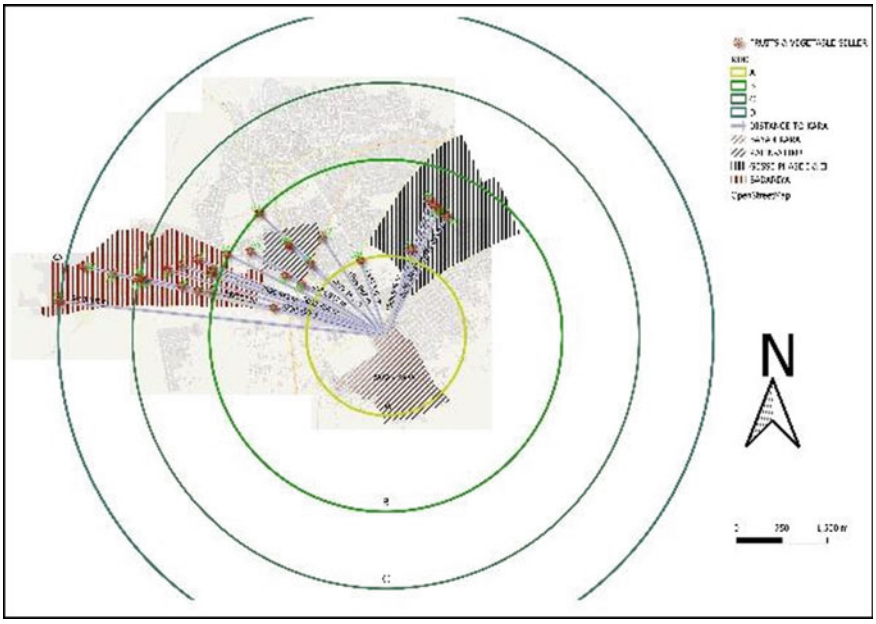


Fig. 15.1 Spatial Distribution of FFAVs in Birnin Kebbi Metropolis, Nigeria. *Source* Authors work, 2021

local language meaning behind Kara, is a medium density neighborhood with a direct road linkage to the food market and at proximity to it. Hence, with this proximity to the market, FFAVS operators consider that residents will prefer to patronize the Kara market than theirs, hence their non-existence in such areas.

To assess, if the incidence and distribution pattern of FFAVS translates to access by residents, a buffer analysis was used. As shown in Fig. 15.2, in the high density area of Badariya, the service radius of about 70% of the FFAVs stands overlaps. These FFAVs can therefore be concluded to have strong centric and pull effects. However, about 40% of the area coverage of the area is excluded from the influence of FFAVS. Hence, residents at areas that are not within the buffer coverage of any FFAVS travels to closest one to purchase fresh fruits and vegetables. However, this situation is not true for the medium density area of Rafin Atiku, where only 15% of its FFAVS have overlapping service radius. For the low density area of Gesse Phase I and II, a 95% overlap of service radius of FFAVS was observed, and less than 20% of the total area is covered by FFAVS. From the foregoing, only Rafin Atiku, a medium density area, has a relatively spread out of FFAVS, which may in a way, inform access and patronage.

The buffer analysis of FFAVS has revealed that incidence of a land use, in this case FFAV stands, does not translate to proximity to residents. In fact, there can be high incidence of a land use type, while users can be spatially excluded. For instance, despite the high incidence of FFAVs stands in the high residential area of Badariya, only about 5% of the residents revealed that they make about 5–10 min' walk before they can access FFAVs stand, while about 50% make about 25–30 min'

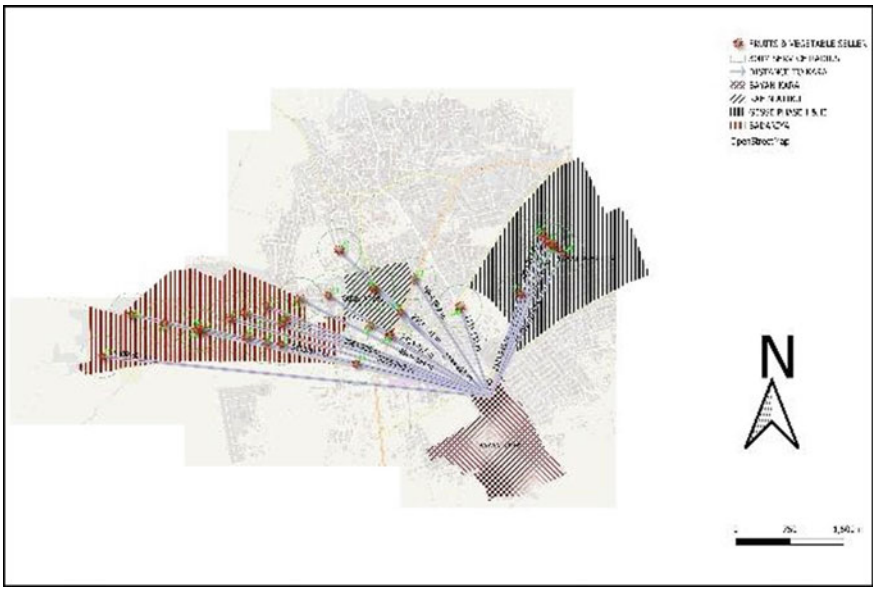


Fig. 15.2 Buffer of FFAVs in Birnin Kebbi Metropolis, Nigeria. *Source* Authors work, 2021

walk. Although this paper did not argue for the littering of residential neighborhoods with FFAVS, it calls for the strategic location of FFAVS and similar economic land uses, at specific intervals to aid easy proximity and eventual access by residents.

Operators of FFAVS disclosed that they obtain their fresh fruits and vegetables for retail from Kara Market. Also, it was observed that the incidence of FFAVS increases with distance to Kara Market, and begins to reduce at a point. Using a ring of 50-m radius to the market, as shown in Fig. 15.1, only one FFAVS is identified, while within 100-m radius, it increased to 12, at 150 m, 11 FFVS were identifiable, whereas 3 FFVS are identifiable at 200-m radius away. From observation, the distance where the highest incidence of FFAVs is recorded is also the beginning of the reduction of such. This point can be regarded as the climax-transition point, while Kara market is the origin. Informal land uses have their origins, usually formal land use, with which they have interaction. The climax-transition point is therefore the location where the formal–informal land use interactions are optimized. To harness the potential of informal land use, in this case, FFAVS, this interaction should be managed through effective land use planning.

B. Locational and Land use Characteristics of FFAVs Shops in the Residential Areas of Birnin Kebbi Metropolis

All the identified FFAVS are located along road networks. About 2% of these are operated in shops built with bricks, while 98% are operated in temporary structures (Table 15.2). Some of FFAV, especially for those in shops built with bricks, are operated with other complimentary services like petty trading, while some of the FFAVS operated in temporary structures are located at proximity or in clusters with other food-related trades such as fish and meat stands, and vegetable oil shops. None of the FFAVS operated in temporary structures complied with the setbacks standards of the state. Some of these FFAVS are directly located on the brink of drainage along road setbacks without observing physical planning standards. Locational decisions of FFAVS operators are informed by proximity to customers (98%), availability of space (85%), and proximity to home (55%).

Land occupied by operators of FFAVS—those in temporary structures—were obtained through informal process. As evident in Table 15.2, about 75.3% of these lands were obtained directly from either the owner of the plots or those in custody of such plots. For about 20% located close to religious centers and other public spaces (including schools), permission to trade in such places were granted by the managers of these places. Irrespective of the method of acquisition of land for trade, FFAVS operators revealed that they were also granted permission by the Kebbi Urban Development Authority (KUDA) to locate on road setbacks—for which a token was paid as registration fee. This, the FFAVS operators believed, has formalized their process of land acquisition.

In a way, the registration of space by FFAVS by KUDA may be regarded as an approach of coordinating their location. However, lack of development control evident in the flagrant defiant of setback by FFAVS do not reflect such objective. The evident unguided pattern of these FFAVS also imply that there is no planning

Table 15.2 Locational characteristics and Patronage of FFAVs shops in Birnin Kebbi Metropolis

Factors	Variables	%	Factors	Variables	%
Material of Shop construction	Bricks/shops	2	Locational factors of FFAVs	Proximity to customers	98
	Temporary structures	98		Availability of space	85
	Total	100		Proximity to home	55
Observance of setbacks	Yes	0			
	No	100	Method of land acquisition	Directly from owner	75.3
	Total	100		Manager	20.0
				Do not want to say	4.7
				Total	100

Source Authors work, 2021

intervention at their orderliness for the purpose of access to residents. Unfortunately, there is neither a law nor direct agencies that are guiding informal businesses in the metropolis. Similarly, there is no legal instrument for the management of informal land use in the metropolis. Worst still, the Nigeria Urban and Regional Planning Law—which provides for effective coordination of land uses—has not been domesticated in the state.

C. **Patronage and Perceived Access of FFAVs to Residents**

About 74% of residents in Birnin Kebbi Metropolis purchase FFAV for at least twice in a week, while only 25% purchases theirs once in a week. This indicates a high consumption of FFAV and its associated demand. To meet their FFAV needs, residents either visits the market or nearest FFAVS. 100% of the sampled respondents claimed to have patronized FFAVS in the past three months. The frequency of patronage of FFAVs, however, differs with density as about 90% of those in high density area patronizes FFAVS frequently while 45% of those in the medium density areas frequently patronizes these shops, and only 5% of those in the low density areas patronizes them frequently. Reasons for patronage include emergency needs (50%), regular purchase (35%), and supplementary purchase (15%). Factors that influence patronage of FFAVS are proximity (55%), quality of FFAVs (35%), and availability of varieties (15%).

About 70% of the residents complained of a relatively high price of goods from FFAVS. Also, about 85% complained of limited varieties, 63.5% reported sales of low quality fresh fruits and blighted vegetables in FFAVS. However, proximity, the attitude of FFAV operators, and neatness of FFAVS are the factors that influence the choice of a FFAVS to be patronized by the residents. There is a limit to the quantity of FFAV that residents can purchase from the shops. The average price of FFAV that

an urban resident in Kebbi Metropolis is willing to purchase from a FFAVS is #500 (equivalent of 1 U.S Dollar). Residents claimed that they prefer to visit the Kara Market for the purchase of FFAV beyond this price limit.

D. **Perceived Nutritional and Dietary Impacts of FFAVS**

In the Birnin Kebbi Metropolis, the type of FFAV in shops informs the nutritional decisions of residents. This is like about 85% of residents, particularly those in the high density area, resort to buying whatever is available at these stands. With $X^2 = 124.20$, $p = 0.03$; there is a relationship between the FFAV consumed by residents and the type of FFAV available in the shops. Also, with the $X^2 = 320$, p = 0.001, there is a relationship between the distance of residents from FFAVS and responses to diet decisions. With increased distance to FFAVs stands in the neighborhoods, residents are reluctant to make dietary decisions—which they say, depends strongly on the availability of FFAVs in the neighborhood. Some of the residents report the usual adjustment of their menu to reflect the available FFAV in the closest shops.

There is however a challenge with the nutritional quality of FFAV obtained from FFAVS in the metropolis. About 75% of the respondents reported that fruits and vegetables obtained from the FFAVS would have, at the time of purchase, either reduced in size or change in appearance. In some cases, it is a situation of both instances. Also, about 95% of the respondents complained that FFAV are expensive in the shops when compared to the food markets. However, the price difference is catered for by the reduced distance between FFAVS and the consumers. Other challenges with products from the FFAVS stores are lack of varieties and poor handling of the FFAV. Unfortunately, products in FFAVS, even in formal grocery stores, are not evaluated for safety by the Community Health Department of the metropolitan government. This exposes consumers to all variants of fresh fruit and vegetables, thereby posing an environmental health threat.

15.5 Implication of Findings on Food Security in Africa Cities and Urban Planning Options

The study has established the importance of FFAVs in the metropolitan area of Birnin Kebbi—particularly on the food choices and diets of the urban poor—who are the predominant residents of high residential areas. However, these activities appear to be unregulated either by planning agencies or community health officials. This implies that while the business is, like other informal businesses, open to high risk, residents have the tendency of exposure to all manner of fresh fruits and vegetables.

Retails spots are important nodes of the food system; hence, the role of FFAVS in food delivery in urban center cannot be overemphasized—however, the research has created an insight into the need for Nigeria's urban centers, and others in Africa to look beyond the incidence of these facilities in their cities—but to organize these facilities to promote and increase access among urban residents.

The absence of legal instruments for the management of informal activities and their land use structures has not only limited the potentials of FFAVS but also exposed them to other risks associated with informal land uses.

As Africa continues to witness an increase in urban poverty, there is a need to look more into the facilities and services that integrate the urban poor into city life—such as FFAVS. This is as these urban poor serve as factory workers, artisans, which are the grassroots of the economic drive in cities. In more personal relations, they are domestic staff to many urban rich. Therefore, if the health of these categories of individuals is compromised due to lack of access to nutritional food, it will pose a serious threat to the survival of the city—in all its dimensions. There is therefore the need for organization of FFAVS—which has been proven to promote food access to the urban poor. The option therefore for urban planning interventions is a rethink of land use planning in Africa to effectively and operationally capture the informality.

15.6 Recommendations and Conclusion

Emerging from the research, it is no doubt that FFAVS is an important component of the food distribution chain in Birnin Kebbi Metropolis. Yet, this category of land use is not without challenges. To address these, the following recommendations are proffered:

1. The Kebbi State Government should establish a multidisciplinary department comprising Ministries of Finance, Ministry of Environment, Department of Community Health and Kebbi Urban Development Authority to organize and register operators of FFAVS and other informal activities in the state. This will, in a way, aid communication between Government and the operators, as well as formalize the operations of the latter.
2. The Multidisciplinary department should engage in a comprehensive inventory of the incidence, spatial distribution, land use, and operational characteristics of the FFAVS for the creation of a database that will inform policy options.
3. A distribution plan for FFAVS in the residential neighborhoods of the metropolis should be developed. This is to aid the redistribution of these activities, inform their orderliness, and the eventual regulation of their activities.
4. Development control should be carried out to ensure that FFAVS located on road setbacks are either relocated to new places within the area or totally removed—in the absence of new areas for relocation.
5. The multidisciplinary department should educate FFAVs operators on food handling, and other health aspects of their trade. This department should also engage in free medical tests, regular checkup and assessment of quality of fresh fruits that are sold by these operators.
6. Preservation facilities should be made available for FFAVs operators for the preservation of their goods. These may be provided on loans with convenient repayment plans.

In Conclusion, food security in urban areas is a mirage in the absence of access to healthy food. It is therefore necessary that channels for this access, including FFAVS, are well positioned, coordinated, and managed to achieve optimality.

References

Africa Development Bank (2020) Africa economic outlook amid COVID-19. AFDB Press
Alhaji A, Lawal A (2017) Urbanisation, cities and health: the challenges to Nigeria—a review. Ann Afr Med 16(4):149–158
Cecillia T (2021) Feeding all city inhabitants. International Institute for Environment and Development. http://www.iied.org/feeding-all-city-inhabitants. Accessed 30 Sep 2021
Gani A, Chand PB (2007) Food security and human development. Int J Soc Econ 35(5):310–319
Hart K (2008) Between bureaucracy and the people: a political history of informality (N0. 2008:27) DIIS Working Paper
Jelili M, Olanrewaju S, Odunola O (2017) Spatial distribution and landuse planning of informal automobile workshops in Osogbo, Nigeria. Ethiop J Environ Stud Manag 10(11):112–124
Julie D, Caroline B (2021) Theoretical approaches for effective sustainable urban food policy making. In: Brand C et al (eds) Designing urban food policies. Urban Agriculture. Springer, Cham. https://doi.org/10.1007/978-3-030-13958-2-4
Lord A (2020) Effects of informal economic activities on formal spaces in Kumasi metropolis. Munich GRIN Verlag. https://www.grin.com/document/542532
Morgan K (2015) Nourishing the city: the rise of urban food question in the Urban North. Urban Stud 8(52):1–16
Porthukuchi K, Kaufman J (2000) The food systems: a stranger to the planning field. J Am Plann Assoc 66(2):113–124
Raja S, Yin L, Roemmich J, Ma C, Epotein L, Yadav P, Ticaolu A (2010) Food environment, built environment and women BMI: evidence from Eric County, New York. J Plan Edu Res 29(4):444–460
Sonnino R (2009) Feeding the city: towards a new research agenda. Int Plan Stud 14(4):425–435
UN-Habitat (2016) Urbanization and development: emerging futures. World Cities Report 3(4):44–51
Yankson P, Bertrand M (2012) Introduction. Challenges of urbanization in Ghana. In: EA-Schandorf P, Yankson M, Bertrand (eds) The mobile city of Accra: urban families, housing and residential practices. Codesria, Dakar
https://www.un.org/en/global-issues/food

Chapter 16
Nutrition, Lifestyle and Health Status Among Tribal Communities: A Case Study of Particularly Vulnerable Tribal Group of Kerala

K. Gowri Priya and Lekha D. Bhat

Abstract Tribal populations, in general, are generally lagging behind in social-economic spheres of lives as they are at different stages of social and economic development compared to the remaining population. Health and nutritional inequities are higher among tribal population in our country. Poor relationship with environment, undernutrition and newly acquired lifestyle factors makes them very vulnerable compared to the general population. The review exercise showed that nutritional status and factors associated with geographical variations were not studied especially among the particularly vulnerable tribal groups in Kerala. Hence, this study was conducted to develop the bio profile of *Kattunayakan* tribes in Kerala and associate their nutritional status with several factors along with their health-seeking behaviors. The study followed a community-based cross-sectional approach using a mixed- method, which is both qualitative and quantitative in nature. The field survey was conducted in Wayanad district in Kerala where more than 85% of the Kattunayakans' population lives. The sample size is calculated as 238. The Kattunayakan community has always been deprived of creche and basic facilities, which has forced them to remain underdeveloped in most aspects of life. The findings of this study have shown a steady social and nutritional transition among the tribes. The determinants that affect the nutrition status most are education, occupation, income, housing conditions and lifestyle. An overall improvement in the quality of life by improving determinants like education, occupation and access to health care is suggested to improve the nutritional status and health indicators of the community.

Keywords Nutrition · Health status · Lifestyle · Tribes · Kerala

K. Gowri Priya · L. D. Bhat (✉)
Department of Epidemiology and Public Health, Central University of Tamil Nadu, Thiruvarur, India
e-mail: lekhabhatd@gmail.com

A. Grover et al. (eds.), *Sustainable Health Through Food, Nutrition, and Lifestyle*,
Advances in Geographical and Environmental Sciences,
https://doi.org/10.1007/978-981-19-7230-0_16

16.1 Introduction

India is a land of co-mingling culture and people with diverse religious, linguistic and socio-economic backgrounds. The tribal population is 10.45 crore accounting for about 8.6% of the total population (Government of India 2011). There are about 635 tribal groups residing in the urban and rural parts of India. Among them, the groups with prevailing primitiveness having a declining population, low economy and literacy rates and still following pre-agricultural level of technology are termed as Particularly Vulnerable Tribal Groups (PVTGs) (Ghosh-Jerath et al. 2018). There are about 75 PVTGs in India with the majority of them located in the northeast and central India (Census of India 2011).

Tribal populations, in general, are generally lagging behind in social-economic spheres of lives as they are at different stages of social and economic development compared to the remaining population. They lag far behind the general population with low socio-economic and participatory indicators as most of them are caught up in the vicious cycle of poverty. This has significantly affected their living condition and health standards.

Health is one of the most important factors that affect the quality of life. With a score of 27.2, India is classified as a country with a level of serious hunger in Global Hunger Index (GHI) (Global Hunger Index 2020).

Nutrition transition, i.e., overnutrition and undernutrition, is a major problem in the country. In that case, undernutrition is notably high in rural areas with a majority of it reported from the tribal population. Malnutrition is widely reported which usually leads to an impact on the disease pattern, morbidity and mortality. Tribal groups in general have their own system, which includes diagnosis, treatment and cure of illness. Socio-economic backwardness coupled with barriers in accessing health care increases their reluctance to reach out to the health care system widely used in the country. So, their nutrition and lifestyle have a significant impact on their health and nutrition.

16.2 Literature Review

The health status of every community is determined by the availability of nutritional food and access to health care. Apart from this, traditions and beliefs play a major role in determining the health of a community, and this stands true especially for the tribals. In general, the health status of tribals in the country is poorer, and health indicators are not promising (Bagai and Nundy 2009). Health inequities among tribal populations are at higher rates than the general population (Das and Bose 2015). Social stratification and marginalization of society with a high prevalence of low weight and anemia are reported among indigenous population compared to non-indigenous population (Haddad et al. 2012).

In India, 50% of adults in scheduled tribes have reported being undernourished with low BMI. The prevalence of chronic energy deficiency is reported in 60% of tribal communities in India, and this is 37.8% in Kerala. Haddad et al. (2012) state that educational and socio-economic levels of tribal and general population are so different that it has a significant difference in the burden of morbidity. Social exclusion and ethnicity-based discrimination add to the burden. Health inequalities are also seen within the tribes as the needs for each group are different.

Tribes live in harmony with their ecosystem making earnings and consumption from nature. Hence, the geographical and ecological conditions predominantly determine the living conditions of the tribal people. Health of any individual or group is directly related to the nutritional status and access to the health services. Our country has a dual burden of overnutrition and undernutrition prevailing known as the nutritional transition phase. Though recent studies have shown improvement in nutrition status, undernutrition still prevails largely in rural tribal communities (Sinha 2018).

Poor relationship with environment, undernutrition and lifestyle factors is the three major reasons affecting the health status of tribal communities (Deodhar 2000). Other factors such as genetic diseases, sexually transmitted diseases, food and nutritional intake and health services used by the tribes also play a major role in deciding health status of tribes (Bisai and Bose 2012). The need to integrate the traditional medical practitioners with modern health services is observed among tribal villages in Central India (Mishra 2012).

In a study conducted among reproductive age Oraon Tribal Women of Jharkhand, India, it was found that even with availability and adequate knowledge, the consumption rates of nutritious food are low. The indigenous food was analyzed and found with a high nutritive value which used properly can steadily improve the nutrition status of the group. Behavior change communication is suggested to increase the nutrition consumption from their natural diets (Ghosh et al. 2012).

Anemia is also seen in the majority of the women which can be the result of worm infestation due to open defecation practices (Kankana 2017). Tribal lives in close association with their ecosystem as they find daily food requirements from nature around them. But the seasonal changes influence them as they have plenty of food at times and very few at the other. It is important to promote settled agriculture and prevent shifting cultivation for improving food habits and ensuring nutritional intake among tribal groups (Panda 2003).

The population explosion and poor access to higher education are identified as important causal factors for poor nutritional status and health outcomes among various tribal societies in the country (Deka 2011). Among the tribal women, the usage of tobacco is high, and due to tobacco use, the quantity of food intake is drastically reduced especially among educated tribal women, as they want to remain skinny. The educational levels were not having a strong association with the nutritional status (Mohandas et al. 2019). Among the Purulias, high infant mortality rate (IMR) and maternal mortality rate (MMR) are observed which are attributed to poor childbirth and nutritional standards (Sikdar 2009).

Kerala has 34 tribal communities spread across predominantly in Wayanad, Idukki, Kasaragod and Palakkad districts. The scheduled tribes account for only

1.8% of the population of the state. Wayanad district accounts for about 35.8% of the total tribal population in the state (Government of India 2013). Kattunayakans who are listed as one among the particularly vulnerable tribes reside in the districts of Wayanad, Kozhikode and Malappuram with a listed population size of 18,886 (Government of India 2011). They are primarily hunters and food gatherers practicing shifting cultivation and other forest-based activities. The nutritional status-related issues are persisting in both sexes among tribal children in Kerala (Vipin 2009). The findings of another study revealed that the severe stress of infant and childhood undernutrition is the reason leading to higher adult malnutrition levels especially among the vulnerable tribal populations. For marginalized communities, these issues add up further hindering their development (Kshatriya and Acharya 2016). The high use of tobacco, severe undernutrition and lack of basic oral health care access has increased the oral disease burden in the Paniya community (Valsan et al. 2016). The prevalence of skin diseases, sexually transmitted infection and reproductive tract infections is higher among various tribal groups in Kerala. The lack of awareness and medication has further deteriorated their health.

16.3 Methodology

As we developed the literature review, we found various health problems but that the nutritional status and factors associated with geographical variations were not studied, especially among the particularly vulnerable tribal groups in Kerala. Hence, this study was conducted to develop the bio profile of *Kattunayakan* tribes in Kerala and associate their nutritional status with several factors along with their health-seeking behaviors.

The study followed a community-based cross-sectional approach using a mixed-method, which is both qualitative and quantitative in nature. A qualitative method was used for a thorough analysis of their knowledge, practices and factors influencing the nutritional status of the Kattunayakan tribal population. Quantitative analysis was used to find the current nutritional status and association with these factors. Kattunayakans belonging to the active and independent age group of 15–59 years of age forms the population of this study. The field survey was conducted in Wayanad district in Kerala where more than 85% of the Kattunayakans' population lives. The sample size calculated using epi info stati calc for population surveys with 90% confidence interval and 5% margin of error. The population of Kattunayakans is 18,886, and hence, the sample size is calculated as 238. Simple random sampling technique is employed to select settlements and the respondents for the study. Local leaders and ST promoters are also interviewed at a later part of this study. In this study, the collected data was coded and entered to MS Excel and then analyzed using SPSS 26.0 software in form of frequencies and corresponding percentage values using the descriptive statistical features. Chi square test was also conducted to interlink some of the variables and find the correlation between them. The level of statistical significance was set at *p-value* less than 0.05.

16.4 Results and Major Findings

With community-based cross-sectional study, a total of 238 responses were collected from various Kattunayakan colonies in Wayanad district of Kerala. The results from the study are illustrated in the form of various tables and figures.

16.4.1 Socio-Demographic and Economic Profile of the Tribes

The demographic data shows that among the respondents, all the age groups and gender were covered almost equally in the study. The majority of respondents were currently living as a nuclear family type. The family members range between 1 and 9 showing a small household in general. The family usually consists of father, mother and unmarried children. The married males try to stay in the same settlements mostly. 36% of the respondents were illiterate, and only 6% had reached at least higher secondary level of education. Majority of the population (52.9%) are working as wage laborers. Kattunayakans are primitive groups that settle close to forest, hence making them forest dependent for income and food. 19.3% still depend on forest for income by collecting honey, a special type of fungi grown in trees and bamboo seeds. Only a 5% of the respondents were engaged in government jobs that too of the lowest cadre. The annual income of the respondents is majorly in between Rs. 25,000/- and Rs. 50,000/- which means the average income in month is around Rs. 6000/-. The daily income is around Rs. 200/-. This meager amount of income they earn shows the poor manual labor conditions. The real poverty-stricken face of the community is revealed through these. All the observed members were belonging to the BPL wealth index. About 82.8% of the population households have electricity either through direct connection or solar provided by the government. About 19.3% of the population finds means of livelihood by collecting forest resources whose sole mode of travel seems to be walking. Only 2.5% of the population uses other means of vehicles like two-wheelers (motor bikes). 68.1% of the population uses flush toilet, most of them build separately behind the house. Most of the settlements have common well from which the population accessed water for household and drinking purposes. Most of the households have pipe connection but few still choose to fetch water directly from the well. 92% of the population uses boiled water for drinking, preventing various water-borne diseases among them. 58.4% of the population still uses firewood for cooking purposes. Only 14.7% have LPG connections.

Other indicators related to housing conditions are shown in Table 16.1.

Table 16.1 Housing conditions of the tribes

Particulars	Categories	Frequency	Percentage
Type of house	Kutcha	12	5.0
	Pucca	161	67.6
	Semi pucca	65	27.3
Type of toilet used	Pit toilet	40	16.8
	Flush toilet	162	68.1
	Open defecation	36	15.1
Source of energy for cooking	Firewood	139	58.4
	Kerosene	64	26.9
	LPG	35	14.7
Mode of travel	Walking	82	34.5
	Bus	150	63.0
	Other vehicles	6	2.5
	Total	238	100.0

16.4.2 Consumption Patterns

Rice is the staple food of the population. Rice is consumed as porridge mostly two times a day. The diet followed by the population is predominantly nonvegetarian. But they consume eggs or meat or fish mostly just once a week. Most of them report two meals a day.

The lack of a proper diet can have an impact on their nutritional status. The majority of them breakfast during the late hours of morning when they leave for work. They skip lunch and have only black tea during the evenings at work. At times, they have some tubers or roots collected at evening times but they usually prefer to save them for later use. It is during dinner time they consume some form of pulses or vegetables available.

There are various government provisions for food provision to them. Majority of the parents sent their kids to school. The kids have midday meal provisions at school which is availed by about 65% of the school-going kids. The part of the population (0–6 year children, pregnant women) eligible for anganwadi services for food and nutrition requirements receive them regularly.

About 31.1% of the population, the majority of them who are men consume alcohol on a daily basis. Most of them consume some form of arrack prepared in their settlements which often has led to liver sorosis especially among men aged 45 years and above.

Tobacco chewing is part of their cultural tradition. Irrespective of age and gender, about 75.5% of the respondents use tobacco. Tobacco consumption has a significant effect on the health and nutrition status of the population as the hunger feeling is suppressed, and food intake happens at irregular intervals. 36% of the respondents report frequent ulcers, whereas 34% report persistent gastric issues.

16.4.3 Knowledge and Practices Related to Nutrition Consumption and Food Hygiene Among the Respondents

The knowledge assessment regarding prevailing nutritional practices among the respondents showed that more than half of them have satisfactory awareness and functional knowledge about the basic needs. They are also well aware of nutritious benefits of milk and milk products and the need for consumption. But contradictorily, majority of the population do not consume them on daily basis mainly because of economic constraints and lack of availability (Table 16.2).

Meat consumption on daily basis is not preferred. About 41.1% of the respondents believe meat consumption must be restricted to once a week. 67.5% of the population is aware of the need to have high iron-rich food for women.

Various practices that impact nutritional and health status have been assessed. Only 57.6% of the population used boiled water alone while 35.3% tend to drink any unboiled water. A significant number of the population regularly wash hands before food consumption. Due to their economic status, the consumption of fruits is very low. Only 19% of the population has consumed fruits regularly. All of them practice closed cooking, thereby reducing the energy source utilization. Regarding the sleep pattern, 84.9% of the population has normal sleeping hours of about 6–8 h. Hardly

Table 16.2 Knowledge regarding the nutrition among the tribes

Particulars	Categories	Frequency	Percentage
Amount of water we should drink in a day	< 1 l	20	8.4
	2 l	181	76.1
	3 l	36	15.1
	> 4 l	1	0.4
	Total	238	100.0
Milk and products good for health	Yes	236	99.2
	Do not know	2	0.8
	Total	238	100.0
Daily meat consumption recommended	Yes	112	47.5
	No	97	41.1
	Do not know	27	11.4
	Total	236	100.0
Iron-rich food to be consumed by women	Spinach	160	67.5
	Banana	27	11.4
	Rice	1	0.4
	Grapes	49	20.7
	Total	237	100.0

Table 16.3 The various practices followed by the respondents

Particulars	Categories	Frequency	Percentage
Drinking water	Boiled	137	57.6
	Unboiled	17	7.1
	Either	84	35.3
Washing hands before consuming food	Yes	233	97.9
	No	3	1.3
	Maybe	2	0.8
Consumption of fruits the day before	Yes	45	19.0
	No	192	81.0
Washing of vegetables	Before peeling and slicing	185	77.7
	After peeling and slicing	53	22.3
Open or closed cooking	Closed pan	238	100.0
	Total	238	100.0

8% of the population has reduced sleep of fewer than 6 h which has a significant impact on their health (Table 16.3).

16.4.4 Anthropometric Measures

The anthropometric measure is used to study, assess and analyze the nutritional status of the individuals. BMI is the most significant anthropometric measure used calculated from the weight and height of an individual (Fig. 16.1).

Here as we observe that the majority of the population belonged either to the underweight or normal weight category. About 40.3% of the population still belongs to the underweight category. This can be due to various reasons. Only 7.6% of the community belongs to the pre-obesity category. Both underweight and pre-obesity show unhealthy nutritional status (Fig. 16.2).

Nutrition deficiency signs are seen in some of the respondents of which the most common sign is angular stomatitis (20.6%), followed by pallor (13.9%) and bitot spots (13.9%). Both age and nutrient deficiency can influence the signs shown (Fig. 16.3).

Majority of the population shows poor oral hygiene. Oral hygiene signs such as DMF teeth are very common in about 74.4% of the population. This can be attributed to the tobacco chewing habit among them.

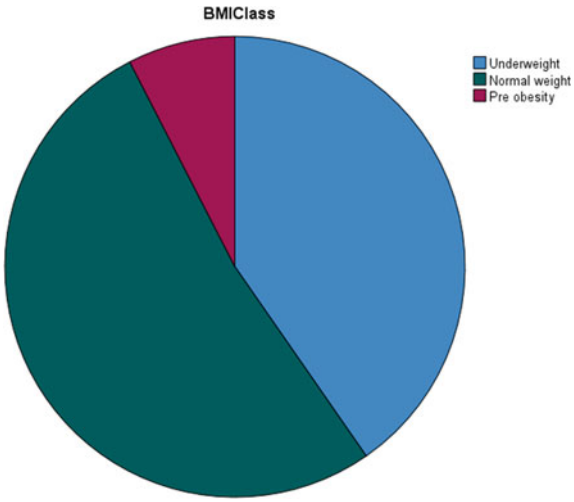


Fig. 16.1 BMI status of the tribes

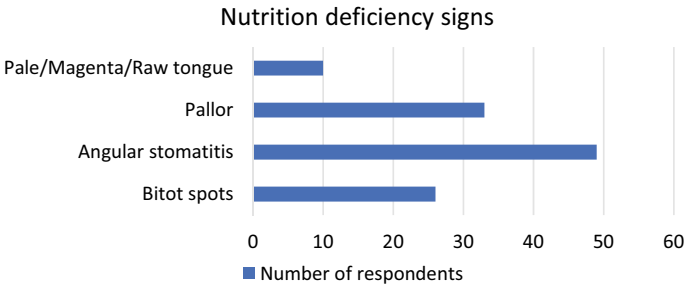


Fig. 16.2 Nutritional deficiency signs observed in the tribes

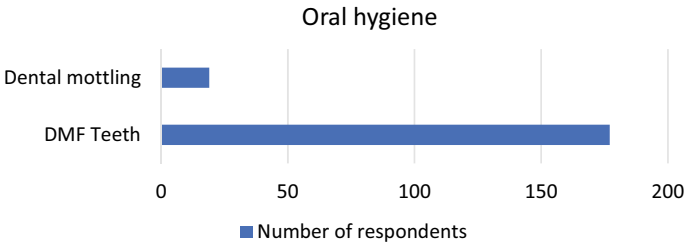


Fig. 16.3 Oral hygiene among the tribes

16.4.5 *Factors Influencing the Anthropometrics of the Respondents*

The various socio-demographic and economic conditions have an impact on the BMI and thereby the nutritional status of the population. The demographic factor of age shows an association with the BMI of the respondent, while gender has no influence on BMI of the respondent. We find the age group 41–45 shows more normal weight. Low BMI is prevalent among respondents aged above 55. More details are depicted in Table 16.4. The data in Table 16.5 shows that there is a significant association between the factor's education, occupation and income on the BMI of the respondents. The type of house also influences the BMI of the respondents. Normal weight was observed more in respondents living in pucca houses. The type of toilet used, however, does not have any association with the BMI status of the respondent.

The lifestyle patterns followed by the respondents such as consumption of alcohol do not have any association with the BMI status of the respondent, while tobacco usage influences the BMI of the respondent tribes (Table 16.6).

Table 16.4 Socio-demographic factors and BMI

Particulars	Categories	Underweight	Normal weight	Pre-obesity	Total
Age *p-value* = *0.002*	15–20	18	14	0	32
	21–25	16	24	3	43
	26–30	12	7	3	22
	31–35	6	10	0	16
	36–40	14	17	8	39
	41–45	9	24	3	36
	46–50	5	17	1	23
	51–55	3	6	0	9
	Above 55	13	5	0	18
Total		96	124	18	238
Gender *p-value* = *0.323*	Male	42	65	7	114
	Female	54	59	11	124
Total		96	124	18	238
Education *p-value* = *0.035*	Illiterate	35	46	5	86
	Read and write	5	20	3	28
	Primary education	32	42	10	84
	Secondary education	16	10	0	26
	Senior secondary education	8	6	0	14
Total		96	124	18	238

Table 16.5 Economic factors and BMI

Particulars	Categories	Underweight	Normal weight	Pre-obesity	Total
Occupation *p-value = 0.001*	Collection of forest resources	17	24	5	46
	Agriculture	5	2	0	7
	Wage laborers	48	72	6	126
	Govt/semi govt job	4	8	0	12
	Unemployed	12	5	7	24
	Student	10	13	0	23
Total		96	124	18	238
Income per annum *p-value = 0.001*	No income	12	4	5	21
	Up to Rs. 25,000	24	20	6	50
	Rs. 25,001–Rs. 50,000	40	51	5	96
	Rs. 50,000–Rs. 100,000	7	29	2	38
	Rs. 100,000–Rs. 200,000	3	7	0	10
	Not applicable	10	13	0	23
Total		96	124	18	238
Type of house *p-value = 0.004*	Kutcha	2	10	0	12
	Pucca	59	92	10	161
	Semi pucca	35	22	8	65
Total		96	124	18	238
Type of toilet used *p-value = 0.176*	Pit toilet	11	25	4	40
	Flush toilet	70	83	9	162
	Open defecation	15	16	5	36
Total		96	124	18	238

Table 16.6 Lifestyle factors influencing the BMI of the tribes

Particulars	Categories	Underweight	Normal weight	Pre-obesity	Total
Consumption of alcohol *p*-value = 0.791	Yes	26	37	6	69
	No	63	80	10	153
Total		89	117	16	222
Smoking/chewing tobacco *p*-value = 0.036	Yes	79	90	10	179
	No	17	33	8	58
Total		96	123	18	237

16.4.6 Health Seeking Behavior

The tribals have their own indigenous medicinal system for diagnosis and treatment. Yet with time, it is observed that they are trying to adjust and utilize the modern medicinal system. Majority of the population visits government health centers, while a minority of 2.6% never visits any of the health centers. 45.8% of the population frequently avail the health services, but 52.1% rarely use the health service provisions. This is mainly because they use their traditional indigenous medicinal system for treatment mostly and their poor economic status. Among the population utilizing the services, 93.1% finds the service provisions affordable and satisfactory.

Medical insurance coverage is availed by 52.5% of the population of which majority are government medical insurances. Most of them are covered under the PM-JAY scheme by the Central Government of India. 47.3% of the population do not have any insurance coverage or have insurance outdated. The major barriers faced by them for achieving better status are illiteracy and non-affordability of the services. Some of the other reasons stated were lack of hospitals close by and some other personal reasons.

The overall development of the community is required for better nutrition and health status. The suggestions from the Kattunayakan tribes themselves have been noted as more government focus and funding (98.3%), providing more jobs (95.8%) and improving their educational status (81.9%) are the main suggestions.

16.5 Discussion

This study was conducted among the Kattunayakan tribes in Wayanad district of Kerala, where a total of 238 people of age group 15–59 were selected as participants. One of the major objectives of our study was to assess the nutritional status of the community. In general, tribal populations in the country report poorer health status and indicators compared to the general population (Basu 2000).

Kerala, as a state with better Human Development Index, has a dual burden of overnutrition and undernutrition prevailing known as the nutritional transition phase. In Kerala, 50% of adults in scheduled tribes are undernourished with low BMI. In our study, 52.1% report normal weight as per their age and height. 7.6% of the participants belonged to the pre-obesity category. This can be due to unhealthy lifestyle and occupational lifestyle factors. The Kattunayakan tribes we studied show fairly good knowledge and practices about nutrition and food consumption. This contrasts the reports that among tribal farm women in general, cooking methods are inappropriate and unhygienic (Dave et al. 2019).The data from Maharashtra tribal population reveals that affordability and accessibility are still the major reason for their low nutrition consumption (Rokade et al. 2020). Our study also confirms the same barrier among Kattunayakan tribes for achieving better nutritional status. The BMI status of tribal women of different age groups revealed that the young adult population has

better nutrition status in comparison with the older population (Nayak and Sreegiri 2016). Our study findings also corroborate with this observation.

Gender gap among BMI values is very commonly observed among tribal communities of India (Mahajan et al. 2019). Prevalence of undernutrition was profoundly higher in women revealing the discrimination still existing in the society. But an exception of males having higher undernutrition was found in the Kukna tribes of Gujarat broadcasting a cross-cultural variation in Indian tribes (Dey and Bisai 2019). Contrasting to these studies, our studies showed no association between gender and BMI status of the tribes. This agrees with some previous studies showing the status of tribes in Kerala having better health and development status compared to other Indian tribes (Devan 2006; Haddad et al. 2012).

The BMI status can be influenced by various social, economic, occupational, educational and lifestyle factors. Our study also seeks to provide insight into specific socio-economic, housing and lifestyle factors that have shown association with anthropometric measures. Occupation and income show significant association with BMI classification in the tribes with p-value 0.001. Lower economic level is always attributed with lower health status. Education is also shown having association with nutritional status but not as significant as occupation or income. Type of house they live in and the habit of tobacco chewing is also observed having association with the nutritional state of participants. These results help us understand the lifestyle, nutritional and health status of the population. As explained by the previous studies (Jancy 2007; Nagda 2001), we find that even improving the health status of the tribal population requires an overall improvement in their economic arena and other development indicators. We have found a significant association between education and occupation on nutritional status and hence improving these two indicators will help improve nutritional status. There is also a need for serious interventions to be taken to reduce tobacco consumption as they give tobacco since childhood considering it their tradition and culture.

16.6 Conclusion

Health of any individual or group is directly related to the nutritional status and access to health services. Tribal lives in close association with nature and is primarily dependent on them to meet the nutritional requirements. The Kattunayakan community has always been deprived of creche and basic facilities, which has forced them to remain underdeveloped in most aspects of life. The findings of this study have shown a steady social and nutritional transition among the tribes. The determinants that affect the nutrition status most are education, occupation, income, housing conditions and lifestyle. Education, occupation and employment are always interrelated, which in this community is comparatively low. The socio-economic upliftment of the community is occurring in the community, and the results are positive in nutritional and health aspects.

The lifestyle pattern of chewing tobacco citing them as a part of their tradition and culture needs to be curbed to further improve their health status.

References

Bagai S, Nundy N (2009) Tribal education: a fine balance. Dasra catalyst for social change. Mumbai
Basu S (2000) Dimensions of tribal health in India. Health Popul Perspect Issues 23(2):61–70
Bisai S, Bose K (2012) Critical nutritional stress among adult tribal populations of West Bengal and Orissa, India. Nat Preceding's.https://doi.org/10.1038/npre.2012.7068.2
Census of India (2011). Registrar General, Government of India. New Delhi
Das S, Bose K (2015) Adult tribal malnutrition in India: an anthropometric and socio-demographic review. Anthropol Rev 78(1):47–65. https://doi.org/10.1515/anre-2015-0004
Dave PH, Mistry J, Chaudhary M (2019) Nutritional status and food consumption pattern of tribal farm women of Sabarkantha. Int J Curr Microbiol App Sci 8(03):2239–2245. https://doi.org/10.20546/ijcmas.2019.803.267
Deka S (2011) Health and nutritional status of the Indian tribes of Tripura and effects on education. Int Student J. http://www.studentpulse.com
Deodhar NS (2000) Rural Health-Merging Scenario. Kurukshetra 49(1):40–47
Devan PK (2006) Kundal Pani: by gone days of bitter Adivasian slavery. Kerala calling
Dey U, Bisai S (2019) The prevalence of under-nutrition among the tribal children in India: a systematic review. Anthropol Rev 82(2):203–217. https://doi.org/10.2478/anre-2019-0015
Ghosh-Jerath S, Singh A, Lyngdoh T, Magsumbol MS, Kamboj P, Goldberg G (2018) Estimates of indigenous food consumption and their contribution to nutrient intake in Oraon tribal women of Jharkhand, India. Food Nutr Bull 39(4):581–594. https://doi.org/10.1177/0379572118805652
Ghosh-Jerath S, Singh A, Bhattacharya A, Ray S, Yunus S, Zodpey SP (2012). Dimensions of nutritional vulnerability: assessment of women and children in Sahariya tribal community of Madhya Pradesh in India. Indian J Public Health 57(4):260–7. https://doi.org/10.4103/0019-557X.123268. PMID: 24351389
Global Hunger Index (2020) One decade to zero hunger: linking health and sustainable food systems. Chaatam House, Bonn
Government of India (2011) Census. Registrar General of India, Delhi
Government of India (2013) Economic survey 2012–13. Department of Statistics and Planning, New Delhi
Haddad S, Mohindra KS, Siekmans, K, Màk G, Narayana, D (2012) Health divide between indigenous and non-indigenous populations in Kerala, India: Population based study. BMC Public Health 12(1). https://doi.org/10.1186/1471-2458-12-390
Jancy FG (2007) Tribal identity, and the distribution and dynamics of Malabar tribes. J IRISH, pp149–162
Kankana D (2017) Health awareness among tribals of rural India. J Mol Genet Med 11(1):1–1000244. https://doi.org/10.4172/1742-0862
Kshatriya GK, Acharya SK (2016) Triple burden of obesity, undernutrition, and cardiovascular disease risk among Indian Tribes. Plos One 11(1). https://doi.org/10.1371/journal.pone.0147934
Mahajan N, Kumari A, Kshatriya GK (2019) Prevalence of undernutrition and gender disparities among Kukna and Santal tribal population groups of India. Res J Humanit Soc Sci 10(2):351. https://doi.org/10.5958/2321-5828.2019.00061.5
Mishra M (2012) Health status and diseases in tribal dominated villages of central India. Health Popul Perspect Issues 35(4):157–175
Mohandas S, Amritesh K, Lais H, Vasudevan S, Ajithakumari S (2019) Nutritional assessment of tribal women in Kainatty, Wayanad: a cross-sectional study. Ind J Commun Med 44(5):50. https://doi.org/10.4103/ijcm.ijcm_39_19

Nagda BL (2001) Tribal development in Rajasthan. Kurukshetra, pp 36–43
Nayak M, Sreegiri S (2016) A study on nutritional status of tribal women in Visakhapatnam district, Andhra Pradesh, India. Int J Commun Med Public Health 2049–2053. https://doi.org/10.18203/2394-6040.ijcmph20162544
Panda PK (2003) Poverty and young women's employment linkages in Kerala. Econ Polit Wkly 35(38)
Rokade S, Mog M, Mondal NA (2020) Nutritional status among tribal women in Maharashtra, India: spatial variations and determinants. Clin Epidemiol Glob Health 8(4):1360–1365. https://doi.org/10.1016/j.cegh.2020.05.012
Sikdar M (2009) Continuity and change in matrilineal marriage system: a case study among the Garos of PoschimBosti, Assam. Stud Tribes Tribals 7(2):125–130
Sinha T (2018) A Study about the health status of tribal women in Bastar Region, Chhattisgarh, India. Int J Prev Curative Commun Med 04(04):5–8. https://doi.org/10.24321/2454.325x.201828
Valsan, I, Josepj J, Janakiran C, Mohamed S (2016) Oral health status and treatment needs of Paniya tribes in Kerala. J Clin Diagn Res 10(10):Zc12–Zc15
Vipin CKP (2009) Nutritional status of pre-school children in rural areas of Kasaragod district in Kerala. PhD thesis submitted to the Kannur University

Chapter 17
Living with Reduced HIV/AIDS Stigma and Discrimination: A Migrants-Theoretical Scheme

Nikhil Kumar Gouda

Abstract As per the Global HIV and AIDS statistics—fact sheet released by the Joint United Nations Programme on HIV and AIDS (UNAIDS) in 2021, the world had a total of 37.7 million people living with HIV in 2020 with adults of 36.0 million and children (0–14 years) of 1.7 million. Women and girls constitute 53% of total HIV population. About 16% of population did not know their HIV status in 2020 (UNAIDS in FACT SHEET—WORLD AIDS DAY 2021. https://www.unaids.org/sites/default/files/media_asset/UNAIDS_FactSheet_en.pdf). India bears the world's third-largest HIV population with 2.3 million having 1.2 million with HIV incidence per 1000 population (all ages) being 0.04 (UNAIDS in Country factsheets INDIA 2020. https://www.unaids.org/en/regionscountries/countries/india). This chapter provides a theoretical scheme to reduce urban migration linked HIV/AIDS stigma and discrimination using narratives of people living with HIV/AIDS (PLHIV) for data collection and Grounded Theory approach (Interpretative Approach) for its analysis. With socially responsible approaches to mass media, the study aims to understand the types of HIV/AIDS stigma and discrimination present in our society; the ways by which HIV/AIDS stigma and discrimination defeat HIV/AIDS reduction campaigns in society and finally the possible measures that can be taken to reduce the HIV/AIDS stigma and discrimination?

Keywords Living with HIV · Stigma and discrimination reduction · Strategy

17.1 Introduction

A number of studies suggest that stigma and discrimination are major obstacles to effective HIV/AIDS response. The stigma attached to HIV/AIDS and subsequent discrimination has shown devastating effects: Abandonment by spouse and/or family, social ostracism, loss of job and property, expulsion from educational institutions,

N. K. Gouda (✉)
Department of Media and Communication, School of Communication, Central University of Tamil Nadu, Thiruvarur, India
e-mail: nikhilkumar@cutn.ac.in

A. Grover et al. (eds.), *Sustainable Health Through Food, Nutrition, and Lifestyle*, Advances in Geographical and Environmental Sciences,
https://doi.org/10.1007/978-981-19-7230-0_17

denial of healthcare services, and violence. These or the fear of them demotivate common people to go for HIV testing, making their HIV status public, practising HIV-safe behaviour, or availing treatment, care and support on diagnosis**.** When they do, they face dire social consequences; letting the disease to spread by leaps and bounds in silence and bringing to a state of monstrous proportion (UNAIDS 2007; Spark 2007).

Marginalized groups, who are at risk of HIV infection, are doubly stigmatized as stigma builds on existing social inequalities. Women face more stigma and discrimination than their men counterparts in many settings. Stigma and discrimination are still an everyday experience even in places where people with HIV/AIDS are publicly recognized and accepted (Spark 2007).

Reduction of HIV/AIDS stigma and discrimination has been a major challenge for policy makers to combat the spread of the disease in a society.

17.1.1 What is Stigma?

Erving Goffman writes in his book, *STIGMA: Notes on the Management of Spoiled Identity* that the term 'stigma' originated by the Greeks refers to some bodily signs denoting something bad, polluted, to be avoided in public places (Goffman 1963). UNAIDS defines it as a dynamic process of devaluation that 'significantly discredits' an individual in the eyes of others. This may be on skin colour, manner of speaking, or sexual preference. Stigma is deeply entrenched in our value system. HIV- or AIDA-related stigma reinforces social equalities especially linked to gender, race and ethnicity, and sexuality. Stigmatization can also happen with people living with HIV may internalize the negative reactions of others which is called 'self' or 'internalized' stigmatization. Where people living with HIV may feel shame, self-blame, worthlessness, isolation which can lead to depression, withdrawal and even suicidal feelings (Aggleton et al. 2005).

17.1.2 What is Discrimination?

When stigma is acted upon, the result is discrimination. Warren Blumenfeld in his chapter of the book, *Encyclopaedia of AIDS: A Social, Political, Cultural, and Scientific Record or of the HIV Epidemic*, defines discrimination as, 'the denial of equal treatment to an individual or to a group of people on the basis of an adverse opinion or belief…' (Blumenfeld 1998). Discrimination is often based on prejudice out of an insensible fear. Denial of services to people living with HIV/AIDS at a restaurant based on their HIV status is an example of a discriminatory act. Some other examples of HIV/AIDS discrimination can be: some religious sects do not accept HIV-positive people into their fold and opine that HIV is God's judgement against sexual perversity like homo-sex. The language of the media such as 'innocent

victims' to refer small children with HIV, people infected from blood transfusions denote that the rest of the HIV-positive people are guilty perpetrators. The externalized stigma or discrimination may lead to decreasing self-confidence; drop in motivation, withdrawal from social contacts, avoidance of health-based interactions, and giving up of planning for the future. HIV-related discrimination frequently makes way to present social inequalities and intersect with other forms of discrimination based on gender, sexuality, ethnicity and those associated with particular behaviours and activities.

17.1.3 Discrimination at Different Settings

Research has shown that discrimination was found across all sections of society. However, some of the key places, important from the point of view of human existence and development are Family, Community, Employment, Education, Health care, Religion, Gender, and People Living With HIV (UNAIDS 2011).

17.1.4 Consequences of HIV/AIDS Stigma and Discrimination

The consequences of stigma and discrimination are many and varied. They can be: no to sex and marriage, no to further education and training, avoiding health care services, unequal treatment at educational institutions, and loss of hope and feelings of worthlessness (UNAIDS 2011).

17.2 HIV/AIDS Present Status

As per the Global HIV and AIDS statistics—fact sheet released by the Joint United Nations Programme on HIV and AIDS (UNAIDS) in 2021, the world had a total of 37.7 million people living with HIV in 2020 with adults of 36.0 million and children (0–14 years) of 1.7 million. Women and girls constitute 53% of total HIV population. About 16% of population did not know their HIV status in 2020 (UNAIDS 2021).

India bears the world's third-largest HIV population with 2.3 million having 1.2 million with HIV incidence per 1000 population (all ages) being 0.04 (UNAIDS 2020). Over the past decades, India has made significant progress by containing the spread of the disease and bringing the new infection down by 85% compared to the peak of 1995 and by 27% between 2010 and 2017 (NACO 2018) by targeted interventions at high-risk groups. However, the emergence of new pockets of infections including in Gujarat, Bihar, Delhi, Chhattisgarh, Rajasthan, Odisha, and Jharkhand

have become points of worry for the policy planner which needs close monitoring and interventions (AVERT 2018).

17.3 HIV/AIDS Stigma and Discrimination as Roadblock in the Containment of the Disease

Author R. Smart in his book writes about various types of stigma: self-stigma, a process of feeling different, inferior, unworthy; felt stigma—the feelings towards people living with HIV/AIDS by others and enacted stigma—the reactions propelled by stigma and sometimes called as discrimination (Smart 2012). Descriptive studies by researchers (Bharat et al. 2001; Pallikadavath et al. 2005; Thomas et al. 2005) mention the presence of Enacted, Perceived, and Internalized stigma (or self-stigma) in the Indian context, whereas researchers (Bharat et al. 2001; Chakrapani et al. 2007) have reported about Courtesy stigma or stigma by association like stigma experienced by family members of HIV-positive men who have sex with men (MSM), etc. Other sets of researchers (Bharat et al. 2001) reported about Layered stigma, i.e. HIV-related stigma spreading over other types of social inequalities expediting the process of exclusion and devaluation of HIV patients. The stigma and discrimination among HIV-positive MSM are compounded due to their being a member of a traditionally stigmatized group of Indian society. Apart from various types, researchers have also found out various places of stigma and discrimination.

HIV/AIDS-related stigma and discrimination may occur at various levels, such as a family, community, workplace, school, healthcare settings, and even after death in relation to the disposal of bodies and funeral arrangements (Maluwa et al. 2002; UNAIDS 2000). Another study by UNAIDS identified a few more places of occurrences of stigma and discrimination: Within individuals, institutions, media, government policies, and practices as critical obstacles to effectively addressing the problem of HIV/AIDS (UNAIDS 2007). This list is further broadened by an Asia Pacific Regional Analysis report (UNAIDS 2011) prepared by UNDP which states HIV stigma and discrimination continues to be felt all over the world and in varying degrees across all settings, e.g. at family, community, employment, education, healthcare, religion, and gender.

Self-stigmatization weighs heavy on the individual in countervailing the community-based initiatives to reduce stigma and discrimination. An Asia Pacific Regional Analysis, 2011 (UNAIDS 2011), prepared by UNAIDS finds that stigma and discrimination is the biggest hurdle for HIV prevention, treatment, care, and support by reducing one's willingness to go for HIV testing, make their status public, indulge in safe sex and to seek health care. Stigma dilutes the services to reach people most in need of prevention, treatment, and care. It also delays the treatment and care for HIV-positive people (Mawar et al. 2005).

Narain (2012) in the book, *Three decades of HIV/AIDS in Asia* suggest that sustained political commitment, adequate human and financial resources and intersectorial crucial for the prevention and management of HIV (Narain 2012). This is supported by a UNAIDS case study of 2001 (UNAIDS 2001) that recommends a decentralized, participatory approach- involvement of all sectors-is the only way to get wider coverage and enable programmes to reach all those who are hard to reach, especially at the grass-roots which will in turn help in reducing stigma and discrimination.

A UNAIDS technical update of 1997 (UNAIDS 1997a, b) puts a premium on community-level actions especially initiated by the victims of disease or the persons affected by HIV as a crucial stakeholder in the global reaction to AIDS. Education for increased acceptance, respect, and compassion for the patients in society goes a long way in reducing HIV/AIDS stigma and discrimination (Maluwa et al. 2002). Ram Shankar Singh and Sunil Kumar in their study indicate that the most important way to change risky behaviour is by health education. It leads to higher health literacy and cautious sex behaviour (Singh and Kumar 2011). However, researcher Jaiswal, in his book, *AIDS-Causes and Prevention* (Jaiswal 1992) writes that AIDS education messages must be customized to the local needs and can be carried out by big and small media. A 2004 report of UNAIDS, *The media and HIV/AIDS: making the difference* (UNAIDS 2004) cites television has been the dominant mass media to receive information about HIV/AIDS. One of the best practice collections of UNAIDS, *Getting the message across: the mass media and the response to AIDS* states that mass media have unrivalled potential to inform and educate the general public. It cites radio and television are key sources of information about AIDS by large numbers of people (UNAIDS 2005). The above findings are shared by a USAID discussion brief (USAID 2009) that points out that mass media have been largely successful in creating awareness about HIV/AIDS among people, but the reduction of stigma needs more than awareness generation. India has used mass media, e.g. radio and TV extensively since the outbreak of the epidemic for dissemination of HIV/AIDS knowledge to create awareness (Bharat 2011).

Again, researchers worldwide have agreed that working with the mass media is hugely challenging. Producing programmes is expensive; competition for broadcast time and space in print media is fierce (UNAIDS 2005). In the Indian context, Indian media with its market orientation covers HIV-related news in a very casual manner. AIDS as an issue has to compete with so many other important events for coverage in dailies, (Singh 2002). Again, media perpetuate certain perceptions of HIV/AIDS and stereotype PLHAs. They are represented as sick and dying, 'promiscuous' others as per a study of tackling HIV/AIDS stigma (Insideout Research 2003). The study further reiterates that media practitioners highlight only those angles of their stories that make them more newsworthy.

Research warns that the HIV/AIDS pandemic is entering a more dangerous phase of growing complacency, continuous denial, and increasing discrimination (Parveen 2010). Creative positioning of efforts against AIDS is needed. Here, the approach of Singhal and Rogers is called Entertainment Education (E-E) (Singhal and Rogers 2002), where individuals can be engaged in observational learning by viewing

mediated content which could be effective in changing stigma-related perceptions (Bandura 1977) emerges as an alternative.

Other alternatives, as per a national IEC/BCC strategic framework document of NACO (2004), is the change in strategy by mixing mass media campaigns on HIV/AIDS with adequate interpersonal communication and community involvement. This change in strategy is further elaborately suggested in one of the best practice collections of UNAIDS (2005) pointing out mixing media to make the maximum impact on the general public (UNAIDS 2005). The above claims are further supported by a USAID discussion brief (USAID 2009) which finds that with the complex nature of HIV and AIDS, interactive, and interpersonal platforms are most effective in disseminating accurate information, clarifying misconceptions, and alleviating fears. Till now, HIV/AIDS communications campaigns worldwide have underestimated and underutilized traditional oral communication channels which are highly rich in visual imagery. Proverbs, adages, riddles, folklore, and storytelling have been found to be important communication tools (UNAIDS 2001).

Counselling and voluntary HIV testing in largely healthy populations have contributed to scale up in safe behaviour at the individual level and are to reduce the ignorance, fear, and stigma connected with HIV infection in the population (UNAIDS 2001). Counselling through plays an important role needs to be right. A 1997 technical update on Counselling and HIV/AIDS by UNAIDS (UNAIDS 1997a, b) talks about the importance of good counselling as the key to helping prevent HIV transmission as it helps people in making informed decisions, e.g. to have an HIV test, to adapt better to their condition, and lead an optimistic life.

Another strategic change for effectively tackling HIV/AIDS stigma and discrimination described by researchers is the use of localized community media for the grassroots level involving multiple stakeholders. It can help normalize rather than marginalize the PLHIV by providing mutual support (Adam and Harford 1999). The above localized concept is further supported by UNAIDS-led deliberations (UNAIDS 2001) which suggest that communication programmes should be localized involving multi-sectoral and multidisciplinary stakeholders, including the government, civil society organizations, and the private sector.

Various formal deliberations on *HIV/AIDS* (UNAIDS 2001) stress the importance of pro-HIV/AIDS government policies, laws, and regulations in the fight against the disease as the continuation of communication campaigns majorly rely on the national policy on the disease. This is further supported by a policy brief on the Criminalization of HIV Transmission of 2008 (UNAIDS 2008a, b) that urges Governments to limit criminalization to cases of intentional transmission of HIV virus to a healthy person instead of punishing and providing discriminatory provisions for people living with HIV/AIDS. Government should roll out measures to reduce HIV transmission that can be providing HIV information, support and commodities to people for practising safer behaviours; increasing access to voluntary confidential HIV testing and counselling; and addressing HIV-related stigma and discrimination.

17.4 Research Questions

With socially responsible approaches to mass media, the study asked:

1. What are the types of HIV/AIDS stigma and discrimination present in our society?
2. How does HIV/AIDS stigma and discrimination defeat HIV/AIDS reduction campaigns in society?
3. How to reduce the HIV/AIDS stigma and discrimination?

17.5 Method and Methodology

Ten (10) narratives were collected from people living with HIV/AIDS (PLHIV) after lots of searches with snowball sampling. Among them were six (6) men of the age range of 30 to 49 years; three (3) women (spouses of migrant workers) of the age ranging from 32 to 37 years; and an MSM (Men who have sex with men) in his 30s.

The proposed research used the Grounded Theory approach (Interpretative Approach) which is a method as well as a methodology for analysing the data as it is the most popular method of analysing qualitative data dealing with sensitive issues like HIV/AIDS.

The narratives can be defined as the life histories of the interviewees constructed by the active interplay between interviewer and interviewee (Cohen et al. 2008).

17.5.1 Place of Research

The place of research—the Ganjam district of the state of Odisha of Govt. of India—accounts for around 33% of Odisha's HIV population (Express News Service 2018) and with HIV prevalence > 1% grouped under the Category A district of India. However, the state Odisha has 46,264 people living with HIV infection (Express News Service 2018) has been able to bring down the HIV prevalence from 0.31% in 2010 to 0.13% which is below the national average of 0.22%. The high prevalence in the district of Ganjam has been linked to large scale migration to urban areas.

17.5.2 Planning and Preparation

The basic questions to ask were planned with special emphasis on its mode of asking in order not to hurt the narrators and risk a walkout in between. Quiet and pleasant places were selected for narratives to be conducted. Sometimes the places of choice of

narrators were agreed upon. Audio recorders were arranged to record the narrations. Refreshments and other orderly services were arranged for the smooth conduct of the narratives.

17.5.3 Gaining Access

Gaining access to PLHIV narrators as per theoretical sampling described in Grounded Theory was really a difficult task. However, it was made possible with the help and support of some of the office bearers of local NGOs and CBOs. Their invaluable leads and references helped in establishing contacts with prospective narrators and then convincing them to narrate their stories without apprehensions.

17.5.4 Conduct and Transcription

Following Riessman (1993), the narratives consisted of three stages: telling, transcribing, and analysing (Riessman 1993).

Telling: The narrators were given a facilitating context and encouraged to narrate stories about landmark moments in their lives. Mostly, open-ended questions were used for this purpose among others. In an attempt to balance between the need to obtain a complete story and the practical limitations of time and data, the narrators were intervened in between mostly to bring them on track during their narration. However, the researcher was sensitive enough not to hurt them at any point in time. Care was taken not to break the flow of narration.

Transcribing: The entire narrations were audio-recoded. Clarifications were sought at the end of the narration. The entire narration was transcribed on paper as the first draft (most of the time at home). The first draft was then taken for editing. In order to bring validity, the narrators were made to read the edited narratives later on and feedback correctness was invited. After making minor changes as per the feedback, the narratives were made ready for analysis.

Analysing: The narratives were analysed with the help of the Grounded Theory (Strauss and Corbin 1998) method.

17.5.5 Ethics in Data Collection

Ethical issues during data collection were kept in mind as the researcher was dealing with a sensitive issue of HIV/AIDS stigma and discrimination. The participants were made aware of the research project—its purpose and objectives. Their consent was

taken before collecting any data from them. The option was also given to them to leave the narration in the midway if they are uncomfortable for whatever reasons possible.

All care was taken to make the narrators comfortable. The privacy issue was addressed with narratives being taken in rooms where no other person except the narrator and researcher were present. Questions, observations, and salutations were very carefully and wisely constructed not to instil in them an iota of stigma which would defeat the very purpose of the study.

Some respondents had objections regarding the recoded audiotapes beyond a specific time. Promises were made to destroy the audiotapes of PLHIV respondents immediately after the fulfilment of research objectives. This was accepted by the respondents.

17.6 Analysis of Data

For analysis of qualitative data, the Grounded Theory method (Strauss and Corbin) was used.

17.6.1 Open Coding

Categories, sub-categories, and concepts of narratives of PLHIV developed by CCM (Constant Comparison Method) of Grounded Theory Approach (Strauss and Corbin 1998) for the study (Table 17.1).

17.6.2 Axial Coding

In Axial coding, sub-categories were related to their respective categories linking categories at the level of properties and dimensions.

17.6.3 Selective Coding

As per the Grounded Theory, selective coding is defined as the process of integrating and refining a theory. All categories are unified under a core category, which is a central phenomenon of the study. The categories after axial coding were.

- HIV/AIDS S&D
- Communication and S&D reduction
- Other S&D reduction means.

Table 17.1 Showing category HIV/AIDS stigma and discrimination and its sub-categories and concepts

Category	Sub-categories with concepts
HIV/AIDS S&D	*Self-stigma*
	Helplessness
	Self-blame
	Repentance
	Shock
	Negative thoughts
	Shame
	Difficulty in justifying
	Death fear
	Thought of relative's harsh behaviour and hatred
	Suicide
	Perceived loss of earning ability
	Anticipation of S&D at village
	S&D at friends
	Honouring confidentiality
	Friends' care and support
	S&D at workplace
	Avoidance by co-workers
	Work unaffected
	Supervisor's behaviour unchanged
	S&D at family
	Wife's support
	Mother's abuse
	Discriminatory behaviour in family
	Separated utensils
	Separating clothes
	Refusal to dine with
	Fear of shared living
	Relatives abandoned
	Hurting most
	Hate
	Blame
	Curse
	Driven out of family
	Wife's grief
	Family (well educated) support

(continued)

Table 17.1 (continued)

Category	Sub-categories with concepts
	S&D at village
	Early death prediction
	Avoiding people
	Merciless beating
	Negligence in religious services
	Bar from community facilities
	Bar from common gatherings
	Treating with contempt
	People's avoidance
	Gossip
	Being shunned
	Derogatory comments
	Denial of barber services
	Difficult life
	Boycotting services
	Job loss
	Perceived threat to others' health
	Suffering of family members
	Things improving
	S&D at hospitals
	Insulting words
	Doctors' abuse
	Doctors' negative attitude
	Doctor's prediction of early death
	Doctors blame
	Doctors curse
	Negligence in surgery dept
	Patients needing surgery die
	Ill treatment at surgery ward
	Refusal to admit
	Doctors' disobedience to superiors
	Minor treatment on insistence
	Admission not operation
	Badmouthing superiors
	A little improvement
	A little treatment at medicine ward
	Treatment to mother–child

(continued)

Table 17.1 (continued)

Category	Sub-categories with concepts
	Factors of S&D
	Associated health problems
	Mental tension
	Financial problems
	Fear of early death
	Fear of children being orphan
	Fear of spread
	Fear of infection
	Negative attitude
	Ignorance
	Consequences of S&D
	Irritation
	Frustration
	Feelings of suicide
	Generating self-stigma
	Creating helplessness
	Fear of future treatments
	Fear of negligence
	Fear of horrible death
	Hesitation for HIV testing
	Hesitation for status disclosure
	Suffering
	Avoiding medicine
	Symptomatic treatments
	Infecting wives/partners and children
	Hospital S&D sowing seeds of further S&D

Source Author (data-driven)

A central or core category was identified which could unify all categories stated above was 'HIV/AIDS S&D reduction'.

During the axial coding, through coding paradigm, i.e. the phenomenon it represents, conditions which give rise to it, the action/interaction by which it is expressed, and the consequences it produces, a theoretical scheme (Fig. 17.1) was found out assembling various concepts from above-mentioned sub-categories and categories showing the spread of HIV/AIDS stigma and discrimination and a mechanism to reduce it.

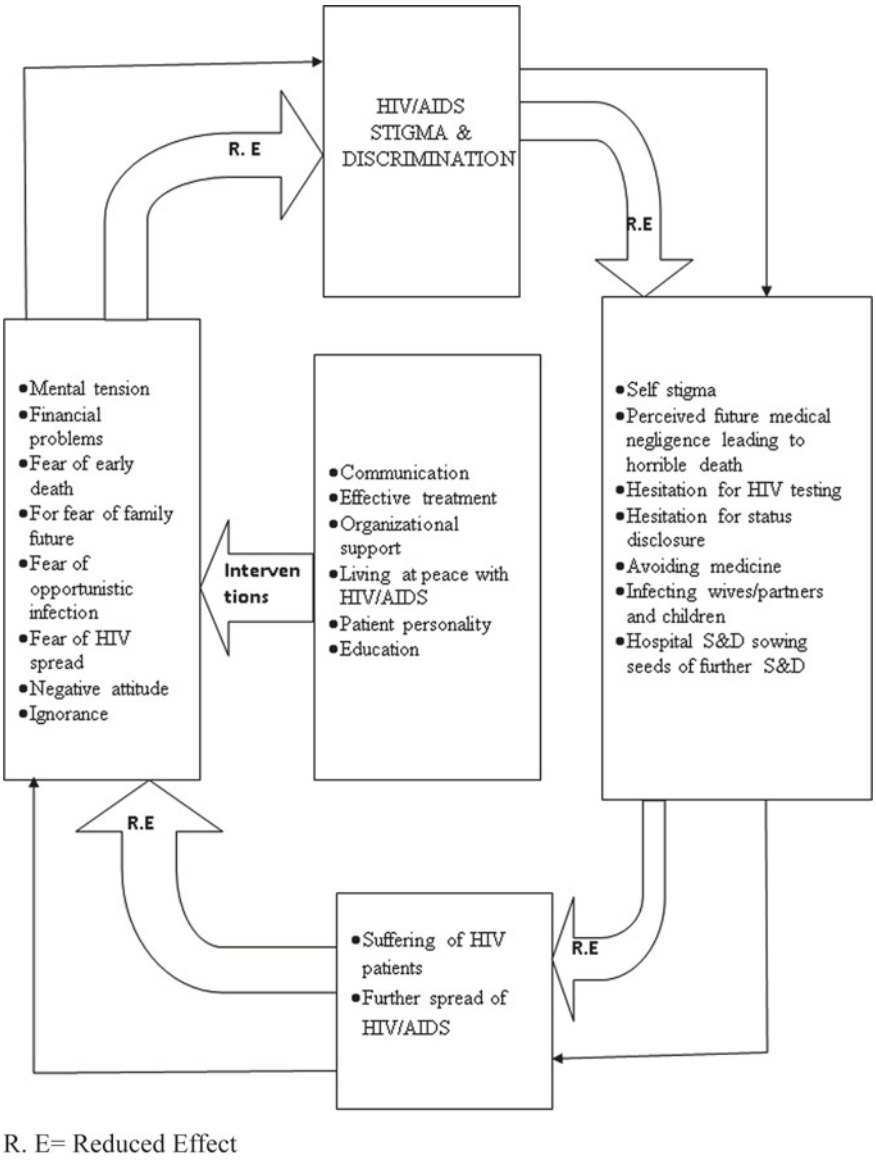


Fig. 17.1 Theoretical scheme showing the mechanism to reduce the spread of HIV/AIDS stigma and discrimination. *Source* Author (Data-driven)

17.6.4 Explanation of Theoretical Scheme

Once diagnosed with HIV/AIDS, the status of PLHIV does not stay secret for long and the infected persons face unfathomable stigma and discrimination at family, village, hospital, and from within.

The consequences of stigma and discrimination experienced at family, village, hospitals, etc., create lots of self-stigma in an HIV positive in the form of irritation, frustration, helplessness, fear of future medical care, fear of medical negligence leading to a horrible death, and finally feeling of committing suicide to escape from all the above troubles. Stigma and discrimination against HIV positives also creates self-stigma in undiagnosed persons with HIV symptoms. They hesitate to go for HIV testing. Even when they do test for HIV, hardly disclose their status.

This hiding of HIV status makes them suffer a lot within. They avoid ART and only go for symptomatic treatments complicating further their state of infection and in the meanwhile infecting their wives/partners and from them to their children.

The study shows that the reasons for HIV/AIDS self-stigma range from associated health problems/infection of the disease which would bother them and drain them financially for the rest of their life, constant mental tension for the incurability nature of the disease, dip in financial health owing to extra expenses for medical care to fear of early death, and its consequences to their family (like children being orphan at some point of time). Once the status is disclosed by whatever means, people around the PLHIV stigmatize and discriminate against them because of fear of the spread of the disease in the community, fear of associated infections of HIV like T.B, Herpes, etc., to healthier persons leading to further stigma and discrimination.

Interventions to reduce of HIV/AIDS stigma and discrimination is imperative not only to check the spread of the HIV virus in the human population but also to check the violations of basic human rights of patients. The silver lining is that it can be done with interventions, i.e. by a multi-means approach, reveals the study. One such important means is ‘communication’.

One-to-one communication in the form of counselling to HIV positives (to reduce self-stigma) and their family members has been given maximum credit as a tool to reduce HIV/AIDS stigma and discrimination. Empathetic counselling and therapy bring newly diagnosed HIV positives out of shock and instils hope for a long, healthy life cycle with HIV/AIDS. It gives them the strength to face the world by dispelling all myths and misconceptions surrounding the disease. With precautions known, counselling makes patients resolve to look for avenues to earn and live life the normal way. It also makes them agree to conduct HIV tests on their other family members. Counselling to family members, community members, and villagers is crucial as it dispels the myths and misconceptions from them and convinces them to be tolerant and compassionate towards PLHIV.

Group communications in the form of interactions in group meetings have been found very useful to convince community members and villagers to reduce stigma and discrimination. In group meetings, the villagers are oriented about HIV/AIDS and its stigma and discrimination, the need for its reduction is discussed at length,

and a sympathetic attitude and collective action are seeking to fight the menace called HIV/AIDS. All these enhance their level of awareness of the disease and help change their attitude which ultimately helps reduce stigma and discrimination substantially.

The big media like radio and TV have been found to be extremely helpful in spreading awareness about HIV/AIDS—its spread, safeguards to be taken, and at best bring people to hospitals for HIV testing; however, it does not help change one's behaviour much, which is crucial to reduce stigma and discrimination. People pay little attention to articles published in newspapers and switch channels to skip the public service advertisements on TV and radio. They also blame media persons of the district for not having proper knowledge about HIV/AIDS and having a prejudiced mindset which results in biased and prejudicial media coverage of the disease.

The HIV patients believe that communications by the outdoor media like hoardings are not very useful in spreading the HIV/AIDS messages across as passers-by often ignore those messages. If read, occasionally, the messages give more shock than hope.

Apart from 'communication', other means like providing 'effective treatment', improvements in 'general facilities', 'organizational support', 'living at peace with HIV/AIDS', 'patient personality', and 'family education' of PLHIV and its community members/villagers go a long way in reducing HIV/AIDS stigma and discrimination.

The success of ART medicines helping patients to live a long-life cycle with PLHIV post their diagnosis helps a lot in reducing self-stigma not only in patients but also in people having symptoms of HIV/AIDS but who hesitate to go for HIV testing.

The general facilities include authority's help which may bring financial independence and ultimately financial well-being, which helps a lot in reducing dependence on others and facing less stigma and discrimination in society.

One of the most important means to reduce stigma and discrimination is organizational support to PLHIV. When a PLHIV becomes part of an organization devoted to HIV positives, he feels a lot relieved as he knows that he is not the only one with the HIV virus in this world. He gets care, support, and guidance from the organization to live with HIV/AIDS. He is made aware of his legal and human rights. He gets a forum to address his concerns. In some cases, deserving PLHIV gets some positional power in the organization and gets a 'purpose in life' in helping other PLHIV. All these help in reducing HIV/AIDS stigma and discrimination a lot.

Living at peace with HIV is another means of reducing HIV/AIDS stigma and discrimination, especially self-stigma. When a patient accepts the fact that the HIV virus is an inherent part of a PLHIV's body and learns to manage it and tries for gainful engagement to earn which helps to live without dependence on others leads to a more dignified life with a tremendous sense of self-satisfaction.

It has also been found that patient personality helps a lot counter stigma and discrimination. A positive attitude, ability to get along with others easily, and easy-going nature are some of the personality traits that come in handy while countering HIV/AIDS stigma and discrimination.

Last but not the least is the education of family/community members. It helps a great deal in reducing stigma and discrimination related to the disease. Educated family members have shown greater tolerance towards the disease and patient. Instead of stigmatizing and discriminating, they try to avail the latest treatment to the patients.

Once these interventions are applied to the PLHIV and the society at large, the effects of HIV/AIDS stigma and discrimination are expected to be reduced at every stage of the theoretical scheme. It is expected persistent interventions will lead to the minimum presence of HIV/AIDS stigma and discrimination giving a near-normal life to the PLHIV.

17.7 Conclusion

How soon will we be able to find a cure for HIV is not known. If at all, we will survive the epidemic by prevention till a cure is found, it is only possible by realizing and adopting a compressive mechanism that would ensure reduced HIV/AIDS stigma and discrimination among other steps in line with an ancient *Vedic* concept of *Vasudhaiva Kutumbakam*—The whole world is but one family!

17.8 Limitations of Study

The study could not conduct more narratives for the obvious unwillingness of HIV patients to participate leading to not achieving the stage of data saturation. Hence, a model could not be carved out of the data. The researcher had to settle for a Theoretical Scheme in the absence of data saturation (Strauss and Corbin 1998).

Funding The study was partially funded by the National AIDS Control Organization (Ministry of Health and Family Welfare, Govt. of India), New Delhi.

References

Adam G, Harford N (1999) Radio and HIV/AIDS: making a difference. a guide for radio practitioners, health workers and donors. UNAIDS, Geneva

Aggleton P, Wood K, Malcolm A, Parker R (2005) HIV-related stigma, discrimination and human rights violations: case studies of successful programmes. http://data.unaids.org/publications/irc-pub06/jc999-humrightsviol_en.pdf

AVERT (2018) HIV and AIDS in India. https://www.avert.org/professionals/hiv-around-world/asia-pacific/india. Accessed 1 Dec, 1BC

Bandura A (1977) Social learning theory. Prentice Hall, Englewood Cliffs

Bharat S (2011) A systematic review of HIV/AIDS-related stigma and discrimination in India: current understanding and future needs. J Soc Aspects HIV/AIDS 8(3):147

Bharat S, Aggleton P, Tyrer P (2001) India: HIV and AIDS-related discrimination, stigmatization and denial

Blumenfeld W (1998) Discrimination. In: Smith RA (ed) Encyclopedia of AIDS: A Social, political, cultural, and scientific record of the HIV epidemic, 1st edn. Fitzroy dearborn publisher, Chicago, p 256–260

Chakrapani V, Newman PA, Shanmugam M, McLuckie A, Melwin F (2007) Structural violence against Kothi identified men who have sex with men in Chennai, India: a qualitative investigation. AIDS Educ Prev 19(4):346–364

Cohen L, Manion L, Morrison K (2008) Research methods in education. Routledge, Abingdon

Express News Service (2018) HIV prevalence in Odisha below national average. http://www.newindianexpress.com/states/odisha/2018/dec/02/hiv-prevalence-in-odisha-below-national-average-1906148.html. Accessed Dec 2, 1BC

Goffman E (1963) STIGMA: notes on the management of spoiled identity. Penguine, London

Insideout Research (2003) Siyam'kela: tackling HIV/AIDS stigma: guidelines for people living with HIV/AIDS who interact with the media

Jaiswal TBL (1992) AIDS-causes and prevention. Mittal Publication, New Delhi

Maluwa M, Aggleton P, Parker R (2002) HIV- and AIDS-related stigma, discrimination, and human rights: a critical overview. Health Hum Right 6(1)

Mawar N, Sahay S, Pandit A, Mahajan U (2005) The third phase of HIV pandemic: social consequences of HIV/AIDS stigma & discrimination & future needs. Indian J Med Res 471–484

NACO (2004) National IEC/BCC strategic framework for HIV/AIDS program. NACO, New Delhi, pp 2–4

NACO (2018) HIV facts & figures. http://naco.gov.in/hiv-facts-figures. Accessed 2 Dec 1BC

Narain JP (2012) Three decades of HIV/AIDS in Asia. SAGE

Pallikadavath S, Garda L, Apte H, Freedman J, Stones RW (2005) HIV/AIDS in rural India: contexts and health care needs. J Biosoc Sci 37:641–655

Parveen S (2010) HIV/AIDS: problems and attitude. Manak

Riessman CK (1993) Narrative analysis, vol 30. Sage, Newbury Park

Singh RS, Kumar S (2011) Treatment and prevention of HIV/AIDS. ABD

Singhal A, Rogers EM (2002) A theoretical agenda for entertainment education. Commun Theory 12(2):117–135

Singh AR (2002) Mass communication in prevention and control of AIDS: strategies for Adolescents. Concept, New Delhi

Smart R (2012) MODULE 1.4: HIV/AIDS-related stigma and discrimination. http://www.iiep.unesco.org/fileadmin/user_upload/Cap_Dev_Training/pdf/1_4.pdf. Accessed 24 Aug 2012

Spark (2007) How can we tackle stigma and discrimination through effective communication? http://panos.org.uk/wp-content/files/2011/03/spark_stigma_backgroundg575y8.pdf. Accessed 19 Aug 2012

Strauss AL, Corbin JM (1998) Basics of qualitative research: techniques and procedures for developing grounded theory, 2nd edn. Sage, Thousand Oaks

Thomas BE, Rehman F, Suryanarayanan D, Josephine K, Dilip M, Dorairaj VS, Swaminathan S (2005) How stigmatizing is stigma in the life of people living with HIV: a study on HIV positive individuals from Chennai, South India. AIDS Care 17(7):795–801. https://doi.org/10.1080/09540120500099936

UNAIDS (1997a) Community mobilization and AIDS. UNAIDS, Geneva

UNAIDS (1997b) Counselling and HIV/AIDS. Geneva

UNAIDS (2000) HIV and AIDS-related stigmatization, discrimination and denial: forms, contexts and determinants

UNAIDS (2001) HIV/AIDS and communication for behaviour and social change: programme experiences, examples, and the way forward. UNAIDS, Dept. of Policy, Strategy & Research, Geneva

UNAIDS (2004) The media and HIV/AIDS: making the difference. UNAIDS, Geneva

UNAIDS (2005) Getting the message across: the mass media and the response to AIDS. UNAIDS, Geneva
UNAIDS (2007) Reducing HIV stigma and discrimination: a critical part of national AIDS programmes: a resource for national stakeholders in the HIV response. UNAIDS, Geneva
UNAIDS (2008a) Criminalization of HIV transmission. Policy Brief, Geneva
UNAIDS (2008b) Fast facts about HIV testing and counselling. UNAIDS
UNAIDS (2011) 30 years into the AIDS epidemic. An UNAIDS Outlook report 2011. UNAIDS, Geneva
UNAIDS (2020) Country factsheets INDIA 2020. https://www.unaids.org/en/regionscountries/countries/india
UNAIDS (2021) Fact sheet—world aids day 2021. https://www.unaids.org/sites/default/files/media_asset/UNAIDS_FactSheet_en.pdf
USAID (2009) Health policy initiative. Discussion brief. From awareness to knowledge: scaling up interactive channels of communication for HIV prevention and stigma reduction in Uttar Pradesh

Chapter 18
Toward Sustainable Understanding of Health: Perception and Worldview on Erectile Dysfunction in Nigeria

Yusuf Qudus Oyindamola and Olayinka Akanle

Abstract In a bid to achieve sustainable development, there is a need for a connection and integration of indigenous knowledge systems and western knowledge (medicine), most especially in the area of health care. In a bid to achieve sustainable development in the health care system, there is a need for a deeper understanding of diseases in terms of their perception among indigenous people based on their indigenous knowledge, consumption, and lifestyle. This will help in designing a sustainable health system. This chapter adopts Idakole (erectile dysfunction)-a unique sexual ailment peculiar to men as a narrative to contribute significantly to knowledge. This chapter, therefore, investigates the gap in knowledge as regards the perception of Idakole in Ibadan metropolis, Oyo State. The closest ailment to Idakole in western medicine is erectile dysfunction. Regarding the perception of Idakole (erectile dysfunction), the chapter examines the perspectives of indigenous and western knowledge systems. Of essence is the fact that the understanding of Idakole in the indigenous system differs in some regards to erectile dysfunction in western medicine. The chapter explores the knowledge gap in terms of the constructions, experiences, and treatment pathways of erectile dysfunction through local contextual research in Ibadan, South-western Nigeria. The findings in the chapter were based on a qualitative study conducted in 2018. A series of in-depth and key informant interviews and a period of six months of interactions were conducted with key stakeholders, including local herbal medicine sellers, local aphrodisiac sellers, men with erectile dysfunction, and urologists.

Keywords Idakole · Erectile dysfunction · Western knowledge · Traditional medicine · Ibadan · Nigeria

Y. Q. Oyindamola (✉)
Department of Sociology, University of Ibadan, Ibadan, Nigeria
e-mail: yakanle@yahoo.com

O. Akanle
Department of Sociology, Faculty of Humanities, University of Johannesburg, Johannesburg, South Africa

A. Grover et al. (eds.), *Sustainable Health Through Food, Nutrition, and Lifestyle*,
Advances in Geographical and Environmental Sciences,
https://doi.org/10.1007/978-981-19-7230-0_18

18.1 Introduction

The focus of this article is to examine constructions, experiences, and treatment pathways of erectile dysfunction (Idakole) from the contextual empirical perspective of an African social system for global importance. Several works of literature have established erectile dysfunction is a significant sexual ailment that affects sexual performance—a situation whereby people find it difficult to achieve an adequate erection for satisfactory sexual intercourse with partners (Akanle et al. 2017; Feldman et al. 1994; Glasser et al. 1998; Shaeer et al. 2003; Lewis et al. 2004; Ariba et al. 2007). Several studies have established the levels of prevalence of Idakole (erectile dysfunction). Shaeer et al. (2003) established there are 80.8%, 63.6%, and 57.4% prevalence levels of erectile dysfunction across Pakistan, Egypt, and Nigeria, respectively. Likewise, Glasser et al. (1998) discovered in their study that there are 78.6%, 66.5%, 63.3%, and 40.6% prevalence levels of erectile dysfunction across Japan, Italy, Malaysia, and Brazil, respectively. There are 57.4% prevalence levels of erectile dysfunction in Nigeria (Shaeer et al. 2003), and this is a pointer that indicates that there is a need for a better understanding of this ailment (Akanle et al. 2017; Feldman et al. 1994; Glasser et al. 1998; Shaeer et al. 2003; Lewis et al. 2004; Ariba et al. 2007). Unfortunately, little attention has been paid to the needed contextual and socio-cultural understanding of Idakole (erectile dysfunction) even when there is increasing realization of the need for more contextual study of etiology of diseases and general social development as social contextual drivers may be implicated within a broader remit of indigenous knowledge systems (World Bank 2004).

In essence, the understanding of disease in contexts varies significantly from western knowledge (Noyoo 2007) and cuts across a different aspect of life. From agriculture to the economy, to technology and more specifically to health, local people develop knowledge systems across these different aspects of life based on the knowledge and skills developed from the community. As a result of the socio-cultural environment of a particular society, every society has a level of specificity as regards knowledge in contexts (Agrawal 1995). Thus, to achieve sustainable development in every aspect of human society, there is a need for synergy between contextual-local-knowledge and western-foreign-knowledge for sustainable solutions and global development. As the discussion about the contestation and orthodoxy of knowledge remains a major issue (Akanle et al. 2017), it is necessary to have a synergy between non-western contextual knowledge and western knowledge as regarding various aspects of the society, more specifically, health issues as a measure of development and quality of life.

18.2 Methodology

The research that informed this article was conducted in Ibadan, Nigeria, in 2018. Ibadan is a rich blend context of traditional and modern social systems and processes.

Traditional social realities and modern elements strategically co-mingle in Ibadan. Ibadan, for instance, is home to the University College of Hospital (UCH), one of the most iconic tertiary hospitals in Africa, and the University of Ibadan, the very first university in Nigeria and a leading higher institution in Africa. Yet, Ibadan, with its brown rusted roofs demonstrating the age-long existence of traditional architecture, is among the very few remaining traditional cities in Africa. A purely qualitative methodology was adopted to have a deeper insight into contextual and social-relational issues that affect the problematic. The qualitative methodology provided the opportunity to understand relevant deep interpretative understanding of inbuilt elements with strategic contextual meanings.

A total of 20 interviews, 10 in-depth interviews, 10 key informant interviews, and over six months of interactions, were conducted. Interviewees were purposively selected based on strategically and carefully developed inclusion criteria. Inclusion criteria included (1) availability, (2) willingness to participate in research (informed consent), (3) experience, (4) currency of practice, and (5) strong referrals. Interviewees included traditional herbal medicine sellers (Agunmu—liquid and powder), aphrodisiac sellers, prophetic medicine sellers (spiritualists), patients—people who have been or are affected by Idakole (erectile dysfunction), and Urologist (western medicine practitioner). The in-depth interviews were conducted for herb sellers at the bode market, which is one of the major traditional markets for herbs in Ibadan and Africa, while aphrodisiacs sellers, Urologist, and prophetic medicine sellers were selected purposively through the inclusion criteria. Data collected were transcribed verbatim and were interpretatively engaged and analyzed using content analysis. All necessary international best practices in social science research ethics like confidentiality, informed consent, beneficence, non-maleficence, right of discontinuation, and protection from harm were diligently adhered to.

18.3 Data Analysis and Presentation of Findings

Constructions of Idakole

Idakole is the Yoruba/indigenous interpretation of erectile dysfunction, a sexual ailment that affects sexual performance. It is when men find it difficult to achieve the adequate erection needed for satisfactory sexual intercourse. Idakole is erectile dysfunction in western medicine. It is believed that one of the hallmarks of *being a man* is the ability to adequately maintain the erection throughout sexual activities and satisfy the sexual partner(s) desires. However, some conditions often deprive a man of the ability to be able to carry out this responsibility, one of which is Idakole-a sexual condition whereby people may not be able to satisfy partners' sexual desires as a result of the inability to achieve adequate erection needed for a satisfactory sexual activity. There are several constructions that surround Idakole among the Yoruba people of Nigeria. It is generally believed that Idakole affects males directly but also affects females indirectly, and the ways and manners people experience idakole

vary from one person to another. Constructions that surround individual experiences and understanding as regards this Idakole also vary. And the experience of Idakole differs by age. Some people experienced Idakole early in their lives, while some others experienced Idakole at a later age.

An interviewee explained that:

> Some people come with such problem right from their birth. Some parents do not usually pay good attention to some children's manhood from birth, which may affect them when they become an adult. (IDI/Female/Herb Seller/Ibadan/22-06-2018)

It is generally expected that a man should experience an early morning erection often, even as a child. It is also expected that every male child should experience an early morning erection, which serves as a sign of being healthy. However, many parents that do not pay close attention to children's manhood may not have any idea children are having problems achieving an erection, and this might eventually become significantly worse as an adult. Individual understanding of what Idakole entails also differs. Different explanations were given by interviewees as regards what they understood about Idakole.

One interviewee explained that:

> Idakole is an ailment that starts from what is called Jedijedi[1] (consumer of the rectum). If one has Jedijedi for a very long time in his body and fails to take care of it by using necessary herbs to cure it. So, when it has spent a long time in the body, it might result in what is called Idakole, to the extent that the problem might start in the course of sexual intercourse between a man and a woman, in which case, the man might have ejaculated even before he achieves adequate erection for penetration. However, if such a man fails to take care of it and the ailment spends like 10 years in his body, it might lead to impotence for the man. So, lack of adequate care for the Jedijedi might lead to Idakole, which might also lead to impotence if it is not adequately taken care of. (IDI/Male/Herb Seller (Agunmu)/Ibadan/25-06-2018)

The respondent above observed that when Idakole stays longer in a man, it could eventually lead to impotence, which is more critical than Idakole. The interviewee, based on his experience, explained the fact that the size of the penis is also an indication of idakole. In which case, a man with small manhood could be said to have Idakole. Various predisposing factors have been identified for Idakole (erectile dysfunction). Smoking, prolonged use of recreational drugs, Marijuana, and codeine, among others, have been identified as important risk factors of erectile dysfunction (Elbendary et al. 2009). However, among the local people, Jedijedi has been identified as one major predisposing factor to Idakole. An interviewee explained that:

> Some of the causes of Idakole come from what we eat. The majority of what we eat in these modern times contains too much starch, and we do not usually pay adequate attention to those foods that are beneficial to the body, even though the majority of our foods in this country contains too much starch, and we usually overlook those ones that are beneficial to our body in which case they are very beneficial to our body system. Part of them are fruits such as pawpaw banana. We cannot categorize oranges as parts of the fruits because once it is too much, it affects the body, but other fruits are good before we decide to consume too many starchy foods like Eba or white yam flower. So, if one fails to take of oneself in

[1] The closest English (medical) meaning of Jedijedi is rectal hemorrhoid.

> order to rid it off Jedijedi (consumer of the rectum), and it spent a long time in one body, then it can lead to Idakole. In which case if such man could have one round of sex before, he might not even be able to have any rounds at all, that is Idakole. (IDI/Male/Herb Seller (Agunmu)/Ibadan/25-06-2018)

From the foregoing, it is evident that Jedijedi remains one major cause of Idakole. The causes of Jedijedi have been identified as consumption of too much sugary food. It is also worthy of note that too much consumption of sweets/sugary things, starchy, or carbohydrate foods can lead to Jedijedi as constructed by interviewees because the end product of carbohydrate is sugar (Akanle et al. 2017). Findings suggest that other causes of Idakole are addiction to watching pornographic films as this might create some psychological effects on the individual, in which case, a man might develop anxiety toward sex due to addiction to pornographic content, such that whenever he wants to have sex with his partner, achieving erection might be a problem. Hence, an interviewee explained that:

> Idakole can be caused by some internal disorder such as *Eeri inu,* which does not allow a man to have an erection. One who has *Eeri inu* will find it difficult to have an erection. Also, a man who engages in sex with multiple sex partners could have dried sperm which may eventually lead to Idakole. So, excessive sexual intercourse may make the penis weak, thereby making it difficult to have an erection when needed. (IDI/Female/Herb Seller/Ibadan/22-06-2018).

Eeri inu could be literarily translated as excess dirt that is stored in a man's body through excess consumption of starchy food or sugary food, which eventually leads to Jedijedi (rectal hemorrhoids). Furthermore, among the constructions around Idakole are the belief that a man could be bewitched with Idakole. There is still the indigenous and traditional belief about the three major causes of diseases, as noted by Akanle et al. (2017), that generally Nigerians still appear to believe in the services of traditional practitioners as they confront health issues, especially those believed to be beyond western medicine due to the three perceived causes of illness—biological, spiritual, and mystical. There is a general belief among traditional Nigerians that there are no natural illnesses. Even though some illnesses may seem natural, they are co-explained and interpreted as spiritual and mystical. Based on this, there are opinions as regards the spiritual or mystical causes of Idakole among the local people. One of the interviewees explained that:

> I cannot totally say it could not have a spiritual dimension, because our people do a lot of things, it can happen that one can be bewitched with it. For example, if a man decides to marry another wife and decide not to take care of the first wife and forget her, she can decide to bewitch him with it. Another example is if a man who has been married to a man for like ten years later sees a new woman, yellow in complexion, that is also educated and social, and he decides to go for her and abandon the former one, then the former wife may decide to go bewitch him with it. (IDI/Male/Prophetic Medicine Seller/Ibadan/10-07-2018)

From the foregoing, it is evident that there are beliefs that Idakole could be used to bewitch a person. It is generally believed that the treatment of any disease or ailment among the local population is dependent on the perception of the causation of such disease. There are actually no natural illnesses among the people even though seen to be natural, they are co-narrated and interpreted as spiritual and mystical. For

instance, erectile dysfunction can be seen as caused by witchcraft, especially when it is not only acute but chronic. This is why traditional contextual constructions need to be sufficiently understood even when western knowledge is deployed in many parts of Africa. These sometimes-contextual constructions influence the perception and construction and treatment pathways of diseases in the long run. In the case of Idakole, the reasons for bewitching a man with it vary from one person to another, as shown in the responses above. There are, however, individuals who believed that Idakole is a natural ailment that can only occur to a man naturally.

One of the interviewees explained that:

> This ailment is usually caused through what we eat, in which case, an individual might just prefer taking too many sugary foods is harmful to the body. In which case, bitter things are also useful for the body system, then taking too many sugary substances. One cannot be bewitched with it, as it is mostly caused through the kind of food that we eat which might leads to Jedijedi, which might later lead to Idakole if it is not taken care of. (IDI/Male/Herb Seller (Agunmu)/Ibadan/25-06-2018)

A female interviewee explained that one cannot be bewitched with Idakole but can be bewitched with impotency which is different from Idakole. She explained that:

> No, they do not bewitch people with it. It can be caused by Eeri inu. However, there are some men in whom their wife could make them impotent if he divorces her in a disrespectful way except if he remarries her. (IDI/Female/Herb Seller/Ibadan/22-06-2018)

It is evident that Idakole only affects men, as it is specifically a male sexual problem. While all the interviewees agree to this, few were also specific about the categories of men that might also experience Idakole. One interviewee explained that:

> A man, who engages in sex with multiple sex partners, could have dried sperm which may eventually lead to Idakole. (IDI/Female/Herb Seller/Ibadan/22-06-2018)

Treatment Pathways of Erectile Dysfunction (Idakole)

The knowledge as regards the nature, causes, and knowledge about a particular ailment goes a long way in determining the treatment pathways that will be adopted. In order to have a sustainable treatment/cure for any ailment, it is necessary to have a good understanding of the root cause (diagnosis). In the case of erectile dysfunction, several treatment pathways (options) are being deployed by western medicine practitioners based on diagnoses. Raina et al. (2007) observed that as a result of the better understanding of the physiology of erectile dysfunction through better diagnostic tests, there had been better treatment methods. Dimitros et al. also observed that there had been needed to conduct clinical examinations, including a detailed history and physical examination of patients through which urologists can better treat patients exhaustively. Western medicine has largely matured in treating erectile dysfunction based on western medical knowledge. Much, however, still needed to be known concerning this ailment as it remains a major health concern as treatment options remain largely palliative in western medicine. Common treatment in

western medicine includes psychological management and aphrodisiacs, which have been found to be only short-term treatments with significant side effects. Erectile dysfunctions thus remain a major yet to be sufficiently understood health challenge needing aggressive studies beyond only biological and medical sciences.

Against this background, while explaining the treatment pathways of erectile dysfunction, and observed explained that:

> Before we start the treatment, having taken a detailed history and examined the patient, usually we want to do certain investigation, and we want to be sure the patient does not have diabetes. There are times we may do other more extensive investigations like to access the blood supply to the penis, which may involve the use of Doppler. But basically, we do basic investigations, first to be sure the patient is not diabetics and so on. There is also the need to if the patient has what we called hyperlipidaemia, i.e., if the patient has high lipid in the blood because those people are more at risk. Investigation depends on what we think from the patient's history; basically, we do those basic investigations before doing a more complex investigation. There are also investigations that assess if the patient has an early morning erection because getting that information is very important. For those who have early morning erection, it is more likely caused by psychological factors, but those who have organic do not have early morning erection. Then, having done those important investigations, the treatment depends on the cause. So those who think their cause is psychogenic need counseling. Those who have discord in the family, and then take them for counseling to the psychologist in a bid to resolve that discord. Surprisingly, that has really helped quite a number of patients, and then apart from counseling, there are certain drugs that we give to enhance erection, like Viagra, which is a common example that we use in that regard. They help to dilate the vessel and allow more blood to pump in, and that would help erection. There are different classes of those drugs. There are also surgical procedures that can be done to help those patients. (IDI/Male/Urologist/Ibadan/5-07-2018)

Furthermore, just as in western medicine, the treatment pathways adopted in the treatment of erectile dysfunction are largely dependent upon the identified root causes of the ailment. While western medical practitioners would take the medical history of the patients to identify the root causes of the ailment, traditional local herb sellers who treat the ailment as Idakole also tried to find ways to understand the root causes of the ailment either by asking several questions from the patient or through the complaints made. One of the interviewees explained that:

> If we want to diagnose such a man, we usually ask the person some questions. This is because some people might say they are being affected by Jedijedi (consumer of the rectum), and the Jedijedi (consumer of the rectum) might have gone beyond that and turn to Idakole, such that whenever such person eats, he might find it difficult to excrete easily in the toilet, and once, one is in a situation whereby food does not digest in his body, and at least, one should visit the toilet once, we could detect that such man has Idakole. This is because nature is different from nurture. Some people just like taking junk foods, all these could cause Idakole. Such a person is usually asked if he always has an early morning erection because once Idakole has been cured in a man when such a person wakes up in the morning, he would always detect that he has an erection, which shows that he is a complete man. But if he is a man that has Idakole, we would always ask him if his manhood always erects in the morning, and if not, then such man has Idakole, and he is not complete as a man. Those are the kind of questions we would ask such man in order to determine the kind of drugs to give such man. (IDI/Male/Herb Seller (Agunmu)/Ibadan/25-06-2018)

It is evident that the diagnostic procedures for a patient suffering from Idakole take different forms. These would eventually determine the kind of treatment methods that would be adopted. It should be noted that local medicine practitioners differ from western medicine practitioners as regards their processes of diagnosing an ailment and eventual treatment options. The nature of cultural understanding determines treatment pathways and the causes and symptoms of diseases among local people. The treatment pathways adopted by local medicine practitioners are built on age-long traditional knowledge, which is often transferred from one generation to another orally and in writing. While the local knowledge about Idakole is somewhat from western knowledge, so are the treatment pathways adopted. Even though western medicine is very popular in the context of the study, local and indigenous treatment pathways are also very popular as patients still patronize traditional herbal medicine. Western medical practitioners generally have mixed feelings and misgivings about the efficacy of conventional treatment options for erectile dysfunctions due largely to their crude procedures. This further demonstrates the contestations between traditional medicine and western medicine. What came to the fore during fieldwork, however, was the general agreement that a lot of patients patronize the traditional treatment options, even if only as additions to western treatments. One of the interviewees (a urologist) explained that:

> Personally, I do not think they (traditional medicines/treatments) are helpful as such. Anyway, we have not really carried out any research on it. But one thing I can tell you is that a number of patients who have come here will tell you that part of what they used before coming are these herbs. So, we have not really looked at those areas, but my own personal opinion is that those herbal products are not helpful. (IDI/Male/Urologist/Ibadan/5-07-2018)

While stating reservation as a urologist, it was noted that some patients visit traditional herbal medicine sometimes even before visiting hospitals for treatment. On the traditional treatment methods erectile dysfunction, one of the sellers of traditional herbal medicine *Agunmu* (powdered herbs) used in the treatment of Idakole explained that:

> We have different types of herbs, both liquids, *Agbo* and powdered *Agunmu,* because the roots and stems that we use are numerous, and they are those used by our forefathers. Part of the herbs (*Agbo*) includes *Ewuro* (bitter leaf), *efinrin*, *lapalapa*, also called *Iyalode* by our forefathers, *Alubosa Ayu* and *Alubosa elewe*. For the powdered herbs (*Agunmu*), we usually use the root of some herbs, e.g., the root of *ede* the root of the *Ayin* tree, which are all parts of what we use for the Agunmu. We also use a newly birthed leaf of *laali*, newly birthed leaf of *asuwon* and also its flowers. (IDI/Male/Herb Seller (Agunmu)/Ibadan/25-06-2018)

In essence, the treatment of erectile dysfunction among people in a context largely involves the use of various herbs which are considered natural from different roots and stems. This is not only peculiar to Nigeria but also to other African countries, like Maud and Hannington noted that the use of various medicinal plants has been useful in the treatment of erectile dysfunction in Uganda. Apart from being able to cure Idakole in totality, some of these indigenous herbs are believed to serve as aphrodisiacs that are used to enhance sexual performance. Osen and Ashton (1993) also noted that many natural herbs had been known in Africa and Europe to serve

as aphrodisiacs. Some of those herbs include Yohimbine and the Mandrake plant as well as ground Rhinoceros horn in the Chinese culture and "Spanish fly", though with questions on toxicity.

Furthermore, as regards the perceived efficacy of indigenous treatment pathways, local people generally believe that indigenous herbs and treatment methods are highly efficient and sustainable. They believe that traditional herbal medicine helps to treat the ailment more sustainably compared to western medicine as traditional herbal medicine tends to address the root cause of Idakole and other probable ailments in the body. The people believed in acquaintance with the social and magical potency and effectiveness of local herbs and incantations. According to an interviewee:

> These herbal/indigenous medicines have been in existence since the time of our forefathers. In which case, whenever someone is sick, they will just go to the forest to the herbs which they will use for the person in order to get well. So, they have been in existence for years, and they do not cause any harm other than to cure ailments. But when modernization sets in and we started having hospitals around that were when our forefathers usually decide that after giving someone all the herbs for an ailment and it is still not going, then they will decide to take such a person to the hospital. Even during the time of our forefathers, whenever a woman is pregnant, it is these herbs that they will give her for easy delivery before the coming of hospitals, in which case, it will not have any negative effects on her. (IDI/Male/Herb Seller (Agunmu)/Ibadan/25-06-2018)

There are, however, concerns regarding using traditional medicine for the treatment of erectile dysfunction. Some of these concerns are in form of probable side effects of traditional medicines. There are also issues around dosage, processes, marketing, and regulation of the sector. There have been several efforts which have been made by the National Agency for Food and Drug Administration and Control (NAFDAC), the regulating and certifying agency in Nigeria.

While expressing these concerns, all western medical practitioners in the context suggested very rigorous further research into the processes of traditional medicine and orientations of people toward the utilization of traditional medicines. The western practitioners blatantly believed the traditional medicines are not helpful and dangerous while the traditional medical practitioners believed otherwise. The patients, however, largely believed and consumed traditional medication, which they consider not only potent, sustainable, and accessible but also resonate with their culture, belief systems, traditions, and cheap as well as affordable. There appears, therefore, to be a stalemate between traditional and western medical practitioners on treatment pathways of erectile dysfunction as general health political economy narrative while the patients are caught in-between.

Generally, many of the local people and traditional medicine sellers expressed confidence in traditional medicine. Traditional medical practitioners are also now making efforts as regards the regulation of the use of traditional medicine to avoid complications. One interviewee explained:

> The indigenous medicines do not have any side effects, in as much as it is those herbs (roots and stems) that we are going to use. We are not going to put any drugs there, or probably, we will put any chemical in it for it to work faster? No. It is the herbs (roots and stems) that we are going to use, and we will put them inside water, and once the person follows

> the instruction given to him, it is okay, and the ailment will leave without injuring him. (IDI/Male/Herb Seller (Agunmu)/Ibadan/25-06-2018)

Efforts are being made by indigenous medicine practitioners to regulate the sector. Traditional medical practitioners now come together in form of associations to attempt to regulate the activities of members. Lack of documentation of processes and procedures, inadequate coordination of the practitioners' activities, poor communication between the practitioners and their patients, secrecy of actual contents, and/or difficulty in determining actual ingredients (especially among the spiritualists—dibia, Babalawo, and boka) is part of the major challenges being faced by indigenous medicines practitioners within the general framework of medical practice. On the regulations of the use of herbs by patients, several opinions were shared:

> We measure the quantity people use. For example, we use small tumblers, the one on top of the schnapps' bottle. So, the person will take two tumblers in the morning before he eats, in which case, it would have worked for about 10 minutes before he eats. The food he is going to eat too must not be too starchy food. He could drink hot pap after that. (IDI/Male/Herb Seller (Agunmu)/Ibadan/25-06-2018)

According to another:

> We usually explain to them. For the use of herbs, we usually explain to them the appropriate time to use them. There are some herbs that one must not dare to use without eating, such a person may get dizzied, and there are some of them that one should use before eating. So, we must explain how to use it for them the moment we are about to give it to them. You cannot just use herbs anyhow, so we must explain to them the dosage to also use. (IDI/Female/Herb Seller/Ibadan/22-06-2018)

Traditional medical practitioners have always had associations. This is related to Yoruba conceptions of Awo (the initiated/knowledgeable in herbal/psychic science) and ogberi (the uninitiated), and these conceptions emphasize the practice of secrecy (from the uninitiated) against the tenets of objectivity and openness in Western science. This is a major gap in traditional medicine when compared with western medicine where comprehensive transparency is a must. Beyond the associations, one practical step being taken by traditional practitioners to regulate herbal medicine is the struggle to register with National Agency for Food Drugs Administration and Control (NAFDAC). NAFDAC is the national government agency in charge of registering and regulating foods and medicine/drugs in Nigeria. Any drug/medicine considered standard in Nigeria is given a number known as *NAFDAC number* as a sign of approval and authenticity. Traditional/indigenous medicine practitioners and sellers struggle to secure these numbers against strict regulations as symbols of legitimacy, authenticity, and certification of practices. While asking whether there is a spiritual dimension to erectile dysfunction, one of the interviewees explained that:

> This ailment is usually caused through what we eat, in which case, an individual might just prefer taking too many sugary foods is harmful to the body. In which case, bitter things are also useful for the body system, then taking too much sugary substances. One cannot be bewitched with it, as it is mostly caused by the kind of food we eat, which might lead to Jedijedi (consumer of the rectum), which might later lead to Idakole if it is not taken care of. (IDI/Male/Herb Seller (Agunmu)/Ibadan/25-06-2018)

In contrast, an interviewee observed:

> I cannot totally say it could not have a spiritual dimension, because our people do a lot of things, it can happen that one can be bewitched with it. For example, if a man decides to marry another wife and decide not to take care of the first wife and forget her, then she can decide to bewitch him with it. Another example is if a man who has been married to a man for like ten years later sees a new woman, yellow in complexion, that is also educated and social, and he decides to go for her and abandon the former one, then the former wife may decide to go bewitch him with it. (IDI/Male/Prophetic Medicine Seller/Ibadan/10-07-2018)

From the foregoing, it is observable that there are diverse opinions as regards whether there is a spiritual dimension to erectile dysfunction or not, but many interviewees believe there are spiritual dimensions, especially when it is chronic. Reasons for choices of treatment pathways vary from one person to another. Some of these include affordability, degree of desperation for a cure, perceived causes, perceived efficacy of traditional medicine, and desire for a hybrid cure. According to an interviewee:

> You see, the indigenous treatment methods and those herbs (Agbo) used in the treatment of Idakole are from the knowledge of our forefathers, and they are natural. That was what they used during their time, and they have passed that knowledge down to our generation. However, western medicines are alien to our culture, they are from the westerners, and they have preserved those drugs which different chemicals which are not natural at all. (KII/Male/70/Former Patient of Idakole/Ibadan/2018)

18.4 Discussion and Conclusion

Since the socio-cultural context of understanding erectile dysfunction has been hitherto understudied in literature across disciplines, most especially in the social sciences and humanities, this article, therefore, makes important contributions to knowledge. Although several studies have been conducted on erectile dysfunction, which is an ailment that can be literarily equated to Idakole, in western medicine, most especially on its experiences and treatment pathways (See Feldman et al. 1994; Glasser et al. 1998; Shaeer et al. 2003; Lewis et al. 2004; Ariba et al. 2007), more works and policies are needed to consider cross-fertilization of local contextual and western knowledge for effective aggravation of cross-impacts of local contextual and western knowledge for better health and social development. This article examined how people construct their disease based on their local contexts, and how these informed their treatment decision-making even within a broad spectrum of acceptability and the political economy of health systems. Constructions and treatment pathways were examined from the local perspectives of key actors, including practitioners and patients. The social context analytical framework was adopted because it is very relevant to the issues to bring depth into the study but strategically connected to more global experiences and analytical nuances. Issues that mediate constructions and treatment pathways of erectile dysfunction include genetics, lifestyle choices (physical activity and what is eating), spirituality, perceived efficacy, affordability, access to health care, and belief systems due to internationalization of values and norms based on successful socialization across generations.

This article is a very interesting and needed contribution, and it is important in understanding how people construct their sexual illness and the choice of treatment pathways within the complex gamut of competing health systems in an underdeveloped context of Sub-Saharan Africa. The article relied on purely qualitative data through in-depth and key informant interviews and extended interactions with key actors to determine constructions and treatments pathways and deep contextual issues that inform the constructions and pathways. This is because of the realization that if erectile dysfunction will be better managed as a global health concern, there is a need to go beyond disciplinary and medical practice boundaries competitions and better understand contextual issues that inform the disease, how patients see it and how they seek treatment and why beyond what we already know in biomedical sciences. This article is very important because the socio-cultural understanding of diseases go a long way at influencing reactions and management of such disease (Akanle et al. 2017), and there are usually differences in the conceptualization and treatment of disease between indigenous medicine and western medicine (Owumi 1993; Clement et al. 2007). There are certainly many things that could be learned and benefit from once there is a better understanding of the contextual issues around health beyond boundaries. This is particularly so relative to improved understanding of traditional medicines in contexts as they correlate with western medicine, especially when the World Health Organization (WHO) has noted that 80% of the world population rely on herbal medicine for the treatment of some ailments and other aspects of their health care especially in developing countries (Akanle et al. 2017; Ekor 2014).

References

Agrawal A (1995) Dismantling the divide between indigenous and scientific knowledge. Dev Chang 26(3):413–439

Akanle O, Adesina JO, Fakolujo OE (2017) Jedijedi: indigenous versus western knowledge of rectal haemorrhoids in Ibadan, Southwestern Nigeria. Afr Stud 76(4):530–545

Ariba AJ, Oladopo OT, Iyaniwura CA, Dada OA (2007) Management of erectile of dysfunction: perception and practices of Nigerian Primary care clinicians. SA Fam Pract 49(9):16–29

Clement YN, Morton-Gittens J, Basdeo L, Blades A, Francis MJ, Gomes N, Janjua M, Singh A (2007) Perceived efficacy of herbal remedies by users accessing primary healthcare in Trinidad. BMC Complement Altern Med 7(4):1–9

Ekor (2014) The growing use of herbal medicines: issues relating to adverse reactions and challenges in monitoring safety. Front Pharmacol 4:177. https://doi.org/10.3389/fphar.2013.00177

Elbendary MA, El-Gamal OM, Salem KA (2009) Analysis of risk factors organic erectile dysfunction in Egyptian patients under the age of 40 years. J Androl 30(5)

Feldman HA et al (1994) Impotence and its medical and psychosocial correlates: results of the Massachusetts male aging study. J Urol 151:54–61

Glasser DB et al (1998) The prevalence of erectile dysfunction in four countries: Italy, Brazil, Malaysia, Japan. Paper presented at the 8th world meeting on impotence research, Amsterdam, the Netherlands, 25–28 Aug 1998

Lewis RW, Fugl-Meyer KS, Bosch R, Fugl-Meyer AR, Laumann EO, Lizza PE, Martin-Morales A (2004) Epidemiology/risk factors of sexual dysfunction. J Sex Med 1(1)

Noyoo N (2007) Indigenous knowledge systems and sustainable development: relevance for Africa by Emmanuel K. Boon and Luc Hens, Editors. Tribes and Tribals, Special 1:121–139

Osen RC, Ashton AK (1993) Pro-sexual drugs: empirical status of the new aphrodisiacs. Arch Sex Behav 22(6):521–543

Owumi BE (1993) The place of traditional medicine in primary healthcare in Nigeria. In: Oke EA, Owumi BE (eds) The State of the Art. University of Ibadan, Ibadan

Raina R, Pahlajani G, Agarwal A, Zippe CD (2007) Treatment of erectile dysfunction: update. Am J Men's Health 1(2)

Shaeer KZM, Osegbe DN, Siddiqui SH, Glasser DB, Jaguste V (2003) Prevalence of erectile dysfunction and its correlates among men attending primary care clinics in three countries: Pakistan, Egypt, and Nigeria. Int J Impot Res 15(1):8–14. https://doi.org/10.1038/sj.ijir.3900971

World Bank (2004) Indigenous knowledge: local pathways to global development—marking five years of the World Bank indigenous knowledge for development program (English). Indigenous Knowledge (IK) Notes; no. 1–60. Washington, DC: World Bank Group. http://documents.worldbank.org/curated/en/981551468340249344/Indigenous-knowledge-local-pathways-to-global-development-marking-five-years-of-the-World-Bank-indigenous-knowledge-for-development-program. Accessed 24 Jul 2019

Chapter 19
An Integrated Enviro-psychological Approach to Health

Prashasti Jain and Harshita Upadhyaya

Abstract Health has always been a matter of concern for all. Changes in behaviours related to health and climate variability have been evident in the past few years. Alterations in ambient air, water, food, and shelter due to changing climate are weakening health infrastructure. Though people in all age groups are more focussed on dietary patterns and lifestyle in general and with the increasing attention towards health-related aspects, preservation of health has become the most important concern globally. Various dimensions of health such as physical, social, psychological, and spiritual are now separately considered contributing factors to the overall maintenance of well-being. Personal, social, and environmental factors significantly impact the state of health and wellness in individuals. Additionally, biological factors such as genetics, gut microbiota, and neurotransmitters affect mental health. Dietary patterns, nutrition, physical exercises, emotional factors, personality traits, socio-environmental, and demographic conditions also play a significant role in promoting health-related behaviours and building the immune system. Creating awareness and spreading knowledge regarding the need and importance of various aspects of health and opting for sustainable developmental strategies specifically in the industrial and agricultural sectors are the need of the hour. An overall assessment and analysis of factors contributing to a healthy state can be influential in developing a multidimensional approach which can, in turn, be beneficial to the society at large to overcome challenging situations such as a pandemic and the stressors generated due to changing climate.

Keywords Behaviour · Climate change · Health · Immunity · Well-being

P. Jain (✉)
Department of Psychology, Manipal University Jaipur, Jaipur, India
e-mail: prashasti.jain@jaipur.manipal.edu

H. Upadhyaya
Department of Geography, IIS (Deemed to be University), Jaipur, India
e-mail: harshita.upadhyaya@iisuniv.ac.in

A. Grover et al. (eds.), *Sustainable Health Through Food, Nutrition, and Lifestyle*,
Advances in Geographical and Environmental Sciences,
https://doi.org/10.1007/978-981-19-7230-0_19

19.1 Introduction

Since the time of inception of the child in the mother's womb, the child's health and development primarily depend upon the nutritional support the child gets from the mother. The physical development of the embryo is affected by the dietary content that the mother consumes. The diet consumed by the mother affects the cognitive and emotional development of the child. The strength of an individual's immune system depends upon the immune environment provided to the foetus at the time of pregnancy of the mother (Basha et al. 2014; Kollmann et al. 2017). It is asserted that foetal growth is affected by maternal and paternal genomes (Surani et al. 1986; McGrath and Solter 1984). The foetal immune system shall be prepared in such a manner that it can fight the internal as well as external unknown pathogenic elements. The foetal immunological setup impacts the overall status of health of a grown-up individual. Children of malnourished mothers are at a more significant risk of chronic diseases (Khalil et al. 2015; Armitage et al. 2004). Development of the brain in the initial years of life, especially from conception to two years, is a critical phase for the physical, social, cognitive, and emotional development, which consequently affects the overall health in the entire life span (Cunha et al. 2015). Infants with low birth weight are at increased risk to develop cardiovascular disorders in adulthood, obesity, and metabolic disorders such as diabetes (Nightingale et al. 2015). Apart from the nutrition from the mother, mental health and lifestyle have a significant impact on the health outcomes (Lewis et al. 2014). Biological, psycho-social, and environmental factors also affect the overall health of people. This chapter focusses on an integrated approach towards developing and maintaining health, taking into account all predicting dimensions of health.

19.2 Models of Health

The concept of health connotes not only the absence of disease or illness but also the state of physical, emotional, and social well-being (World Health Organization 1958). The biomedical model and the biopsychosocial model encompass the dimensions of health prescribed by WHO. The biomedical model contributes to the identification of illnesses through physiological parameters and treatment of the same through physical interventions (Deacon 2013). Engel (1977) proposed the biopsychosocial model, which asserts that health is affected through the interplay of biological factors (genetics and biochemical), psychological factors (mood, personality, and behaviour), and social factors (socio-economic, cultural, or familial). With the advancement of medical practice, the model contributes to the ideal practice of modern medicine (Nadir et al. 2018). Social factors were identified as the significant elements affecting the development of illnesses and behaviours as an extension of the work of Urie Bronfenbrenner (Biopsychosocial model 2020). The linkages between the biological, psychological, and social factors are extensively explained to

contribute to physical health outcomes as well as subjective well-being (Karunamuni et al. 2021). Despite the number of criticisms posed to the model, the implications of the same have been found helpful in improving patient satisfaction, physical, and psychological health.

19.3 Internal Environment: Psycho-biological Factors of Health

19.3.1 Immune System

The immune system of the body helps in fighting against the unexpected pathogens that constantly pose danger to the survival mechanism of the body. The immune system that functions well is constantly alert and monitors the dangerous indicators of the invaders from the external environment. Innate immunity is the primary defence system for the body and protects the body through physical, chemical, and biological barriers, specialized cells, and soluble molecules (Medzhitov and Janeway 2000).

19.3.2 Gut Microbiota and Neurotransmitters

Mental health is affected by the neurotransmitters, which are regulated by the microbiota found in the gastrointestinal tract of the human body. Gut microbiota is found to be a significant factor that contributes to mental disorders such as depression (Jiang et al. 2015; Valles-Colomer et al. 2019) and anxiety (Foster and Neufeld 2013). The composition of gut microbiota has been found to be linked with sleeping disorders (Smith et al. 2019) and eating disorders (Glenny et al. 2017) in human beings. Gut microbiota plays a crucial role in directly producing neurotransmitters and regulating metabolism pathways which changes the level of neurotransmitters in the body (Liu and Huang 2019). More than 90% of Serotonin, a brain neurotransmitter, is synthesized within the digestive tract (Gershon and Tack 2007; Terry and Margolis 2016) and is regulated by the gut miocrobiota (Sjögren et al. 2012; Yano et al. 2015). Additionally, about 50% of dopamine is produced and stored in the gut (Eisenhofer et al. 1997; Xue et al. 2018) and is regulated by the gut microbiota (Liu et al. 2016; Özoğul 2004). Neurotransmitters such as norepinephrine (Asano et al. 2012), gamma-aminobutyric acid (Bravo et al. 2011), Histamine (Gezginc et al. 2013), and acetylcholine (Stanaszek et al. 1977) are produced by the gut microbiota. It has been found that mood disorders such as depression and anxiety are linked with an imbalance of dopamine, serotonin, and norepinephrine (Moret and Briley 2011; Blier and El Mansari 2013; El Mansari et al. 2010). Reduced levels of GABA were found to increase depression (Anisman et al. 2012) and anxiety (Nuss 2015; Lydiard 2003), whereas GABA, when secreted normally, is found to increase the

experience of relaxation and lowers anxiety and mood disorders (Liu et al. 2020; Wierońska et al. 2011). Studies have shown that interruption in the secretions of various neurotransmitters leads to mental disorders (Mittal et al. 2017).

19.3.3 Age

Immune system is found to function differently amongst different age groups. Young children and aged people are found to be more vulnerable to infectious diseases when compared with people from other age groups (Dowling and Levy 2014; Simon et al. 2015). Studies reveal that immune responses are impaired with age (Yager et al. 2008). Degeneration of immune cells and decreased variable receptor genes on lymphocytes B and T cells causes the immune system to respond slowly in aged people (Goronzy and Weyand 2003). Due to the loss of lymphoid tissue during the process of ageing (Pan et al. 2008), the qualitative and quantitative decline of immune functions make the aged people susceptible to cardiovascular diseases (Stern et al. 2003), autoimmune diseases, and impaired responses to vaccinations and infections (McElhaney and Effros 2009). It is asserted that the biological immune system deteriorates constantly with age, but the mid-to-late fifties are a crucial period for screening and intervention (Palmer et al. 2018).

19.3.4 Sex

Differences in immunity levels are found in terms of gender. The immune responses to viral infections are asserted to be stronger in females than males (Klein and Huber 2010). Antibody production by B cells is found to be higher in females than males (Falter et al. 1991; Gomez et al. 1993). It is found that women exhibit superior immune-mediated tissue repair capacities (Klein et al. 2020). Although, factors like menopause in women inflate the risk of diseases like coronary heart disease (De Kat et al. 2016). Type 2 diabetes (Ercan et al. 2017) and osteoporosis (Jung et al. 2019), weakens the women's immune system after menopause.

19.3.5 Genetics

Inheritance of genetics is one of the major determinants of health status. Family members share the genomic and environmental interactions in an individual's lifetime; therefore, family history becomes one of the significant predictors of disease risk (Kardia et al. 2003). Human beings are found to be 99.9% similar in their genetic makeup, and 0.1% indicates the probable causes of diseases. It is found that susceptibility to infections that are life-threatening (Sørensen et al. 1988), and

immune-mediated diseases are both hereditary and have specific genetic variants (Clohisey and Baillie 2019). Genomics, along with the interaction of genes with the environment, also studies complex diseases such as cancer, diabetes, and asthma that are caused due to genes and environmental interaction (Collins and Guttmacher 2002). Understanding the interaction between genes and the environment is helpful in finding better ways to improve the status of health and the prevention of diseases (Khoury et al. 2004). Not only physical diseases but mental disorders and mental illnesses are also found to be associated with a particular genetic makeup. Disorders such as schizophrenia, autism, major depression, manic depressive illness, panic disorder, and ADHD are found to be associated with heredity (Craddock and Jones 1999; Kendler et al. 1994; McGuffin et al. 1996; Risch et al. 1999).

19.3.6 Personality

Immune system responses and physiological mechanisms are associated with personality traits (Chapman et al. 2009; LeBlanc and Ducharme 2005). Personality traits are also linked with proneness to infections (Totman et al.1980). Pathogenesis, health behaviours, and coping with illness are mechanisms identified that influence health outcomes (Roberts et al. 2007). Traits have an influence on social cognition (Conner and Abraham 2001) associated with symptoms and illness behaviours (Ader and Cohen 1982). High scores on extraversion are linked with the absence of illness, whereas high scores on neuroticism increase the proneness to diseases (Goodwin and Friedman 2006).

19.3.7 Diet and Nutrition

Diet plays a significant role in the growth and development of an individual. It maintains health and builds up the ability to fight against diseases by strengthening the immune system. Diet and disease are found to be closely interlinked with each other (Aruoma 2015). A poor diet can enhance the process of ageing and can increase the risk of chronic diseases such as cancer, arthritis, and type II diabetes, whereas studies reveal that diets including bioactive compounds reduce the risk (Halliwell and Gutteridge 2015). The benefits of specific dietary intake are not found to be the same for everyone. Appropriate weight in accordance with height, balancing the consumption of alcohol, not smoking, and maintaining a regular exercise routine is factors that are conclusive of the predisposing risk towards chronic illness (Johnson 2015). Malnutrition due to undernutrition or overnutrition can be considered the determinant of increased risk for disability or disease.

19.4 External Environment

The surroundings have been an influential factor in the development, growth, and evolution of biotic as well as abiotic factors. The human body reacts to the environment and also influences it. Weather and temperature changes are found to be significant factors affecting respiratory functioning. Respiratory infections are more commonly witnessed in winters due to sudden temperature changes and less ventilation in homes (D'Amato et al. 2018). Since the beginning of the industrial revolution, humans have exploited resources and polluted nature. The anthropogenic factors on the earth have caused so much destruction that they have now become irreversible, and a phenomenon of climate change has been triggered. With an increase of 0.85 °C warming of the earth over the last 130 years, there have been changes in precipitation levels globally along with melting of glaciers, sea-level rise, and more frequent and intense extreme events (Climate Change and Health 2021). The essential health components like safe housing, food supply, and water quality and quantity get affected due to climate change. Factors such as agricultural productivity, especially the availability of land, adverse weather, and food security are significant in giving rise to malnutrition (Friedrich 2015). Even though the entire world population faces risk yet, children, nursing mothers, the elderly, and economically and socially deprived sections are more at threat (Leonard 2020). High temperatures may result in respiratory, cardiovascular diseases, and vector-borne diseases (Climate Change and Health 2021), along with premature deaths, malnutrition, water-borne diseases, and even threats to mental health (Climate Effects on Health 2021). The risk increases with exposure, degree of sensitivity, and lack of adaptation (Understanding the Connections Between Climate Change and Human Health 2020). Therefore, chemical risk assessment, studying the suspended particulate matter, natural disaster control and prevention, research regarding bacteria, viruses, and infections, improved access to health care, development of public health care infrastructure, supply of clean drinking water, and prevention of pollution become key issues requiring the cooperation of international organizations and national governments globally.

19.4.1 External Environment: Psycho-social Factors

Health sciences have made tremendous progress in concentrating on the development of new interventional approaches, not only in the physical dimensions of health but integrating psychological and social factors, to achieve an overall perspective on the concept of health. Psychosocial factors include the social conditions and experiences along with the psychological states (Singh-Manoux 2003; Martikainen et al. 2002). The conditions in which people are born and live define social inequalities in health that affect the individual's development (Marmot 2010). Factors such as social, economic, political, and cultural environment are identified to be determining the health status. Health behaviours are found to be related to psychological

resources such as a sense of coherence (Hassmen et al.2000; Larm et al. 2016; Wainwright et al. 2007; Swan et al. 2015), self-esteem (Sani et al. 2016; Hale et al. 2015; Umberson et al. 2010), resilience, and mastery (Daniel et al. 2006). Psychological risk factors such as cynicism (Sims et al. 2017) and depressiveness (Kull et al. 2012) are also found to be related to health behaviours. One of the factors that influence health maintaining behaviours is psychological stress (Marmot and Wilkinson 2001). Prolonged stressors along with working conditions and stressful living lead to high blood pressure, diabetes, and heart diseases (Brotman et al.2007). Stressful events in life are found to be linked with the onset of depression (Mazure 1998; Stroud et al. 2008), suicidal thoughts (Liu and Miller 2014), and self-harm (O'Connor et al. 2012). Psychosocial stressors such as lack of social support, money problems, and work-related stress are found to be associated with irritable bowel syndrome (Konturek et al. 2011). Long-term illness can be stressful and can lead to physical and psychological problems due to a perceived lack of support from the medical services (Mental Health Foundation Scotland 2018). Factors such as social isolation and loneliness have been found to be linked with an enhanced risk of depression and early mortality (Marmot et al. 2010). Coronary heart disease is linked with chronic work stress directly mediated by the neuroendocrine stress response and indirectly by health behaviours (Chandola et al. 2008).

19.5 Psychoneuroimmunology

Psychoneuroimmunology (PNI) examines the influence of psychological, neurological, and immunological processes that interact with each other in maintaining health and behaviour in human beings (Irwin and Slavich 2017). Research in psychoneuroimmunology shows that the interaction of the three factors affects the functioning of the immune system consequently impacts the cognitive, emotional, and neural behaviour that ultimately leads to physical health problems (chronic pain, cardiovascular diseases, cancer, neurodegeneration, etc.) and mental health issues such as mood disorders, anxiety, depression, and post-traumatic stress disorder (Ader et al. 1995; Cohen and Herbert 1996; Haroon et al. 2012; Kiecolt-Glaser et al. 2002; Maier and Watkins 1998; Miller et al. 2009).

19.6 Conclusion

Health is an aspect of life that needs to be taken care of with absolute contention. Adopting an integrated approach to health has become the utmost prerequisite for survival, considering the overall change in climatic and agricultural patterns. The environment, which can be categorized into internal and external to the human body, in combination, affects the health status of individuals, consequently affecting global health. Internal factors such as foetal immune environment, immune system, gut

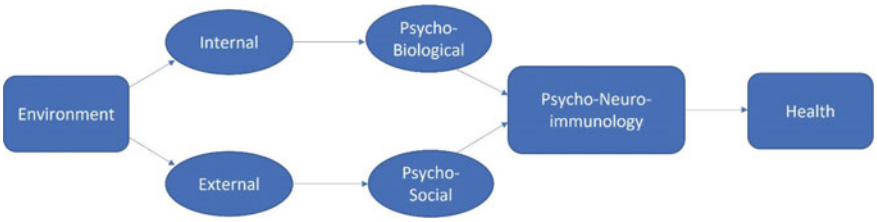


Fig. 19.1 Internal and external environment leading to the overall health. *Source* Prepared by the researcher

microbiota, neurotransmitters, food, and nutrition are definitely important elements contributing to health; besides, other psycho-biological factors such as personality, age, sex, genetics, and genomics are also noteworthy. External environmental alterations impact the quality of production, availability of resources, supply, distribution, and consumption of resources amongst the masses. Psychosocial variables such as social and economic conditions and political and cultural environment are found to be determining the health condition. A sense of coherence and social support also contributes to the health maintaining behaviours. Stressors such as work-related stress, social isolation, and disturbed relationships can be another contributing factor to maladaptation to the social environment. Prolonged psychological stress can lead to developing physical and mental illnesses. These factors are found to be mediated by neuroendocrine responses to environmental stress. Therefore, an amalgamation of psycho-neuro-immunological and environmental factors influences the development of the overall health pattern in an individual (Fig. 19.1). Taking care of all these factors can help individuals to be healthier and make them more adaptable to the changing needs of the environment. For a healthy child, the mother needs both the internal and external environment to be healthy. The strength of the internal environment of the mother will be developed according to the overall lifestyle that has been taken care of in the entire lifespan by the mother. The physical, mental, and overall well-being of both the father and the mother impact the health of their offspring. In such a case, it becomes the sole responsibility of each individual to remain healthy by monitoring and regulating health behaviours to maintain good health for the welfare of society and humanity at large.

References

Ader R, Cohen N (1982) Behaviorally conditioned immunosuppression and murine systemic lupus erythematosus. Science 215(4539):1534–1536

Ader R, Cohen N, Felten D (1995) Psychoneuroimmunology: interactions between the nervous system and the immune system. Lancet 345:99–103. https://doi.org/10.1016/s0140-6736(95)90066-7

Anisman H, Merali Z, Poulter M (2012) Gamma-aminobutyric acid involvement in depressive illness. Neurobiol Basis Suicide Front Neurosci 65–86

Armitage JA, Khan IY, Taylor PD, Nathanielsz PW, Poston L (2004) Developmental programming of the metabolic syndrome by maternal nutritional imbalance: how strong is the evidence from experimental models in mammals? J Physiol 561(2):355–377
Aruoma OI (2015) Nutrition, genomics, and human health: a complex mechanism for wellness. Genomics Proteomics Metabolomics Nutraceuticals Funct Foods 135
Asano Y, Hiramoto T, Nishino R, Aiba Y, Kimura T, Yoshihara K, Sudo N (2012) Critical role of gut microbiota in the production of biologically active, free catecholamines in the gut lumen of mice. Am J Physiol Gastrointest Liver Physiol 303(11):G1288–G1295
Basha S, Surendran N, Pichichero M (2014) Immune responses in neonates. Exp Rev Clin Immunol 10(9):1171–1184. https://doi.org/10.1586/1744666X.2014.942288
Biopsychosocial model (2020) In Wikipedia. https://en.wikipedia.org/wiki/Biopsychosocial_model
Blier P, El Mansari M (2013) Serotonin and beyond: therapeutics for major depression. Philos Trans Royal Soc b Biol Sci 368(1615):20120536
Bravo JA, Forsythe P, Chew MV, Escaravage E, Savignac HM, Dinan TG, Cryan JF (2011) Ingestion of Lactobacillus strain regulates emotional behavior and central GABA receptor expression in a mouse via the vagus nerve. Proc Natl Acad Sci 108(38):16050–16055
Brotman DJ, Golden SH, Wittstein IS (2007) The cardiovascular toll of stress. Lancet 370(9592):1089–1100
Chandola T, Britton A, Brunner E, Hemingway H, Malik M, Kumari M, Marmot M (2008) Work stress and coronary heart disease: what are the mechanisms? Eur Heart J 29(5):640–648
Chapman BP, Khan A, Harper M, Stockman D, Fiscella K, Walton J, Moynihan J (2009) Gender, race/ethnicity, personality, and interleukin-6 in urban primary care patients. Brain Behav Immun 23(5):636–642
Climate Change and Health (2021) World Health Organization. https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health. Accessed on 16 July 2021
Climate Effects on Health (2021) Centres for disease control and prevention. https://www.cdc.gov/climateandhealth/effects/default.htm. Accessed on 16 July 2021
Clohisey S, Baillie JK (2019) Host susceptibility to severe influenza. A virus infection. Crit Care 23(1):1–10
Cohen S, Herbert TB (1996) Health psychology: psychological factors and physical disease from the perspective of human psychoneuroimmunology. Annu Rev Psychol 47:113–142. https://doi.org/10.1146/annurev.psych.47.1.113
Collins FS, Guttmacher AE (2002) Genomic medicine—a primer. N Engl J Med 347:1512–1520
Conner M, Abraham C (2001) Conscientiousness and the theory of planned behavior: toward a more complete model of the antecedents of intentions and behavior. Pers Soc Psychol Bull 27(11):1547–1561
Craddock N, Jones I (1999) Genetics of bipolar disorder. J Med Genet 36(8):585–594
Cunha AJLAD, Leite ÁJM, Almeida ISD (2015) The pediatrician's role in the first thousand days of the child: the pursuit of healthy nutrition and development. J Pediatr (rio j) 91:S44–S51
D'Amato M, Molino A, Calabrese G, Cecchi L, Annesi-Maesano I, D'Amato G (2018) The impact of cold on the respiratory tract and its consequences to respiratory health. Clin Transl Allergy 8(1):1–8
Daniel M, Brown A, Dhurrkay JG, Cargo MD, O'Dea K (2006) Mastery, perceived stress and health-related behaviour in northeast Arnhem Land
De Kat AC, Verschuren WMM, Eijkemans MJC, Van Der Schouw YT, Broekmans FJM (2016) The association of low ovarian reserve with cardiovascular disease risk: a cross-sectional population-based study. Hum Reprod 31(8):1866–1874
Deacon BJ (2013) The biomedical model of mental disorder: a critical analysis of its validity, utility, and effects on psychotherapy research. Clin Psychol Rev 33(7):846–861
Dowling DJ, Levy O (2014) Ontogeny of early life immunity. Trends Immunol 35(7):299–310
Eisenhofer G, Åneman A, Friberg P, Hooper D, Fåndriks L, Lonroth H, Mezey EVA (1997) Substantial production of dopamine in the human gastrointestinal tract. J Clin Endocrinol Metab 82(11):3864–3871

El Mansari M, Guiard BP, Chernoloz O, GhanbariR KN, Blier P (2010) Relevance of norepinephrine–dopamine interactions in the treatment of major depressive disorder. CNS Neurosci Ther 16(3):e1–e17

Engel GL (1977) The need for a new medical model: a challenge for biomedicine. Science 196(4286):129–136

Ercan A, Kohrt WM, Cui J, Deane KD, Pezer M, Yu EW, Nigrovic PA (2017) Estrogens regulate glycosylation of IgG in women and men. JCI Insight 2(4)

Falter H, Persinger MA, Reid K (1991) Sex differences in primary humoral responses of albino rats to human serum albumin. Immunol Lett 28(2):143–145

Foster JA, Neufeld KAM (2013) Gut-brain axis: how the microbiome influences anxiety and depression. Trends Neurosci 36(5):305–312

Friedrich MJ (2015) Assessing and addressing global malnutrition. JAMA 313(3):235–235

Gershon MD, Tack J (2007) The serotonin signaling system: from basic understanding to drug development for functional GI disorders. Gastroenterology 132(1):397–414

Gezginc Y, Akyol I, Kuley E, Özogul F (2013) Biogenic amines formation in Streptococcus thermophilus isolated from home-made natural yogurt. Food Chem 138(1):655–662

Glenny EM, Bulik-Sullivan EC, Tang Q, Bulik CM, Carroll IM (2017) Eating disorders and the intestinal microbiota: mechanisms of energy homeostasis and behavioral influence. Curr Psychiatry Rep 19(8):1–9

Gomez E, Ortiz V, Saint-Martin B, Boeck L, Díaz-Sánchez V, Bourges H (1993) Hormonal regulation of the secretory IgA (sIgA) system: estradiol-and progesterone-induced changes in sIgA in parotid saliva along the menstrual cycle. Am J Reprod Immunol 29(4):219-223

Goodwin RD, Friedman HS (2006) Health status and the five-factor personality traits in a nationally representative sample. J Health Psychol 11(5):643–654

Goronzy JJ, Weyand CM (2003) Ageing, autoimmunity and arthritis: T-cell senescence and contraction of T-cell repertoire diversity–catalysts of autoimmunity and chronic inflammation. Arthritis Res Ther 5(5):1–10

Hale WJ, Perrotte JK, Baumann MR, Garza RT (2015) Low self-esteem and positive beliefs about smoking: a destructive combination for male college students. Addict Behav 46:94–99

Halliwell B, Gutteridge JM (2015) Free radicals in biology and medicine. Oxford University Press, USA

Haroon E, Raison CL, Miller AH (2012) Psychoneuroimmunology meets neuropsychopharmacology: translational implications of the impact of inflammation on behavior. Neuropsychopharmacology 37:137–162. https://doi.org/10.1038/npp.2011.205

Hassmen P, Koivula N, Uutela A (2000) Physical exercise and psychological well-being: a population study in Finland. Prev Med 30(1):17–25

Irwin MR, Slavich GM (2017) Psychoneuroimmunology. In Cacioppo JT, Tassinary LG, Berntson GG (eds) Handbook of psychophysiology (4th ed., pp. 377–398). Cambridge University Press, New York, NY

Jiang H, Ling Z, Zhang Y, Mao H, Ma Z, Yin Y, Ruan B (2015) Altered fecal microbiota composition in patients with major depressive disorder. Brain Behav Immun 48:186–194

Johnson M (2015) The role of the food and nutritional sciences in examining the determinants of health. F Nutr Reprt 1(1):27–29

Jung HS, Nho JH, Ha YC, Jang S, Kim HY, Yoo JI, Lee YK (2019) Incidence of osteoporotic refractures following proximal humerus fractures in adults aged 50 years and older in Korea. J Bone Metab 26(2):105–111

Kardia SL, Modell SM, Peyser PA (2003) Family-centered approaches to understanding and preventing coronary heart disease. Am J Prev Med 24(2):143–151

Karunamuni N, Imayama I, Goonetilleke D (2021) Pathways to well-being: untangling the causal relationships among biopsychosocial variables. Soc Sci Med 272:112846

Kendler KS, Gruenberg AM, Kinney DK (1994) Independent diagnoses of adoptees and relatives as defined by DSM-III in the provincial and national samples of the Danish adoption study of Schizophrenia. Arch Gen Psychiatry 51(6):456–468

Khalil H, Murrin C, Viljoen K, Segurado R, Somerville R, O'Brien J, Cecily CC (2015) Metabolic syndrome risk in Irish children is associated with maternal diet: prospective findings from the lifeways cross-generation cohort study 2001–2014. Atherosclerosis 241(1):e171
Khoury MJ, Little J, Burke W (eds) (2004) Human genome epidemiology: a scientific foundation for using genetic information to improve health and prevent disease. Oxford University Press.
Kiecolt-Glaser JK, McGuire L, Robles TF, Glaser R (2002) Psychoneuroimmunology: psychological influences on immune function and health. J Consult Clin Psychol 70:537–547. https://doi.org/10.1037//0022-006x.70.3.537
Klein SL, Dhakal S, Ursin RL, Deshpande S, Sandberg K, Mauvais-Jarvis F (2020) Biological sex impacts COVID-19 outcomes. PLoS Pathog 16(6):e1008570
Klein SL, Huber S (2010) Sex differences in susceptibility to viral infection. In: Sex hormones and immunity to infection. Springer, Berlin, pp 93–122
Kollmann TR, Kampmann B, Mazmanian SK, Marchant A, Levy O (2017) Protecting the newborn and young infant from infectious diseases: lessons from immune ontogeny. Immunity 46(3):350–363. https://doi.org/10.1016/j.immuni.2017.03.009
Konturek PC, Brzozowski T, Konturek SJ (2011) Stress and the gut: pathophysiology, clinical consequences, diagnostic approach and treatment options. J Physiol Pharmacol 62(6):591–599
Kull M, Ainsaar M, Kiive E, Raudsepp L (2012) Relationship between low depressiveness and domain specific physical activity in women. Health Care Women Int 33(5):457–472
Larm P, Åslund C, Starrin B, Nilsson KW (2016) How are social capital and sense of coherence associated with hazardous alcohol use? Findings from a large population-based Swedish sample of adults. Scand J Public Health 44(5):525–533
LeBlanc J, Ducharme MB (2005) Influence of personality traits on plasma levels of cortisol and cholesterol. Physiol Behav 84(5):677–680
Leonard J (2020) How climate change effects human health. Medical News Today. https://www.medicalnewstoday.com/articles/climate-change-and-health. Accessed on 16 July 2021
Lewis AJ, Galbally M, Gannon T, Symeonides C (2014) Early life programming as a target for prevention of child and adolescent mental disorders. BMC Med 12(1):1–15
Liu RT, Miller I (2014) Life events and suicidal ideation and behavior: a systematic review. Clin Psychol Rev 34(3):181–192
Liu WH, Chuang HL, Huang YT, Wu CC, Chou GT, Wang S, Tsai YC (2016) Alteration of behavior and monoamine levels attributable to Lactobacillus plantarum PS128 in germ-free mice. Behav Brain Res 298:202–209
Liu T, Feenstra KA, Heringa J, Huang Z (2020) Influence of gut microbiota on mental health via neurotransmitters: a review. J Artif Intell Med Sci 1(1–2):1–14
Liu T, Huang Z (2019) Evidence-based analysis of neurotransmitter modulation by gut microbiota. In: International conference on health information science. Springer, Cham, pp 238–249
Lydiard RB (2003) The role of GABA in anxiety disorders. J Clin Psychiatry 64:21–27
Maier SF, Watkins LR (1998) Cytokines for psychologists: Implications of bidirectional immune-to-brain communication for understanding behavior, mood, and cognition. Psychol Rev 105:83–107. https://doi.org/10.1037/0033-295X.105.1.83
Marmot M (2010) Fair society, healthy lives: a strategic review of inequalities in England. University College London, London
Marmot M, Allen J, Goldblatt P (2010) A social movement, based on evidence, to reduce inequalities in health: fair society, healthy lives (The Marmot Review). Soc Sci Med (1982) 71(7):1254–1258
Marmot M, Wilkinson RG (2001) Psychosocial and material pathways in the relation between income and health: a response to Lynch et al. Bmj 322(7296):1233–1236
Martikainen P, Bartley M, Lahelma E (2002) Psychosocial determinants of health in social epidemiology
Mazure CM (1998) Life stressors as risk factors in depression. Clin Psychol Sci Pract 5(3):291
McElhaney JE, Effros RB (2009) Immunosenescence: what does it mean to health outcomes in older adults? Curr Opin Immunol 21(4):418–424

McGrath J, Solter D (1984) Completion of mouse embryogenesis requires both the maternal and paternal genomes. Cell 37(1):179–183
McGuffin P, Katz R, Watkins S, Rutherford J (1996) A hospital-based twin register of the heritability of DSM-IV unipolar depression. Arch Gen Psychiatry 53(2):129–136
Medzhitov R, Janeway C Jr (2000) Innate immunity. N Engl J Med 343(5):338–344
Mental Health Foundation Scotland (2018) Supporting the emotional and mental health needs of people with cancer. Mental Health Foundation, Glasgow
Miller G, Chen E, Cole SW (2009) Health psychology: developing biologically plausible models linking the social world and physical health. Annu Rev Psychol 60:501–524. https://doi.org/10.1146/annurev.psych.60.110707.163551
Mittal R, Debs LH, Patel AP, Nguyen D, Patel K, O'Connor G, Liu XZ (2017) Neurotransmitters: the critical modulators regulating gut-brain axis. J Cell Physiol 232(9):2359–2372
Moret C, Briley M (2011) The importance of norepinephrine in depression. Neuropsychiatr Dis Treat 7(1):9
Nadir M, Hamza M, Mehmood N (2018) Assessing the extent of utilization of biopsychosocial model in doctor-patient interaction in public sector hospitals of a developing country. Ind J Psychiatry 60(1):103–108
Nightingale CM, Rudnicka AR, Owen CG, Newton SL, Bales JL, Donin AS, Whincup PH (2015) Birthweight and risk markers for type 2 diabetes and cardiovascular disease in childhood: the child heart and health study in England (CHASE). Diabetologia 58(3):474–484
Nuss P (2015) Anxiety disorders and GABA neurotransmission: a disturbance of modulation. Neuropsychiatr Dis Treat 11:165
O'Connor RC, Rasmussen S, Hawton K (2012) Distinguishing adolescents who think about self-harm from those who engage in self-harm. Br J Psychiatry 200(4):330–335
Özoğul F (2004) Production of biogenic amines by Morganella morganii, Klebsiella pneumoniae and Hafnia alvei using a rapid HPLC method. Eur Food Res Technol 219(5):465–469
Palmer S, Albergante L, Blackburn CC, Newman TJ (2018) Thymic involution and rising disease incidence with age. Proc Natl Acad Sci 115(8):1883–1888
Pan WR, Suami H, Taylor GI (2008) Senile changes in human lymph nodes. Lymphat Res Biol 6(2):77–83
Risch N, Spiker D, Lotspeich L, Nouri N, Hinds D, Hallmayer J, Myers RM (1999) A genomic screen of autism: evidence for a multilocus etiology. Am J Hum Genet 65(2):493–507
Roberts BW, Kuncel NR, Shiner R, Caspi A, Goldberg LR (2007) The power of personality: the comparative validity of personality traits, socioeconomic status, and cognitive ability for predicting important life outcomes. Perspect Psychol Sci 2(4):313–345
Sani SHZ, Fathirezaie Z, Brand S, Pühse U, Holsboer-Trachsler E, Gerber M, Talepasand S (2016) Physical activity and self-esteem: testing direct and indirect relationships associated with psychological and physical mechanisms. Neuropsychiatr Dis Treat 12:2617
Simon AK, Hollander, GA, McMichael A (2015) Evolution of the immune system in humans from infancy to old age. Proc Royal Soc B Biol Sci 282(1821):20143085
Sims M, Lipford KJ, Patel N, Ford CD, Min YI, Wyatt SB (2017) Psychosocial factors and behaviors in African Americans: the Jackson heart study. Am J Prev Med 52(1):S48–S55
Singh-Manoux A (2003) Psychosocial factors and public health. J Epidemiol Commun Health 57(8):553–556
Sjögren K, Engdahl C, Henning P, Lerner UH, Tremaroli V, Ohlsson LMK, C, (2012) The gut microbiota regulates bone mass in mice. J Bone Miner Res 27(6):1357–1367
Smith RP, Easson C, Lyle SM, Kapoor R, Donnelly CP, Davidson EJ, Tartar JL (2019) Gut microbiome diversity is associated with sleep physiology in humans. PLoS ONE 14(10):e0222394
Sørensen TI, Nielsen GG, Andersen PK, Teasdale TW (1988) Genetic and environmental influences on premature death in adult adoptees. N Engl J Med 318(12):727–732
Stanaszek PM, Snell JF, O'Neill JJ (1977) Isolation, extraction, and measurement of acetylcholine-from Lactobacillus plantarum. Appl Environ Microbiol 34(2):237–239
Stern S, Behar S, Gottlieb S (2003) Aging and diseases of the heart. Circulation 108(14):e99–e101

Stroud CB, Davila J, Moyer A (2008) The relationship between stress and depression in first onsets versus recurrences: a meta-analytic review. J Abnorm Psychol 117(1):206
Surani MAH, Barton SC, Norris ML (1986) Nuclear transplantation in the mouse: heritable differences between parental genomes after activation of the embryonic genome. Cell 45(1):127–136
Swan E, Bouwman L, Hiddink GJ, Aarts N, Koelen M (2015) Profiling healthy eaters. Determining factors that predict healthy eating practices among Dutch adults. Appetite 89:122–130
Terry N, Margolis KG (2016) Serotonergic mechanisms regulating the GI tract: experimental evidence and therapeutic relevance. Gastrointest Pharmacol 319–342
Totman R, Kiff J, Reed SE, Craig JW (1980) Predicting experimental colds in volunteers from different measures of recent life stress. J Psychosom Res 24(3–4):155–163
Umberson D, Crosnoe R, Reczek C (2010) Social relationships and health behavior across the life course. Ann Rev Sociol 36:139–157
Understanding the Connections Between Climate Change and Human Health (2020) United States Environmental Protection Agency. https://www.epa.gov/climate-indicators/understanding-connections-between-climate-change-and-human-health. Accessed 16 July 2021
Valles-Colomer M, Falony G, Darzi Y, Tigchelaar EF, Wang J, Tito RY, Raes J (2019) The neuroactive potential of the human gut microbiota in quality of life and depression. Nat Microbiol 4(4):623–632
Wainwright NW, Surtees PG, Welch AA, Luben RN, Khaw KT, Bingham SA (2007) Healthy lifestyle choices: could sense of coherence aid health promotion? J Epidemiol Commun Health 61(10):871–876
Wierońska JM, Stachowicz K, Nowak G, Pilc A (2011) The loss of glutamate-GABA harmony in anxiety disorders. Anxiety disorders, pp 135–156
World Health Organization (1958) The first ten years of the World Health Organization. World Health Organization
Xue R, Zhang H, Pan J, Du Z, Zhou W, Zhang Z, Bai L (2018) Peripheral dopamine controlled by gut microbes inhibits invariant natural killer T cell-mediated hepatitis. Front Immunol 9:2398
Yager EJ, Ahmed M, Lanzer K, Randall TD, Woodland DL, Blackman MA (2008) Age-associated decline in T cell repertoire diversity leads to holes in the repertoire and impaired immunity to influenza virus. J Exp Med 205(3):711–723
Yano JM, Yu K, Donaldson GP, Shastri GG, Ann P, Ma L, Hsiao EY (2015) Indigenous bacteria from the gut microbiota regulate host serotonin biosynthesis. Cell 161(2):264–276