Kumiko Sakamoto
Lilian Daniel Kaale
Reiko Ohmori
Tamahi Kato (Yamauchi) *Editors*

Changing Dietary Patterns, Indigenous Foods, and Wild Foods

In Relation to Wealth, Mutual Relations, and Health in Tanzania

Springer

Changing Dietary Patterns, Indigenous Foods, and Wild Foods

Kumiko Sakamoto • Lilian Daniel Kaale •
Reiko Ohmori • Tamahi Kato (Yamauchi)
Editors

Changing Dietary Patterns, Indigenous Foods, and Wild Foods

In Relation to Wealth, Mutual Relations, and Health in Tanzania

Springer

Editors
Kumiko Sakamoto
School of International Studies
Utsunomiya University
Utsunomiya, Tochigi, Japan

Lilian Daniel Kaale
Department of Food Science and Technology
University of Dar es Salaam
Dar es Salaam, Tanzania

Reiko Ohmori
School of Regional Design
Utsunomiya University
Utsunomiya, Tochigi, Japan

Tamahi Kato (Yamauchi)
Center for African Area Studies
Kyoto University
Kyoto, Kyoto, Japan

ISBN 978-981-99-3369-3 ISBN 978-981-99-3370-9 (eBook)
https://doi.org/10.1007/978-981-99-3370-9

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

This book is dedicated to the people of Tanzania.

Acknowledgment

The fruits of the research have been possible firstly with the cooperative participation of the people and of the understanding and support at the village, district, regional, and national levels in Tanzania. The Kiswahili version of the SF-36 was generously shared by Dr. Anita Wagner and Dr. Barbara Gande. The research has been assisted by various students and staff of Utsunomiya University for inserting data, data analysis, and secretarial support. Special thanks go to Mr. Frimpong Andrew Charles for his continued support of the manuscript as a research assistant in the process, from editing reference style and text to checking reference and data agreement. Appreciation also goes to Mr. Polgahagedara Don Pubudu Sanjeewa for editing, checking, and making the list of abbreviations and index, and Ms. Yukiko Kikuchi for her assistance in checking data and reference agreement. I would like to thank the students attending the "Basic Subjects for Practical Skills to Act Globally II" class at the School of International Schools, Utsunomiya University who read, translated, and discussed my previous publication with Springer, which gave me insights to improve this book.

The research has been granted permission from Tanzania Commission for Science and Technology (COSTECH) as "Social Development and Culture: The Case of Tanzania" (File No.: RCA 2001-29, Permit No.: 2005-287-ER-2001-29). The research has been pursued based on ethical clearance granted from Utsunomiya University (H18-0008 and H22-0012).

This research was funded by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan Society for the Promotion of Science (JSPS), and Grants-in-Aid for Scientific Research (KAKENHI) Program. "Possibilities of wild edible plants and traditional meals in East Africa: Through nutrition analysis in Tanzania" (18H03438, 2018-2021, B) and "African indigenous knowledge for SDGs and future generations: Contribution of wild food on nutrition and health principal" (22H00032, 2022-2026, A) both led by Kumiko Sakamoto and partly by 18H00776 (2018–2021, B). Financial support was also provided by Utsunomiya University.

Contents

Editors and Contributors

About the Editors

Kumiko Sakamoto works at the School of International Studies, Utsunomiya University in Japan. Worked with UNICEF and UNDP Tanzania. Ph.D. and MA from Waseda University. Researched in Tanzania for over 23 years. Author of *Factors Influencing Child Survival in Tanzania* (Springer, 2020), *Social Development, Culture, and Participation* (Shumpusha, 2009, 2021), and first author of *91 Useful Plants in the Deciduous Bushland and Thickets of the Dodoma Region, Central Tanzania* (Impress R&D, 2020), *109 Useful Plants in the Coastal Bushland of the Lindi Region, Southeast Tanzania*, (Yama-Kei Publishers, 2020), and *104 Plants for Spices, Fruits and Traditional Medicine in Zanzibar* (Dar es Salaam University Press, 2019), Nutrient content of seven African wild leafy vegetables in semi-arid Tanzania (*Journal of International Development Studies*, 2022, (54), 17–28) and Correlation between intake of wild food and health in four areas of Tanzania: analysis from semi-arid central and inland/coastal southeast *(Journal of International Development Studies*, 2021, 30 (2), 93–112). Principal Investigator for JSPS Grant-in-Aid for Scientific Research (A) "African Indigenous Knowledge for SDGs and Future Generations: Contribution of Wild Food on Nutrition and Health" and (B) "Possibilities of Wild Edible Plants and Traditional Meals in East Africa: Through Nutrition Analysis in Tanzania."
School of International Studies, Utsunomiya University, Tochigi, Japan

Lilian Daniel Kaale works at the Department of Food Science and Technology, University of Dar es Salaam in Tanzania. Dr. Kaale holds a Ph.D. degree in Food Science and Engineering. She currently serves as the Head of the Department of Food Science and Technology at the University of Dar es Salaam. Her main research areas are Food Nutrition, Food Processing (food value addition), and antimicrobial substances for food preservation and safety. Dr. Kaale has published more than 30 articles for local and international journals within food processing, nutrition, and antimicrobial agents for food preservation and safety. Dr. Kaale also has a wealth of

international experience, having been able to participate in numerous conferences and workshops on food and nutrition security. Dr. Kaale has also reviewed several articles in different Journals: *International Journal of Refrigeration*, *Journal of Food Engineering, LWT - Food Science and Technology*, *Aquaculture and Current Journal of Applied Sciences and Technology*. Dr. Kaale has led several teams working on consultancy and research issues. She is Principal Investigator in several projects funded locally and internationally.
Department of Food Science and Technology, University of Dar es Salaam, Dar es Salaam, Tanzania

Reiko Ohmori works at the School of Regional Design, Utsunomiya University in Japan. Holds Ph.D. and M.S. degree from Ochanomizu University. Worked at National Defense Medical College and belonged to the National Institute of Health and Nutrition, and Ochanomizu University as visiting researcher. Her research theme is association among health, dietary, and genetic factor. Furthermore, researching on relations of health with social capital. Published more than 50 reports in journals such as *Atherosclerosis* and *Arterioscler Thromb Vasc Biol*. She also contributes to school education in Japan. Engaged in the editing of current Japanese government course guidelines, which are used in senior high school. Wrote text-books used at a high school and a junior high school.
School of Regional Design, Utsunomiya University, Utsunomiya, Japan

Tamahi Kato teaches at several universities in Japan and does consultancy work. Worked extensively in Tanzania including at the JICA Tanzania office and have researched for more than 12 years in Tanzania, and in Guatemala. Holds Ph.D. degree in Development Studies from the University of Sussex. Published several articles in journals including Women's empowerment through small-scale mixed porridge flour processing in the Morogoro region of Tanzania (*Journal of International Development Studies*, 2021, 30 (2), 129–144), Agricultural input subsidies in Sub-Saharan Africa (*IDS Bulletin*, 2016, Vol. 47, No. 2, 33–48) and Poverty monitoring in Tanzania (*Journal of International Cooperation*, 2006, Vol. 22, No. 2, 29–42)
Center for African Area Studies, Kyoto University, Kyoto, Japan

About the Contributors

Katsunori Tsuda As a researcher, Katsunori Tsuda belongs to the Center for the Multicultural Public Sphere (CMPS) of Utsunomiya University. Holds a master's degree in agriculture from the Tokyo University of Agriculture and Technology. He is a former Japan International Cooperation Agency (JICA) Volunteer assigned as a

Garage Manager in the Christian Council of Tanzania with Gesellschaft fur Technische Zusammenarbeit (GTZ) for 2 years. He has also done research on traditional medicinal plants in Dar es Salaam and on wild edible plants in Dodoma. In recent years, he is also doing research and has been an advisor to improve the relationships between humans and wild animals in Japan.
Center for the Multicultural Public Sphere (CMPS) of Utsunomiya University, Utsunomiya, Japan

Momoko Muto As a researcher, Momoko Muto belongs to the CMPS of Utsunomiya University. She holds a master's degree in nutrition from Showa Women's University in Japan (published High dietary saturated fat is associated with a low risk of intracerebral hemorrhage and Ischemic stroke in Japanese but not in non-Japanese: A review and meta-analysis of prospective cohort studies, *J Atheroscler Thromb*, 25(5), 375–392) and a national license as a registered dietitian in Japan. Majored in nutritional epidemiology for over 7 years in graduate school. Studying the nutrition situation in Tanzania from a healthy epidemiology perspective as one of the members of Prof. Sakamoto's study team since 2020 and as one of the members of the grant-in-aid for the scientific research team "African Indigenous Knowledge for SDGs and Future Generations" since 2022.
Center for the Multicultural Public Sphere (CMPS) of Utsunomiya University, Utsunomiya, Japan

Ayusa Okui As a research collaborator, Ayusa Okui is one of the members of the scientific research, "African Indigenous Knowledge for SDGs and Future Generations" since 2022. She is a former Japan International Cooperation Agency (JICA) volunteer assigned as a community development officer in Ifunda Ward, Iringa District Council for 2 years and 4 months. She has also researched edible and useful plants in Iringa and has collaborated on the questionnaire implemented in Iringa and Dodoma during her volunteer in Tanzania. Apart from her current job at an agency for international development assistance in Japan, she makes Swahili picture book movies and shows them on YouTube which emphasize environmental preservation in Tanzania.
"African Indigenous Knowledge for SDGs and Future Generations", Utsunomiya University, Utsunomiya, Japan

Parinya Khemmarath is a graduate from the School of Regional Development and Creativity of Utsunomiya University holding a master's degree in international studies. He focused his research on the entrepreneurial characteristics among rice producers in Lao PDR. While working in the agricultural sector of Japan and as an entrusted researcher at Utsunomiya University, he is actively and keenly engaged in Japanese learning and social research. In an attempt to improve his future research in theorizing the entrepreneurship mind, he is working to enhance soft and hard skills

through working in a Japanese company and cooperating in scientific research "African Indigenous Knowledge for SDGs and Future Generations: Contribution of Wild Food on Nutrition and Health." Co-author of Health, livelihoods, and food intake in coastal southeast Tanzania (*Journal of the Faculty of International Studies, Utsunomiya University*, (50), 11–29).
Center for the Multicultural Public Sphere (CMPS) of Utsunomiya University, Utsunomiya, Japan

Anna Calisti Maro works at the Department of Community Development, Lindi region, Tanzania. Her main research areas are community, with a focus on women, children, and youth. She published many articles for local and international journals within the community on determinants of adolescent pregnancy, non-communicable diseases, climate changes, Environmental Impact Assessments (EIA), poverty eradication through household income-generating activities, hunger, nutrition, and health. Co-author of Health, livelihoods, and food intake, food intake and health of school children in southeast Tanzania (*Journal of the Faculty of International Studies, Utsunomiya University*, No. 50, pp. 11–29). Anna Maro also has experience in participating and presenting papers from the grassroots (village level) to the national level. Anna has led several teams working on research issues and later presenting research findings to the community for their self-understanding and planning. She is Principal Community Development Expert at several projects funded locally and internationally.
Department of Community Development, Lindi, Tanzania

Frank M. Mbago Chief technician and curator of the University of Dar es Salaam Herbarium. Born in 1963, he was awarded an international diploma in herbarium techniques and plant taxonomy from Royal Botanical Gardens, Kew, England in 1992. Certificate and diploma in plant identification awarded in 1996 and 2007 from other institutions. Participated in various projects as a botanist.
University of Dar es Salaam Herbarium, Dar es Salaam, Tanzania

Abbreviations

Ad-RML	*Adansonia digitata,* raw mature leaves
Ad-RYL	*Adansonia digitata,* raw young leaves
AFPs	Adequate Feeding Practices
AIDS	Acquired Immunodeficiency Syndrome
ANFs	Antinutritional Factors
ANOVA	Analysis of Variance
AWLVs	African wild leafy vegetables
BMI	Body Mass Index
BOT	Bank of Tanzania
BP	Body Pain
BRELA	Business Registration and Licensing Agency
BRT	Bus Rapid Transit system
CCCs	Children's Care Centers
Cd-RL	*Cucumis dipsaceus*, raw leaves
Cg-RL	*Cleome gynandra*, raw leaves
Ch-RL	*Cleome hirta*, raw leaves
CMPS	Center for the Multicultural Public Sphere
COSTECH	Tanzania Commission for Science and Technology
Cs-RL	*Ceratotheca sesamoides*, raw leaves
CVDs	Cardiovascular Diseases
DART	Dar-es-Salaam Rapid Transit
DBM	Double Burden of Malnutrition
DHS	Demographic Health Survey
DM	Diabetes Mellitus
FA	Factor Analysis
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GH	General Health
HIV	Human Immunodeficiency Virus
HNP	Health, Nutrition, and Population

HPLC	High Performance Liquid Chromatography
HSD	Honestly Significant Difference
HSSP	Health Sector Strategic Plan
IBM Corp	International Business Machines Corporation
IBM SPSS	IBM Statistical Package for the Social Sciences
ICRAF	International Council for Research in Agroforestry
IFAD	International Fund for Agricultural Development
IITA	International Institute of Tropical Agriculture
IMR	Infant Mortality Rate
IQOLA	International Quality of Life Assessment
IRAN	Inter-Agency Regional Analysts Network
Isb-RL	*Ipomoea sinensis* subsp. *Blepharosepala,* raw leaves
IYCF	Infant and Young Child Feeding
JSPS	Japan Society for the Promotion of Science
KFC	Kentucky Fried Chicken
MCS	Mental Components Summary
MDGs	Millennium Development Goals
MH	Mental Health
MoH	Ministry of Health
MoHCDGEC	Ministry of Health, Community Development, Gender, Elderly and Children
MO-USA	Missouri-United States of America
NBS	National Bureau of Statistics
NCDs	Non-Communicable Diseases
NJ	New Jersey
NMNAP	National Multisectoral Nutrition Action Plan
NNS	National Nutrition Survey
NTFPs	Non-Timber Forest Products
NY	New York
OCGS	Office of the Chief Government Statistician
PCA	Principal Component Analysis
PCS	Physical Component Summary
PF	Physical Functioning
QOL	Quality of Life
RDAs	Recommended Dietary Allowances
RE	Role Emotional
RP	Role Physical
SDGs	Sustainable Development Goals
SDH	Social Determinants of Health
SF	Social Functioning
SF-12	Short Form 12-Item Health Survey
SF-36	Short Form 36-Item Health Survey
SPSS	Statistical Package for Social Sciences
SWFVs	Street Women Food Vendors

TBS	Tanzania Bureau of Standards
TDHS	Tanzania Demographic Health Survey
TFNC	Tanzania Food and Nutrition Centre
TNNS	Tanzania National Nutrition Survey using SMART Methodology
TSh	Tanzanian Shilling
U5MR	Under-5 Mortality Rate
UK	United Kingdom
UN	United Nations
UNDP	United Nations Development Programme
UNICEF	United Nations International Children's Emergency Fund
URT	United Republic of Tanzania
US	United States
USA	United States of America
USD	United States Dollar
UTI	Urinary Tract Infection
UU-A	Utsunomiya University-Africa
VEO	Village Executive Officer
VT	Vitality
WFP	World Food Programme
WHO	World Health Organization

List of Figures

List of Tables

Chapter 1
Introduction: Changing Dietary Patterns, Indigenous Foods, and Wild Foods in Relation to Wealth, Mutual Relations, and Health in Tanzania

Kumiko Sakamoto, Lilian Daniel Kaale, Reiko Ohmori, and Tamahi Kato

Abstract Indigenous and wild foods continue to be used, but changes in dietary patterns are taking place worldwide, including in sub-Saharan Africa, leading to a double burden of malnutrition. This book discusses the effects of these dietary patterns on health as well as how wealth and mutual relationships are associated. It provides an analysis of data from the largest economic city (Dar es Salaam), the highly productive rural south (Iringa region), a coastal village in transition from traditional to purchase dietary patterns and a wild food-abundant inland village (Lindi region), and a semiarid agro-pastoral village (Dodoma region) in Tanzania to provide vivid evidence of unrevealed issues in Tanzania, sub-Saharan Africa, and developing countries. Part I provides an overview of dietary patterns and food combinations in Tanzania and analyzes their relationship with how food is obtained. Part II analyzes how dietary patterns, health, wealth, and mutual relations are associated. Part III investigates case studies to understand the changing dietary patterns and their implications for health. Part IV focuses on wild food and analyzes its association with health within its social context. The book clarifies the advantages and disadvantages of eating wild, indigenous, or modern foods and relates them to wealth and mutual relations, a missing link in previous research.

K. Sakamoto (✉)
School of International Studies, Utsunomiya University, Tochigi, Japan
e-mail: ksaka@cc.utsunomiya-u.ac.jp

L. D. Kaale
Department of Food Science and Technology, University of Dar es Salaam, Dar es Salaam, Tanzania
e-mail: elykaale@gmail.com; dlilian@udsm.ac.tz

R. Ohmori
School of Regional Design, Utsunomiya University, Tochigi, Japan
e-mail: rohmori@cc.utsunomiya-u.ac.jp

T. Kato
Center for African Area Studies, Kyoto University, Kyoto, Japan

K. Sakamoto et al. (eds.), *Changing Dietary Patterns, Indigenous Foods, and Wild Foods*, https://doi.org/10.1007/978-981-99-3370-9_1

Keywords Tanzania · Africa · Double burden of malnutrition (DBM) · Vegetables · Nutrition · Wild foods

1.1 Background and Perspectives of the Book

1.1.1 Changes in Dietary Patterns and the Double Burden of Malnutrition (DBM)

Changes in dietary patterns are taking place around the world, including in rural sub-Saharan Africa. Dietary patterns are subject to socioeconomic and cultural changes, such as urbanization, economic expansion, and the globalization of food markets, and these changes have been crucial to the transition in food and nutrition. Such changes are most prevalent in urban areas but are not limited to these areas.

These changes in socioeconomic and dietary patterns have taken place while the issue of malnutrition has not been solved, leading to a double burden of malnutrition (DBM). Rapid global nutrition transition has led to the DBM, increasing the risk of diet- and nutrition-related noncommunicable diseases, inflammation, and childbirth complications (Wells et al., 2022). The relationship between stunting and overweight in children has been documented in societies that are going through a nutritional transition, which refers to shifts in food composition from indigenous diets to “Western” diets (Zhang et al., 2016). DBM influences all countries, wealthy and poor, but is particularly worrisome in countries with high rates of stunting, and it has been observed at various levels, including the country level, household level, and even the individual level (Popkin et al., 2020). According to current estimates, 2.28 billion children and adults are overweight, and more than 150 million children are stunted (Popkin et al., 2020). However, due to the existing controversies, further research is required to fully comprehend the situation. For example, an analysis of 451,321 women (20–49 years) indicates that there are negative correlations between underweight and overweight at the country level (Corsi et al., 2011).

Nevertheless, the prevalence of overweight, obesity, and DBM is also seen in various age groups. Evidence from 192,132 children in 33 sub-Saharan African countries indicated that obesity is prevalent in children under 5 years old, with East Africa having the second highest prevalence after southern Africa (Ayele et al., 2022). A review of research on school-age children and adolescents (5–19 years) also indicates that DBM is prevalent throughout low- and middle-income countries across seven global regions (Wrottesley et al., 2023). The review also indicates that interventions against overweight and obesity are limited (Wrottesley et al., 2023). Another study that analyzed 142,565 adolescents (12–15 years) from 60 countries indicated the coexistence of obesity and hunger but stated that hunger is most prevalent in Africa (Liu et al., 2022).

Generally, Africans consume more grains, while the majority are perceived to eat very few vegetables and fruits. Locally accessible staples usually serve as the foundation of a meal but are accompanied by vegetables and fruits (e.g., wild fruits).

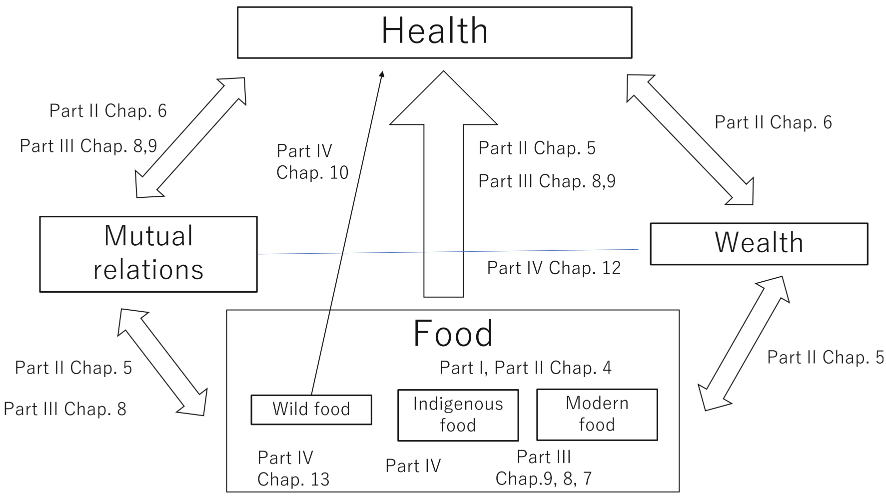


Fig. 1.1 Main perspectives of this book

Despite similarities among African communities, the food consumed varies throughout the continent. According to an analysis of food balance sheet data, the equatorial cluster, which includes Tanzania, consumes starchier roots, fruits, and vegetables but has the lowest cereal intake and the greatest rates of child stunting among all African clusters (Nel & Steyn, 2022). Cross-country comparisons of dietary patterns and overweight and obesity of adult women in urban Ghana, Tanzania, and Malawi identified protein and health dietary patterns in women of reproductive age in Ghana and Malawi and older women in Tanzania (Bliznashka et al., 2021). Intake of protein is associated with higher BMI (body mass index) and overweight/obesity in Ghana but not in Tanzania (Bliznashka et al., 2021). A study of 252 women (16–45 years) in rural Tanzania indicated that purchase patterns characterized by bread, cake, sugar, and black tea were associated with higher BMI (Keding et al., 2011). A similar finding was observed in Kenya, providing evidence of a nutritional transition in rural East Africa (Keding, 2016). Against this background of changing dietary patterns, this book further clarifies the diverse and dynamic situation of dietary patterns in Tanzania in relation to their health implications (Fig. 1.1, Parts I, II).

1.1.2 Wealth, Indigenous Foods, and Wild Foods

Although there is a need to raise micronutrient intake in traditional diets, traditional diets tend to be healthier than unconventional diets impacted by urbanization, economic growth, and the globalization of food markets. Previous research on child survival and death has indicated that children who have been fed sorghum, an indigenous grain, in coastal villages had higher rates of survival than those who were given other food (Sakamoto, 2020). This book confirms the extent to which indigenous food and traditional diets[1] have been maintained or changed into modern diets in the respective local areas (Part I; Part II Chap. 4; case studies in Parts III and IV).

Different environmental, sociocultural, and economic settings can be seen in relation to the food that communities consume. The changes in eating patterns are closely related to wealth and education. On the other hand, FAO (Food and Agriculture Organization of the United Nations) et al. (2021, p. 100) indicate that poor households consume less animal protein and fewer carbohydrates. An affordable healthy diet is essential to solving this problem (FAO et al., 2021, p.25). Wild foods can be part of the solution because they can normally be obtained free of charge by residents if available. However, the availability of wild food depends on the location, and previous research indicates that forest patterns influence dietary quality in Africa (Rasmussen et al., 2020). This finding emphasizes the importance of confirming the availability of wild food in each location, which will be presented in this book for the case studies (Fig. 1.1, Part IV).

In fact, wild edible plants have historically been an essential food supply for the poor or for food-insecure households in developing countries (Duguma, 2020). The forest provides foods and a means of subsistence for almost 300 million people as non-timber forest products (NTFPs) (Bharucha & Pretty, 2010). Wild foods are an essential component of local diets globally, and their utilization in local food cultures provides access to necessary nutrients for sustainable food systems based on local indigenous resources (Ekesa et al., 2022). Wild foods provide residents access to calories, animal and plant proteins, essential minerals and micronutrients such as iron and iodine, vitamins A, Bs, C, D, and E (Sneyd, 2013), and medicine (Duguma, 2020). For example, in Tanzania, the agro-pastoral Batemi people use various species as food (31 species), thirst quenchers (six species), chewing gum (seven species), flavorings (two species), and honey beer (one species) (Bharucha & Pretty, 2010). In addition to their contribution to micronutrient intake, wild foods have been recognized for their importance in providing locals with a safety net during times of food insecurity (Powell et al., 2013). Wild edible plants have also been well researched in other African countries, for example, in Ethiopia, as a means to combat food insecurity (Lulekal et al., 2011).

Although wild food constitutes an essential missing link to improve the diet of the poor, its implications for health have not been fully investigated in previous research. This book presents specific examples in Tanzania and evaluates the implications of wild food for health (Fig. 1.1, Part IV).

---

[1] Indigenous foods are original food ingredients that originated in the geographic area in the narrow sense, but the book also includes traditional diets when discussing indigenous foods in a broader context. A traditional diet is a combination of food ingredients inherited in the geographic area.

1.1.3 Social Capital, Mutual Relations, and Health

Social capital, defined as "features of social organization, such as networks, norms, and trust, that facilitate coordination and cooperation for mutual benefit," has been shown to provide political strength in Italy (Putnam, 1993, p. 2). This social capital concept, which was traditionally conceived of as an external factor in economics, started to gain attention in the 1990s. Redefined as "norms and networks that enable people to act collectively," the concept further gained recognition in international development, even by the World Bank (Woolcock & Narayan, 2000).

The concept of social capital has also expanded to health outcomes in various disciplines, such as sociology, economics, political science, and public health (De Silva et al., 2005; Kawachi & Kennedy, 1997; Murayama et al., 2012; Uphoff et al., 2013). Many studies have indicated that higher levels of trust, reciprocity, and civic engagement lead to better health outcomes (Field, 2008; Kawachi et al., 1999; Subramanian et al., 2002).

The World Health Organization (WHO) also states that social determinants of health (SDH)—such as places where people live, learn, and work—influence health risks and outcomes (WHO, 2003). For example, social isolation and exclusion are associated with increased rates of premature death. A community with high levels of social cohesion has lower rates of coronary heart disease and protective health (WHO, 2003).

Empirical research on the relationship between social capital and health is limited in sub-Saharan Africa. Studies in South Africa (Cramm & Nieboer, 2011; Ramlagan et al., 2013), Ghana (Avogo, 2013; Bisung et al., 2018), and Kenya (Goodman et al., 2017; Musalia, 2016) show that social capital is generally associated with better health outcomes. Research on factors influencing child survival in rural Tanzania indicated that food sharing within the community had a positive association with child survival (Sakamoto, 2020). However, the effects on the health of adults are unknown in Tanzania. This book further elaborates on the correlation between mutual relations, health, and dietary patterns and provides an evaluation of the social context involved (Fig. 1.1, Part II, Chaps. 5 and 6; case studies in Part III, Chaps. 8 and 9; Part IV, Chap. 12).

1.1.4 Quality of Life (QOL) and SF-12

While medical assessment of the health situation is essential, well-being and QOL defined by individuals are increasingly recognized as important and have been given attention in the health and medical field since the 1960s (Doi, 2004). Attempts have been made to capture the subjective evaluation in Africa as well. Zereyesus et al. (2016) report the determinants of household-level well-being in Northern Ghana, and Jelsma et al. (2008) report the health-related quality of life of urban isiXhosa-speaking people in South Africa.

Table 1.1 Subjective evaluation of SF-12, consisting of two components and eight subscales (Formulated from Patel et al., 2017, Wagner et al., 1999; Wyss et al., 1999)

Components	Subscales		Questions
Physical Component Summary (PCS)	PF	Physical Functioning	Moderate activities (carrying water, washing clothes, carrying children) Heavy activities (climbing a steep mountain)
	RP	Role Physical	Accomplished less work due to physical problems was limited in kinds of activities
	BP	Body Pain	Pain interferes with work
	GH	General Health	Present health situation
Mental Component Summary (MCS)	VT	Vitality	Have considerable energy
	SF	Social Functioning	Health interference with social activities
	RE	Role Emotional	Accomplished less due to emotional problems less careful than usual
	MH	Mental Health	Felt calm and peaceful felt downhearted

One of the global standards used to measure QOL is the Short Form (SF) Survey. The SF-12 mental and physical health measure has been validated in low-income countries in sub-Saharan Africa using the case of Malawi (Ohrnberger et al., 2020). The Kiswahili version of the SF-12 has been validated in Kenya (Patel et al., 2017), and the SF-36, a longer version that includes questions in the SF-12, has been validated in Tanzania (Wyss et al., 1999). Chapters in this book utilize this validated Kiswahili SF-12 to measure quality of life. As indicated in Table 1.1, the instrument consists of the Physical Components Summary (PCS, calculated from PF: Physical Functioning; RP: Role Physical; BP: Body Pain; GH: General Health) and Mental Components Summary (MCS, calculated from VT: Vitality; SF: Social Functioning; RE: Role Emotional; MH: Mental Health) based on a questionnaire. The ten indicators were statistically analyzed to understand their contribution to PCS and MCS.

Some studies have utilized the SF-12 and SF-36 to understand health-related quality of life in sub-Saharan Africa. A study in Malawi indicates that mental health shows a stronger association with the health dimension in Malawi compared with that in the United States (Ohrnberger et al., 2020). A study of fertile-age Ghanaian women indicated that higher vegetable intake and vegetable variety were associated with health-related quality of life (Azupogo et al., 2018). Associating dietary pattern and quality of life is considered important; however, studies examining this association in Tanzania are not readily available. This book clarifies the relationship between dietary patterns and quality of life in Tanzania (Fig. 1.1, Part II, Chap. 5; case studies in Part III, Chaps. 8 and 9; Part IV, Chap. 10).

1.2 Research Country and Areas

1.2.1 Tanzania

Tanzania, a country in sub-Saharan East Africa with a variety of natural zones, has sustained long-term political stability but experiences occasional food deficits and exposure to external influences. Following independence, Ujaama (an African form of socialism, from the original Swahili meaning "extended family") encouraged internal movement through villagization in the 1970s, which was meant to foster mutual relations but ended up maintaining poverty widely. Currently, the liberalized economy has increased the total wealth of the country as well as wealth disparities among people. Under these circumstances, Tanzania has an interesting diversity of dietary patterns, including the consumption of indigenous and wild foods. Based on these reasons, the book focuses on cases in Tanzania to provide relevant cases to discuss the topic of changing dietary patterns, health, and wealth.

1.2.2 Research Areas

While the book makes use of previous research on Tanzania, other regions of Africa, and developing countries, firsthand information was primarily gathered from Lindi region in southeastern Tanzania, Dodoma region in central Tanzania, Iringa region in south-central Tanzania, and Dar es Salaam, the largest economic city, on the central coast.

The research areas, although not comprehensive, provide examples of the diversity in Tanzania. Since Dar es Salaam is the country's most populous city, changes in dietary patterns and disparities are visible. Chapter 7 elaborates on its situation and uniqueness. Iringa region in rural inland areas has high maize production and ample staple foods, yet there has been debate concerning child nutrition. Further analysis and a case study will be introduced in Chap. 8. The dietary patterns in Lindi region vary greatly. A coastal village is introduced in Chap. 9, and the use of wild foods from an inland village is covered in Chap. 11. Chapters 12 and 13 provide more details on the semiarid Dodoma region and its case studies. As shown in Table 1.2, other chapters use information from various sources with references to earlier studies conducted in Tanzania and generally. The regions' locations are shown in Fig. 1.2.

1.3 Summary of Each Part and Chapter

The book consists of four parts. Part I, entitled "Dietary patterns in Tanzania: Obtaining foods and combining them in the varied environment," provides an overview of the dietary patterns in Tanzania. Part II, entitled "Dietary patterns,

Table 1.2 Scope of the research area in each chapter

Part	Chapter	General Tanzania	Lindi (southeast)	Dodoma (central)	Iringa (south)	Dar es Salaam (coast)
	Chap. 1	■				
I	Chap. 2	■	■	■		■
	Chap. 3		■	■		■
II	Chap. 4	■	■	■	■	
	Chap. 5	■	■	■	■	
	Chap. 6	■	■	■	■	
III	Chap. 7					■
	Chap. 8				■	
	Chap. 9		■			
IV	Chap. 10	■	■	■		
	Chap. 11		■			
	Chap. 12			■		
	Chap. 13	■		■		
	Chap. 14	■	▇	▇	▇	▇

health, wealth, and mutual relations," analyzes the relationship involving food intake, health, wealth, mutual relations, and health. Part III, entitled "Case studies: Changing dietary patterns and implications for health," consists of various case studies in Tanzania. Part IV, entitled "Wild food intake and its association with health," provides an analysis of the relationship between wild food intake and health.

Fig. 1.2 Locations of the researched regions (Lindi, Dodoma, Iringa, and Dar es Salaam) in Tanzania (created by Sakamoto from https://n.freemap.jp)

1.3.1 Part I: Dietary Patterns in Tanzania: Obtaining Foods and Combining Them in the Varied Environment

The first chapter in Part I, Chap. 2, entitled "Environment, dietary patterns and combinations of food intake in Tanzania," by Kumiko Sakamoto, Lilian Kaale, Reiko Ohmori, Katsunori Tsuda, and Tamahi Kato provides an overview of the variety and characteristics of the dietary patterns in Tanzania. What is a healthy dietary pattern, and are we changing for the better? In Tanzania, traditional-inland, traditional-coast, pulse, meat, and purchased food dietary patterns can affect health and risk certain diseases. This chapter provides an overview based on a literature review and describes the actual frequency and combinations of foods from firsthand information on food diaries in rural semiarid central inland, southeastern bushland, and urban Tanzania.

Chapter 3, entitled "Purchase, cultivation, and forage: Does it make a difference in food intake frequency?" by the same authors, further analyzes the above dietary patterns. There are differences in food intake frequency between regions based on food diaries recorded in rural central, southeastern, and urban Tanzania. Differences within households are also observed. Through correlation analysis between food group intake frequency and how it is obtained, a relationship is seen between fruit and nut intake and cultivation. The result reveals the possibility of cultivating fruits and nuts for increased intake of these food groups. The preliminary analysis of this chapter was published in Japanese (Sakamoto et al., 2022a).

1.3.2 Part II: Dietary Patterns, Health, Wealth, and Mutual Relations

The first chapter in Part II, Chap. 4, entitled "Does staple food sufficiency ensure food variety?" by Momoko Muto, Kato, Sakamoto, and Ohmori, provides an analysis of the food balance. Food production has seasonality, and it is common in lowland areas of Tanzania for the majority of people to experience food deficits during the rainy season. However, an analysis of food group intake in four rural villages revealed differences among villages, and more variety is seen in the rainy season, which is considered the lean season in most villages.

The initial analysis was presented by Muto, Sakamoto, and Ohmori in 2021 with the title "Regional and seasonal comparison of food intake frequency in Tanzania" at the Japan Society of Nutrition and Food Science 74th Annual Meeting in Japanese. The analysis was further presented in English by Muto in 2002 in "Potentials of wild edible plants and traditional foods in Africa: Findings from Tanzania" (The fourth UU-A International Web Symposium) and published in Muto et al. (2022).

Chapter 5, entitled "Changing dietary patterns and associated social context: Subjective health qualities of life, wealth, and mutual relations in Tanzania," by Sakamoto, Kaale, Ohmori, and Kato, provides an analysis of the influence of dietary patterns on health using the Swahili SF-12 version of a global standard to measure QOL. There are differences in food group intake in different areas, but how does that influence people's subjective health? Various dietary patterns have been identified in previous research and through statistical analysis of firsthand information. A traditional inland dietary pattern is indicated as a healthy pattern preventing lifestyle diseases. Traditional coastal dietary patterns with an emphasis on seafood are associated with high subjective evaluations. Animal products, which are associated with wealth, are also associated with positive subjective evaluations. The pulse pattern is strong in the inland southeast, and the purchase pattern with a high intake of sugar, oil, and salt is prevalent in the southern highland. A pilot study to test the method was presented by Ohmori and Sakamoto in 2020, entitled "Associations between food intake and health-related quality of life in East Africa," at the Japan Society of Nutrition and Food Science 73rd Annual Meeting in Japanese and published in Ohmori et al. (2020).

Chapter 6, entitled "Social capital and subjective "poverty" contributing to people's subjective health, but not financial support," by Ohmori, Kato, and Sakamoto, further analyzes the factors that influence people's subjective health. Many factors affect people's health. To capture these factors, multiregression analysis of SF-12 is implemented against various factors, including food intake frequency, subjective wealth, and mutual assistance, using data collected through firsthand questionnaire interviews in four rural villages in Tanzania. Wealth (in semiarid central villages) and mutual relations (in coastal southeast villages) are positively related to health. On the other hand, food intake frequency (inland southeastern village) and receiving food assistance (central highland village) are negatively related to subjective health. Various social factors need to be considered to improve people's subjective health, and their relationships differ among areas. The initial analysis of the chapter was presented by Ohmori and Sakamoto in 2021 as "Factors affecting health-related quality of life in East Africa: Comparative survey of four regions in Tanzania" at the Japan Society of Nutrition and Food Science 74th Annual Meeting in Japanese.

1.3.3 Part III: Case Studies: Changing Dietary Patterns and Implications for Health

Part III consists of various case studies in Tanzania from urban Dar es Salaam, the highly productive Iringa region, and the coastal Lindi region. Part III starts with Chap. 7, entitled "Growth with disparity in a rich diverse city: Case of the economic capital Dar es Salaam," by Kaale, Kato, and Sakamoto.

Dar es Salaam has grown into a gigantic city with skyscrapers through economic development and has drawn people from various regions. However, prosperity is only seen in limited places of the city, such as Masaki, Kunduchi, and Bahari beaches. Other places of the city have ineffective urban planning and insufficient infrastructure investment, which have led to urban sprawl and the growth of informal settlements. Over 70% of Dar es Salaam's population lives in unplanned settlements without adequate housing, safe and clean drinking water, or affordable sanitation and does not have access to three important meals of a day. These conditions have created large disparities between the poor, the middle class, and the rich. The economic growth in Tanzania does not befit all classes, and the benefits are not evenly distributed. For example, there is a large disparity between those who are rich and can access basic needs such as sufficient food, good health services, clean and safe water, and adequate housing and the poor, who cannot access these basic needs.

Unfortunately, both groups suffer malnutrition, as many in the rich and middle classes (adequate income earners) are not aware of nutritious foods and dietary practices, while the poor cannot access nutritious food and hence cannot follow the recommended dietary practices. Food preference and lack of knowledge of food nutrition and healthy dietary practices have largely contributed to various diseases, especially noncommunicable diseases. Rich people prefer foods that provide status and pleasure, such as processed foods (which include high amounts of salt, oil, and sugar). On the other hand, some people in the upper and middle classes have become conscious about their health based on necessity and/or education and information disseminated. Dar es Salaam is a place where great diversity and disparities can be seen and where food intake makes a difference in people's health.

Chapter 8, entitled "High maize productive rural inland: Ample staple foods, but what about health?" by Kato, Sakamoto, Ohmori, Ayusa Okui, and Parinya Khemmarath, provides a case study from the Iringa region. This region in the southern highlands is considered one of the major maize-producing regions of Tanzania. This chapter elaborates on this region based on questionnaire interviews focusing on women. Even at household levels, residents of this region rarely experience lean seasons of food deficiency. However, women who claimed to have sufficient food have low subjective health evaluations, pointing to wealth disparities. On the other hand, wealthier people have a risk of lifestyle diseases. The initial compilation and analysis were published by Sakamoto et al. (2020b).

Chapter 9, "Coastal traditional and changing dietary patterns: Protein from fish and pulses as well as purchase patterns," by Anna C. Maro, Kaale, Khemmarath, Sakamoto, and Ohmori, is a case study from the coastal Lindi region. Coastal areas have the advantage of benefiting from the quality protein by seafood. The chapter introduces findings from a questionnaire interview with adults in a coastal village (Sakamoto et al., 2021c), a questionnaire with school children in a coastal town (Sakamoto et al., 2020c), and a food diary in a semicoastal area. All studies indicated the high-frequency intake of fish in the coastal areas in the southeast, ensuring the intake of protein throughout the seasons, in comparison to other inland rural areas. At the same time, a questionnaire completed by school children indicated potential negative health effects of overeating pulses. Mutual assistance also has positive effects on QOL for adults in this coastal village. The purchase pattern is also seen in a proportion of households.

1.3.4 Part IV: Wild Food Intake and Association With Health

Part IV provides analysis and case studies showing evidence of a relationship between wild food intake and health. Chapter 10 is an overall analysis, and the subsequent chapters provide case studies of villages from the inland Lindi region and the semiarid Dodoma region.

Chapter 10, entitled "Does intake of wild foods improve subjective health? Evidence from 3 areas of Tanzania," by Sakamoto, Ohmori, Kaale, Frank Mbago, Tsuda, and Kato, analyzes data from three villages to evaluate the relationship between wild food intake and health. While wild foods have a high potential in improving the quantity, variety, and quality of food diversity with very low or no cost, it is also important to evaluate the health benefits of these foods. Based on questionnaire interviews with adults in three distinct rural villages in Tanzania, correlation and multiple regression analyses were implemented. The effect was different among areas. In the coastal village with wild foods even near the homestead, high wild food intake had negative implications, especially psychologically. In an inland bushland/forest village, a high frequency of wild food intake was frequently related to good physical health. In an inland semiarid area, those who frequently consumed wild food in the rainy season had good health.

The analysis was first published in the *Journal of International Development Studies* (Sakamoto et al., 2021a) in Japanese. Parts of the contents have also been presented by Sakamoto in "Potentials of Wild Edible Plants and Traditional Foods in Africa: Findings from Tanzania" (The fourth UU-A International Web Symposium).

Chapter 11, "The case of inland forest vicinities: General low health evaluation, but higher for those with access to a variety of wild food?" by Sakamoto, Kaale, Maro, Ohmori, Khemmarath, Mbago, and Kato, introduces a case study from the inland Lindi region, where wild foods may be positively associated with health. Malolo had a relatively low health evaluation. However, those who had access to wild foods had high evaluations of their health. Malolo village, located in the inland Lindi region, is endowed with a rich variety of wild plants and animals in the vicinity of forests. The variety includes an outstanding diversity of tubers, fruits, vegetables, pulses, mammals, and insects. The first analysis was published by Sakamoto et al. (2021b). The chapter introduces some of the main wild foods and their potential benefits.

Chapter 12, entitled "Traditional semi-arid agro-pastoral inland dietary patterns: Frequent food deficits but balanced BMI and prevention of anemia," by Sakamoto, Ohmori, Kaale, Mbago, Khemmarth, Tsuda, and Kato, is a case study from Dodoma region and also indicates a positive association between wild food intake and health. In semiarid agro-pastoral villages in the Dodoma region, the minority with access to cattle have a relatively frequent intake of dairy food products, but the majority dietary pattern is the "inland traditional" pattern, with an emphasis on staple foods and vegetables. Previous research indicates the health benefits of this dietary pattern for certain conditions, such as BMI and anemia. Firsthand questionnaire interviews in Chinangali village also indicated that a high intake of wild foods in the rainy season is associated with a good self-evaluation of health. These results also emphasize the high health potential of African leafy vegetables in semi-arid regions.

The preliminary analysis was published in Sakamoto et al. (2020a). Parts of the analysis were presented in a research group (MEXT JSPS KAKENHI 18H00776) in Japanese and received valuable comments from the members.

Chapter 13, entitled "Nutrition potential of the African leafy vegetables: Evidence from semi-arid central Tanzania," by Kaale, Sakamoto, and Ohmori, further analyzes the leafy vegetables obtained in the area introduced in Chap. 12. Previous research has emphasized the health benefits of consuming vegetables, such as preventing and controlling noncommunicable diseases, including cardiovascular diseases, type II diabetes, and obesity. This chapter further emphasizes the importance of consuming African wild leafy vegetables (AWLVs). Such foods are low in calories, nutrient-rich, contain fiber to promote health and well-being, and are cultivated with low or no use of pesticides. The proximate composition and mineral and vitamin contents of seven AWLVs consumed locally by rural populations in the semiarid Dodoma region in Tanzania were determined.

Parts of the analysis introduced in this chapter were originally published by Sakamoto et al. (2022b). The findings were also presented by Lilian Kaale in a lecture titled “Potentials of Wild Edible Plants and Traditional Foods in Africa: Findings from Tanzania” (The fourth UU-A International Web Symposium) in 2022.

Chapter 14, “What is the secret to good health, and how are wealth and mutual relations related?” presents a conclusion by the editors. The book has introduced diverse dietary patterns and diverse environments in Tanzania. There will be diverse answers depending on the endowment of each area. Wild foods give a mixed picture, but utilization of African leafy vegetables provides a positive example in semiarid areas. While wealth is generally believed to be beneficial to health, this linear generalization does not apply to food intake, dietary patterns, and health. Wealth provides choices for a healthy diet and access to unhealthy “rich” foods through purchase. On the other hand, simple dietary patterns of traditional and indigenous foods in areas lacking food can provide health benefits. Mutual relations are generally beneficial for health but are not comprehensive in some regions, as seen in previous research (Sakamoto, 2020). Within the context of the modernization of dietary patterns, the health benefits of utilizing available resources are confirmed, but an in-depth understanding of the economic and social context is necessary.

References

Avogo, W. A. (2013). Social capital, civic engagement, and self-rated health in Ghana. *African Population Studies, 27*(2), 188–202. https://doi.org/10.11564/27-2-440

Ayele, B. A., Tiruneh, S. A., Ayele, A. A., Zemene, M. A., Chanie, E. S., & Hailemeskel, H. S. (2022). Prevalence and determinants of overweight/obesity among underfive children in sub-Saharan Africa: A multilevel analysis. *BMC Pediatrics, 22*(1), 585. https://doi.org/10.1186/s12887-022-03645-z

Azupogo, F., Seidu, J. A., & Issaka, Y. B. (2018). Higher vegetable intake and vegetable variety is associated with a better self-reported health-related quality of life (HR-QoL) in a cross-sectional survey of rural northern Ghanaian women in fertile age. *BMC Public Health, 18*(1), 920. https://doi.org/10.1186/s12889-018-5845-3

Bharucha, Z., & Pretty, J. (2010). The roles and values of wild foods in agricultural systems. *Philosophical Transactions of the Royal Society B, 365*, 2913–2926. https://doi.org/10.1098/rstb.2010.0123

Bisung, E., Kangmennaang, J., & Luginaah, I. (2018). Neighborhood structural differences and women’s mental health: An empirical study in Accra, Ghana. *Quality of Life Research, 27*(3), 661–671.

Bliznashka, L., Danaei, G., Fink, G., Flax, V. L., Thakwalakwa, C., & Jaacks, L. M. (2021). Cross-country comparison of dietary patterns and overweight and obesity among adult women in urban sub-Saharan Africa. *Public Health Nutrition, 24*(6), 1393–1403. https://doi.org/10.1017/S1368980019005202

Corsi, D. J., Finlay, J. E., & Subramanian, S. V. (2011). Global burden of double malnutrition: Has anyone seen it? *PLoS One, 6*(9), e25120. https://doi.org/10.1371/journal.pone.0025120/

Cramm, J. M., & Nieboer, A. P. (2011). The influence of social capital and socioeconomic conditions on self-rated health among residents of an economically and health-deprived South African township. *International Journal for Equity in Health, 10*, 51. https://doi.org/10.1186/1475-9276-10-51

De Silva, M. J., McKenzie, K., Harpham, T., & Huttly, S. R. (2005). Social capital and mental illness: A systematic review. *Journal of Epidemiology Community Health, 59*(8), 619–627. https://doi.org/10.1136/jech.2004.029678

Doi, Y. (2004). Introduction-conceptual issues on quality of life (QOL) and importance of QOL research. *Journal of the National Institute of Public Health, 53*(3), 176–180.

Duguma, H. T. (2020). Wild edible plant nutritional contribution and consumer perception in Ethiopia. *International Journal of Food Science, 2020*, 1–16. https://doi.org/10.1155/2020/2958623

Ekesa, B., Fongar, A., & Nasser, M. (2022). Access to and utilization of wild species for food and nutrition security in Teso and Acholi subregions of Uganda. *Frontiers in Sustainable Food System, 6*(836212), 1–16. https://doi.org/10.3389/fsufs.2022.836212

FAO, IFAD, UNICEF, WFP, WHO. (2021). *The state of food security and nutrition in the world 2021*. FAO.

Field, J. (2008). *Social capital* (2nd ed.). Routledge.

Goodman, M. L., Johnson, T. M., Guillot-Wright, S., Porter, K. A., Keiser, P. H., & Gitari, S. (2017). How do Kenyan orphan girls experience less meaningful lives and how much does it matter for 'health'? *Quality of Life Research, 26*(6), 1551–1559. https://doi.org/10.1007/s11136-017-1511-y

Jelsma, J., Mkoka, S., & Amosun, S. L. (2008). Health-related quality of life (HRQoL) domains most valued by urban isiXhosa-speaking people. *Quality of Life Research, 17*(1), 137–145. https://doi.org/10.1007/s11136-007-9283-4

Kawachi, I., & Kennedy, B. P. (1997). The relationship of income inequality to mortality: Does the choice of indicator matter? *Social Science & Medicine, 45*(7), 1121–1127. https://doi.org/10.1016/s0277-9536(97)00044-0

Kawachi, I., Kennedy, B. P., & Glass, R. (1999). Social capital and self-rated health: A contextual analysis. *American Journal of Public Health, 89*(8), 1187–1193. https://doi.org/10.2105/ajph.89.8.1187

Keding, G. (2016). Nutrition transition in rural Tanzania and Kenya. In H.K. Biesalski and R. E. black (Eds.), *Hidden hunger. Malnutrition and the first 1,000 days of life: Causes, consequences, and solutions. Nutrition transition and nutritional deficiencies in low-income countries*, Basel, Karger, World Rev Nutr Diet. 115, 61–74. https://doi.org/10.1159/000442073.

Keding, G. B., Msuya, J. M., Mass, B. L., & Krawinkel, M. B. (2011). Dietary patterns and nutritional health of women. *Food and Nutrition Bulletin, 32*(3), 218–226. https://doi.org/10.1177/156482651103200306

Liu, H., Fu, P., Zhang, M., & Zhou, C. (2022). Coexistence of obesity and hunger in young adolescents: Evidence from the global school-based student health survey. *Pediatric Obesity, 17*(11), e12952. https://doi.org/10.1111/ijpo.12952

Lulekal, E., Asfaw, Z., Kelbessa, E., & Van Damme, P. (2011). Wild edible plants in Ethiopia: A review on their potential to combat food insecurity. *Afrika Focus, 24*(2), 71–122. https://doi.org/10.1163/2031356X-02402006

Murayama, H., Fujiwara, Y., & Kawachi, I. (2012). Social capital and health: A review of prospective multilevel studies. *Journal of Epidemiology, 22*(3), 179–187. https://doi.org/10.2188/jea.je20110128

Musalia, J. (2016). Social capital and health in Kenya: A multilevel analysis. *Social Science & Medicine, 167*, 11–19. https://doi.org/10.1016/j.socscimed.2016.08.043

Muto, M., Sakamoto, K., Ohmori, R., & Tsuda, K. (2022). Regional and seasonal comparison of food intake in 4 areas in Tanzania. *Annual Journal of the Center for the Multicultural Public Sphere (CMPS), 15*, 166–176 (in Japanese).

Nel, J. H., & Steyn, N. P. (2022). The nutrition transition and the double burden of malnutrition in sub-Saharan African countries: How do these countries compare with the recommended LANCET Commission global diet? *International Journal of Environmental Research and Public Health, 19*(24), 16791. https://doi.org/10.3390/ijerph192416791

Ohmori, R., Sakamoto, K., & Tsuda, K. (2020). Associations between food intake and health-related quality of life in East Africa: From pilot study in two regions of Tanzania. *Journal of the Faculty of Regional Design Utsunomiya University, 7*, 35–42 (in Japanese). Retrieved from http://hdl.handle.net/10241/00012126.

Ohrnberger, J., Anselmi, L., Fichera, E., & Sutton, M. (2020). Validation of the SF12 mental and physical health measure for the population from a low-income country in sub-Saharan Africa. *Health and Quality of Life Outcomes, 18*(1), 78. https://doi.org/10.1186/s12955-020-01323-1

Patel, A. R., Lester, R. T., Marra, C. A., van der Kop, M. L., Ritvo, P., Engel, L., Karanja, S., & Lynd, L. D. (2017). The validity of the SF-12 and SF-6D instruments in people living with HIV/AIDS in Kenya. *Health and Quality of Life Outcomes, 15*(1), 143. https://doi.org/10.1186/s12955-017-0708-7

Popkin, B. M., Corvalan, C., & Grummer-Strawn, L. M. (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

Powell, B., Maundu, P., Kuhnlein, H. V., & Johns, T. (2013). Wild foods from farm and forest in the East Usambara Mountains, Tanzania. *Ecology of Food and Nutrition, 52*, 451–478. https://doi.org/10.1080/03670244.2013.768122

Putnam, R. D. (1993). *The prosperous community: Social capital and public life*. American Prospect, 13, 35–42. Retrieved December 1, 2022, from http://faculty.washington.edu/matsueda/courses/590/Readings/Putham%201993%20Am%20Prospect.pdf

Ramlagan, S., Peltzer, K., & Phaswana-Mafuya, N. (2013). Social capital and health among older adults in South Africa. *BMC Geriatrics, 13*, 100. https://doi.org/10.1186/1471-2318-13-100

Rasmussen, L. V., Fagan, M. E., Ickowitz, A., Wood, S. L. R., Kennedy, G., Powell, B., Baudron, F., Gergel, S., Jung, S., Smithwick, E. A. H., Sunderland, T., Wood, S., & Rhemtulla, J. M. (2020). Forest pattern, not just amount, influences dietary quality in five African countries. *Global Food Security, 25*, 100331. https://doi.org/10.1016/j.gfs.2019.100331

Sakamoto, K. (2020). *Factors influencing child survival in Tanzania: Comparative analysis of diverse deprived rural villages*. Springer.

Sakamoto, K., Ohmori, R., & Okui, A. (2020a). Situation of women and children in southern Tanzania: From questionnaires in Ifunda, Iringa with focus on food-intake and health. *Journal of the School of International Studies, Utsunomiya University, 49*, 61–78. Retrieved from http://hdl.handle.net/10241/00012115.

Sakamoto, K., Parinya, K., Ohmori, R., & Maro, A. C. (2020b). Health, livelihoods, and food intake in coastal southeast Tanzania: From questionnaire interviews in Kijiweni village, Lindi region. *Journal of the School of International Studies, Utsunomiya University, 50*, 11–29. Retrieved from http://hdl.handle.net/10241/00012361.

Sakamoto, K., Ohmori, R., & Tsuda, K. (2020c). Health, livelihoods, and food intake of children and adults in central Tanzania. *Journal of the Faculty of Regional Design Utsunomiya University, 7*, 43–64. Retrieved from http://hdl.handle.net/10241/00012127.

Sakamoto, K., Ohmori, R., & Tsuda, K. (2021a). Correlation between intake of wild food in 3 areas of Tanzania: Analysis from semi-arid central and inland/coastal southeast. *Journal of International Development Studies, 30*(2), 93–112 (in Japanese).

Sakamoto, K., Parinya, K., Ohmori, R., & Maro, A. C. (2021b). Health, livelihoods, and food intake in inland southeast Tanzania: From questionnaire interviews in Malolo village, Lindi region. *Journal of the School of International Studies, Utsunomiya University, 51*, 15–34. Retrieved from http://hdl.handle.net/10241/00012762.

Sakamoto, K., Parinya, K., Ohmori, R., & Maro, A. C. (2021c). Food intake and health of school children in southeast Tanzania: Preliminary questionnaire in Raha Leo elementary school, Lindi municipal. *Journal of the School of International Studies, Utsunomiya University, 52*, 27–38. Retrieved from http://hdl.handle.net/10241/00012958.

Sakamoto, K., Kaale, L., & Ohmori, R. (2022a). Nutrient content of seven African wild leafy vegetables in semi-arid Tanzania. *Journal of International Development Studies, 54*, 17–28.

Sakamoto, K., Ohmori, R., & Tsuda, K. (2022b). Food intake in 3 areas of Tanzania from food diary: Preliminary analysis of food group intake, diversity, and relation with origin. *Journal of the School of International Studies, Utsunomiya University, 53*, 15–30. Retrieved from http://hdl.handle.net/10241/00013096.

Sneyd, L. Q. (2013). Wild food, prices, diets and development: Sustainability and food security in urban Cameroon. *Sustainability, 5*, 4728–4759. https://doi.org/10.3390/su5114728

Subramanian, S. V., Kim, D. J., & Kawachi, I. (2002). Social trust and self-rated health in US communities: A multilevel analysis. *Journal of Urban Health, 79*(4 Suppl. 1), S21–S34. https://doi.org/10.1093/jurban/79.suppl_1.s21

Uphoff, E. P., Pickett, K. E., Cabieses, B., Small, N., & Wright, J. (2013). A systematic review of the relationships between social capital and socioeconomic inequalities in health: A contribution to understanding the psychosocial pathway of health inequalities. *International Journal for Equity in Health, 12*, 54. https://doi.org/10.1186/1475-9276-12-54

Wagner, A. K., Wyss, K., Gandek, B., Kilima, P. M., Lorenz, S., & Whiting, D. (1999). A Kiswahili version of the SF-36 health survey for use in Tanzania: Translation and tests of scaling assumptions. *Quality of Life Research, 8*(1–2), 101–110. https://doi.org/10.1023/a:1026441415079

Wells, J. C., Sawaya, A. L., Wibaek, R., Mwangome, M., Poullas, M. S., Yajnik, C. S., & Demaioet, A. (2022). The double burden of malnutrition: Etiological pathways and consequences for health. *The Lancet, 395*(10217), 75–88. https://doi.org/10.1016/S0140-6736(19)32497-3

Woolcock, M., & Narayan, D. (2000). Social capital: Implications for development theory, research, and policy. *The World Bank Research Observer, 15*(2), 225–249. https://doi.org/10.1093/wbro/15.2.225

World Health Organization. (2003). *Social determinants of health: The solid facts* (2nd ed.) Retrieved December 1, 2022, from https://apps.who.int/iris/handle/10665/326568

Wrottesley, S. V., Mates, E., Brennan, E., Bijalwan, V., Menezes, R., Ray, S., Ali, Z., Yarparvar, A., Sharma, D., & Lelijveld, N. (2023). Nutritional status of school-age children and adolescents in low- and middle-income countries across seven global regions: A synthesis of scoping reviews. *Public Health Nutrition, 26*(1), 63–95. https://doi.org/10.1017/S1368980022000350

Wyss, K., Wagner, A. K., Whiting, D., Mtasiwa, D. M., Tanner, M., Gandek, B., & Kilima, P. M. (1999). Validation of the Kiswahili version of the SF-36 health survey in a representative sample of an urban population in Tanzania. *Quality of Life Research, 8*(1–2), 111–120. https://doi.org/10.1023/a:1026431727374

Zereyesus, Y. A., Shanoyan, A., Ross, K. L., & Amanor-Boadu, V. (2016). The determinants of household-level well-being in Northern Ghana. *Development Studies Research, 3*(1), 1–10. https://doi.org/10.1080/21665095.2016.1229128

Zhang, N., Bécares, L., & Chandola, T. (2016). Patterns and determinants of double-burden of malnutrition among rural children: Evidence from China. *PLoS One, 11*(7), e0158119. https://doi.org/10.1371/journal.pone.0158119

Part I
Dietary Patterns in Tanzania: Obtaining Foods and Combining them in the Varied Environments

Part I introduces the natural environment and food production in Tanzania that influences dietary patterns. The various dietary patterns diversified by this background are introduced. It further introduces examples of meals in three distinct areas, a semiarid agro-pastoral rural village (Mbelezungu village, Dodoma region), high rainfall village (Rutamba and Michee villages, Lindi region), and an urban city (Dar es Salaam), based on food diaries of 15 households. In Chap. 2, a combination of ingredients and food groups is analyzed to understand the actual meals and the situation of changing dietary patterns. Chapter 3 further analyzes the same data against how it is obtained to see how it is related to dietary patterns.

Chapter 2
Environment, Dietary Patterns, and Combinations of Food Intake in Tanzania

Kumiko Sakamoto, Lilian Daniel Kaale, Reiko Ohmori, Katsunori Tsuda, and Tamahi Kato

Abstract What is a healthy dietary pattern, and is it changing for the better? Food security and traditional perspectives place a strong emphasis on food sufficiency, particularly in terms of calories or staple foods, yet this is insufficient for a balanced and healthy diet. Dietary patterns can impact health and increase the risk of certain diseases. Based on a literature review, this chapter introduces Tanzania's diverse environment and agricultural production as well as a summary of dietary patterns. Furthermore, it focuses on the household level and details the actual frequency and food combinations based on food diaries from 15 households in rural semiarid central inland, southeastern bushland, and urban Tanzania. Correlation analysis was used to further assess the frequency of intake by food group. The results indicated that households with a high intake of tea have a high intake of staple foods (Pearson correlation: 0.564, $p = 0.003$) but a low intake of green vegetables (Pearson correlation: 0.650, $p = 0.000$). Tea represents increased wealth and purchasing power, which may assure food sufficiency or quantity but may also result in a decrease in green vegetable consumption. Understanding the benefits and drawbacks of increasing wealth is essential for improving household health.

K. Sakamoto (✉)
School of International Studies, Utsunomiya University, Utsunomiya, Japan
e-mail: ksaka@cc.utsunomiya-u.ac.jp

L. D. Kaale
Department of Food Science and Technology, University of Dar es Salaam, Dar es Salaam, Tanzania
e-mail: elykaale@gmail.com; dlilian@udsm.ac.tz

R. Ohmori
School of Regional Design, Utsunomiya University, Utsunomiya, Japan
e-mail: rohmori@cc.utsunomiya-u.ac.jp

K. Tsuda
Center for the Multicultural Public Sphere of Utsunomiya University, Utsunomiya, Japan

T. Kato
Center for African Area Studies, Kyoto University, Kyoto, Japan

K. Sakamoto et al. (eds.), *Changing Dietary Patterns, Indigenous Foods, and Wild Foods*, https://doi.org/10.1007/978-981-99-3370-9_2

Keywords Environment · Crop · Production · Dietary pattern · Relish · Vegetable

2.1 Introduction

Wild foods and indigenous foods, which constitute part of the topic of the book, are influenced by the environment. The diverse environment in Tanzania that influences wild foods and indigenous foods is first introduced in this chapter. Second, the dietary patterns and actual meals at household levels in three regions are introduced to understand the changing food patterns and indigenous foods in Tanzania. The chapter serves as an illustrative introduction to the topic of the book: changing dietary patterns, indigenous foods, and wild foods.

2.2 Diverse Environment and Agricultural Production in Tanzania

The various dietary patterns in Tanzania are supported by diverse environments within the country. Tanzania experiences a wide range of annual rainfall, from semiarid regions with less than 750 mm to regions with high rainfall of more than 2000 mm (Fig. 2.1). The semiarid areas with limited rainfall extend from central Tanzania to the north and to some extent to the southwest. Dodoma region, which is discussed in this chapter and Chaps. 3–6, 10, 12, and 13 of the book, has an average rainfall of less than 750 mm and a high risk of famine. Tanzania's west and parts of its south and southeast have regions with moderate rainfall, ranging from 750 to 1000 mm. The northeastern, southern, and northwestern regions near Lake Victoria have significant rainfall levels of more than 1000 mm. Lindi region discussed in this chapter and Chaps. 3–6 and 9–11 experiences mainly moderate rainfall, but some of the coastal areas, such as Dar es Salaam, experience high amounts of rainfall. Iringa region, which is covered in Chaps. 4–6, 8 of the book, has varying levels of rainfall, ranging from amounts on par with those of semiarid regions to heavy.

Tanzania has a varied range of vegetation (Fig. 2.2). Although the vegetation on the map is based on that in 1971, woods dominate in areas with considerable rainfall. Furthermore, areas with high elevation have/had more forests, especially in the Arch Mountains, including parts of Iringa. On the other hand, geographic areas with less rainfall have/had more grasslands, and some are transitioning to deserts.

Figure 2.3 shows the land resource zones and farming system in Tanzania. Coastal areas are identified as cassava, cashew, and coconut farming systems. Lindi region discussed in this chapter and Chaps. 3–6 and 9–11 is included in this farming system. Some parts of the coastal areas along the river or lakes are identified as wetland paddy and sugarcane farming systems. The research area of Lindi along Lake Lutamba, which is noted in this chapter, resembles this farming system even though it is not depicted on the map.

Semiarid areas are identified as having livestock and sorghum–millet farming systems. The livelihood of the people is agro-pastoralist in central Tanzania and

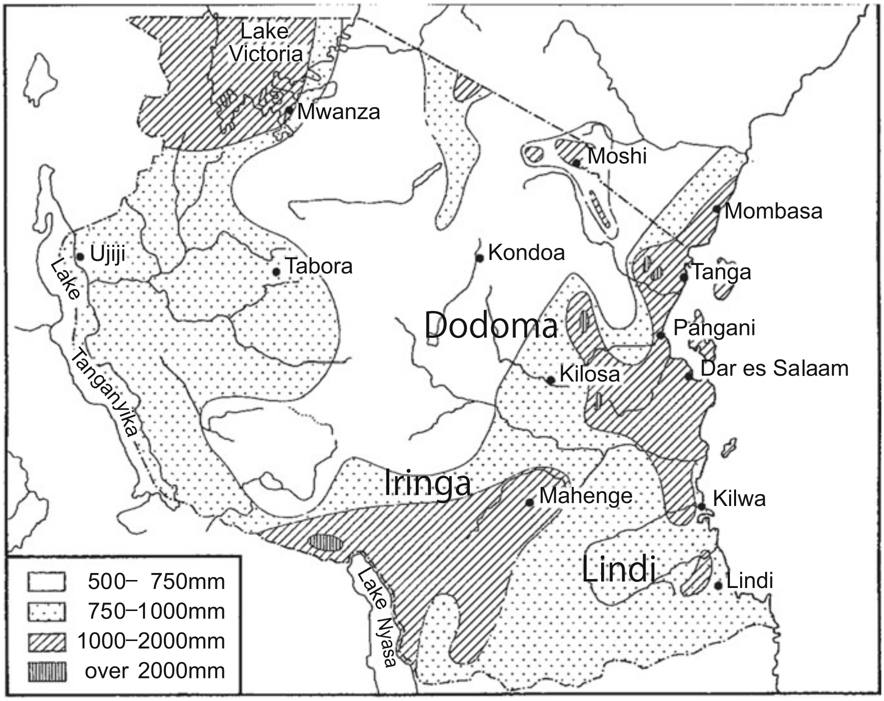


Fig. 2.1 Rainfall probability of Tanzania (Sakamoto 2009, 2021, p. 104 adapted from Koponen, 1988, p. 51)

pastoralist in parts of the north. This farming style is used in Dodoma region, where the members of the Gogo ethnic groups are regarded as agro-pastoralists. The predominant farming system in southern Tanzania, which receives an abundance of rainfall, involves maize and legumes. Dodoma region is also regarded as having high levels of food production, and Iringa, which is covered in Chap. 8 and other chapters, also has this system. A coffee and banana agricultural system is present in the northern highlands, close to Lake Victoria. The map illustrates various farming systems, but it is difficult to capture how people utilize wild foods.

In terms of recorded production, the southern highlands are a zone with a surplus of maize production, with Mbeya region producing over 400,000 tons annually and Iringa region generating between 250,100 and 400,000 tons, while Dodoma, Singida, and Lindi regions produce the least—less than 100,000 tons. Pwani region produces the most cassava, with more than 200,000 tons annually, followed by Mtwara region and areas along Lake Victoria, with production ranging from 100,000 to 200,000 tons. The western zone, such as Kagera and Kigoma regions, produces the most bananas as a staple food, with over 200,000 tons annually, followed by Kilimanjaro region in the north, in which production is between 100,000 and 200,000 tons (Cochrane & D’Souza, 2015). However, because of the difficulty in

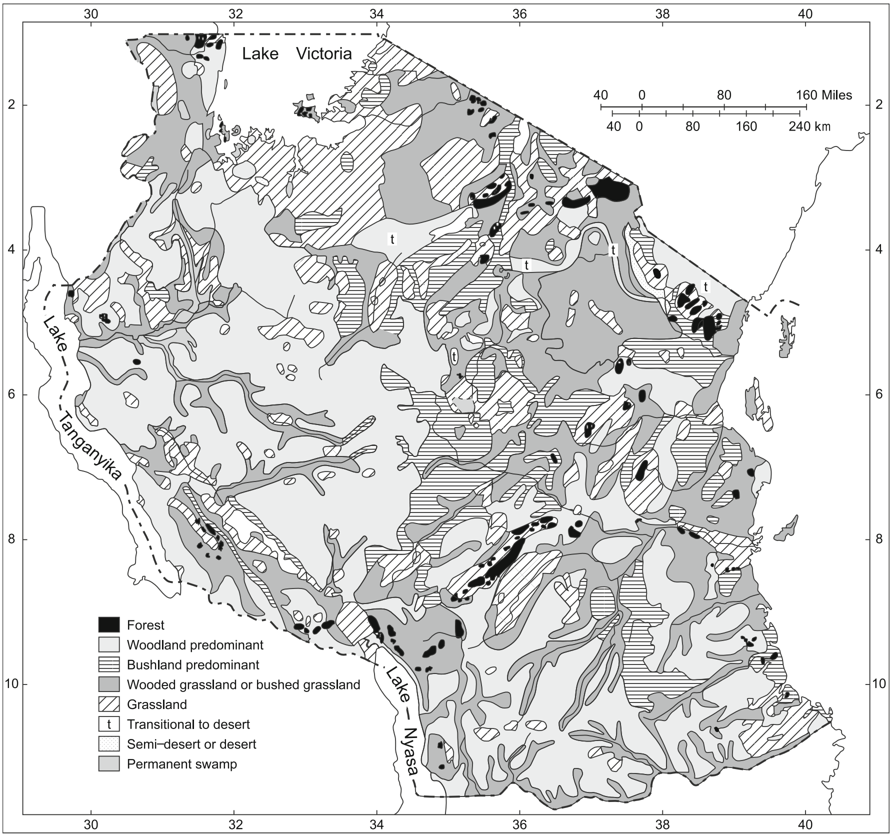


Fig. 2.2 Vegetation association of Tanzania (Sakamoto 2009, 2021, p. 106 adapted from Berry, 1970, p. 31)

capturing production for self-consumption, these production estimates should be viewed with caution.

2.3 What Are the Dietary Patterns in Tanzania?

Cochrane and D'Souza (2015) indicated dietary patterns in Tanzania with the food basket approach based on the percentage of calories. Their work revealed that households in Dar es Salaam have a diverse diet: 23% maize, 21% rice, and 9% millet and sorghum. On the other hand, maize accounted for 51% of the calories in the southern highlands. However, maize accounted for 32% around the Lake Victoria, and cassava accounted for 19% (Cochrane & D'Souza, 2015). However, this is based on calories, and vegetable intake is underestimated. Additionally, the

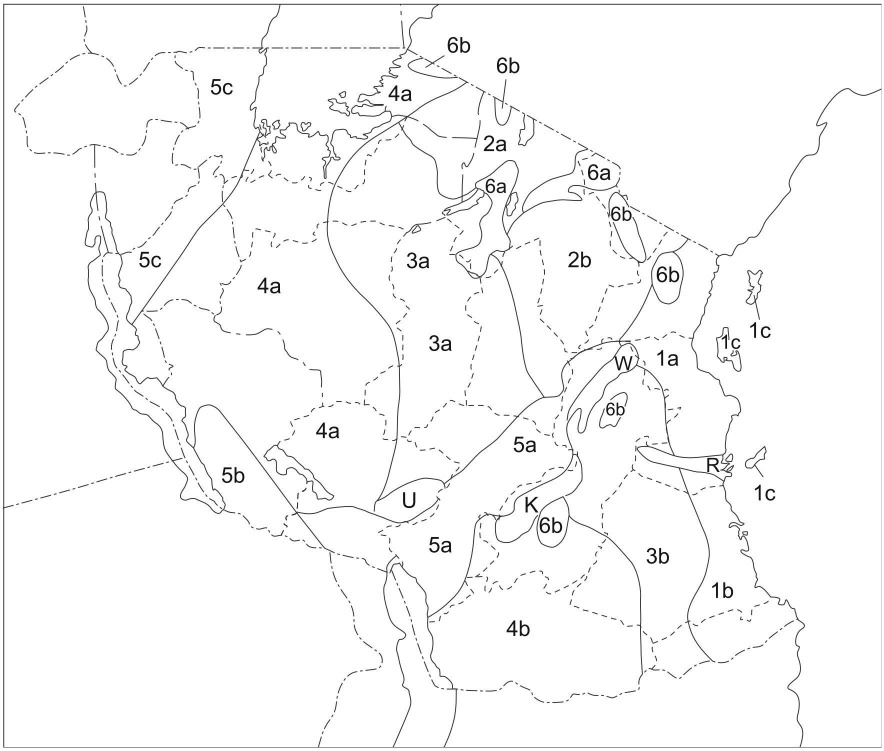


Fig. 2.3 Land resource zones and farming systems in Tanzania
(Sakamoto 2009, 2021, p. 9 adapted from Pauw, 1994, p. 9).
Cassava, cashew, and coconut farming system: 1a, 1b, 1c, 3b.
Wetland paddies and sugarcane: K, R, U, W.
Livestock and sorghum–millet farming system: 3a, 4a, 6a, 6b, R, U, W.
Agro-pastoralism: 3a, U. Pastoralism: 2a, 2b.
Maize and legume farming system: 4a, 4b, 5a, 5b.
Coffee and banana: 5c, 6a, 6b

semiarid central region and coastal regions aside from Dar es Salaam were not included in this previous study.

A survey on the nutritional intake and health of 252 female adults from six rural villages in three central (Dodoma region) and northeastern (Tanga region) Tanzania regions classified dietary patterns into five categories (Keding et al., 2011):

(1) The "traditional-inland" dietary pattern has relatively more grains, oils, and vegetables.
(2) The "traditional-coastal" dietary pattern has relatively more fruits, nuts, tubers, bananas, and fish.
(3) The "pulse" dietary pattern has relatively more pulses and fewer vegetables.
(4) The "animal products" dietary pattern has relatively more ingredients derived from animals other than fish.
(5) The "purchase" dietary pattern has relatively more bread, cake (including oil), sugar, and tea.

(1) The traditional-inland dietary pattern was common in central Tanzania, and it was relatively healthy, as indicated by people with a relatively low BMI and a lesser degree of anemia (Keding et al., 2011). A nutritional intake survey of 333 women from two villages in Chamwino district in Dodoma region showed that they consumed more leafy vegetables and more vitamin A and iron (Stuetz et al., 2019), supporting this trend.

(2) The traditional-coastal dietary pattern was common in Tanga region in the northeast. (3) The pulse dietary pattern, (4) animal product dietary pattern, and (5) purchase dietary pattern involve fewer vegetables. Additionally, (4) is related to wealth, and (5) tends toward obesity and a high prevalence of anemia. However, even in rural areas, farmers are not only self-sufficient but also grow produce for sale. Therefore, the transition from (2) to (5) and lifestyle-related diseases are conspicuous, especially in the northeast (Keding et al., 2011).

These regional differences in dietary patterns, wealth accumulation, and food modernization suggest health impacts. To obtain a deeper understanding of food culture, it is also important to comprehend the actual ingredients that constitute meals at the household level. Understanding how they obtained these foods is also important. The remaining parts of the chapter elaborate on the combination of ingredients used for staple foods and other dishes in meals at the household level, the information of which comes first hand. This is coupled with the dietary patterns explained in previous research.

2.4 Obtaining Information at the Household Level From Food Diaries in Three Areas of Tanzania

This chapter introduces the cases of the central region of Dodoma, the southeastern region of Lindi, and the metropolitan city of Dar es Salaam to provide a clearer picture of meals. The diary records of 15 households from five households in each region were researched (Table 2.1).

For the daily food diary research, the target households were asked to record all meals and snacks they had eaten every day for 3–5 consecutive days with information on food ingredients and how they obtained them, as well as to take photographs with instant cameras. Table 2.1 provides a list of each household's recorder and cook. The above research was conducted twice in Lindi and Dodoma during the dry season (August 2018) and the rainy season (February 2019). Participation observation in Dar es Salaam for an extended period suggested that the seasonal difference was minimal. As a result, the research was carried out only in August 2019. Although all household members were included, some snacks or meals may have been omitted for some of the members of the household.

Records and photographs were collated to organize the information, and in the case of omissions of records and photographs, they were mutually supplemented to bring the situation closer to reality. Wild plants were identified by staff at the

University of Dar es Salaam Herbarium after observations, interviews, and sampling in the study regions from 2018 to 2020.

Tables 2.2, 2.5, and 2.8 indicate the food items used in the household in each region. Tables 2.3, 2.4, 2.6, 2.7, and 2.9 show the combination of staple food in each region (according to the season) and other ingredients that are used for relishing. The seasoning ingredients are not counted because the record was not comprehensive. The foods classified as staple foods are depicted in each column in principle, whereas other foods are depicted in each row as relish. When more than one staple food ingredient was included in a single meal, it is generally noted between the columns in the supplementary note, but when it is treated as a relish concerning the food group, it is noted in the row. When there were multiple relishes, the combination is described for each dish. The main dishes of relish are listed as the representative relish in principle. Since a relish in a meal counts as one when there are multiple relishes, staple foods may be counted twice or more, and the overall sum and the total number of appearances of actual staple foods may not match. Figures 2.4, 2.5, and 2.6 show photographs of typical or regular meals from each region, along with the dietary pattern. To understand the common combination of food groups, correlations (Pearson) between food groups were analyzed. Additionally, as shown in Fig. 2.7, the results are presented as a scatter plot and focus on vegetable and staple food intake.

2.5 Meals at the Household Level in Dodoma Region in Semiarid Central Tanzania

Dodoma region has low annual rainfall—between 500 and 750 mm (Fig. 2.1), and its vegetation is primarily made up of grassland and bushland, with some transitioning to desert (Fig. 2.2). Its dominant livelihood is agro-pastoralism involving livestock keeping and cultivating sorghum–millet (Fig. 2.3). According to regional data, the production of maize is low (below 100,000 tons), production of cassava is modest (10,000–100,000 tons), and production of bananas is unknown (Cochrane & D'Souza, 2015, pp. 4–6).

The food culture of the semiarid Dodoma has been the subject of several previous studies. According to a study of foods in three Sandawe (historically hunter-gatherer) households, the staple foods are maize (44% of the staple foods) and millet (33%), and the relishes are edible weeds (38% of the staple foods), pulses (21%), leafy vegetables (18%), and mushrooms (13%). More than half of the relishes are collected as food, and dried leaves of false sesame (*Ceratotheca sesamoides*) are used in the dry season. Along with the kind of leaves utilized in the dry season, additional edible weeds and mushrooms are also eaten during the rainy season (Yatsuka, 2012, pp. 68–69). According to a study of 20 Gogo households' food diaries, during the dry season, all households eat *ugali* (solid porridge) or pulses and boiled maize as their main dish. However, during the rainy season, more than half of the "poor" households consume porridge. Relishes include leafy greens or the edible weed *mlenda* (sticky relish), which are more common among "poor" households and more frequent during the rainy season than amount "rich" households. While "poor" households typically consume *uji* (liquid maize porridge) for breakfast during the dry season, "rich" and "average" households drink tea and occasionally eat *chapati* cooked by frying wheat dough in oil (Kuroda, 2016).

The meals of the households discussed in this section focus on the Gogo ethnic group that resides in the village of Mbelezungu in Chamwino district, an arid area approximately 70 km from Tanzania's capital city, Dodoma. The village used to be located in the vicinity of Majeleko village, but recently, it became a new village. In addition to maize, sorghum, and millet, edible weeds that naturally grow in fields are consumed as relishes. Some villagers keep domestic animals such as cattle. There is no market in the village, but there are street vendors and shops along the main road where you can obtain meat, tomatoes, onions, green vegetables, and fruits. There are regular marketplaces located close to the village that also sell cattle, and there are also locals who sell vegetables or sugarcane close to their homes. The research targeted five households with different occupations and household compositions (Table 2.1).

Table 2.2 shows the major food items, and Tables 2.3 and 2.4 shows the combination of staple foods and relishes by season as a summary of the results from the food diary. Maize *ugali* (made from maize flour) is the primary food source, and maize is widely cultivated. The majority of relish ingredients are vegetables, with *mlenda* being the most popular in both seasons. Edible weeds, including false sesame, **mgalu**[1] (*Ceratotheca sesamoides*), **chipali** (*Ipomoea obscura*), baobab leaves, and **mpapala** (unidentified), are also consumed (Fig. 2.4, photographs 1 and 2). During the dry season, grown peanuts are both consumed independently and used to make *mlenda*. In both seasons, *ugali* is eaten with a relish made from cultivated cowpea leaves known as **sansa** in the Gogo language (photographs 3 and 4). The rainy season is when edible weeds such as **muhilili** and *Cleome hirta* can be found (photograph 5). The study households' "traditional-inland" dietary pattern (Keding et al., 2011) is based on cultivated crops (staple foods and peanuts) and edible weeds (leafy vegetables).

Purchased kidney beans are consumed year-round as a relish with *ugali* (photograph 6), but farmed cowpea beans are consumed only during the dry season. While there were pulse dishes served in every household, there were also 13 single relishes and five double relishes with leafy vegetables. In household D1, where cattle are reared, milk is mostly consumed with *ugali* in the rainy season (photograph 7). Three meals included fish, five meals included vegetables, and four meals consisted of a single relish. During the rainy season, fish and animal meat are also more common, although not in households D3 and D4. Members of only some of the households were able to consume "animal products," most likely due to the expense.

[1] Local plant names are in bold.

Table 2.1 Family composition of the participating households

Region	District	Village	Ethnic group	Household	Number of people in a household	Number of persons surveyed (by age and sex)									Main occupation (other occupation)	Dates of research
							Infants	Children	Other children	Adolescent		Adult		Elderly people		
						Age:	<1	1 ≦ x < 5	5 ≦ x < 10	10 ≦ x < 18		18 ≦ x < 60		60<		
						Gender: Season	Boys & girls	Boys & girls	Boys & girls	Girls	Boys	Woman	Man	Men & women		
Dodoma	Chamwino	Mbelzungu	Gogo	D1	8	Dry:		1	2	1	2	1[a, b]	1		Livestock farming and agriculture	16–19, 21
						Rainy:		1	2	1	2	1[a]	1[b]			2019/2/5–9, 11
				D0	4					1		1[a]	2[b]		Agriculture	2018/8/16–21, 2019/2/7, 14–16,20–21
				D2	7				2	1	2	1[a]	1[b]		Agriculture (hunting)	2018/8/16–21, 2019/2/2–3, 5, 9
				D3	3	Dry:					1	1[a, b]		1	Agriculture	2018/8/16–21
					3	Rainy:						1[a, b]	1	1		2019/2/5–10
				D4	7			1	1	3		1[a]	1[b]		Agriculture (bar)	2018/8/16–21, 2019/2/12–15, 22–24
Lindi	Lindi	Rutamba	Mwera	L2	15			2	1	3	2	1[a, b]	4	2	Agriculture	2018/8/28–9/1
					15			2		3	2	2[a, b]	4	2		2019/2/2–5
				L0	7	Dry:			2	1	1	2[a, b]	1		Agriculture	2018/8/28–9/1
					6	Rainy:			2			2[a, b]			Housekeeping	2019/2/6–14
				L1	4	Dry:		2				2[a, b]			Agriculture	2018/8/28–9/1
					5	Rainy:		2		1		2[a, b]				2019/2/3–9,11
		Miche		L3	5			1			1	2[a, b]	1		Agriculture	2018/8/28–9/1, 2019/2/2–6
				L4	5						2	2[a, b]		1	Agriculture	2018/8/28–9/1
											2[b]	2[a]		1		2019/2/18–3/1–5
Dar es Salaam	Kinondoni	–	Chaga	Dar4	4						1	2[a]	1[b]		Teaching	2019/8/27–31
			Kinga	Dar0	4							1[a, b]			Houseworking and dairy farming	2019/8/25–30
		–	Bonde	Dar2	3							2[a]	1[b]		Accounting	2019/8/19–23
	Ubungo	–	Makonde	Dar3	9		1			1	2	2[a]	3[b]		Former automobile mechanic working	2019/8/19–23
	Temeke	–	Sambaa	Dar1	5		1		1		1	1[a]	1[b]		Day laboring	2019/8/19–23

[a]Cooking household member
[b]Recorder

Table 2.2 Food items consumed in the households in Dodoma (From food diaries)

Food groups		Food item	Local name	Scientific name
Staple foods	Grain	Rice	***Mchele***	*Oryza sativa*
		Maize	***Mahindi***	*Zea mays*
		Sorghum	***Mtama***	*Sorghum bicolor*
		Millet	***Uwele***	*Pennisetum glaucum*
	Tuber	Sweet potatoes	***Viazi vitamu***	*Ipomoea batata*
Animal products		Meat	*Nyama*	
		Fish	*Samaki*	
		Milk	*Maziwa*	
Pulse		Kidney beans	***Maharagwe***	*Phaseolus vulgaris*
		Cowpea	***Kunde*** **, Safwe**	*Vigna unguiculata*
		Bambara beans	***Njugu mawe***	*Vigna subterranea*
		Hyacinth beans	***Fiwi***	*Lablab purpureus*
Vegetables	Green vegetables	Cowpea leaves	**Sansa**	*Vigna unguiculata*
		Sweet potato leaves	***Matembele***	*Ipomoea batata*
		Pumpkin leaves	***Nghabwajilila***	*Cucurbita maxima*
		Chinese cabbage	***Chinese kabichi***	*Brassica rapa*
		Spinach	***Spinachi***	*Spinacia oleracea*
		Wild vegetable	**Muhilili**	*Cleome hirta*
		Mlenda	*Mlenda*	*Ceratotheca sesamoides*, etc.
		Mlenda of wild vegetable	**Mgalu, Mugalu**	*Ceratotheca sesamoides*
		Mlenda of wild vegetable	**Mpapala**	Unidentified
		Wild sweet potato leaves	***Matembele pori,*** **Sagula Sagula, Chipali**	*Ipomoea obscuraIpomoea mombassana*
		Baobab leaves	***Mbuyu***	*Adansonia digitata*
		Okra	***Bamia***	*Abelmoschus esculentus*
	Other	Tomatoes	***Nyanya***	*Solanum lycopersicum*
		Gourd	***Mamamunya***	*Lagenaria siceraria*
		Onion	***Kitunguu***	*Allium cepa*
		African eggplant	***Nyanya chungu***	*Solanum macrocarpon*
Fruits	Cultivated	Banana	***Ndizi***	*Musa cultivars*
		Jambolan	***Mzambalau***	*Syzygium cumini*
	Wild	Baobab pulp	***Ubuyu***	*Adansonia digitata*
		Wild fruit pulp	**Udawi, Udai**	*Cordia sinensis*
		Wild fruit pulp	**Msanze**	Unidentified

(continued)

Table 2.2 (continued)

Food groups		Food item	Local name	Scientific name
		Wild fruit pulp	**Ngwelu, Mgalu**	*Grewia conocarpoides, Grewia* sp. *nov*
		Wild fruit pulp	**Nafuta, Mtafuta**	*Grewia burtii, G. similis*
		Wild fruit pulp	**Ngande, Mgandu**	*Berchemia discolor*
		Wild fruit pulp	**Msena**	*Cordia ovalis*
Nuts	Cultivated	Peanut	***Karanga***	*Arachis hypogaea*
		Sunflower seeds	***Mbegu ya alizeti***	*Helianthus annuus*
	Wild	Dried wild fruit pulp	**Premehe**	*Grewia flavescens*
Other		Oil	*Mafuta*	
		Salt	*Chumvi*	
		Tea	*Chai*	
		Sugar	*Sukari*	
		Sugarcane	***Miwa, Muwa***	*Saccharum officinarum*
		Honey	*Asali*	

The words in **bold** are the Gogo names. The words in italics are Swahili (Swahili plant names in bold italics) or scientific name

2.6 Meals at the Household Level in Lindi Region in the Southeastern Bushland

Rainfall in Lindi region is generally in the range of 750–1000 mm, while some areas receive up to 2000 mm (Fig. 2.1). The vegetation is bushland and woodland, with small patches of forests (Fig. 2.2). Cassava, cashew, and coconut farming systems are predominant in the region (Fig. 2.3). Similar to Dodoma region, this region has low maize production (below 100,000 tons) and moderate cassava production (10,000–100,000 tons), but there is no information on banana production (Cochrane & D'Souza, 2015, pp. 4–6).

There is little prior research on meals at the household level in the southeast. The case of the Mwera, an agriculturally based matrilineal ethnic group in the southeast, is introduced to elaborate on meals at the household level. The villages of Rutamba and Miche in the Lindi region are the target areas; they are situated on the shores of Lake Lutamba, some 65 km from Lindi city. Sorghum, cassava, and pulses are grown in the mountains, and fish from Lake Lutamba and the ocean is also available. The area around Lake Lutamba also supports double cropping of rice and maize, as well as coconut, and tomato. There is a permanent market where ingredients such as tomatoes, onions, coconuts, fish, and green and yellow vegetables as well as processed foods, meals, and everyday items can be purchased. Miche, formerly Rutamba village, has recently become a new village. Small shops are operating out of a portion of their home where pulse, rice, salt, and other daily necessities are sold.

Table 2.3 Combinations of ingredients in the households in Dodoma during the dry season (From food diaries)

Relish, etc.	Staple foods	Maize	Sorghum	Sweet potato	Rice	Without staple food	Total	Photographs[a]
Vegetables	False sesame and other *mlenda*	9	1				10	(1, 2)
	Mgalu, edible weed	2					2	
	Mpapala, edible weed	1					1	
	Cowpea leaves	6					6	3 (4)
	Sweet potato leaves	4					4	
	Muhilili, edible weed	2					2	(5)
	Pumpkin leaves	1					1	
	Chinese cabbage				1		1	
	“Spinach”	1					1	
	Other leafy vegetables				1		1	
	Tomato	2					2	
	Gourd					1	1	
Pulse	Cowpea	4	2				6	
	Kidney beans	4			1		5	(6)
	Bambara beans	1					1	
	Hyacinth beans	1					1	
Meat, fish, and milk	Animal meat				1		1	
	Fish	2					2	
	Milk	2					2	(7)
Seeds	Peanut					6	6	

Other	Black tea			2			2	
	Sugar			2			2	
	Sugarcane					5	5	
	Honey					4	4	
	Sunflower seeds					1	1	
	Baobab					1	1	
	Premehe, wild fruit					1	1	
	Banana					1	1	
Without relish (porridge)		3					3	
Total number of relish ingredients		45	3	4	4	20	76	
Total staple food occurrences		42	4	2	1		49	
Photographs[a]		3, 5 (1, 6, 7)	(2)					

Bold: local (Gogo) plant names
[a] See Fig. 2.4 for photographs. ( ) The photograph numbers in the brackets differ in season or match only a part of the ingredients

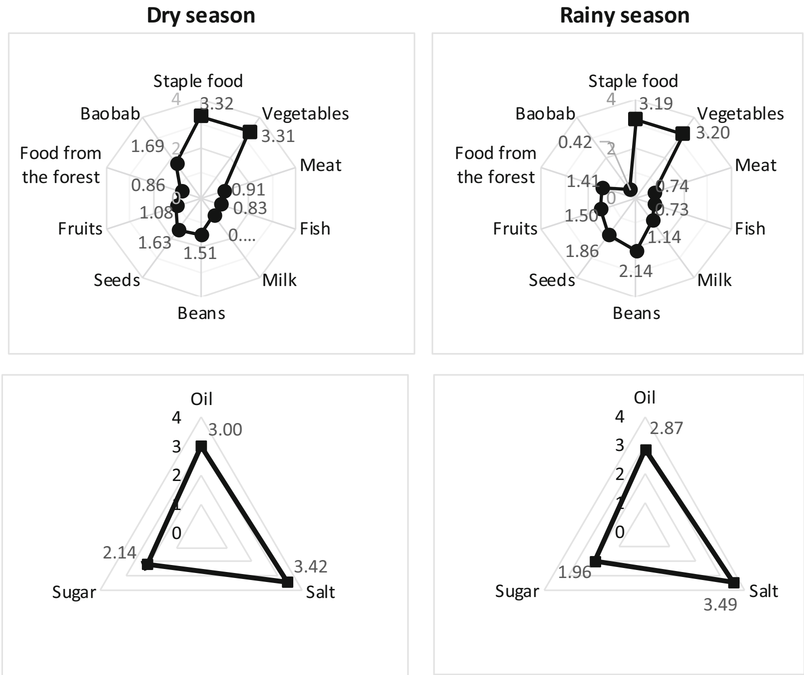


Fig. 2.4 Dietary patterns in Central Dodoma (Photographs by participants). The household number is shown in parentheses. D = dry season, R = rainy season. The timing of meals is indicated

Coconut trees are grown in abundance close to houses. Along the roads, there are stands where fermented sorghum juices, wild tubers, seasonal vegetables, and fruits are sold. This study included two houses in Miche village and three households in Rutamba village, all of which have different economic standings, living environments, and household compositions (Table 2.1).

Table 2.5 shows lists of the food items consumed by the researched households. Table 2.6 and 2.7 provides information on the households in Lindi region, including a summary of their food diaries. Rice and maize, which are considered staple foods, are purchased or grown. Regarding relishes, all households consume fish, which is the most popular meal available for purchasing (Fig. 2.4, photographs 1 and 2). Flesh from coconuts, whether purchased or cultivated, is indispensable for seasoning. The second most popular food, cassava, is frequently cultivated and consumed as a single food item or as *ugali*. It can be eaten raw, fried, char-grilled, etc. (photographs 3, 4, and 7). Cassava (photograph 3), sweet potatoes, and coconut-braised bananas are also available for breakfast. The wild tuber **ming'oko** (*Dioscorea hirtiflora*) is boiled in households L3 or L4, salted, eaten alone, or eaten as a relish with cassava *ugali*, which is crushed and mixed with the skin (photograph 4). During the rainy season, members of household L0 consume mangoes, whereas household L4 consumes the

Table 2.4 Combinations of ingredients in the households in Dodoma during the rainy season (From food diaries)

Relish	Staple foods	Maize	Sorghum	Pearl millet	Rice	Without staple food	Total	Photographs[a]
Vegetables	False sesame and other *mlenda*	8					8	(1, 2)
	Mgalu, edible weed	2					2	
	Chipali, edible weed	1					1	
	Baobab leaves	1					1	
	Cowpea leaves	1	2	3			6	(3, 4)
	Muhilili, edible weed	5	1				6	(6)
	Pumpkin leaves	1					1	
	Other leafy vegetables	10					10	
	Okra	3					3	
Meat, fish, and milk	Milk	8	1	2			11	(7)
	Fish	5		1			6	
	Animal meat	1	1	2			4	
Fruits	**Udawi**, wild fruit					4	4	
	Msanze, wild fruit					3	3	
	Baobab fruit	1				1	2	
	Ngwelu, wild fruit			1			1	
	Nafuta, wild fruit			1			1	
	Ngandu, wild fruit					1	1	
	Msena, wild fruit					1	1	
	Jambolan					1	1	
Pulse	Kidney beans	4					4	(6)
	Cowpea				1		1	

(continued)

Table 2.4 (continued)

Relish	Staple foods	Maize	Sorghum	Pearl millet	Rice	Without staple food	Total	Photographs[a]
Other	Sunflower seeds					4	4	
	Oil	1					1	[a]
	Salt	1					1	
Without relish (porridge, etc.)		2						
Total number of relish ingredients		53	5	10	1	15	84	
Total staple food occurrences		61	4	3	1		69	
Photographs[a]		(1) (6) (7) (3, 5)		(4)				

Bold: local (Gogo) plant names
[a]Same as that in Table 2.3

Table 2.5 Food items consumed in households in Lindi (From food diaries)

Food groups		Food item	Local name	Scientific name
Staple foods	Grain	Rice	***Mchele***	*Oryza sativa*
		Maize	***Mahindi***	*Zea mays*
		Sorghum	***Mtama***	*Sorghum bicolor*
		Bulrush millet	***Uwele***	*Pennisetum glaucum*
		Millet	***Ulezi***	*Eleusine coracana*
		Wheat	***Ngano***	*Triticum aestivum*
	Tuber	Cassava	***Mihogo***	*Manihot esculenta*
		Sweet potatoes	***Viazi vitamu***	*Ipomoea batata*
		Potatoes	***Viazi***	*Hieracium solanum*
		Wild tuber	**Ming'oko**	*Dioscorea hirtiflora*
		Cooking banana	***Ndizi za kupika***	*Musa cultivars*
Animal products		Chicken	*Kuku*	
		Fish	*Samaki*	
		Milk	*Maziwa*	
Pulse		Kidney beans	***Maharagwe***	*Phaseolus vulgaris*
		Cowpea	***Kunde***	*Vigna unguiculata*
		Pigeon peas	***Mbaazi***	*Cajanus cajan*
		Bambara beans	***Njugu mawe***	*Vigna subterranea*
Vegetables	Green vegetables	Cowpea leaves	***Majani ya kunde***	*Vigna unguiculata*
		Amaranth	***Mchicha***	*Amaranthus hybridus, Amaranthus spp.*
		Cassava leaves	***Kisamvu***	*Manihot esculenta*
		Pumpkin leaves	***Majani ya maboga***	*Cucurbita maxima*
		Chinese cabbage	***Chinese kabichi***	*Brassica rapa*
		Sweet potato leaves	***Matembele***	*Ipomoea batata*
			Mkokobado	*Ipomoea aquatica*
		Mlenda	***Mlenda***	*Unidentified*
		Okra	***Bamia***	*Abelmoschus esculentus*
	Other	Tomatoes	***Nyanya***	*Solanum lycopersicum*
		Pumpkin	***Maboga***	*Cucurbita maxima*
		Onion	***Kitunguu***	*Allium cepa*
		Cucumber	***Tango***	*Cucumis sativus*
		Mushrooms	***Uyoga***	*Unidentified*
Fruits	Cultivated	Mango	***Embe***	*Mangifera indica*
		Papaya	***Papai***	*Carica papaya*
		Orange	***Chungwa***	*Citrus sinensis*
		Banana	***Ndizi***	*Musa cultivars*

(continued)

Table 2.5 (continued)

Food groups		Food item	Local name	Scientific name
		Guava	***Mpera***	*Psidium guajava*
		Watermelon	***Tikitimaji***	*Citrullus lanatus*
		Cashew nuts	***Mabibo***	*Anacardium occidentale*
	Wild	Wild fruit	**Mgurugai**	*Vangueria madagascariensis*
		Wild fruit	**Manjichi**	*Strychnos cocculoides*
		Wild fruit	**Usofu**	*Uvaria leptocladon*
		Wild fruit	**Vitoro**	*Landolphia kirkii*
Nuts		Coconuts	***Nazi***	*Cocos nucifera*
		Sesame	***Ufuta***	*Sesamum indicum*
		Peanuts	***Karanga***	*Arachis hypogaea*
		Pumpkin seeds	***Mbegu ya maboga***	*Cucurbita maxima*
Other		Oil	*Mafuta*	
		Salt	*Chumvi*	
		Tea	*Chai*	
		Mendi tea	*Mendi*	
		Sugar	*Sukari*	
		Sugarcane	***Miwa***	*Saccharum officinarum*
		Chili	***Pilipili***	*Capsicum sp.*
		Ginger	***Tangawizi***	*Zingiber officinale*

The words in **bold** are the local ethnic names. The words in *italics* are Swahili (Swahili plant names in bold italics) or scientific name

wild fruits **manjichi** (*Strychnos mitis*), **usofu** (*Uvaria leptocladon*), and **vitoro** (*Landolphia kirkii*).

The emphasis on fruit consumption is similar, and the pattern of fish and nuts is common when compared to the northeast's "traditional-coastal" pattern (Keding et al., 2011), which was described in earlier research as involving more fruits, nuts, bananas, and fish. However, tubers are also eaten, but grains are more common.

Regarding pulses, purchased kidney beans are widespread in both seasons (photograph 5), but cultivated cowpea (photograph 6) and pigeon peas also appear in the dry season. Every household consumes pulses, but the variety differs depending on whether household members purchase or cultivate their own and differs by household. With respect to the pulse relish, 23 meals were single relishes, and 11 meals were compound relishes with green vegetables and fruits (fish appeared in only one of them).

The intake of vegetables is not insignificant, as there was an abundance of leaves of cultivated cowpea (photograph 7) and water hyacinth obtained from cultivation and by purchase. **Mkokobado**, a wild vegetable growing around Lake Lutamba collected by members of household L4 as a relish, was the same as the water spinach *Ipomoea aquatica* (photograph 8).

Table 2.6 Combination of ingredients in the households in Lindi during the dry season (From food diaries)

Relish	Staple foods	Rice		Wheat		Maize		Cassava			Sweet potato		**Ming'oko**	Cooking banana	Pearl millet	Sorghum	Without staple food	Total	Photographs[a]
Meat and fish	Fish	11	1	[b]		11												23	1 (2)
	Chicken	2				2												4	
Legume	Kidney bean	3				3												6	5
	Cowpea	4				1												5	6
	Pigeon pea	1				4												5	
	Bambara bean	1				2												3	
Vegetables	Cowpea leaves	2				1												3	(7)
	Green Amaranthus	3				4	1	[b]										8	
	Okra					4												4	
	Chinese cabbage	1				2												3	
	Sweet potato leaves					2												2	
	Water spinach					1												1	8
	Other leafy vegetables	1																1	
	Tomato	1					1	[b]										2	
Fruits	Mango																7	7	
	Papaya																5	5	
	Orange																2	2	
	Cashew nuts																1	1	
	Mgurugai, wild fruit																1	1	
Seeds	Coconut pulp	3				1				1	[b]			2				7	3
	Peanut																3	3	
Other	Oil	1			1				1									3	
	Salt					1							1					2	
	Black tea	4	2	[b]	4				3					3			1	18	9
	Sugarcane																3	3	
	Ming'oko , *w*ild tubers[c]								1									1	4

(continued)

Table 2.6 (continued)

Relish	Staple foods	Rice		Wheat		Maize		Cassava			Sweet potato		**Ming'oko**	Cooking banana	Pearl millet	Sorghum	Without staple food	Total	Photographs[a]
Relishes unknown					1	1										1		3	
Without relish (porridge, deep fried, etc.)									10				1		2			14	
Total number of relish ingredients		38	3	[b]	6	40	2	[b]	15	1	[b]		2	5	2	1	23	140	
"Staple food" as a relish[c]													1						
Total staple food occurrence		37			7	24		17					3	3	2	1		97	
Photographs[a]		1, 5		(9)		2 (6, 8)													

[a] See Fig. 2.5 for photographs. ( ) The photograph numbers in the brackets are seasonal or match only a part of the ingredients
[b] Staple food combinations, for example, leftover cooked rice and wheat products (breakfast), *ugali* mixed with maize and cassava flour, and cassava and sweet potato boiled in coconut
[c] Although it is a "staple food" in the food group, it was treated as (part of) a relish according to the ratio

Fig. 2.5 Dietary patterns in the Southeast (Lindi) (Photographs by participants)

All households, except L4, consumed sugar-sweetened tea for breakfast, which is purchased. Sugar-sweetened tea is frequently paired with a variety of foods, such as doughnuts (picture 9), a sweet cake made of processed rice powder that is fried in oil, cooked rice, and cassava. Focusing on sugar-sweetened tea, "purchase" dietary patterns are seen in households with purchasing power (Keding et al., 2011).

2.7 Meals at the Household Level in Urban Dar es Salaam

Dar es Salaam is the economically largest city in Tanzania. Despite the political transfer to Dodoma City, its population continues to expand, and it is home to diverse ethnic groups. Given these circumstances, rainfall, vegetation, and crop production have less influence on dietary patterns. Rather, the diversity of ethnic groups and commercialization of food characterized the meals there.

There have been a few studies done on food intake in Dar es Salaam. In a 24-h retrospective survey of 271 men and women of various ages conducted in suburban and central Dar es Salaam in the 1990s, protein deficiencies were identified, animal products were infrequently consumed in the suburbs, and the central region was at high risk for vegetable deficiencies and lifestyle-related diseases (Mazengo et al., 1997). In addition to regular oil consumption, skipping meals was also common

Table 2.7 Combinations of ingredients in the households in Lindi during the rainy season (From food diaries)

Relish	Staple foods	Rice	Maize	Cassava	Pearl millet	Finger millet	Sorghum	Wheat	Cooked banana	Without staple food	Total	Photographs[a]
Fish, meat, and milk	Fish	3	12	1							16	(1, 2)
	Chicken		1								1	
	Milk	1									1	
Pulse	Kidney beans	7	4								11	(5)
	Cowpea		3								3	(6)
	Cowpea leaves		1									
	Bambara beans		1								1	
Vegetables	Cowpea leaves	3	4	4							12	(7)
	Green Amaranthus		2								2	
	Okra		2								2	
	Cassava leaves	1	2								3	
	Pumpkin leaves		2								2	
	Water spinach		1 [b]								1	(8)
	Mlenda		1								1	
	Other leafy vegetables		1								1	
	Pumpkin									3	3	
	Cucumber		1							1	2	
	Mushrooms	1									1	
Fruits	Mango									1	1	
	Orange									3	3	
	Banana									2	2	
	Guava									1	1	

	Watermelon													1	1	
	Other fruits													2	2	
	Manjichi, wild fruit,													1	1	
	Usofu, wild fruit													1	1	
	Vitoro, wild fruit													1	1	
Seeds	Coconut pulp										1		1		2	(3)
	Sesame seeds	1													1	
	Peanut													1	1	
Other	Oil	1										2			3	
	Salt					1									1	
	Black tea	6				4						2	2	2	16	(9)
	Mendi tea	1													1	
	Sugarcane													1	1	
	Ming'oko, wild tuber[c]					2									2	(4)
Relishes unknown		1	1												2	
Without relish (porridge, etc.)			3			4	1	b		1					9	
Total number of relish ingredients		26	40	1	b	16	1	b		1	1	4	3	21	114	
Total staple food occurrences		21	31			17		1		1	1	2	2		76	
Photographs[a]		(1, 5)	(2, 6, 8)			(7) (3, 4)						(9)				

[a] and [c] are the same as those in Table 2.6

[b]The staple food combinations shown are cassava and pearl millet porridge and *ugali* mixed with maize and cassava flour

according to a 2009 questionnaire survey of 237 men and women in Dar es Salaam (Yamazaki & Oyanagizu, 2012).

This section includes an analysis of the meals of five houses in the large Kinondoni district in the north, the nearby Ubungo central business district, and the Temeke district's southern downtown area. Although pricing and variety can change with the season, there are sizable permanent markets for food in these places, from both Tanzania and overseas. The households of different ethnic groups are introduced here: Chaga (from the north), Kinga (from the southwest), Bondi (from the northeast), Makonde (from the southeast and a neighbor of the Mwera), and Sambaa (from the northeast) (Table 2.1).

Table 2.8 lists the food items used by the research households based on the food diary. Table 2.9 shows the combination of staple food and relish in meals at the households in Dar es Salaam. All items are purchased, except for milk and leafy vegetables in household Dar0. Rice and maize are the main staple foods, followed by wheat and potatoes.

Relishes include animal meat for Dar2, fish for Dar3, and milk for Dar0 and Dar4, but the frequency of intake of animal protein is generally high compared with that in other regions. Animal meat (Fig. 2.1.3, photographs 1 and 2) and fish (photograph 3) are often eaten with cooked rice or maize *ugali* (stiff porridge). Milk (photograph 4) and tea (photograph 5) are often consumed alongside processed bakery products. Members of Dar1 and Dar2 eat foods such as French fries and beef (photograph 4) and *chips zege* (omelet with French fries) (photograph 7). In addition to the "purchase" patterns described for bakery products and sugar-sweetened tea in cities (Keding et al., 2011), oily fries are viewed as constituting a comparable example and overlap with the "animal products" pattern.

Leafy vegetables are also eaten as relishes of cooked rice (photograph 8) and *ugali* (sweet potato leaves) (photograph 9), which together resembles the "traditional-inland" pattern (ibid). On the other hand, compared to that of members of rural households, urban households, eat multiple relishes in one meal (photograph 1).

There were also peas and soybeans. However, there is a significant difference between households that consume pulses (Dar4) and those that do not (Dar3). Leafy vegetables are served with every meal, and eight of them also include animal meat, whereas six include fruits (photograph 1).

2.8 Combination of Food Groups and Vegetable Intake

To further understand the common combination of food group intake, correlations between vegetables (green vegetables, leafy vegetables), staple foods (grains, tubers), animal products (meat, fish, milk, eggs, meat/fish/milk), pulses, fruits, nuts, and other foods (tea, sugar) were analyzed (Table 2.10). Both leafy vegetables and green vegetables (including okra) have a strong negative correlation with tea and sugar. The strongest correlation is detected between green vegetables and tea (Pearson correlation: 0.650, $p = 0.000$). A scatter plot was generated (Fig. 2.7a)

Table 2.8 Food items consumed in the households in Dar es Salaam city (From food diaries)

Food groups		Food item	Local name	Scientific name
Staple foods	Grain	Rice	***Mchele***	*Oryza sativa*
		Maize	***Mahindi***	*Zea mays*
		Millet	***Ulezi***	*Eleusine coracana*
		Wheat	***Ngano***	*Triticum aestivum*
		Noodles	***Tambi***	
	Tuber	Cassava	***Muhogo***	*Manihot esculenta*
		Potatoes	***Viazi***	*Hieracium solanum*
		Sweet potatoes	***Viazi vitamu***	*Ipomoea batata*
Animal products		Chicken	*Kuku*	
		Other meat	*Nyama*	
		Fish	*Samaki*	
		Milk	*Maziwa*	
		Eggs	*Mayai*	
Pulse		Kidney beans	***Maharagwe***	*Phaseolus vulgaris*
		Soybean	***Soya***	*Glycine max*
		Peas	***Njegere***	*Pisum sativum*
Vegetables	Green vegetables	Sweet potato leaves	***Matembele***	*Ipomoea batata*
		Amaranth	***Mchicha***	*Amaranthus hybridus, Amaranthus spp.*
		Cassava leaves	***Kisamvu***	*Manihot esculenta*
		Pumpkin leaves	***Majani ya maboga***	*Cucurbita maxima*
	Other	Tomatoes	***Nyanya***	*Solanum lycopersicum*
		Onions	***Kitunguu***	*Allium cepa*
		African eggplant	***Nyanya chungu***	*Solanum macrocarpon*
Fruits	Cultivated	Orange	***Chungwa***	*Citrus sinensis*
		Banana	***Ndizi***	*Musa cultivars*
		Watermelon	***Tikitimaji***	*Citrullus lanatus*
		Avocado	***Parachichi***	*Persea americana*
Nuts		Coconuts	***Nazi***	*Cocos nucifera*
Other		Oil	*Mafuta*	
		Salt	*Chumvi*	
		Tea	*Chai*	
		Sugar	*Sukari*	
		Soda	*Soda*	
		Honey	*Asali*	

The words in *italic* are Swahili or scientific name; plants are in bold

Table 2.9 Combinations of ingredients in households in Dar es Salaam city during the dry season (From food diaries)

Relish	Staple foods	Potatoes		Rice		Maize		Wheat	Cassava	Finger millet	Sweet potato	Without staple food	Total	Photographs[a]
Meat, fish, and milk	Chicken					2							2	
	Other animal meat	1		7	1 [b]	3		1					13	(1, 2)
	Fish			5		7					1		13	(4)
	Milk						1 [b]	7		1			9	(4)
	Egg	1						1					2	(5)
Vegetables	Sweet potato leaves					4							4	(8)
	Green Amaranthus		1 [b]			1							2	
	Pumpkin leaves						1 [b]						1	
	Cassava leaves			2									2	
	Other leafy vegetables			8	1 [b]	12		1				1	23	(8)
Pulse	Kidney beans		1 [b]	7	1 [b]	7							16	(1)
	Soybean					3						1	4	
	Peas			3		1							4	

Fruits	Orange		1	b	3			2										6	
	Banana				4	1	b								1		3	9	(1)
	Watermelon							2			1						1	4	
	Avocado							1										1	
	Other fruits				2												1	3	
Other	Oil										4					1		5	
	Black tea				1						3	1	b	3		2	1	11	(5)
	Soda										1							1	
	Honey							1										1	
	Finger millet[c]										1							1	
	Noodles (*tambi*)[c]				1													1	
Without relish (porridge, etc.)					1			1			1			1	1				
Total number of relish ingredients		2	3	b	44	4	b	47	2	b	21	1	b	4	3	4	8	143	
"Staple food" as a relish		2													1				
Total staple food occurrences		5			21			25			16			4	4	1		76	
Photographs[a]		(6, 7)		(1)	① (3) (8)			(2, 9)			(4, 5)								

[a]See Fig. 2.6 for photographs
[b]Staple food combiations

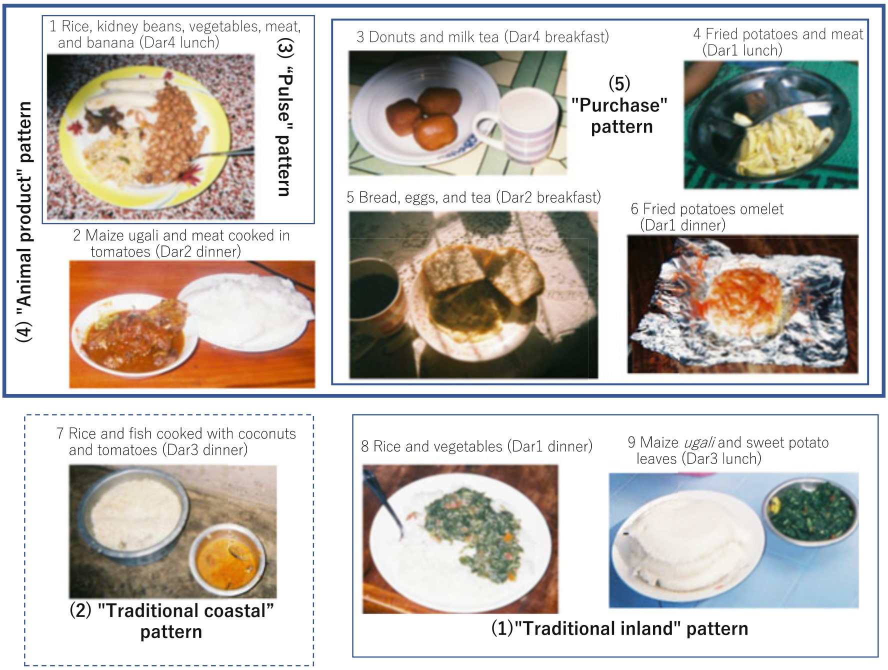


Fig. 2.6 Dietary patterns in Dar es Salaam city (Photographs by participants)

indicating that households whose members do not drink tea consume green vegetables frequently, while Lindi households whose members drink tea have a minimum intake of green vegetables. On the other hand, there is a household in Dar es Salaam in which both green vegetables and tea are consumed (Dar4).

Correlations are seen between staple foods and tea/sugar, as well as grains/tubers and tea. The strongest correlation is detected between staple foods in general and tea (0.564, $p = 0.003$). A scatter plot was generated (Fig. 2.7b) showing that households in Lindi and Dar es Salaam whose members drink tea consume staple foods more frequently.

Tubers also have a strong relationship with nuts (0.544, $p = 0.005$). A scatter plot was generated (Fig. 2.7c) indicating that households in Lindi region have a frequent intake of tubers and nuts. The actual food items would be mostly cassava and coconuts.

Vegetables and nuts also have a strong correlation (0.511, $p = 0.009$). A scatter plot was generated (Fig. 2.7d) indicating a high frequency of both food groups in Lindi households. Common relish cooked with vegetables such as tomatoes and onion with coconut is likely to increase the frequent intake of vegetables and nuts.

Staple foods/grains and fish or meat/fish/milk also are correlated. The strongest occurs between staple foods in general and fish (0.509, $p = 0.009$). A scatter plot was generated (Fig. 2.7e) indicating a higher frequency in Lindi households. This is the most common meal in Lindi region, with rice or maize *ugali* eaten with fish as a relish.

Table 2.10 Correlations between food groups

		Green vegetables	Leafy vegetables	Vege-tables	Staple foods	Grains	Tubers	Meat	Fish	Milk	Eggs	Meat Fish Milk	Pulse	Fruits	Nuts	Tea	Sugar
Green vegetables	Pearson correlation	1	0.977**	0.232	−0.155	−0.001	−0.286	−0.135	−0.138	0.337	−0.087	−0.021	−0.314	0.124	−0.303	−0.650**	−0.601**
	Significance (2-tailed)		0.000	0.264	0.459	0.997	0.166	0.519	0.511	0.100	0.678	0.920	0.126	0.554	0.141	0.000	0.002
	n	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Leafy vegetables	Pearson correlation	0.977**	1	0.243	−0.132	−0.002	−0.242	−0.119	−0.107	0.383	−0.074	0.037	−0.261	0.086	−0.287	−0.637**	−0.573**
	Significance (2-tailed)	0.000		0.243	0.529	0.994	0.243	0.570	0.612	0.059	0.725	0.860	0.208	0.684	0.165	0.001	0.003
	n	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Vegetables	Pearson correlation	0.232	0.243	1	0.494*	0.385	0.407*	−0.291	0.445*	−0.248	−0.286	0.006	−0.085	0.229	0.511**	0.198	0.152
	Significance (2-tailed)	0.264	0.243		0.012	0.057	0.044	0.158	0.026	0.232	0.166	0.977	0.688	0.270	0.009	0.342	0.467
	n	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Staple foods	Pearson correlation	−0.155	−0.132	0.494*	1	0.853**	0.727**	0.019	0.509**	0.007	0.124	0.401*	0.381	0.203	0.314	0.564**	0.424*
	Significance (2-tailed)	0.459	0.529	0.012		0.000	0.000	0.929	0.009	0.972	0.556	0.047	0.060	0.330	0.126	0.003	0.035
	n	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Grain	Pearson correlation	−0.001	−0.002	0.385	0.853**	1	0.261	0.066	0.435*	0.271	0.100	0.498*	0.347	0.211	0.028	0.443*	0.355
	Significance (2-tailed)	0.997	0.994	0.057	0.000		0.207	0.753	0.030	0.191	0.633	0.011	0.089	0.312	0.896	0.027	0.082
	n	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Tuber	Pearson correlation	−0.286	−0.242	0.407*	0.727**	0.261	1	−0.052	0.370	−0.343	0.097	0.086	0.249	0.099	0.544**	0.461*	0.317
	Significance (2-tailed)	0.166	0.243	0.044	0.000	0.207		0.804	0.069	0.094	0.646	0.682	0.231	0.639	0.005	0.020	0.123
	n	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25

(continued)

Table 2.10 (continued)

		Green vegetables	Leafy vegetables	Vege-tables	Staple foods	Grains	Tubers	Meat	Fish	Milk	Eggs	Meat Fish Milk	Pulse	Fruits	Nuts	Tea	Sugar
Meat	Pearson correlation	−0.135	−0.119	−0.291	0.019	0.066	−0.052	1	−0.233	0.136	0.670**	0.519**	0.208	0.226	−0.310	0.171	0.196
	Significance (2-tailed)	0.519	0.570	0.158	0.929	0.753	0.804		0.262	0.518	0.000	0.008	0.319	0.278	0.131	0.413	0.348
	n	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Fish	Pearson correlation	−0.138	−0.107	0.445*	0.509**	0.435*	0.370	−0.233	1	−0.154	−0.160	0.543**	−0.121	−0.047	0.355	0.362	0.301
	Significance (2-tailed)	0.511	0.612	0.026	0.009	0.030	0.069	0.262		0.462	0.446	0.005	0.563	0.824	0.081	0.076	0.144
	n	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Milk	Pearson correlation	0.337	0.383	−0.248	0.007	0.271	−0.343	0.136	−0.154	1	0.013	0.470*	0.087	0.258	−0.492*	−0.106	−0.128
	Significance (2-tailed)	0.100	0.059	0.232	0.972	0.191	0.094	0.518	0.462		0.950	0.018	0.679	0.213	0.012	0.613	0.543
	n	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Eggs	Pearson correlation	−0.087	−0.074	−0.286	0.124	0.100	0.097	0.670**	−0.160	0.013	1	0.381	0.184	−0.152	−0.387	−0.090	−0.092
	Significance (2-tailed)	0.678	0.725	0.166	0.556	0.633	0.646	0.000	0.446	0.950		0.060	0.378	0.469	0.056	0.670	0.662
	n	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Meat/fish/Milk	Pearson correlation	−0.021	0.037	0.006	0.401*	0.498*	0.086	0.519**	0.543**	0.470*	0.381	1	0.027	0.142	−0.190	0.280	0.244
	Significance (2-tailed)	0.920	0.860	0.977	0.047	0.011	0.682	0.008	0.005	0.018	0.060		0.898	0.497	0.362	0.175	0.239
	n	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Pulse	Pearson correlation	−0.314	−0.261	−0.085	0.381	0.347	0.249	0.208	−0.121	0.087	0.184	0.027	1	0.445*	0.050	0.391	0.303
	Significance (2-tailed)	0.126	0.208	0.688	0.060	0.089	0.231	0.319	0.563	0.679	0.378	0.898		0.026	0.813	0.053	0.140
	n	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25

Fruits	Pearson correlation	0.124	0.086	0.229	0.203	0.211	0.099	0.226	−0.047	0.258	−0.152	0.142	0.445*	1	0.066	0.249	0.096
	Significance (2-tailed)	0.554	0.684	0.270	0.330	0.312	0.639	0.278	0.824	0.213	0.469	0.497	0.026		0.753	0.230	0.647
	n	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Nuts	Pearson correlation	−0.303	−0.287	0.511**	0.314	0.028	0.544**	−0.310	0.355	−0.492*	−0.387	−0.190	0.050	0.066	1	0.414*	0.340
	Significance (2-tailed)	0.141	0.165	0.009	0.126	0.896	0.005	0.131	0.081	0.012	0.056	0.362	0.813	0.753		0.039	0.096
	n	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Tea	Pearson correlation	−0.650**	−0.637**	0.198	0.564**	0.443*	0.461*	0.171	0.362	−0.106	−0.090	0.280	0.391	0.249	0.414*	1	0.896**
	Significance (2-tailed)	0.000	0.001	0.342	0.003	0.027	0.020	0.413	0.076	0.613	0.670	0.175	0.053	0.230	0.039		0.000
	n	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Sugar	Pearson correlation	−0.601**	−0.573**	0.152	0.424*	0.355	0.317	0.196	0.301	−0.128	−0.092	0.244	0.303	0.096	0.340	0.896**	1
	Significance (2-tailed)	0.002	0.003	0.467	0.035	0.082	0.123	0.348	0.144	0.543	0.662	0.239	0.140	0.647	0.096	0.000	
	n	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25

* Correlation is significant at the 0.05 level (2-tailed)

** Correlation is significant at the 0.01 level (2-tailed)

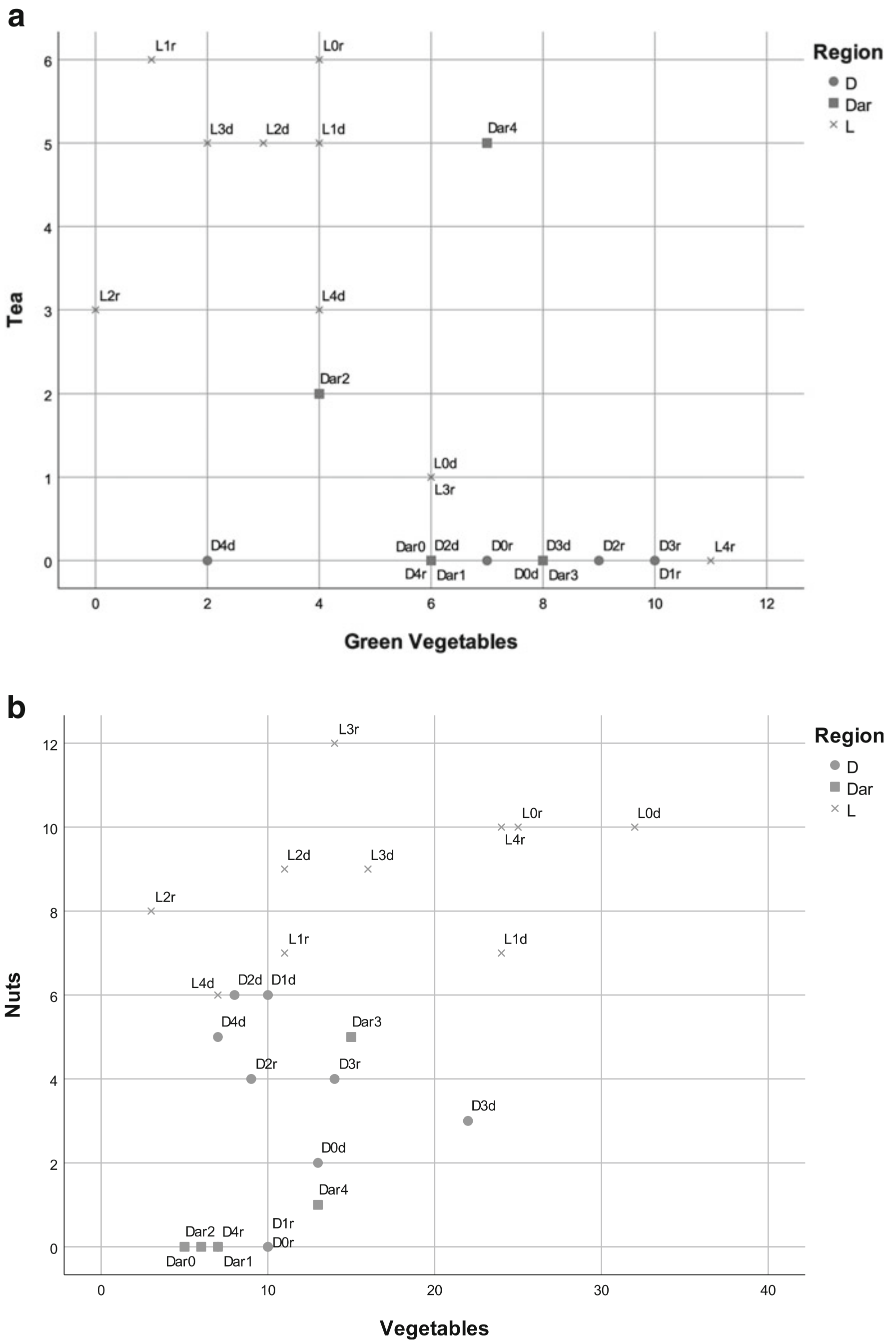


Fig. 2.7 Scatter plot of food group intake. (**a**) Scatter plot of green vegetable and tea intake. Pearson correlation: 0.650, $p = 0.000$. (**b**) Scatter plot of staple food and tea intake. Pearson correlation: 0.564, $p = 0.003$. (**c**) Scatted plot of tuber and nuts intake. Pearson correlation: 0.544, $p = 0.005$. (**d**) Scatter plot of vegetable and nut intake. Pearson correlation: 0.511, $p = 0.009$. (**e**) Scatter plot of staple food and fish intake. Pearson correlation: 0.509, $p = 0.009$. (**f**) Scatter plot of

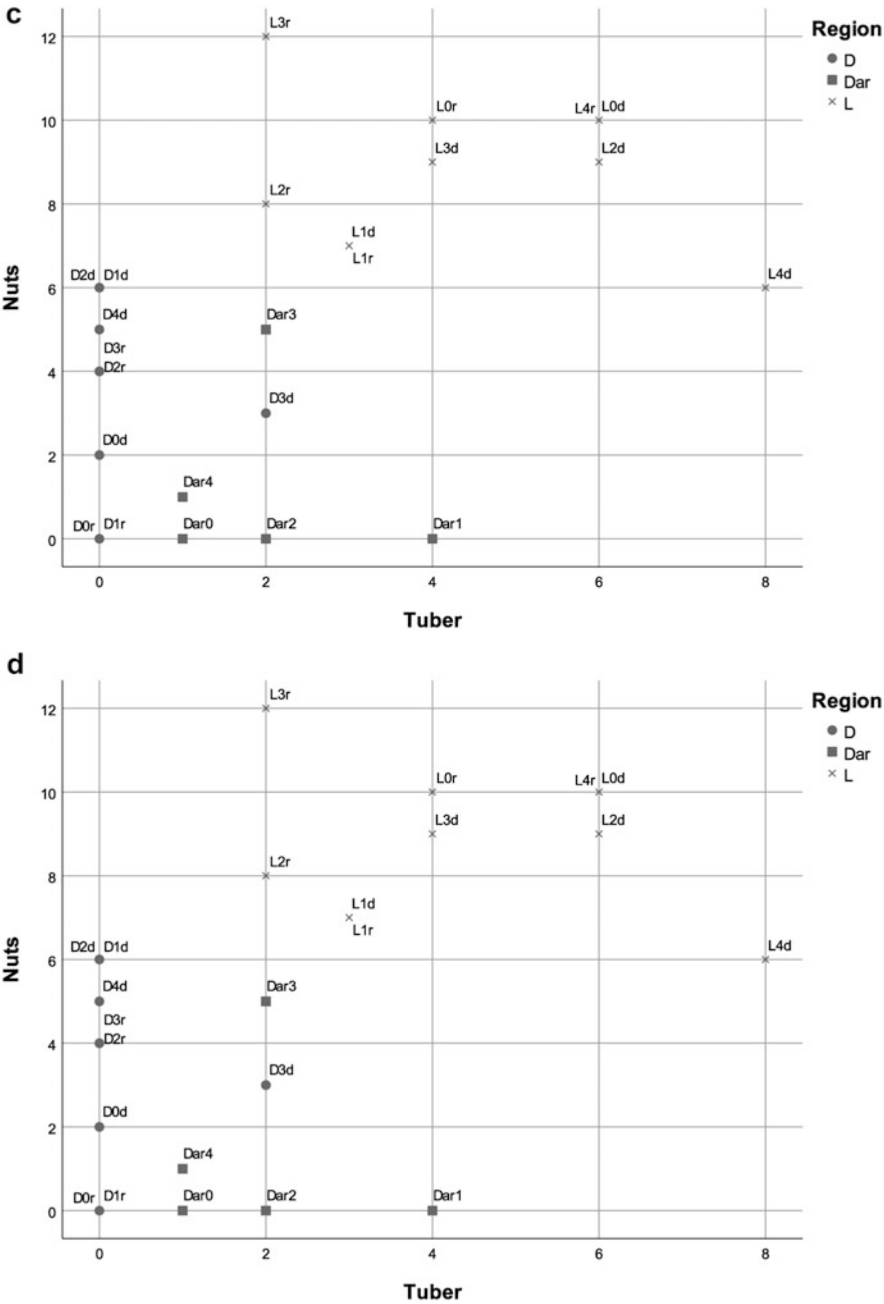


Fig. 2.7 (continued)

Fig. 2.7 (continued) milk and nut intake. Pearson correlation: 0.492, $p = 0.012$. (**g**) Scatter plot of staple fruit and pulse intake. Pearson correlation: 0.455, $p = 0.026$. (**h**) Scatter plot of nut and tea intake. Pearson correlation: 0.414, $p = 0.039$

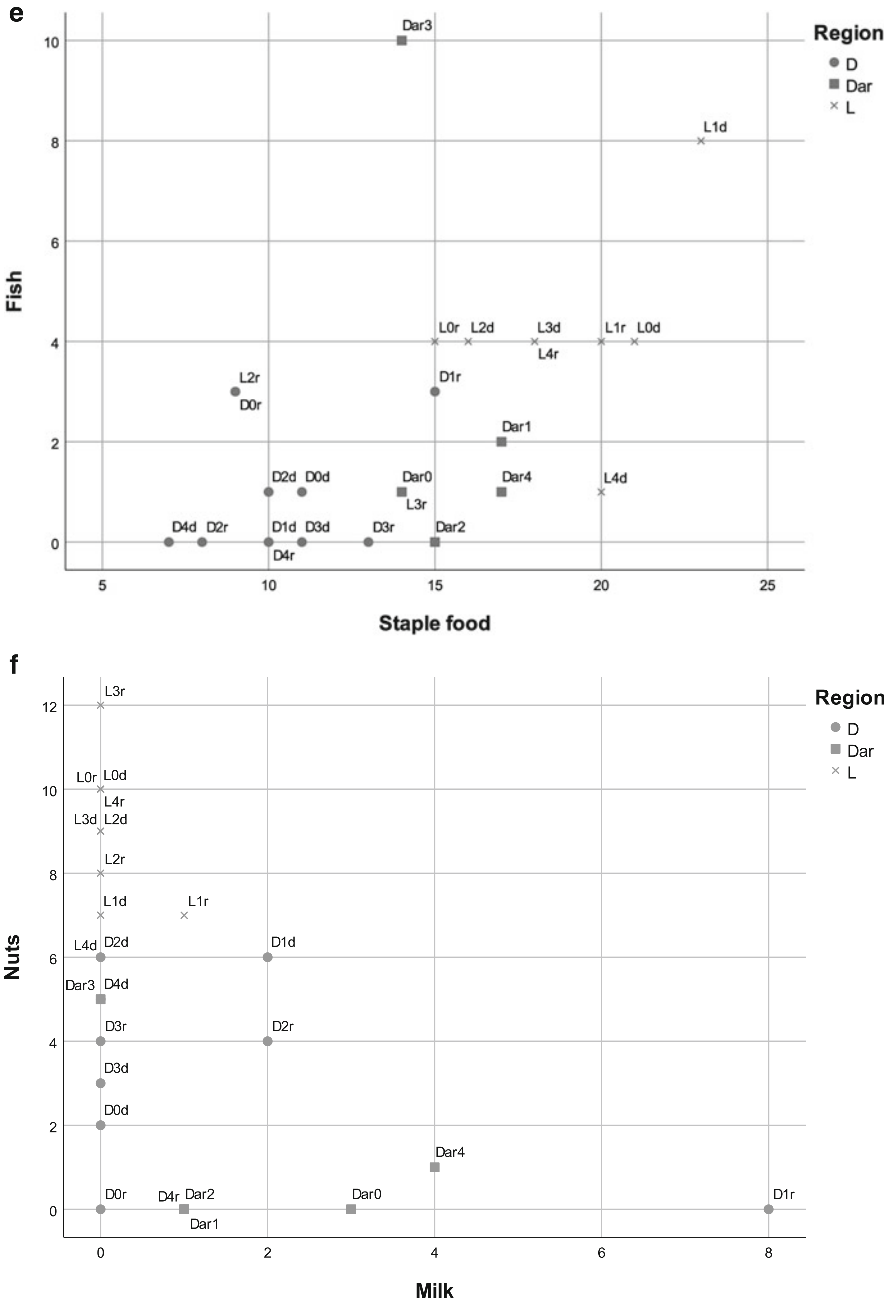
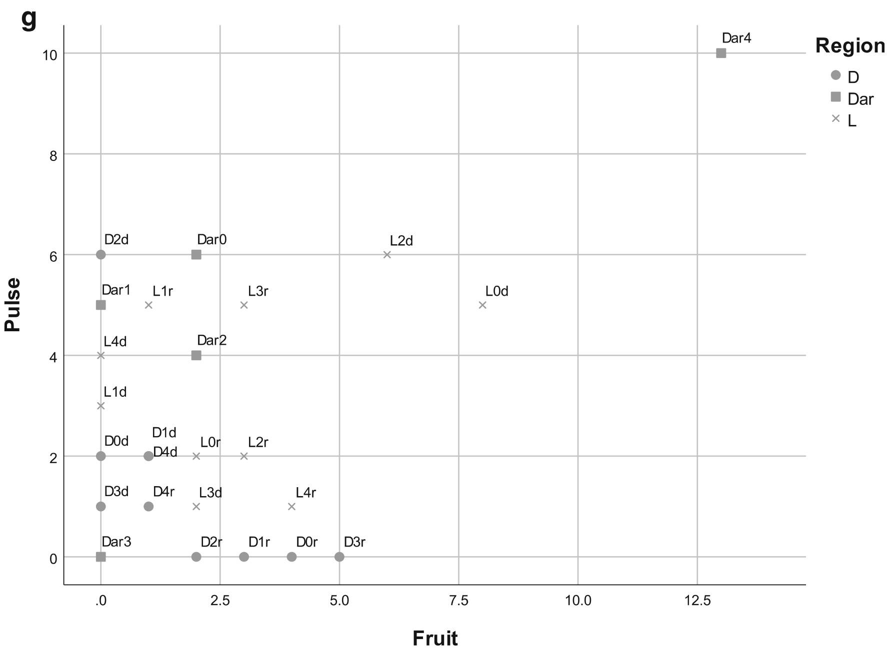


Fig. 2.7 (continued)



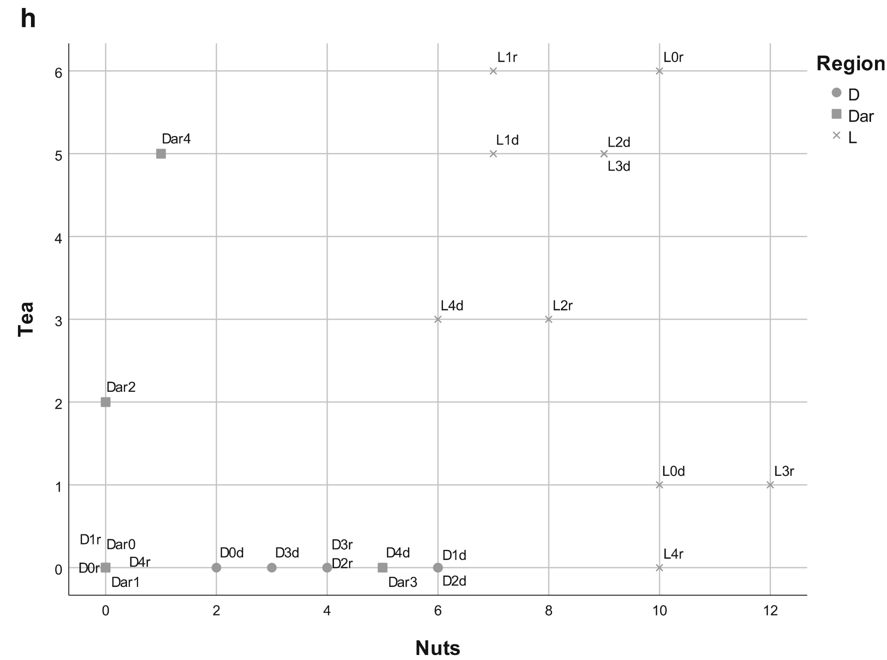


Fig. 2.7 (continued)

A moderate negative correlation is detected between milk and nuts (−0.492, $p = 0.012$). A scatter plot was generated (Fig. 2.7f) indicating that households in Lindi have a high intake of nuts but that milk is rarely drank. Only limited households in Dodoma and Dar es Salaam consume milk.

A moderate positive correlation was observed between fruits and pulses (0.455, $p = 0.026$, Fig. 2.7g). As an exception, one Dar es Salaam household (Dar4) consumes an abundant amount of fruits and pulses, while two Lindi households consume them moderately (L2d and L0d).

There was a moderately positive correlation between nuts and tea (0.414, $p = 0.039$, Fig. 2.7h). Additionally, in Lindi, there is a high prevalence of tea and nut consumption.

2.9 Summary and Discussion

This chapter has provided an overview of Tanzania's environment and various dietary patterns. Additionally, this chapter has focused on the diversity of meals available in Dar es Salaam city and in central and southeast Tanzania. When compared to the dietary patterns addressed in an earlier study (Keding et al., 2011), the "traditional-inland" pattern is similar in the households of Dodoma, but grains and vegetables were also eaten in Lindi and Dar es Salaam city. The "traditional-coastal" pattern was consistent in terms of the composition of fish, nuts, and fruits in Lindi, but it was more specific to grains than tubers, confirming some variation. However, households in Lindi consumed more tubers than did those in other regions (Fig. 2.7c).

In addition to cultivated cowpea in Dodoma and cultivated cowpea and chickpea in Lindi during the dry season, the "pulse" pattern of purchased kidney beans was observed in all regions. Differences among households were found in the variety of pulses in Lindi and the presence or absence of pulses in some urban households. However, *mlenda* and pulse are served in Dodoma, as are cowpeas and their leaves in Lindi. In Dar es Salaam city, they are combined with leafy vegetables and animal meat, and the effect on health varies depending on how they are consumed. The highest consumption of pulses was found in Dar es Salaam, followed by Lindi (Fig. 2.7g).

The "animal products" pattern was found in combination with the "purchase" pattern in Dar es Salaam city and Dodoma among households with cattle during the rainy season. Regarding fish, there were hardly any differences between households in terms of wealth.

Households in Dar es Salaam city and Lindi exhibit the "purchase" pattern, which is characterized by a diet that is high in protein as well as fat and sugar. A strong negative correlation between tea and green vegetables (Fig. 2.7a) and a positive correlation between tea and staple foods (Fig. 2.7b) were observed. Wealth to afford tea is likely to promote the consumption of more staple foods, which is correlated with a decrease in the consumption of green vegetables and hence an increase in the risk of lifestyle-related diseases. This indicates both positive and negative consequences on health resulting from increased wealth.

Acknowledgments We sincerely thank the members of the 15 households for their efforts to record their daily food intake. We also thank the government of Tanzania for welcoming this research and the Tanzania Commission for Science and Technology (COSTECH) for permission. This research was supported by Grants-in-Aid for Scientific Research (Nos. 18H03438, 18H00776, and 15H05139) and the JST (Japan Science and Technology Agency) Utsunomiya University Female Researcher Dispatch Program. An initial analysis of the collected data was first presented at the 58th Academic Conference of the Japan Association for African Studies and the 22nd Spring Conference of the Japan Society for International Development. Appreciation also goes to the anonymous reviewers of the *Journal of African Studies*, who provided valuable insights into data presentation; however, the authors are fully responsible for the final presentation of the data.

Sakamoto is responsible for the conceptualization; information collection in Dodoma and Lindi; analysis of the data; and the drafting, and editing of the chapter. Kaale is responsible for editing and revising the manuscript. Ohmori contributed to the conceptualization of information collection. Tsuda is responsible for the information collection in Dar es Salaam. Kato contributed to reviewing and editing the manuscript. All the authors have reviewed the final manuscript and have accepted it.

References

Berry, L. (1970). *Tanzania in maps*. University of London Press.

Cochrane, N., & D'Souza, A. (2015). *Measuring access to food in Tanzania*. USDA Economic Research Service. Retrieved October 23, 2022 from https://www.ers.usda.gov/webdocs/publications/43932/51864_eib135.pdf?v=2057

Keding, G. B., Msuya, J. M., Mass, B. L., & Krawinkel, M. B. (2011). Dietary patterns and nutritional health of women. *Food and Nutrition Bulletin, 32*(3), 218–226. https://doi.org/10.1177/156482651103200306

Koponen, J. (1988). *People and production in late precolonial Tanzania: History and structures*. Finnish society for development studies, Finnish Anthropological Society, Finnish Historical Society and Scandinavian Institute of African Studies.

Kuroda, M. (2016). The dietary patterns and livelihood strategies of rural households in semi-arid Tanzania. In S. Maghimbi, K. Sugimura, & D. G. Mwafupe (Eds.), *Endogenous development, moral economy and globalization in agro-pastoral communities in central Tanzania*. University of Dar es Salaam Press.

Mazengo, M. C., Simell, O., Lukmanji, Z., Shirima, R., & Karvetti, R. L. (1997). Food consumption in rural and urban Tanzania. *Acta Tropica, 68*(3), 313–326.

Pauw, E. D. (1994). Development of land use planning and land tenure in Tanzania.. FAO technical support service project TSS1 URT/94/02T.

Sakamoto, K. (2009, 2021). *Social development, culture, and participation: Toward theorizing endogenous development in Tanzania.* Shumpusha.

Stuetz, W., Gowele, V., Kinabo, J., Bundala, N., Mbwana, H., Rybak, C., Eleraky, L., Lambert, C., & Biesalski, H. K. (2019). Consumption of dark green leafy vegetables predicts vitamin A and iron intake and status among female small-scale farmers in Tanzania. *Nutrients, 11*, 1025. https://doi.org/10.3390/nu11051025

Yamazaki, K., & Oyanagizu, A. (2012). Survey on the dietary habits of Tanzanians. *Journal of the Japanese Society for Dietary Studies, 23*(2), 111–116. https://doi.org/10.2740/jisdh.23.111

Yatsuka, H. (2012). *Environmental utilization and changes in social relations in Sandawe society*. Kyoto University Africa Studies Series 011. Shokodo Publishing.

Chapter 3
Purchase, Cultivation, and Forage: Does It Make a Difference in Food Intake Frequency?

Kumiko Sakamoto, Lilian Daniel Kaale, Reiko Ohmori, Katsunori Tsuda, and Tamahi Kato

Abstract Does the method used to obtain the ingredients for meals affect the frequency of food intake? This chapter attempts to answer this question from firsthand information from Tanzania. There are regional variations in food intake frequency and food combination, as captured in Chap. 2. The analysis in this chapter underlines the difference based on food diaries from 15 households, five each in rural central (Mbelezungu village, Dodoma region), southeast (Rutamba and Michee villages, Lindi region), and urban Tanzania (Dar es Salaam city). Differences within the household are also observed. Presentation in box-and-whisker diagram, correlation analysis, and average indicates relationships between intake frequency and how it is obtained. Ingredients such as sugar, oil, and salt (categorized as others) are mostly purchased. Although the vegetables are purchased and cultivated, data from the 15 participating households show that growing vegetables may ensure daily consumption of vegetables. Further research is necessary, particularly in the area of foraging, since the opportunity is area-specific.

Keywords Tanzania · Africa · Production · Wild foods · Family · Food group

K. Sakamoto (✉)
School of International Studies, Utsunomiya University, Utsunomiya, Japan
e-mail: ksaka@cc.utsunomiya-u.ac.jp

L. D. Kaale
Department of Food Science and Technology, University of Dar es Salaam, Dar es Salaam, Tanzania
e-mail: elykaale@gmail.com; dlilian@udsm.ac.tz

R. Ohmori
School of Regional Design, Utsunomiya University, Utsunomiya, Japan
e-mail: rohmori@cc.utsunomiya-u.ac.jp

K. Tsuda
Center for the Multicultural Public Sphere, Utsunomiya University, Utsunomiya, Japan

T. Kato
Center for African Area Studies, Kyoto University, Kyoto, Japan

K. Sakamoto et al. (eds.), *Changing Dietary Patterns, Indigenous Foods, and Wild Foods*, https://doi.org/10.1007/978-981-99-3370-9_3

3.1 Introduction

Among all known species, modern humans (*Homo sapiens*) have the most diverse and extensive range of food preferences. Foraging natural resources, such as hunting and gathering, is thought to have been the original form of human subsistence. Foraging is the process of gathering plants, small animals, birds, and insects for food, as well as hunting. However, the majority of humans have changed from mostly engaging in hunting and gathering to more intense types of agriculture, such as cultivation, animal keeping, and fishing. Generalized history indicates that humans progressed from being hunters and gatherers to cultivation, and livestock-keeping, and eventually becoming industrialized after the industrial revolution.

However, human livelihood is not linear progress. Although many countries strive for industrialization, it goes without saying that the majority of the food consumed by people is sustained by farming, livestock-keeping, and foraging, at times supplementing one another.

Moreover, the effects of evolution have not always been positive; they can also be detrimental. For instance, with increased industrialization and development, chronic diseases are more common (Gherasim et al., 2020). Dietary habits and, consequently, the lifestyle of an individual or society generally have been significantly altered by this transformation. At the same time, dietary patterns are crucial in health and consequently in preventing chronic diseases. A purchase dietary pattern that has increased in popularity since industrialization has altered the lifestyles of many people around the world and has been a major contributor to many ailments, notably noncommunicable diseases (NCDs). Tanzanians, particularly those who live in cities, have shifted from consuming nutritious, traditional, and unprocessed foods to cheap, unhealthy, and processed foods that are high in salt and sugar, processed foods made from animal fat that are high in saturated fatty acids, and artificial food additives. This is evidenced by the fact that in Tanzania, the incidence of NCDs, which are mostly related to dietary habits, has considerably grown and now accounts for 15–28% of male deaths and 14–27% of female deaths between the ages of 15 and 59 (Tanzania, 2014). Examples of a "purchase" dietary pattern that results in lifestyle disease are discussed in Chap. 2 (Keding, 2016; Keding et al., 2011).

From this perspective, one of the keys to resolving food and nutrition problems is comprehending the various food intake and delivery sources connected with various food cultures. The chapter's purpose is to clarify different food groups that are consumed and analyze their relation to their sources (cultivation/purchase/collection), which is deeply connected with the topic of the book to understand the changing dietary patterns, indigenous foods, and wild foods. It will also provide information on the differences among household members.

The detailed food diary introduced in Chap. 2 will be further analyzed in this chapter: five households in Mbelezungu village, Chamwino district in Dodoma region, five households in Rutamba and Michee villages, Lindi rural district, Lindi region, and five households in Dar es Salaam.

Food groups were classified with reference to the *Tanzania Food Composition Table* (Lukmanji et al., 2008) as staple foods, meat/fish/milk, beans, nuts, vegetables, fruits, and others (salt, sugar, oil, etc.). Reference was made to a prior study on the frequency of nutrient intake in Japan (Mizoguchi et al., 2004; Tsunoda et al., 2015), which categorized staple foods, vegetables, and other foods (salt, sugar, oil, etc.) into four levels: four points for "twice a day or more," three points for "every day," two points for "four to six days a week," and one point for "three days or less." For other food groups, four points were used for "every day," three points for "four to six days a week," two points for "two to three days," and one point for "once or less." Considering the variety of food available in Tanzania, "not eating" received 0 points. There were two cases, including one for staple foods, where the days that people ate once and twice were the same. In such exceptional cases, 3.5 points were applied. In case there are any missing days or ingredients other than meals, the frequency of intake may be higher than reported but not lower.

This chapter's analysis approach focuses on purchasing, cultivating/breeding, and gathering/hunting. Gifts are a significant method of acquisition and are counted as "others." However, because it was unable to fully grasp the situation, this study does not analyze this aspect.

The following four points, which are based on food diaries, are analyzed and compared with previous studies. First, the regional and seasonal differences in the frequency of intake of food groups are validated. Second, differences in intake within households are noted by comparing food diaries with interview surveys.

Third, methods of acquiring foodstuffs by food group (cultivation, purchase, collection, etc.) have been compared and analyzed by region and season. A box-and-whisker diagram was used to identify the median, maximum and minimum values, upper and lower hinges, and outliers. Finally, we analyzed the correlation (Spearman) between (1) the frequency of intake and (2) the way the ingredients were obtained by the food group. For food groups that were correlated, the percentage of the method of obtaining them was compared by frequency to interpret the results. Based on these findings, analyzing the relationship between food intake and availability is the main emphasis of this chapter.

3.2 Comparisons of Regional and Seasonal Food Group Intake

The average intake frequency per food group was high for staple foods (mean 3.7 standard deviation (SD) ± 0.7), vegetables (3.4 ± 0.8), and low for fruits (1.2 ± 1.1, and pulse (1.7 ± 1.0) (Fig. 3.1a). Rural households in Lindi had the highest regional average (1.2 ± 3.0), followed by Dar es Salaam (1.4 ± 2.4) and Dodoma (1.5 ± 2.1). These results are similar to those of the analysis based on the questionnaire interview survey conducted in the same households in Lindi and Dodoma (Ohmori et al., 2020).

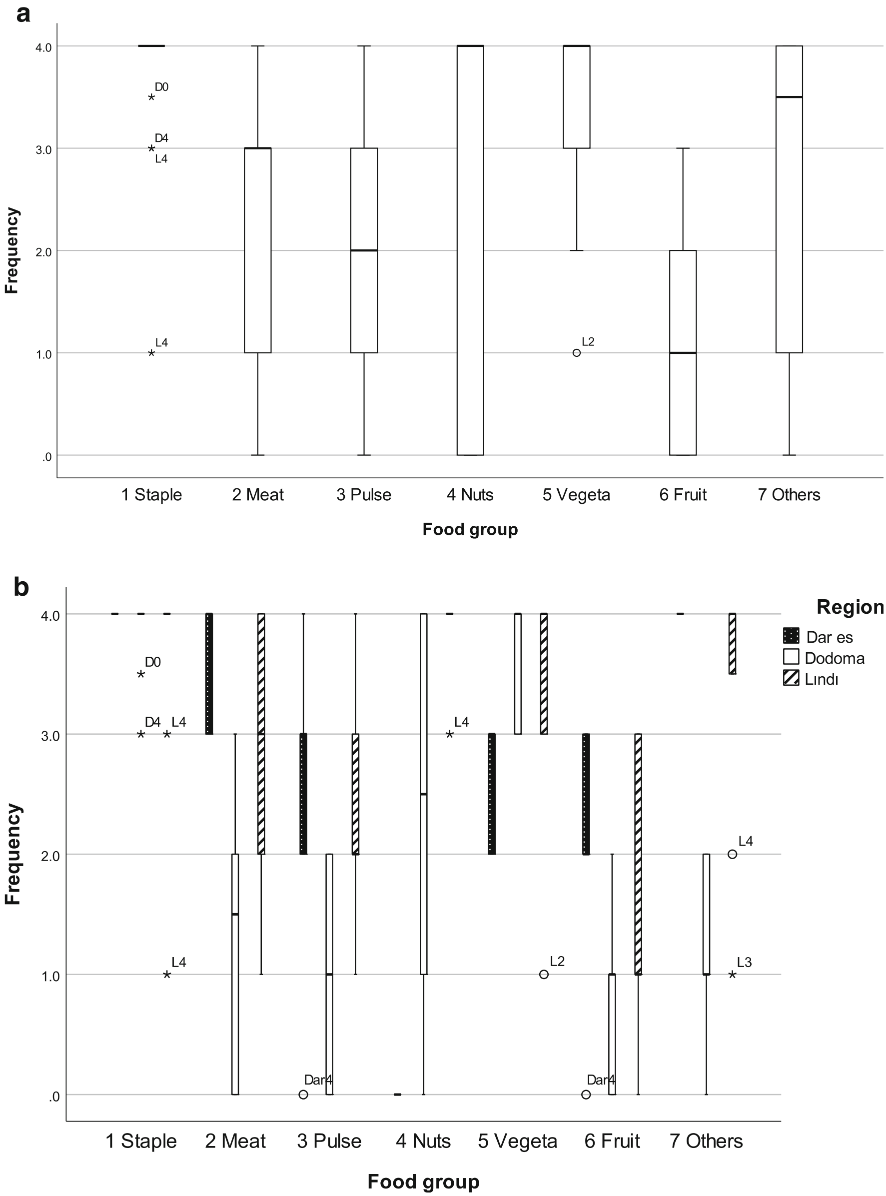


Fig. 3.1 Frequency of intake by food groups (Sakamoto et al., 2022). (**a**) Frequency of household intake by food group. (**b**) Frequency of household intake by food group per region. (**c**) Frequency of household intake by food group per season. 1 Staple = Staple foods; 2 Meat = Animal meat, fish, and milk; 5 Vegeta = Vegetable. Dar es = Dar es Salaam

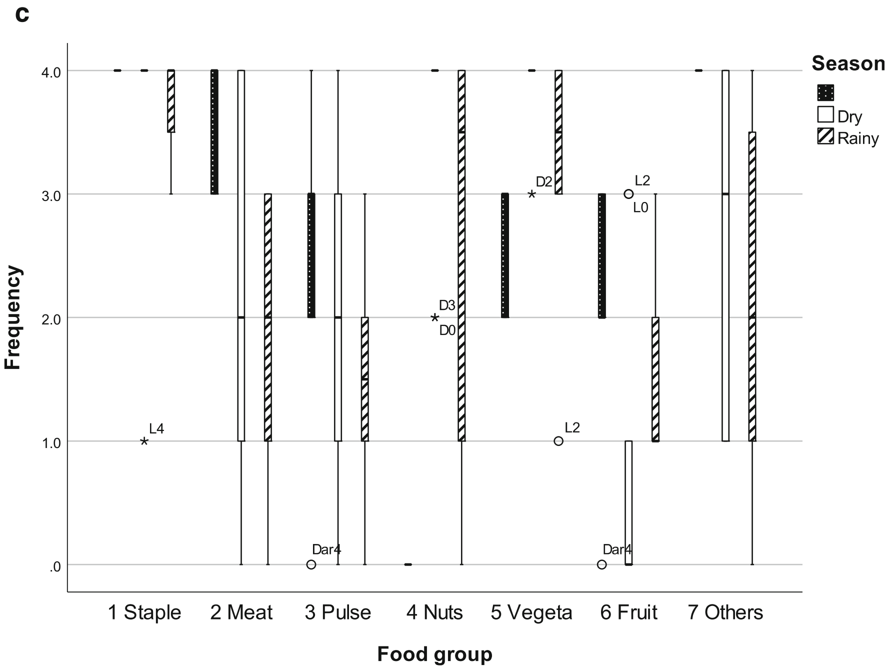


Fig. 3.1 (continued)

In comparison to Dodoma households, Lindi households consumed more nuts, meat (actually fish), pulses, and fruits (Fig. 3.1b). They also consumed more salt, sugar, oil, and other ingredients, along with urban Dar es Salaam. The households in Dar es Salaam consumed fruits the second most frequently after those in Lindi. In contrast to Dar es Salaam, vegetables were regularly consumed in Lindi and rural Dodoma.

Regarding the outliers, L2 households in Lindi had extremely low vegetable intake and extremely high bean intake during the rainy season. This is the consumption pattern outlined in an earlier study (Keding et al., 2011, pp. 221–222), where their dietary pattern lacks vegetables.

Lindi is comparable to the "traditional coastal" consumption pattern, with high consumption of fruits, coconuts, potatoes, and fish, when compared to the consumption patterns classified in earlier research (Keding et al., 2011). It is a diet that also includes a "purchase" consumption pattern that is at risk for lifestyle-related diseases. Dodoma follows "traditional inland" consumption patterns, as noted above, but Dar es Salaam has a higher risk of lifestyle-related diseases in "purchase" consumption patterns; however, these vary by household.

Overall, there were no significant seasonal variations, but during the rainy season, they consumed more fruit and less meat, fish, milk, and pulses (Fig. 3.1c). Analysis of the frequency of consumption in the same households in Lindi and Dodoma over the rainy and dry seasons based on a questionnaire also confirmed similar results

(Ohmori et al., 2020, pp. 38–39). Lindi had a comparatively high average frequency of consumption, but the frequency of protein sources such as meat and seafood declined during the rainy season.

3.3 Differences Between Family Members Within the Households

Different eating habits were observed among household members (Sakamoto et al., 2022, pp. 19–22).

3.3.1 Differences Within Families in Lindi Region

According to food diary entries, some families in the Lindi households tended to eat fruits alone rather than with all household members. Household L0 adult woman (rainy season) and children, L1 adult woman and children (both seasons), L3 adult man (dry season), L4 adult woman, and the elderly (both seasons) were recorded to have eaten fruits. Children and adult women tended to consume more fruits than other group members.

In terms of fish consumption, L3 adult and adolescent boy consumed significantly more fish than their families. In contrast, for pulses, L0 adolescent boy (during both seasons), L2 adult women (during both seasons), L3 adult man and adolescent boy (during the rainy season), and L4 adult women and adolescent boys (during the dry season) have lower intake frequencies than the entire family. L0 adolescent boy and L2 adult women having low pulse intake in both seasons may be due to their preference. The L1 family's grandchildren would buy samosas during the dry season, eat *ugali* at a friend's house, or consume millet porridge at school during both seasons.

It was also established that the meals documented in the diary used not only coconut but also vegetables as spices for side dishes. However, when asked in a questionnaire, L4 household members claim that they rarely consume nuts. On the other hand, L2 households believed that their members consumed vegetables regularly during the rainy season, and their actual diaries revealed that this was not the case.

3.3.2 Differences Within Families in Dodoma Region

There were several participating households in Dodoma in which only adults purchased meat, fish, and milk at markets or ate out (father of D0 household in the dry season, father and mothers of D1 household in both seasons). However, in some households, only children and young people ate before heading to school (D4 households in both seasons).

The intake of nuts such as baobabs and peanuts and the intake of pulses varied between families as well. In the D3 household, adult women consumed noticeably more pulses in both seasons and nuts in the dry season. Both adult women and men in D0 households (both seasons) and D1 households (rainy season) exhibited high intake frequencies.

Fruits were eaten by D0 adolescent girl, adult men, and adult woman, and D4 adolescent girls consumed wild fruits during the rainy season. In terms of frequency of consumption, adult women in D1 households consume significantly more during the rainy season. In addition, during the dry season, collected honey was consumed by D1 adult men and children and D4 adolescent girls, and sugarcane was purchased by D0 adolescent girl and D2 children.

3.3.3 Differences Within Families in Dar es Salaam City

Individual eating is common in Dar es Salaam; however, it was not possible to gain a complete picture of every family member, but some adult men and women consumed more fish, vegetables (adult men and women in the Dar3 household) and fruits (adult men in the Dar4 household) than other family members. Some young people preferred not to consume fruits or dairy products due to allergies, as well as adults who restricted their carbohydrate intake due to diabetes (based on observation in Dar0). In one meal in household Dar1, the children consumed French fries, while the mother consumed French fries with greens, and the father consumed *ugali* with greens.

Even though seasons and geographical regions varied, there were variations in household consumption. In some households, both adult men and women consumed more meat, fish, and milk, which provided them with protein. In some households, children were the only ones to consume a separate breakfast before school or to consume fruit or nuts.

3.4 How Are Foods Obtained?

How are the ingredients used in each household's meals obtained? Households in Dar es Salaam, Lindi, and Dodoma all purchased foods to a greater or lesser extent (97%, 63%, and 28%, respectively). On the other hand, Dodoma households had the most cultivations and collections, at 50% and 17%, respectively.

Figure 3.2 indicates the ratio of ingredients purchased by food groups. The food groups with the highest purchase ratios were meat (including fish and milk) and others (e.g., salt, sugar, and oil) (Fig. 3.2a). Comparing Lindi and Dodoma, the

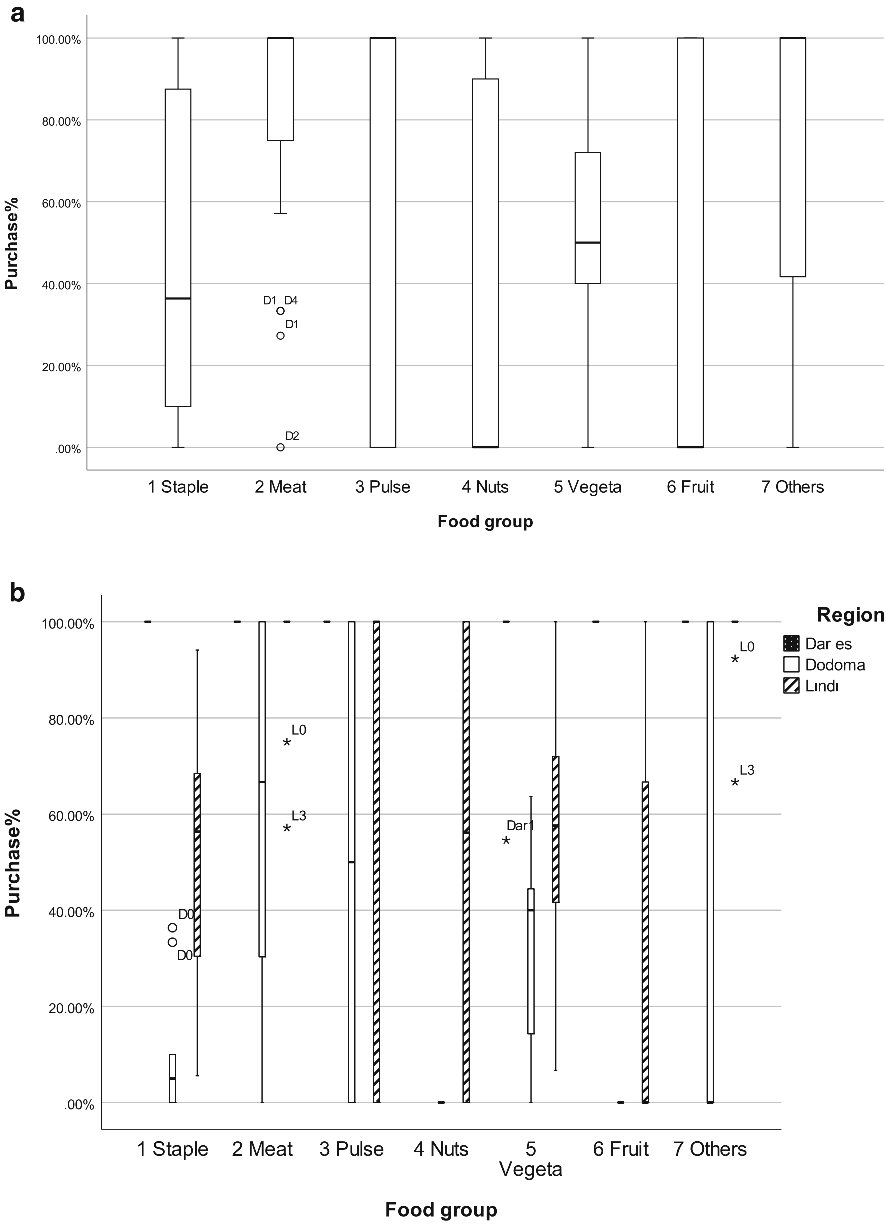


Fig. 3.2 Ratio of purchased ingredients by food group. (**a**) Ratio of purchased ingredients by food group. (**b**) Ratio of purchased ingredients by food group per region. (**c**) Ratio of purchased ingredients by food group per season. 1 Staple = Staple foods; 2 Meat = Animal meat, fish, and milk; 5 Vegeta = Vegetable. Dar es = Dar es Salaam

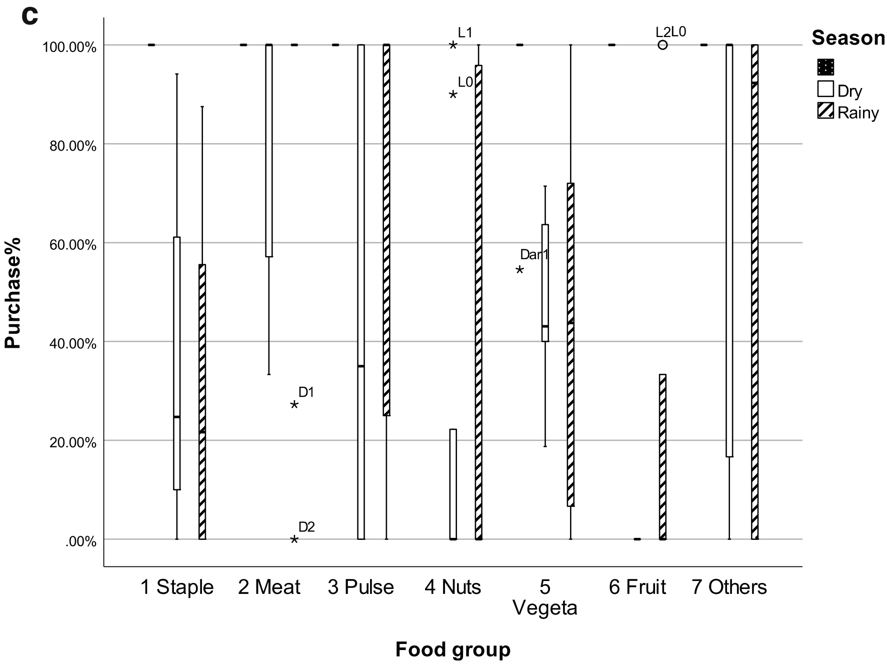


Fig. 3.2 (continued)

purchase ratio of staple foods and vegetables was higher in Lindi, but the purchase ratio of pulses varied among households even in the same area (Fig. 3.2b). Fruits were not purchased during the dry season (Fig. 3.2c).

The ratios of different food groups grown vary, although nuts and staple foods were relatively well represented (Fig. 3.3a). In particular, Dodoma had a high ratio of crops grown for staple foods and nuts (Fig. 3.3b). However, this result may be related to the relatively stable harvest in the study year and area. Comparing the seasons, a high proportion of pulses and nuts are obtained during the dry season (Fig. 3.3c).

The proportion of ingredients collected was not large, but fruits and vegetables were particularly high in Dodoma (Fig. 3.4a, b). Fruits were collected especially in the rainy season (Fig. 3.4c).

3.5 Relationship Between Food Group Intake and the Source of Food

The relationship between intake frequency and method of acquisition per food group is examined in Table 3.1. There was a significant positive correlation between the ratio of purchases and other foods, including oil, salt, tea, and sugar. In a previous

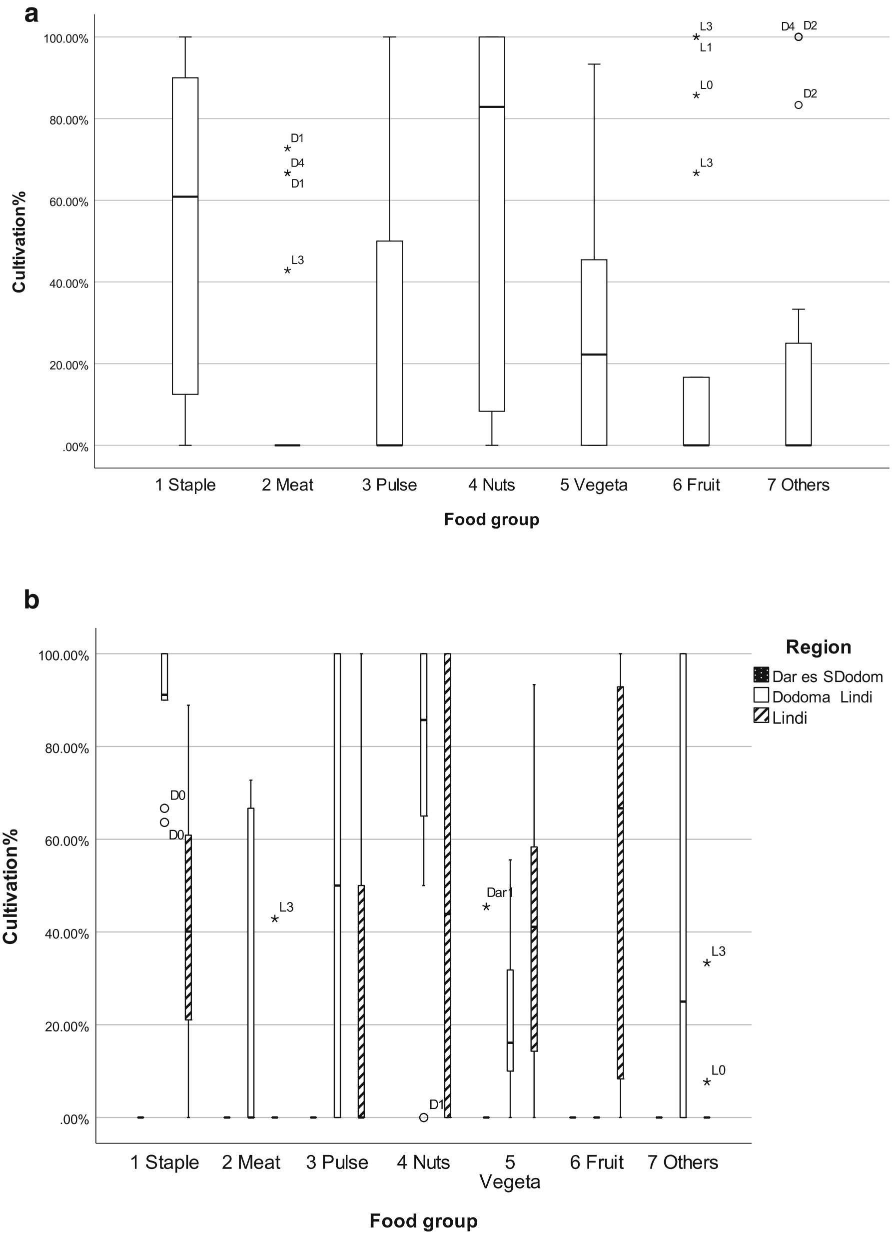


Fig. 3.3 Ratio of cultivated ingredients by food group. (**a**) Ratio of cultivated ingredients by food group. (**b**) Ratio of cultivated ingredients by food group per region. (**c**) Ratio of cultivated ingredients by food group per season. 1 Staple = Staple foods; 2 Meat = Animal meat, fish, and milk; 5 Vegeta = Vegetable. Dar es = Dar es Salaam

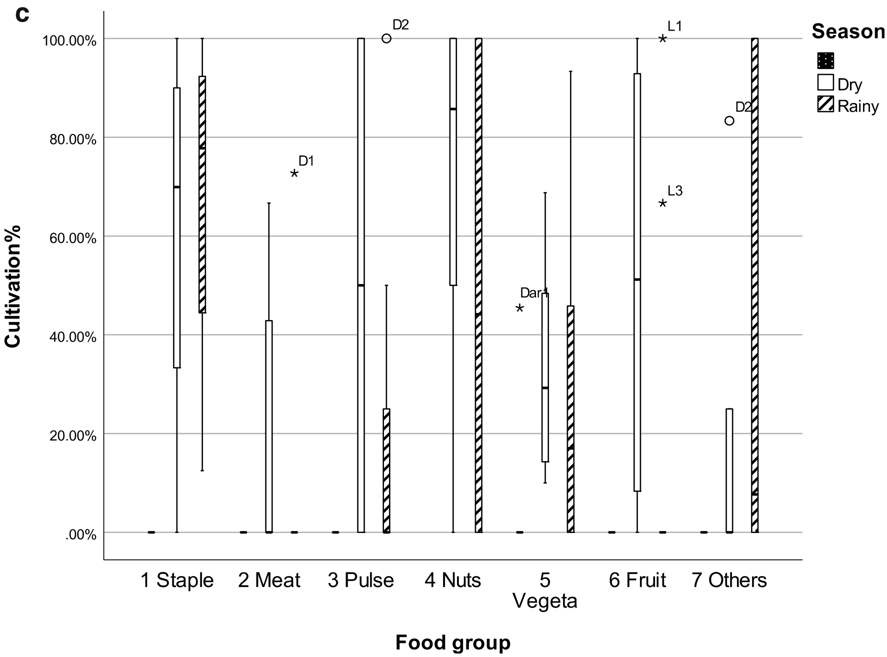


Fig. 3.3 (continued)

study, a trend of frequent consumption of oil, sugar, and tea (with sugar) was referred to as the "purchase pattern," which revealed a trend toward obesity (Keding et al., 2011). In this analysis, we confirmed that consumption of oil, salt, and tea (with sugar) was related to the ratio of consumption, supporting the perspective that the risk of lifestyle-related diseases increases along with an increase in purchasing power.

Table 3.2 shows the average (mean) of the method's percentage derived based on food group frequency for the food group that was significantly correlated in Table 3.1. The average (mean) percentage of methods obtained also indicates that households frequently taking other ingredients such as sugar, oil, and salt (points four to two: more than 4 days a week) purchased these ingredients (Table 3.2). There have been instances of sunflower cultivation in Dodoma, but not to the point where it has increased consumption.

Vegetables show a negative correlation with the purchasing percentage and a positive correlation with the cultivation percentage (Table 3.1). Although the percentage of vegetables purchased is higher than the percentage of vegetables grown for all frequencies, Table 3.2 shows that no households that cultivate vegetables have a low frequency of vegetable intake (points one and two: less than 6 days a week). It can be interpreted that households that cultivate vegetables eat vegetables every day.

On the other hand, pulses have a positive correlation with purchase percentage and a negative correlation with cultivation percentage (Table 3.1). According to

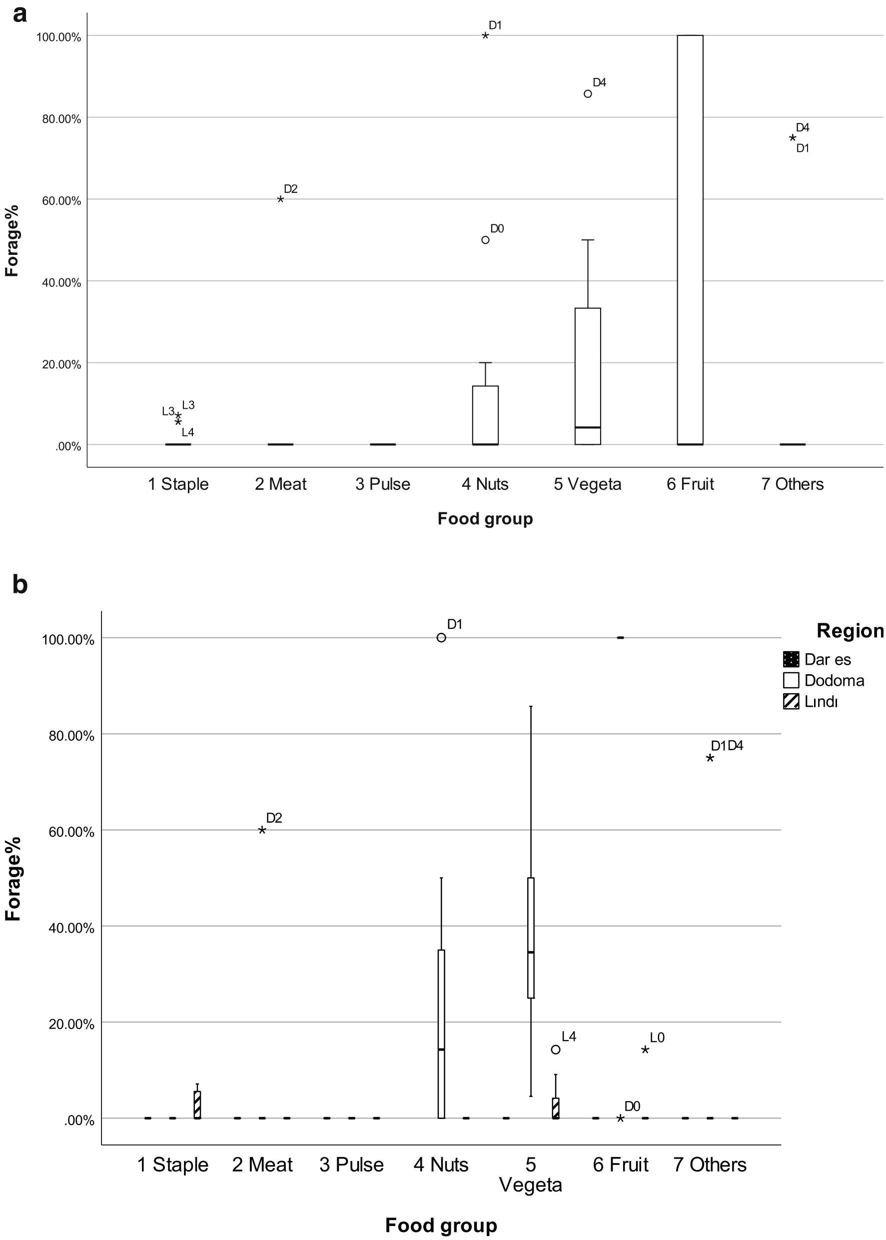


Fig. 3.4 Ratio of foraged ingredients by food group. (**a**) Ratio of foraged ingredients by food group. (**b**) Ratio of foraged ingredients by food group per region. (**c**) Ratio of foraged ingredients by food group per season. 1 Staple = Staple foods; 2 Meat = Animal meat, fish, and milk; 5 Vegeta = Vegetable. Dar es = Dar es Salaam

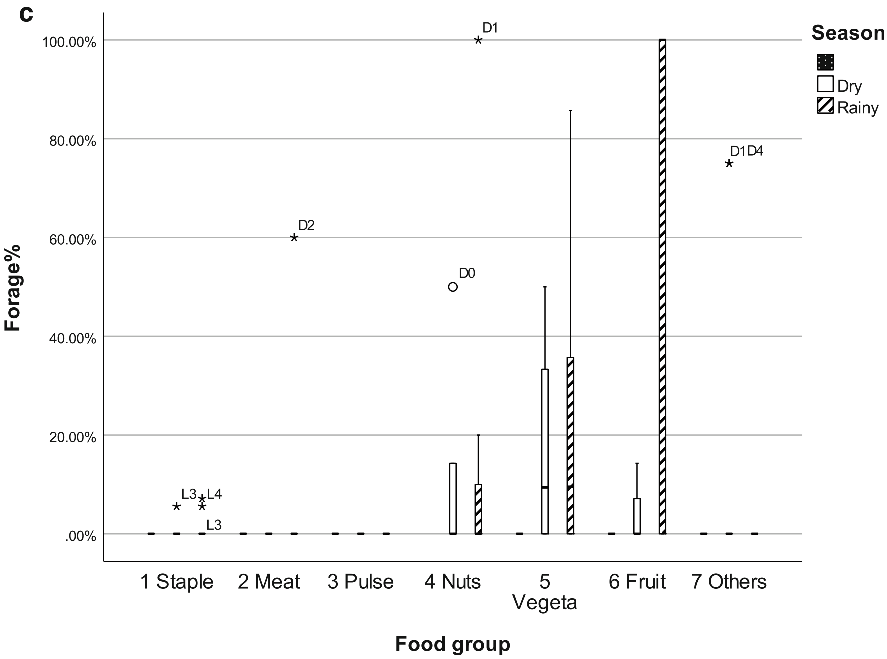


Fig. 3.4 (continued)

Table 3.2, households that consume pulses frequently (points 4 to 2) have higher pulse purchase percentages, whereas households that use pulses less frequently have higher cultivation percentages (points 0 to 2). Although cowpea and other pulses are cultivated in both Dodoma and Lindi, the food intake was limited to the dry season. On the other hand, purchased kidney beans are consumed year-round. The amount of pulse cultivated did not seem to have a significant influence on the average frequency of intake.

The intake frequency of nuts had a negative correlation with forage (Table 3.1). Nuts, such as peanuts and coconuts, are mostly cultivated and to some extent purchased. The intake frequency of foraged nuts is minimal and not to the point where it would increase intake frequency.

3.6 Food Balance and Food Origin in Each Region

3.6.1 Households in Southeast, Lindi

The main diet consumed by households in the southeast of Lindi is typically rice or maize, with fish cooked in coconut soup as a relish. The abundance of coconuts, which are preferred for seasoning foods, is a major factor in the southeast's high

Table 3.1 Correlations between food group intake frequency and obtaining method

Frequency of food group		Percentage of method obtained: Purchase%	Cultivation%	Forage%
Staple foods	Correlation coefficient	0.111	−0.094	−0.160
	Sig. (2-tailed)	0.599	0.656	0.444
	n	25	25	25
Meat	Correlation coefficient	−0.013	0.061	−0.124
	Sig. (2-tailed)	0.953	0.789	0.582
	n	22	22	22
Pulse	Correlation coefficient	**0.503***	−**0.434***	
	Sig. (2-tailed)	**0.017**	**0.044**	
	n	**22**	**22**	22
Nuts	Correlation coefficient	0.422	0.030	−**0.567***
	Sig. (2-tailed)	0.081	0.906	**0.014**
	n	18	18	**18**
Vegetables	Correlation coefficient	−**0.530****	**0.563****	0.234
	Sig. (2-tailed)	**0.006**	**0.003**	0.259
	n	**25**	**25**	25
Fruits	Correlation coefficient	0.478	0.111	−0.380
	Sig. (2-tailed)	0.052	0.670	0.133
	n	17	17	17
Others	Correlation coefficient	**0.683****	−**0.661****	−**0.425***
	Sig. (2-tailed)	**0.000**	**0.000**	**0.039**
	n	**24**	**24**	**24**

Bold* Correlation is significant at the 0.05 level (2-tailed)
Bold** Correlation is significant at the 0.01 level (2-tailed)
Meat = Animal meat, fish, and milk

frequency of nut consumption. They can be used as essential ingredients for cooking since they are farming locally, and they are inexpensive. Fish is commonly utilized as a side dish in the community since it is generally accessible (by purchase), but it is less frequently consumed by low-income households. The fact that more purchased kidney beans than cultivated cowpea beans are used during the rainy season may also be linked to the harvest season of cowpeas. On the other hand, there are variations in the consumption of vegetables and sugar-sweetened tea among homes, and wealthy households are especially susceptible to the risk of diseases linked to a sedentary lifestyle. Despite the lack of prior research on this area, it was established that the region's consumption of coconut, fish, and cassava is similar since it is located close to the coast, as is the case in the northeast (Keding et al., 2011), which has a traditional coastal consumption pattern.

Table 3.2 Average (mean) percentage of method obtained by food group frequency

Food group	Frequency		Percentage of method obtained:			
			Purchase%	Cultivation%	Forage%	Other%
3 Pulse	0.0	Mean	0.0%	**100.0%**	0.0%	0.0%
		n	1	**1**	1	1
		Std. deviation				
	1.0	Mean	20.0%	**60.0%**	0.0%	20.0%
		n	5	**5**	5	5
		Std. deviation	0.447	**0.548**	0.000	0.447
	2.0	Mean	**88.9%**	11.1%	0.0%	0.0%
		n	**9**	9	9	9
		Std. deviation	**0.220**	0.220	0.000	0.000
	3.0	Mean	**64.0%**	26.0%	0.0%	10.0%
		n	**5**	5	5	5
		Std. deviation	**0.498**	0.371	0.000	0.224
	4.0	Mean	**100.0%**	0.0%	0.0%	0.0%
		n	**2**	2	2	2
		Std. deviation	**0.000**	0.000	0.000	0.000
	Total	Mean	**64.5%**	28.6%	0.0%	6.8%
		n	**22**	22	22	22
		Std. deviation	**0.456**	0.413	0.000	0.234
4 Nuts	1.0	Mean	0.0%	0.0%	**100.0%**	0.0%
		n	1	1	**1**	1
		Std. deviation				
	2.0	Mean	0.0%	**75.0%**	25.0%	0.0%
		n	2	**2**	2	2
		Std. deviation	0.000	**0.354**	0.354	0.000
	3.0	Mean	0.0%	**90.0%**	10.0%	0.0%
		n	2	**2**	2	2
		Std. deviation	0.000	**0.141**	0.141	0.000
	4.0	Mean	38.8%	**59.0%**	2.2%	0.0%
		n	13	**13**	13	13
		Std. deviation	0.478	**0.462**	0.054	0.000
	Total	Mean	28.0%	**61.0%**	11.0%	0.0%
		n	18	**18**	18	18
		Std. deviation	0.440	**0.440**	0.256	0.000
5 Vegetable	1.0	Mean	**100.0%**	0.0%	0.0%	0.0%
		n	**1**	1	1	1
		Std. deviation				
	2.0	Mean	**100.0%**	0.0%	0.0%	0.0%
		n	**2**	2	2	2
		Std. deviation	**0.000**	0.000	0.000	0.000
	3.0	Mean	**61.5%**	18.9%	19.7%	0.0%
		n	**8**	8	8	8

(continued)

Table 3.2 (continued)

Food group	Frequency		Percentage of method obtained: Purchase%	Cultivation%	Forage%	Other%
		Std. deviation	**0.319**	0.214	0.295	0.000
	4.0	Mean	**40.0%**	**35.3%**	17.3%	7.4%
		n	**14**	**14**	14	14
		Std. deviation	**0.250**	**0.263**	0.206	0.212
	Total	Mean	54.0%	25.8%	16.0%	4.1%
		n	25	25	25	25
		Std. deviation	0.321	0.257	0.228	0.161
7 Others	1.0	Mean	27.8%	**47.2%**	25.0%	0.0%
		n	6	**6**	6	6
		Std. deviation	0.443	**0.424**	0.387	0.000
	2.0	Mean	**63.3%**	36.7%	0.0%	0.0%
		n	**5**	5	5	5
		Std. deviation	**0.506**	0.506	0.000	0.000
	3.5	Mean	**100.0%**	0.0%	0.0%	0.0%
		n	**1**	1	1	1
		Std. deviation				
	4.0	Mean	**99.4%**	0.6%	0.0%	0.0%
		n	**12**	12	12	12
		Std. deviation	**0.022**	0.022	0.000	0.000
	Total	Mean	**74.0%**	19.8%	6.3%	0.0%
		n	**24**	24	24	24
		Std. deviation	**0.427**	0.361	0.212	0.000

Bold = Largest percentage

3.6.2 Households in Central, Dodoma

The primary source of staple food is *ugali* made for maize or other cereals for homes in the central region. It is frequently accompanied by a side dish of bean leaves or *mlenda* made from edible weeds. Similar trends were seen in the consumption of vegetables, including *mlenda,* in the Sandawe community (Yatsuka, 2012), although the researched Gogo did not utilize as much foraged food as the Sandawe. These diets are also consistent with the “traditional inland” consumption pattern with less obesity, higher iron content, and better health (Keding et al., 2011). However, the consumption of nuts such as peanuts, which were grown in the surveyed households and consumed more by the households, is not included in the “traditional inland” consumption pattern reported in previous research.

In this study, the frequency of meat/fish/milk consumption was also high in households with cattle or where milk or fish could be purchased, although this difference was not statistically significant. This partially agrees with earlier research (Kuroda, 2016), which revealed that “affluent” families drink milk during the rainy season in food diary studies in the surrounding area partly because meat products are expensive.

This is also in line with the analysis by Keding et al. (2011). Since the greatest frequency used in this survey is "twice daily" even for staple foods, the frequency of meals above twice is not considered when calculating the score. The frequency of meals, however, decreased from three times during the dry season to two times during the rainy season, which is consistent with earlier studies (Kuroda, 2016).

3.6.3 Households in Dar es Salaam

Each family in Dar es Salaam had a different meal, with rice, maize, wheat products, and potatoes as the staple foods accompanied by meat, fish, milk, pulse, etc. Each household has a different focus, and households in Dar0 consumed milk and vegetables, Dar1 consumed vegetables and meat, Dar2 consumed vegetables and fish, and Dar4 consumed beans, vegetables, and fruits regularly.

Except for a part of Dar0, where food is grown in the suburbs, the majority of households purchased their food. Since the destitute were not necessarily included in this survey, missing meals, as observed in earlier studies (Yamazaki & Oyaizu, 2012), were not particularly noticeable. The intake of vegetables was generally low, and meals with excessive amounts of sugar and oil were conspicuous.

3.7 Conclusions

This study examined diets in different environments in Tanzania, where maize production is low, to identify differences in intake and how it is obtained by household, food group, region, and season and to analyze their relationship to how it is obtained.

Households in the southeast ate rice and maize as staple foods and coconut-flavored fish soup as a side dish, so they ate nuts and fish more frequently. Within families, individuals with high fruit consumption at different ages were found, particularly among adult women. In some households, children ate porridge at school and *ugali* at friends' homes, especially in households where grandchildren had daily meals at their grandmother's house. Some adult women and children had extremely low pulse intake. On the other hand, some families consumed coconuts according to the diary, but they were not aware of consuming nuts according to the interviews (Ohmori et al., 2020).

In the Dodoma households, maize, millet, and vegetables were eaten rather frequently because relish was primarily made from bean leaves or wild leafy vegetables, which are easily obtainable either in their field or even others in the case of wild leafy vegetables. In some households, only a few members consume protein from meat, fish, and milk, such as adults who eat out in the market or children before going to school. Pulse, nuts (including peanuts and baobab), and wild fruits during the rainy season were prominently consumed by some adults.

The main foods in Dar es Salaam were rice, maize, wheat products, potatoes, etc.; the side dishes were meat, fish, milk, beans, etc.; and there are significant differences in meals between households. Vegetable intake frequency was rather low, whereas intake frequency of sugar, salt, and oil was high. The purchase rate of foodstuffs was also high, and individual meals were eaten. Although the full picture of each family member was not available, some adult men and women consumed more fish, beans, vegetables, and fruits than other family members, as well as children with allergies or adults with diabetes, who had limited access to carbohydrates and dairy products and disliked fruits.

As previously mentioned, there are similarities and differences between regions, households, and seasons. However, in addition to enhancing household economic conditions and food intake by acquiring foodstuffs, it is also necessary to take actions that pay close attention to household disparities and recognize differences arising from survey methods (frequency surveys and food diary surveys).

Earlier research in the Morogoro region demonstrated improved nutritional balance and food acquisition through higher incomes and sales of agricultural products (Madzorera et al., 2020; Yamane et al., 2018). The analysis in this chapter also indicated that the frequency of consumption of meat, fish, and milk, which are sources of protein, is related to a high purchase ratio. The result agrees with previous research that it is important to pay special attention to the quantity and mode of protein intake among the poor.

In contrast, oil and tea were also related to the purchase ratio, but the danger of lifestyle-related diseases, which has been feared in previous studies, is a significant issue in lifestyle changes related to urbanization and income improvement. Growing vegetables can be a way to assure vegetable intake because there was a statistically significant association between growing vegetables and their intake frequency.

The investigation in this chapter, however, was only done on 15 households in three regions. Even within the region, both Lindi region and Dodoma region would have other places and households that have a higher intake of foraged food. In the book's later chapters, a wider sample will be covered.

Acknowledgments We would like to thank the families who cooperated with the food diary. This research is the result of MEXT JSPS KAKENHI Grants 18H03438, 18H00776, and 22H00032 and the JST Utsunomiya University female researcher dispatch system. We also thank the Government of Tanzania for welcoming this research and the Tanzania Commission for Science and Technology (COSTECH) for permission. Initial analysis of the collected data was first presented at the 58th academic conference of the Japan Association for African Studies and the 22nd spring conference of the Japan Society for International Development and published in Sakamoto et al. (2022) in Japanese. The draft translation editing from DeepL mechanical translation and secretarial support at the initial stage was provided by Mr. Frimpong Andrew Charles. The original article has been further analyzed and revised for this chapter.

Sakamoto is responsible for conceptualization, information collection in Dodoma and Lindi, analysis, drafting, editing, and editing of the chapter. Kaale is responsible for editing and revising the manuscript. Ohmori has contributed to the conceptualization of information collection. Tsuda is responsible for information collection in Dar es Salaam. Kato has contributed to reviewing and editing the manuscript. All the authors have gone through the final manuscript and accepted it.

References

Gherasim, A., Arhire, L. I., Niță, O., Popa, A. D., Graur, M., & Mihalache, L. (2020). The relationship between lifestyle components and dietary patterns. *Proceedings of the Nutrition Society, 79*, 311–323. https://doi.org/10.1017/S0029665120006898

Keding, G. (2016). Nutrition transition in rural Tanzania and Kenya. In H. K. Biesalski & R. E. Black (Eds.), *Hidden hunger. World Review of Nutrition and Dietetics* (Vol. 115, pp. 61–74). https://doi.org/10.1159/000442073

Keding, G. B., Msuya, J. M., Maass, B. L., & Krawinkel, M. B. (2011). Dietary patterns and nutritional health of women. *Food and Nutrition Bulletin, 32*(3), 218–226. https://doi.org/10.1177/156482651103200306

Kuroda, M. (2016). The dietary patterns and livelihood strategies of rural households in semi-arid Tanzania. In S. Maghimb, K. Sugimura, & D. G. Mwafupe (Eds.), *Endogenous development, moral economy and globalization in agro-pastoral communities in central Tanzania*. University of Dar es Salaam Press.

Lukmanji, Z., Hertzmark, E., Mlingi, N., Assey, V., Ndossi, G., & Fawzi, W. (2008). *Tanzania food composition tables*. Muhimbili University of Health and Allied Sciences, Tanzania Food and Nutrition Centre, & Harvard School of Public Health. Retrieved October 30, 2022, from https://cdn1.sph.harvard.edu/wp-content/uploads/sites/30/2012/10/tanzania-food-composition-tables.pdf

Madzorera, I., Blakstad, M. M., Bellows, A. L., Canavan, C. R., Mosha, D., Bromage, S., Noor, R. A., Webb, P., Ghosh, S., Kinabo, J., Masanja, H., & Fawzi, W. W. (2020). Food crop diversity, women's income-earning activities, and distance to markets in relation to maternal dietary quality in Tanzania. *The Journal of Nutrition, Community and International Nutrition, 151*(1), 186–196. https://doi.org/10.1093/jn/nxaa329

Mizoguchi, K., Takemi, Y., & Adachi, K. (2004). Relationship between good work consciousness and dietary habits and working life among young working men. *Nutrition Journal, 6*(5), 269–283.

Ohmori, R., Sakamoto, K., & Tsuda, K. (2020). The relationship between food intake and health related QOL in East Africa. *Regional Design Science, 7*(35), 43–62. http://hdl.handle.net/10241/00012127.

Sakamoto, K., Ohmori, R., & Tsuda, K. (2022). Food intake in 3 areas of Tanzania from food diary: Preliminary analysis of food group intake, diversity, and relation with origin. *Journal of the School of International Studies, Utsunomiya University, 53*, 15–30 (in Japanese). http://hdl.handle.net/10241/00013096

Tanzania, United Republic of, Ministry of Health and Social Welfare (MOHSW). (2014). *National nutrition strategy July 2021/12-June 2015/16*. MOHSW. Retrieved February 23, 2023, from https://www.tfnc.go.tz/uploads/publications/sw1538745120-NNS%20FINAL_Sept%202011.pdf

Tsunoda, N., Inayama, T., Hata, K., & Oka, J. (2015). Vegetable dishes, dairy products and fruits arekey items mediating adequate dietary intake for Japanese adults with spinal cord injury. *Spinal Cord, 53*, 78–790.

Yamane, Y., Kularatne, J., & Ito, K. (2018). Agricultural production and food consumption of mountain farmers in Tanzania. *Agric & Food Security, 7*, 54. https://doi.org/10.1186/s40066-018-0207-z

Yamazaki, K., & Oyaizu, A. (2012). Survey on the dietary habits of Tanzanians. *Journal of the Japanese Society for Dietetics, 23*(2), 111–116. https://doi.org/10.2740/jisdh.23.111

Yatsuka, H. (2012). Environmental utilization and changes in social relations in Sandawe society in Tanzania. In *Kyoto University Africa studies series 011*. Shokodo Publishing (in Japanese). https://doi.org/10.11619/africa.2011.78_25

Part II
Analysis of Dietary Patterns, Health, Wealth, and Mutual Relations

Part II analyses the actual dietary patterns and how dietary patterns, health, and social factors such as wealth and mutual relations are related. The data set from 424 adults is obtained based on first-hand questionnaire interviews with women of reproductive age in a high food production rural village in the southern highlands (Ifunda and Bandabichi villages, Iringa region), and women and men in a semiarid agro-pastoral village in central Tanzania (Chinangali village, Dodoma), coastal bushland village in the southeast (Kijiweni village, Lindi region), and inland village in the southeast (Malolo village, Lindi region). Chapter 4 analyzes the food group intake frequency in the four villages and prevalent common and unique issues related to sufficiency and balance. Chapter 5 further analyzes the dietary pattern concerning quality of life (QOL), wealth, and mutual relations, indicating a significant relationship between animal protein intake and social context. Finally, in Chap. 6, the association of mutual relation and wealth with QOL is determined. (See Fig. 1.1 to locate these associations in this part within the overall perspective of the book.)

Chapter 4
Does Staple Food Sufficiency Ensure Food Variety? A Comparative Analysis from Southern, Southeastern, and Central Tanzania

Momoko Muto, Tamahi Kato, Kumiko Sakamoto, and Reiko Ohmori

Abstract Understanding the differences in food group intake frequencies by location and season is essential to eradicate hunger and improve nutritional status as described in the SDGs. Food availability varies by geographic area and seasonality, and this chapter provides evidence of food group intake differences from questionnaires administered to 424 people in four rural areas in Tanzania. The results indicated that meat was consumed infrequently in all four villages, and fish and milk were also consumed infrequently in three of the villages. These findings raise concerns about inadequate intakes of animal protein, fat, and micronutrients derived from animal products. In terms of seasonality, it is common in lowland areas of Tanzania for the majority of people to experience food deficits during the rainy season. However, differences among villages were detected, and more variety was seen in the rainy season, which was considered the lean season. Although some areas consumed a variety of foods during the dry season that were different from those consumed during the rainy season, there is concern about unbalanced food intake during the dry season in many villages. A variety of food preservation methods make it possible to consume a wide variety of foods even during the dry season.

Keywords Foods · Food intake · Nutrition · East Africa · Season

M. Muto (✉)
Center for the Multicultural Public Sphere of Utsunomiya University, Utsunomiya, Japan

T. Kato
Center for African Area Studies, Kyoto University, Kyoto, Japan

K. Sakamoto
School of International Studies, Utsunomiya University, Utsunomiya, Japan
e-mail: ksaka@cc.utsunomiya-u.ac.jp

R. Ohmori
School of Regional Design, Utsunomiya University, Utsunomiya, Japan
e-mail: rohmori@cc.utsunomiya-u.ac.jp

K. Sakamoto et al. (eds.), *Changing Dietary Patterns, Indigenous Foods, and Wild Foods*, https://doi.org/10.1007/978-981-99-3370-9_4

Within the overall objective of understanding the changing dietary patterns in Tanzania, this chapter analyzes the geographic and seasonal differences (dry and rainy) in food group intake frequency in four different areas within Tanzania.

4.1 Overview of Geographical and Seasonal Differences in Food Intake in Tanzania

According to the FAO (2021) report "The State of Food Security and Nutrition in the World," tens of millions of new people have become chronically undernourished in the past 5 years, and the number of undernourished people worldwide was estimated at up to 811 million. In particular, the number of undernourished people in Africa is expanding rapidly. This situation is believed to be due to the high cost of obtaining food and low food availability due to economic reasons. Based on these circumstances, eradication of extreme poverty and hunger was set as one of the Millennium Development Goals (MDGs) established in 2001. Additionally, the Sustainable Development Goals (SDGs) established in 2015 continue to set the goal of ending hunger and improving nutrition. To achieve this goal, understanding the characteristics of each region is necessary.

In Tanzania, from 1992 to 2015, underweight and chronic malnutrition among children under 5 years of age showed an improving trend. However, as of 2015, an estimated 2.7 million children were stunted due to chronic malnutrition, and the improvement target could not be achieved (UNICEF, n.d.). Additionally, there are several studies on hunger/food security and its determinants in Tanzania. In her analysis of the impacts of large-scale conservation and development projects on local meanings of foods, fertility, and hunger and their interconnection, Kinshella (2014) finds that displacement from resources by conservation and development projects has exacerbated existing food security issues of irregular rains, increasing food prices and malnutrition. The downward cycle of food insecurity has led local villagers to worry about the viability of their community's future, embodied in the health of local children and their performance in school. In their study of gendered mobilities and food security in Tanzania, Mason et al. (2017) find that persistent gendered mobilities hold negative consequences for women in particular, although gendered norms of mobility may actually enhance men's food security strategies. Phillips (2009) describes how central Tanzanian villagers accessed food aid from the state during the East African food crisis of 2006 and finds that food aid is converted into political power and naturalizes a contemporary political and economic order in which it is the rural farmer who goes hungry.

The nutrition situation in Tanzania still needs improvement, and understanding regional characteristics is essential for that purpose. There was a 2.9-fold difference between the highest and lowest levels of child stunting in Tanzania, with marked regional differences. According to the 2010 data, 52% of children in Iringa, 56% in Dodoma, and 54% in Lindi were stunted. The rate of child stunting in these three regions is higher than that in the rest of Tanzania. In particular, Dodoma has the highest rate of stunting in Tanzania (Tanzania, 2011). According to 2018 data, improvements were seen in the regions of Lindi and Dodoma, but the level in Iringa remained high at 47% (Tanzania, 2018).

The production of staple foods in Tanzania is highly regional. Maize is the main ingredient in *ugali*, a national staple food. According to a food basket study conducted by Cochrane and D'Souza (2015), maize production is high in the southern highlands but low in the central, coastal, and southeastern regions. Cassava is produced nationally, particularly along the coast and near Lake Victoria. Maize accounted for approximately half (51%) of the energy intake in the southern highlands, but staple food items and seeds consumed vary by region. However, pulse is the primary protein source, and meat and fish are in short supply nationwide.

In Tanzania, food intake frequency and the necessity for nutritional education were studied by several researchers. In their study on diversity and dietary adequacy of farming households in Morogoro, Tanzania, Kinabo et al. (2016) suggest that low intake of nutrients was generally attributed to inadequate food intake due to low feeding frequency, poorly diversified diets, and suboptimal practices in food preparation and cooking. They suggest that educating farmers on the importance of consuming diversified and adequate diets from different food groups will improve their nutrition situation. Traditional African vegetables are able to contribute to reducing malnutrition, stunting, and poor health. Kimambo et al. (2018) found that educating households on the nutritional importance and medicinal attributes of traditional African vegetables can enhance the consumption of traditional African vegetables. As a daily intake of fruits and vegetables is recommended for protecting against almost all major noncommunicable diseases, Msambichaka et al. (2018) studied the prevalence of inadequate fruit and vegetable intake, frequency of fruit and vegetable intake, the portions of fruit and vegetable intake, and their associations with sociodemographic and lifestyle factors in southeastern Tanzania. Their findings suggest that people with higher education were more likely to consume fruits daily, and inadequate fruit and vegetable intake is correlated with young age, being male, low education, low-income occupations, low alcohol consumption, high tobacco use, and low health care use. Hadley et al. (2007) studied the relationships between seasonal food security, wealth, and social support. Their findings suggest that greater social support is associated with food security, and assistance may protect against the occurrence of seasonal food insecurity. Social support also interacts with wealth to offer greater protection against food insecurity. Seasonal food insecurity also appears to have lasting effects that likely create and reinforce poverty.

However, studies comparing the food intake frequency between seasons and areas in Tanzania are limited. Additionally, adequate food frequency tools in Tanzania have not been studied. In their study of meal structures, meal patterns, and nutrient intake in Tanzania, Ambikapathi et al. (2022) suggest that children's intake of nutrients increased with age; however, median micronutrient intakes for calcium, iron, zinc, and vitamin A remained below recommended nutrient intakes. It appears that the TZ-24-h dietary recall tool is a good measure of macro- and micronutrients for adults, given that all the micronutrients estimated from the tablet-based recall range were close to those obtained by Zack et al. (2018) using paper-based methods among adults from the same study setting. Zack et al. (2018) concluded that the food frequency questionnaire was able to yield good estimates of macronutrients and minerals but not vitamins.

4.2 Research Method and Area

4.2.1 Method of Systematic Analysis

The food frequency survey was modified based on a preliminary survey on food intake status and health-related quality of life conducted in the regions of Dodoma and Lindi (Ohmori et al., 2020) with reference to a previous survey (Sakamoto et al., 2020a, b, c) and conducted in the dry season[11] of 2019. We investigated the food intake frequency of 12 common foods in Tanzania by referring to the main ingredients that make up the Japanese diet in Tanzania. For staple foods, vegetables, oil, salt, and sugar, four points were given for “twice a day or more,” three points for “once a day,” two points for “four to six days a week,” one point for “three days or less a week,” and 0 points for “not eating.” For meat, fish, milk, pulses,[2] seeds, fruits, and wild foods, four points were given for “every day,” three points for “4–6 days a week,” two points for “2–3 days a week,” one point for “once a week or less,” and 0 points for “not eating.”

Statistical analysis was performed using IBM SPSS Statistics (v 27.0.1) using the Kruskal–Wallis test for regional comparisons and the Wilcoxon signed-rank test for seasonal comparisons.

4.2.2 Research Area and Target Population

The research areas are Ifunda and Bandabichi villages of Iringa district in Iringa region in the central and southern highlands, Chinangali I village of Chamwino district in Dodoma region in the inland semiarid region, Malolo village of Ruangwa district in the inland Lindi region in the southeast, and Kijiweni village of Lindi district on the coast of Lindi region.

The characteristics of each village from regional and seasonal differences are presented in Tables 4.1 and 4.2.

---

[1] This survey has uncertainty on food intake frequency in the rainy season because this survey was conducted during the dry season.

[2] Legumes are plants in the Fabaceae family, pulses are seeds of the legume plants, including beans, lentils, and peas (School of Public Health, Harvard T. H. Chan, n.d.). The survey uses the term pulse in accordance with Lukmanji et al. (2008).

Table 4.1 Characteristics of each village with regional differences

Village name	Characteristics of food intake frequency
Ifunda and Bandabichi villages	[Rainy season] – Sugar intake was high – Pulse intake was low
Chinangali I village	[Common points] – Staple food and vegetable intake was high [Dry season] – Fish and wild food intake was low [Rainy season] – Fruit intake was low
Malolo village	[Common points] – Staple food and pulse intake was high – Sugar intake was low
Kijiweni village	[Common pints] – Fish intake was high [Dry season] – Meat, vegetable, and oil intake was low [Rainy season] – Fish, pulse, wild food, and sugar intake was high – Meat intake was low

Table 4.2 Characteristics of each village with seasonal differences

Village name	Characteristics of food intake frequency
Ifunda and Bandabichi villages	– Milk, pulse, and seed intake was high in the rainy season
Chinangali I village	– Milk, pulse, fruit, and wild food intake was high in the rainy season
Malolo village	– Staple food and pulse intake was high in the dry season and in the rainy season – Vegetable and fruit intake was high
Kijiweni village	– Vegetable, pulse, fruit, and wild food intake was high in the rainy season

Ifunda and Bandabichi villages have purchasing power because of their cereal production; the food intake frequency of sugar was high in the rainy season, and the intake of pulses, which are simple protein sources, was low. We confirmed that Chinangali I village has a "traditional inland" consumption pattern (Keding et al., 2011) and that the food intake frequency of staple foods was high in both the dry and rainy seasons. Malolo village consumes several foods that follow each season, and the food intake frequency of sugar was low. In Kijiweni village along the coast, the food intake frequency of fish was high. Generally, in the rainy season, the villages suffer from food shortages; however, all villages compensate for these shortages with food other than staple foods.

For each month in 2018, 32% of the households in Ifunda and Bandabichi villages were food-deficient in February during the rainy season (Sakamoto et al., 2020a). Nevertheless, most households have sufficient food throughout the year. On the other hand, in Chinangali I village, which is an agricultural and livestock village, 85% of households experienced food shortages in October, and the majority of households experienced food shortages from August before the rainy season in November–December after the rainy season. In Malolo village, 95% of households experienced food shortages in February, and the majority of households experienced food shortages during the rainy seasons of January–March and November–December (Sakamoto et al., 2021). In Kijiweni village, 90% of households experienced food shortages in March, and the majority of households experienced food shortages during the rainy season from January to May. Although food production, especially seasonal differences and regional differences, affects food intake, the pattern is not always consistent. Furthermore, comprehensive studies on these topics have not been conducted previously. In this chapter, the frequency of intake by food groups is clarified, and various environments, modes of food production, and attributes of food culture are examined.

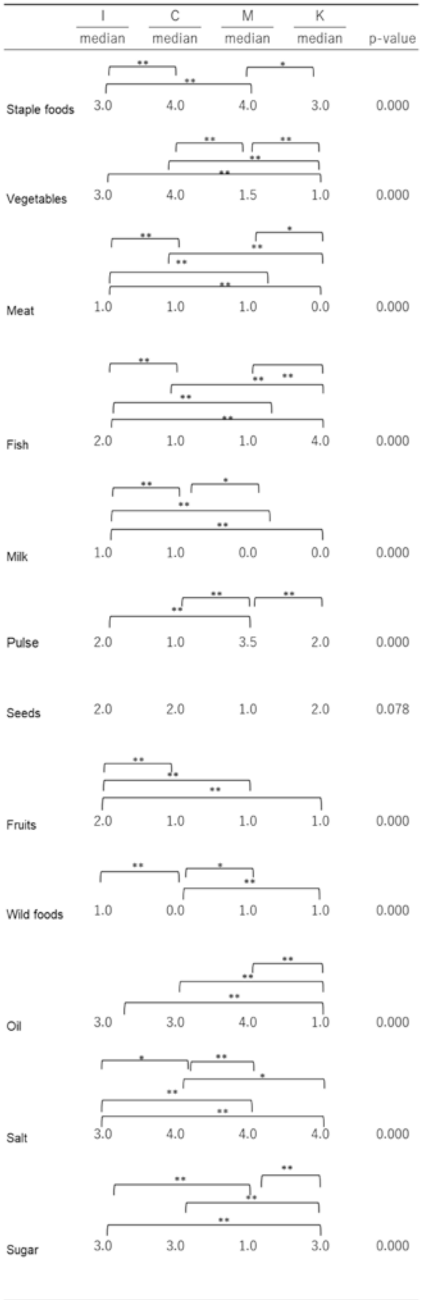
The participants of the analysis were 171 people from Ifunda and Bandabichi villages, Iringa district, Iringa region (a granary area); 81 people from Chinangali I village, Chamwino district, Dodoma region (an inland semiarid area); 88 people from Malolo village, Ruangwa district, Lindi region (an inland area in the southeast); and 84 people from Kijiweni village, Lindi district, Lindi region (a coastal area in the southeast).

4.3 How Different Are Food Intake Frequencies Between the Villages?

Figure 4.1 shows the results of the frequency of food consumption during the dry season. Figure 4.2 shows the results in the rainy season. The Kruskal–Wallis test was used.

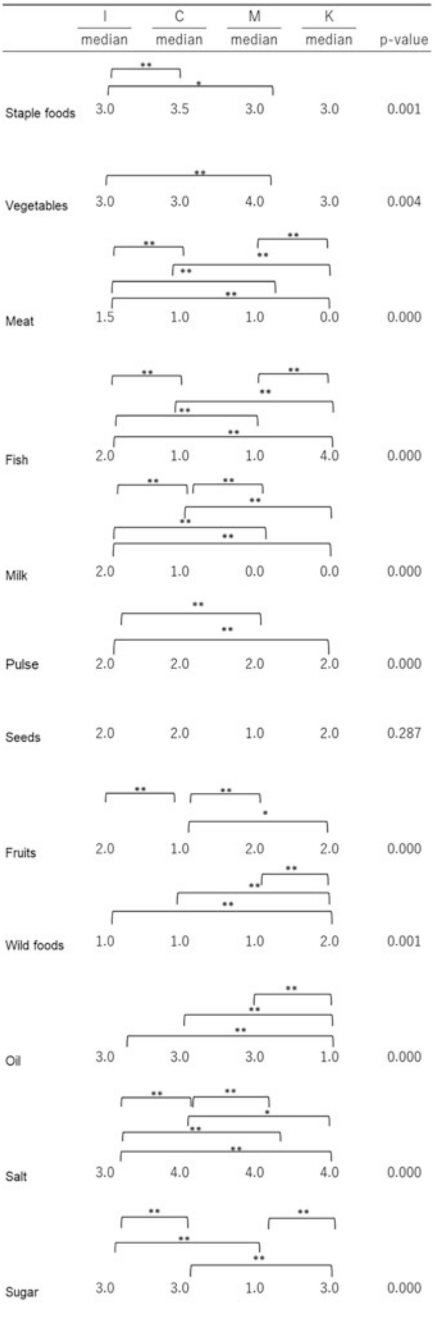
Regional comparisons during the dry season revealed significant differences among the four villages in food intake frequency of vegetables, meat, fish, milk, fruits, salt, and sugar (Fig. 4.1). These indices show significant differences among the four villages: pulse shows a significant difference mainly in Malolo village; wild foods show a considerable difference mainly in Chinangali I village; and oil shows a significant difference in Kijiweni village. Staple foods differed significantly between Ifunda/Bandabichi villages and Chinangali I village, between Ifunda/Bangabichi villages and Malolo village, and between Malolo village and Kijiweni village.

During the rainy season, significant differences were identified among all four villages in the food intake frequency of meat, fish, milk, salt, and sugar (Fig. 4.2). These indices show substantial differences among the four villages: fruits show a significant difference mainly in Chinangali I village; wild foods show a considerable difference mainly in Kijiweni village. Staple foods differed significantly only among Ifunda and Bandabichi villages, Chinangali I village, and Malolo village. Vegetables show a significant difference between Ifunda and Bandabichi villages and Malolo village. Pulse shows a significant difference between Ifunda and Bandabichi



	I median	C median	M median	K median	p-value
Staple foods	3.0	4.0	4.0	3.0	0.000
Vegetables	3.0	4.0	1.5	1.0	0.000
Meat	1.0	1.0	1.0	0.0	0.000
Fish	2.0	1.0	1.0	4.0	0.000
Milk	1.0	1.0	0.0	0.0	0.000
Pulse	2.0	1.0	3.5	2.0	0.000
Seeds	2.0	2.0	1.0	2.0	0.078
Fruits	2.0	1.0	1.0	1.0	0.000
Wild foods	1.0	0.0	1.0	1.0	0.000
Oil	3.0	3.0	4.0	1.0	0.000
Salt	3.0	4.0	4.0	4.0	0.000
Sugar	3.0	3.0	1.0	3.0	0.000

Fig. 4.1 Comparison of food intake frequency in four villages in the dry season (Muto et al., 2022). *I* Ifunda and Bandabichi village, Iringa district, Iringa region. *C* Chinangali I village, Chamwino district, Dodoma region. *M* Malolo village, Ruangwa district, Lindi region in the southeast. *K* Kijiweni village, Lindi district, Lindi region. $p < 0.05$, $**p < 0.01$



	I median	C median	M median	K median	p-value
Staple foods	3.0	3.5	3.0	3.0	0.001
Vegetables	3.0	3.0	4.0	3.0	0.004
Meat	1.5	1.0	1.0	0.0	0.000
Fish	2.0	1.0	1.0	4.0	0.000
Milk	2.0	1.0	0.0	0.0	0.000
Pulse	2.0	2.0	2.0	2.0	0.000
Seeds	2.0	2.0	1.0	2.0	0.287
Fruits	2.0	1.0	2.0	2.0	0.000
Wild foods	1.0	1.0	1.0	2.0	0.001
Oil	3.0	3.0	3.0	1.0	0.000
Salt	3.0	4.0	4.0	4.0	0.000
Sugar	3.0	3.0	1.0	3.0	0.000

Fig. 4.2 Comparison of food intake frequency in four villages in the rainy season (Muto et al., 2022). *I* Ifunda and Bandabichi village, Iringa district, Iringa region. *C* Chinangali I village, Chamwino district, Dodoma region. *M* Malolo village, Ruangwa district, Lindi region in the southeast. *K* Kijiweni village, Lindi district, Lindi region. $p < 0.05$, **$p < 0.01$

villages, Malolo village, and Kijiweni village. For seeds, there was no significant difference between the dry and rainy seasons.

Focusing on the results of each village, in Ifunda and Bandabichi villages, the food intake frequency of fish in the dry season was moderate. The food intake frequency of sugar and oil in the rainy season was high. However, the food intake frequency of milk was moderate, and the food intake frequency of pulses was low. In Chinangali I village, the food intake frequency of staple foods and vegetables during the dry season was high, and those of fish and wild foods were low. During the rainy season, the food intake frequency of oil was high; on the other hand, the food intake frequency of fruits was low. In Malolo village, the food intake frequency of staple foods and pulses was high in both the dry and rainy seasons, and the food intake frequency of sugar in the dry season was low. In Kijiweni village, the food intake frequency of fish in the dry season was high. The food intake frequency of meat, vegetables, and oil was low. During the rainy season, the food intake frequency of fish, pulses, wild foods, and sugar was high, and salt intake frequency was relatively high; however, meat intake frequency was low (Figs. 4.1 and 4.2).

4.4 How Different Are Food Intake Frequencies Between Seasons?

Table 4.3 and Figs. 4.3, 4.4, 4.5, and 4.6 show the results of the comparisons between seasons. The Wilcoxon signed-rank test was used.

In Ifunda and Bandabichi villages (Fig. 4.3), the food intake frequencies of milk ($p = 0.003$), pulses ($p = 0.013$), and seeds ($p = 0.026$) in the rainy season were higher than those in the dry season. In particular, the range of the food intake frequency was widened, but the difference in the food intake frequency of milk was remarkable. The food intake frequency of seeds generally increased in the rainy season. The food intake frequency of salt in the dry season was slightly higher ($p = 0.048$).

In Chinangali I village (Fig. 4.4), milk ($p = 0.001$), pulses ($p = 0.000$), fruits ($p = 0.013$), and wild foods ($p = 0.003$) were consumed more frequently in the rainy season than in the dry season. In particular, the difference in the food intake frequencies of milk and pulses was remarkable. The food intake frequency of meat was slightly higher during the dry season ($p = 0.005$).

In Malolo village (Fig. 4.5), the food intake frequency of staple foods ($p = 0.004$) and pulses ($p = 0.000$) was high during the dry season, and the food intake frequency of meat was also high ($p = 0.005$). Vegetables ($p = 0.000$) and fruits ($p = 0.000$) were consumed more frequently during the rainy season, and wild foods were consumed slightly more frequently (0.023). Notably, the difference in the food intake frequencies of vegetables, pulses, and fruits was remarkable.

In Kijiweni village (Fig. 4.6), the food intake frequency of vegetables ($p = 0.000$), pulses ($p = 0.002$), fruits ($p = 0.000$), and wild foods ($p = 0.000$)

Table 4.3 Comparison of food intake frequency and seasons in four villages

		I		C		
	Median (dry)	Median (rainy)	*p* value	Median (dry)	Median (rainy)	*p* value
Staple foods	3.0	3.0	0.715	4.0	3.5	0.365
Vegetables	3.0	3.0	0.308	4.0	3.0	0.395
Meat	1.0	1.5	0.150	1.0	1.0	0.005**
Fish	2.0	2.0	0.278	1.0	1.0	0.116
Milk	1.0	2.0	0.003**	1.0	1.0	0.001**
Pulse	2.0	2.0	0.013*	1.0	2.0	0.000**
Seeds	2.0	2.0	0.026*	2.0	2.0	0.341
Fruits	2.0	2.0	0.352	1.0	1.0	0.013*
Wild foods	1.0	1.0	0.398	0.0	1.0	0.003**
Oil	3.0	3.0	0.643	3.0	3.0	0.229
Salt	3.0	3.0	0.048*	4.0	4.0	0.412
Sugar	3.0	3.0	0.984	3.0	3.0	0.089
		M			K	
	Median (dry)	Median (rainy)	*p* value	Median (dry)	Median (rainy)	*p* value
Staple foods	4.0	3.0	0.004**	3.0	3.0	0.355
Vegetables	1.5	4.0	0.000**	1.0	3.0	0.000**
Meat	1.0	1.0	0.005**	0.0	0.0	0.130
Fish	1.0	1.0	0.097	4.0	4.0	0.887
Milk	0.0	0.0	1.000	0.0	0.0	0.404
Pulse	3.5	2.0	0.000**	2.0	2.0	0.002**
Seeds	1.0	1.0	0.675	2.0	2.0	0.124
Fruits	1.0	2.0	0.000**	1.0	2.0	0.000**
Wild foods	1.0	1.0	0.023*	1.0	2.0	0.000**
Oil	4.0	3.0	0.081	1.0	1.0	0.706
Salt	4.0	4.0	0.334	4.0	4.0	0.408
Sugar	1.0	1.0	0.132	3.0	3.0	0.655

I Ifunda and Bandabichi village, Iringa district, Iringa region
C Chinangali I village, Chamwino district, Dodoma region
M Malolo village, Ruangwa district, Lindi region in the southeast
K Kijiweni village, Lindi district, Lindi region
$^{*}p < 0.05$, $^{**}p < 0.01$

during the rainy season was significantly higher than that during the dry season. In particular, differences in the food intake frequencies of vegetables, fruits, and wild foods were remarkable.

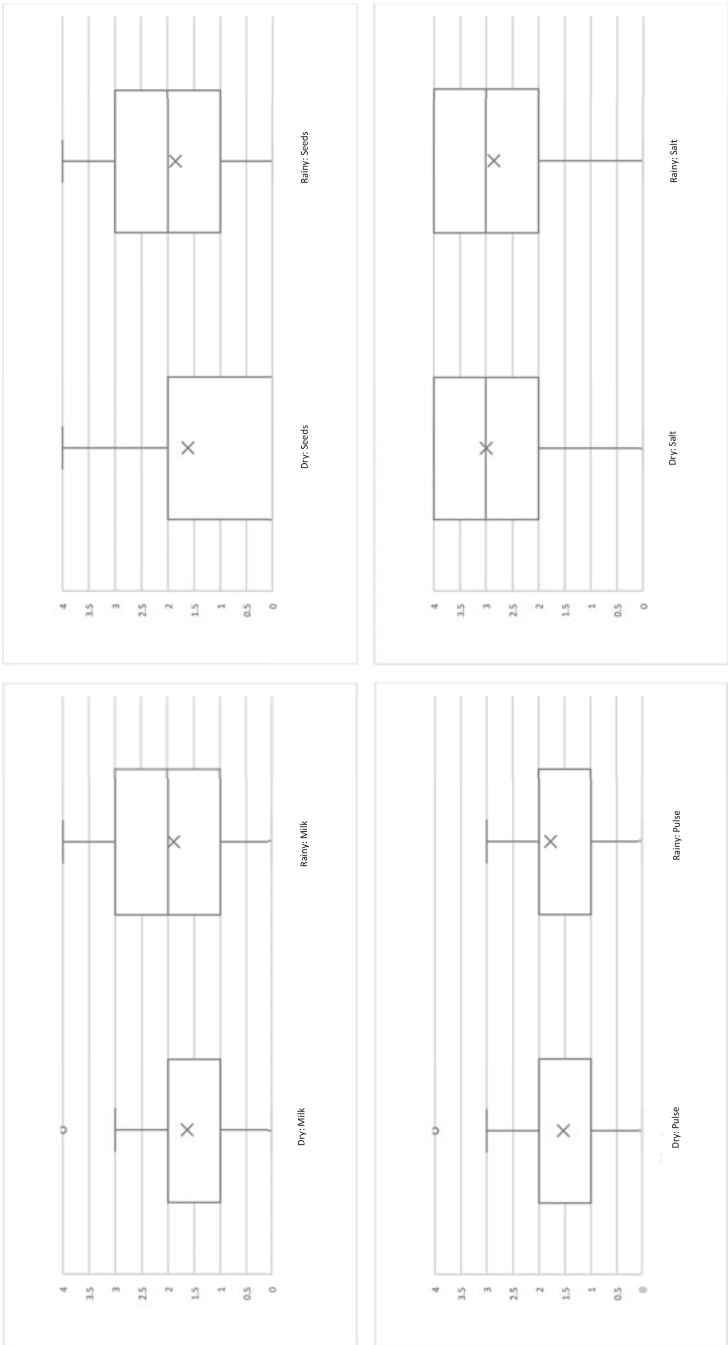


Fig. 4.3 Box plots confirming significant differences by the Wilcoxon signed-rank test (Ifunda and Bandabichi villages) (Muto et al., 2022)

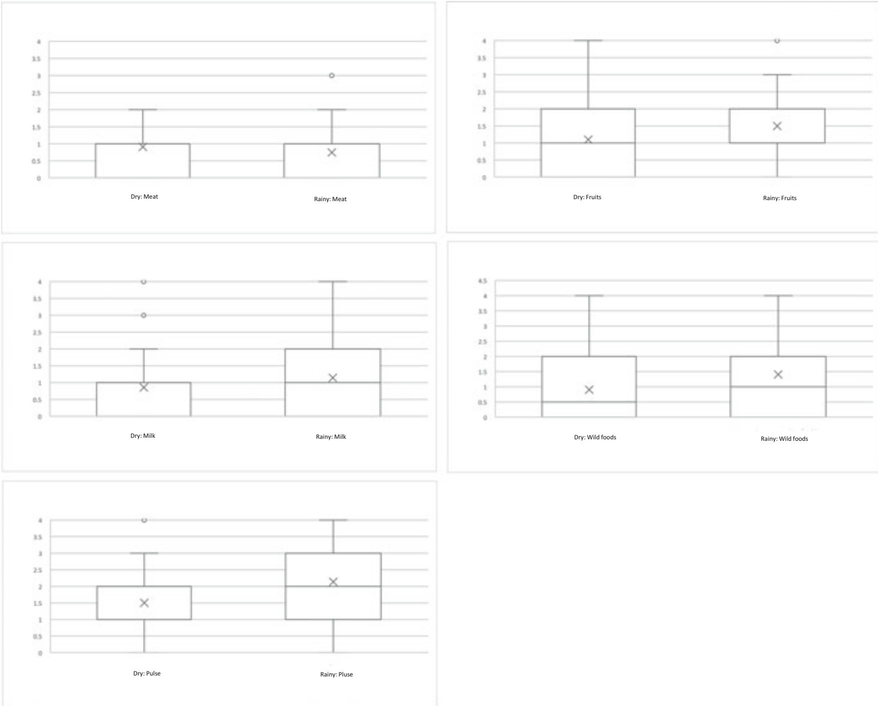


Fig. 4.4 Box plots confirming significant differences by the Wilcoxon signed-rank test (Chinangali I village) (Muto et al., 2022)

4.5 Discussion and Conclusion

Ifunda and Bandabichi villages in the Iringa region, located in the central and southern highlands, which is known as a granary region with high maize production, had a higher intake of sugar and a lower intake of pulses than other villages. In addition, the comparison between the dry and rainy seasons showed that the food intake frequency of milk, pulses, and seeds was high in the rainy season, suggesting that a greater variety of foods were consumed in the rainy season. Most households recognized that there was sufficient food production in both the rainy and dry seasons (Sakamoto et al., 2020a). Not only was the food intake frequency of staple foods high regardless of the season, but also the purchasing power was also high due to cereal production, suggesting that the villagers ate side dishes other than those containing sugar and pulses. Furthermore, unlike in other villages, there are many households that do not suffer from food shortages during the rainy season, and the food intake frequency of milk and seeds increases as the amount of milk increases during the rainy season. Staple foods and vegetables (especially during the dry season) were consumed more frequently in the semiarid state of Dodoma in

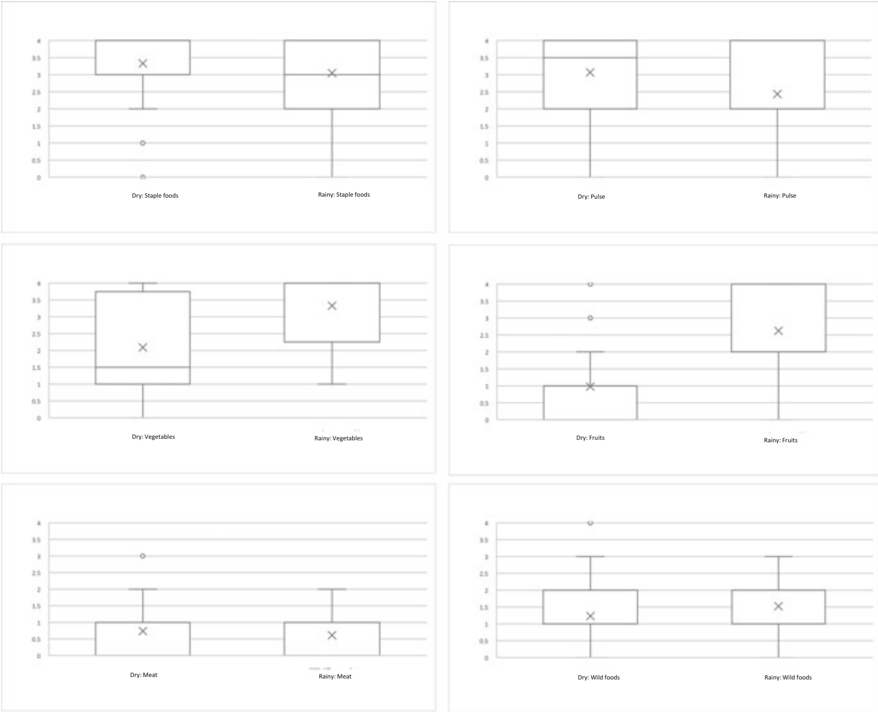


Fig. 4.5 Plot boxes confirming significant differences by the Wilcoxon signed-rank test (Malolo village) (Muto et al., 2022)

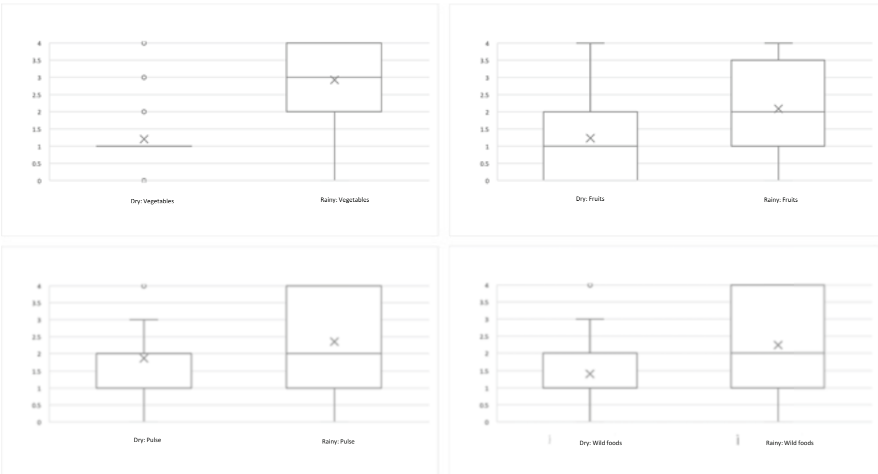


Fig. 4.6 Plot boxes confirming significant difference by the Wilcoxon signed-rank test (Kijiweni village) (Muto et al., 2022)

Chinangali I village, which is often food insecure, than in other villages. Keding et al. (2011), Keding (2016) identified consumption in semiarid areas of Tanzania, including Dodoma, as a "traditional inland consumption pattern" with a high intake of leafy vegetables, an adequate intake of iron, and a low intake of fats and oils. Chinangali I village also confirmed that this characteristic of the "inland traditional consumption pattern" was consistent. Drying techniques were developed, and cooking and eating foods made from dried wild grasses seemed to affect the frequency of vegetable consumption.

In addition, seasonal comparisons revealed a higher frequency of meat consumption during the dry season and higher consumption of milk, pulses, fruits, and wild foods during the rainy season. A previous study of neighboring villages in the region reported that the frequency of milk consumption increased in wealthy families during the rainy season, while the frequency of milk consumption decreased in poor families (Kuroda, 2016), and season is one of the major factors affecting food intake. In a preliminary survey in the neighboring village of Chinangali I village, the food intake frequency of cereals, meat, fish, and baobab decreased during the rainy season; however, the food intake frequency of other wild foods increased (Ohmori et al., 2020). Even in the present survey results, a "food shortage" was felt even before the rainy season started, but the intake of vegetables was an advantage of the low-rainfall environment, while milk, fruits, and wild foods were consumed more frequently during the rainy season. These results suggest that herders in semiarid regions obtain nutrients from foods that can be eaten in each season.

In Malolo village, the intake of food items according to the season varied, and the intake of sugar was low. This village was also characterized by a high intake of staple foods and pulses. Staple foods and pulses were consumed more frequently during the dry season, while during the rainy season, vegetables and fruits were consumed more frequently and staple foods were consumed less frequently. Malolo village was selected for the survey because the authors were informed that despite experiencing food shortages in the Lindi region, efforts were made to avoid starvation and death by utilizing wild foods. Although many households engage in agriculture, the wild foods utilized are diverse (Sakamoto et al., 2021).

In Kijiweni village, the food intake frequency of fish was high, and the frequency of wild food intake was high even in the rainy season. The frequency of intake of vegetables, pulses, fruits, and wild foods in the rainy season was high. These findings indicated that a greater variety of foods could be consumed in the rainy season. Keding et al. (2011) and Keding (2016) suggested that people used fruits, nuts, and starch in the Tanzanian coastal region of Tanga. They identified this diet as a "traditional coastal pattern" characterized by mostly plant and fish consumption. Kijiweni village was located along the coast, and it was confirmed that the intake could fit this pattern.

The low food intake frequency of meat in the four villages reconfirmed the findings of many previous studies, including Cochrane and D'Souza (2015). In Ifunda and Bandabichi villages, Chinangali I village, and Malolo village, the food intake frequency of fish and milk is also low, and there is a concern about the shortage of animal protein, fat, and micronutrients in these villages, while in Kijiweni village, the intake of protein by fish was confirmed.

Finally, except for Malolo village, which utilized wild foods according to the season, Ifunda and Bandabichi villages, Chinangali I village, and Kijiweni village consumed various kinds of foods in the rainy season but did not always eat a balanced diet in the dry season. Generally, it is recognized that grain is harvested during the dry season and that a "food shortage" occurs in Chinangali I village, Malolo village, and Kijiweni village (Sakamoto et al., 2020a, b, c, 2021). In contrast, the present analysis focuses on the food intake frequency of different food groups. The results revealed that, contrary to expectations, a greater variety of foods were consumed during the rainy season. In this chapter, it was confirmed that each household maintains a diversity of food intake by adapting its dietary pattern according to the season and not simply as a function of grain production. On the other hand, the results also suggested that attention should be given in the future to the possibility that such ingenuity and diversity in dietary patterns may decline as food production becomes sufficient.

Acknowledgments Residents of the villages (for answering questions and providing information), Ms. Nobuko Tsubaki, Mr. Michael Chimosa, Ms. Anna Maro (research coordinators), and Ms. Ayusa Okui are appreciated. We also thank our students for their data input, which enabled the data analysis. This study was supported by Grant-in-Aid for Scientific Research 18H03438 and by Utsunomiya University.

Muto was responsible for data analysis and the initial and final manuscript. Kato was responsible for the literature review and editing of the manuscript. Sakamoto was responsible for conceptualization, interviews, field data collection and coordination, data input coordination, data checking, interpretation of the analyzed data, and editing of the manuscript. Ohmori was responsible for conceptualization and data and analysis verification.

References

Ambikapathi, R., Irema, I., Lyatuu, I., Caswell, B., Mosha, D., Nyamsangia, S., Galvin, L., Mangara, A., Boncyk, M., Froese, S. L., Verissimo, C. L., Itatiro, J., Kariathi, V., Kazonda, P., Wandella, M., Fawzi, W., Killewo, J., Mwanyika-Sando, M., PrayGod, G., Leyna, G., Patil, C., & Gunaratna, N. S. (2022). Gender and age differences in meal structures, food away from home, chrono-nutrition, and nutrition intakes among adults and children in Tanzania using a newly developed tablet-based 24-hour recall tool. *Current Developments in Nutrition, 6*(3), nzac015.

Cochrane, N., & D'Souza A. (2015). Measuring access to food in Tanzania: A food basket approach, economic information bulletin 135. *United States Department of Agriculture.*

FAO, IFAD, UNICEF, WFP, & WHO. (2021). *The state of food security and nutrition in the world 2021*. FAO.

Hadley, C., Mulder, M. B., & Fitzherbert, E. (2007). Seasonal food insecurity and perceived social support in rural Tanzania. *Public Health Nutrition, 10*(6), 544–551.

Keding, G. (2016). Nutrition transition in rural Tanzania and Kenya. In H. K. Biesalski & R. E. Black (Eds.), *Hidden hunger. Malnutrition and the first 1,000 days of life: Causes, consequences, and solutions. Nutrition transition and nutritional deficiencies in low-income countries* (World Rev Nutr Diet) (Vol. 115, pp. 61–74). Karger. https://doi.org/10.1159/000442073

Keding, G., Msuya, J. M., Maass, B. L., & Krawinkel, M. B. (2011). Dietary patterns and nutritional health of women: The nutrition transition in rural Tanzania. *Food and Nutrition Bulletin, 32*(3), 218–226.

Kimambo, J. J., Kavoi, M. M., Macharia, J., & Nenguwo, N. (2018). Assessment of factors influencing farmers' nutrition knowledge and intake of traditional African vegetables in Tanzania. *African Journal of Food, Agriculture, Nutrition and Development, 18*(2), 13353–13371.

Kinabo, J., Mamiro, P., Dawkins, N., Bundala, N., Mwanri, A., Majili, Z., Jumbe, T., Kulwa, K., Mamiro, D., Amuri, N., Ngowi, M., & Msuya, J. (2016). Food intake and dietary diversity of farming households in Morogoro region, Tanzania. *African Journal of Food, Agriculture, Nutrition and Development, 16*(4), 11295–11309.

Kinshella, M. L. W. (2014). 'The land is now not fertile': Social landscapes of hunger in southeastern coastal Tanzania. *Anthropology & Medicine, 21*(3), 290–301.

Kuroda, M. (2016). The dietary patterns and livelihood strategies of rural households in semi-arid Tanzania: Some findings from household diary survey in Majeleko, Dodoma region. In S. Maghimbi, K. Sugimura, & D. G. Mwafupe (Eds.), *Endogenous development, moral economy and globalization in agro-pastoral communities in central Tanzania*. University of Dar es Salaam Press.

Lukmanji, Z., Hertzmark, E., Mlingi, N., Assey, V., Ndossi, G., & Fawzi, W. (2008). *Tanzania food composition tables*. Muhimbili University of Health and Allied Sciences, Tanzania Food and Nutrition Centre, & Harvard School of Public Health. Retrieved October 30, 2022, from https://cdn1.sph.harvard.edu/wp-content/uploads/sites/30/2012/10/tanzania-food-composition-tables.pdf

Mason, R., Parkins, J. R., & Kaler, A. (2017). Gendered mobilities and food security: Exploring possibilities for human movement within hunger-prone rural Tanzania. *Agriculture and Human Values, 34*(2), 423–434.

Msambichaka, B., Eze, I. C., Abdul, R., Abdulla, S., Klatser, P., Tanner, M., Kaushik, R., Geubbels, E., & Probst-Hensch, N. (2018). Insufficient fruit and vegetable intake in a low- and middle-income setting: A population-based survey in semiurban Tanzania. *Nutrients, 10*(2), 222.

Muto, M., Sakamoto, K., Ohmori, R., & Tsuda, K. (2022). Regional and seasonal differenced of food intake frequency in 4 areas of Tanzania. *Center for the Multicultural Public Sphere (CMPS) Annual Report, 2022*, 166–176.

Ohmori, R., Sakamoto, K., & Tsuda, K. (2020). Associations between food intake and health-related quality of life in East Africa. *Journal of the School of Regional Design, 7*, 36–42.

Phillips, K. (2009). Hunger, healing, and citizenship in central Tanzania. *African Studies Review, 52*(1), 23–45.

Sakamoto, K., Kemmarath, P., Ohmori, R., & Maro, A. C. (2021). Health, livelihoods, and food intake in inland southeast Tanzania: From questionnaire interviews in Malolo village, Lindi region. *Journal of the School of International Studies, Utsunomiya University, 51*, 15–34. http://hdl.handle.net/10241/00012361

Sakamoto, K., Ohmori, R., & Okui, A. (2020a). Situation of women and children in southern Tanzania: From questionnaires in Ifunda, Iringa with focus on food-intake and health. *Journal of the School of International Studies, Utsunomiya University, 49*, 61–78. http://hdl.handle.net/10241/00012115

Sakamoto, K., Ohomori, R., & Tsuda, K. (2020b). Health, livelihoods, and food intake of children and adults in central Tanzania: From questionnaire interviews in Chinangali I village, Chamwino district, Dodoma region. *Regional Design Science, 7*, 43–63. http://hdl.handle.net/10241/00012127

Sakamoto, K., Kemmarath, P., Ohmori, R., & Maro, A. C. (2020c). Health, livelihoods, and food intake in coastal southeast Tanzania: From questionnaires interviews in Kijiweni village, Lindi region. *Journal of the School of International Studies, Utsunomiya University, 50*, 11–29.

School of Public Health, Harvard T. H. Chan. (n.d.). *Legumes and pulses, the nutrition source*. Retrieved February 1, 2023, from https://www.hsph.harvard.edu/nutritionsource/legumes-pulses/

Tanzania, Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC), Ministry of Health (MoH), Tanzania Food and Nutrition Centre (TFNC), National Bureau of Statistics (NBS), Office of the Chief Government Statistician (OCGS) and UNICEF. (2018). *Tanzania national nutrition survey using SMART methodology (TNNS) 2018*. MoHCDGEC, MoH, TFNC, NBS, OCGS, and UNICEF.

Tanzania, National Bureau of Statistics and ICF Macro. (2011). *2010 Tanzania demographic and health survey: Key findings*. Calverton.

UNICEF United Republic of Tanzania. (n.d.). *Nutrition*. Retrieved December 1, 2021, from https://www.unicef.org/tanzania/what-we-do/nutrition

Zack, R. M., Irema, K., Kazonda, P., Leyna, G. H., Liu, E., Gilbert, S., Lukmanji, Z., Spiegelman, D., Fawzi, W., Njelekela, M., Killewo, J., & Danaei, G. (2018). Validity of a food FFQ to measure nutrient and food intake in Tanzania. *Public Health Nutrition, 21*(12), 2211–2220. https://doi.org/10.1017/S1368980018000848

Chapter 5
Changing Dietary Patterns and Associated Social Context: Subjective Health Quality of Life, Wealth, and Mutual Relations in Tanzania

Kumiko Sakamoto, Lilian Daniel Kaale, Reiko Ohmori, and Tamahi Kato

Abstract Dietary patterns and health-related quality of life (QOL) are considered important, but their relationships with social context are unknown. This chapter aims to determine the relationships between dietary patterns, QOL, social context, geographical differences, wealth, and food/monetary mutual assistance in rural Lindi, Dodoma, and Iringa regions. Using food frequency questionnaires administered throughout the dry season to 424 respondents in questionnaire interviews in four villages, the dietary consumption of 11 food groups was assessed. The data were analyzed with factor analysis to identify dietary patterns. Associations of dietary pattern factor scores were evaluated with wealth, mutual relations, and QOL based on the 12-item short-form (SF-12) health survey. Dietary patterns were related to geographic locations ($p < 0.001$). Animal products and traditional coast (fish emphasis) dietary patterns strongly correlated positively with mental QOL (Mental Component Summary). Animal product consumption pattern was associated with wealth status ($p < 0.001$). Traditional coast ($p = 0.014$) and animal product ($p = 0.021$) dietary patterns were associated with providing food assistance, and purchase patterns were associated with monetary assistance ($p = 0.034$) to others.

K. Sakamoto (✉)
School of International Studies, Utsunomiya University, Utsunomiya, Japan
e-mail: ksaka@cc.utsunomiya-u.ac.jp

L. D. Kaale
Department of Food Science and Technology, University of Dar es Salaam, Dar es Salaam, Tanzania
e-mail: elykaale@gmail.com; dlilian@udsm.ac.tz

R. Ohmori
School of Regional Design, Utsunomiya University, Utsunomiya, Japan
e-mail: rohmori@cc.utsunomiya-u.ac.jp

T. Kato
Center for African Area Studies, Kyoto University, Kyoto, Japan

K. Sakamoto et al. (eds.), *Changing Dietary Patterns, Indigenous Foods, and Wild Foods*, https://doi.org/10.1007/978-981-99-3370-9_5

Protein intake was associated with high QOL, wealth, and providing others with food/monetary assistance.

Keywords Africa · Dietary habits · Food group · QOL · Subjective health · Tanzania

5.1 Introduction: Dietary Patterns, Wealth, and Quality of Life

Within the overall objective of the book to understand the changing dietary patterns, indigenous food, and wild food intake in relation to wealth, mutual relations, and health in Tanzania, this chapter focuses on the association between food group intake, health, wealth, and mutual relations.

Dietary patterns are the set or group of foods consumed by a specific community as determined by statistical aggregation or component reduction (Da Corrêa et al., 2017). Dietary patterns are influenced by several variables, such as biology, culture, food accessibility, and way of life (Bhagtani et al., 2022). Dietary patterns, which represent the entirety of dietary and nutritional profiles, are directly correlated with food security (Ntwenya et al., 2015) and health through a reduced risk of noncommunicable diseases. Furthermore, dietary patterns are fundamental in reducing malnutrition worldwide. To achieve Sustainable Development Goal 2 (zero hunger), an affordable healthy diet including macronutrients such as proteins, fats, and carbohydrates, as well as essential micronutrients (vitamins and minerals), is considered important based on the respective cultural context, locally available food, and dietary customs (FAO et al., 2021). Income and food production might affect access to a healthy diet. In Tanzania, food access is an issue for the lowest-income quintiles. Specifically, grain-deficient zones face greater difficulties than grain-growing zones, such as the southern highlands (Cochrane & D'Souza, 2015). Consumption of animal products is low throughout the country (Kinabo et al., 2016; Mazengo et al., 1997), especially in the southern highlands (FAO et al., 2021), and it has been related to wealth status (Keding et al., 2011). Freshwater fish are associated with wealth status, contribute to protein consumption, and are frequently given as gifts, according to research conducted in a floodplain area (Moreau & Garaway, 2018). Food crop diversity and access to the market, especially for vegetables (Keding et al., 2012), have also been associated with food diversity (Madzorera et al., 2021).

In low- to middle-income countries, the double burden of being underweight and overweight, albeit contested, is considered an issue (Bliznashka et al., 2020a; Corsi et al., 2011). A change in dietary patterns has been documented in Tanzania in both urban and rural areas (Keding, 2016; Mazengo et al., 1997). Five distinctive dietary patterns in central and northeast Tanzania have been identified using principal component analysis (PCA) research: traditional-inland (cereals, oil/fat, and vegetables), traditional-coast (fruits, nuts, starchy plants, and fish), pulse, animal products, and purchase (bread/cakes, sugar, and tea) (Keding et al., 2011). The traditional-inland diet was regarded as healthy, while the purchase dietary pattern was regarded as unhealthy, as evidenced by the body mass index (BMI) and hemoglobin levels of subjects in the various groups of dietary patterns (Keding et al., 2011).

Along with objective measurements such as medical testing, quality of life (QOL) as evaluated by subjective satisfaction is gaining prominence as a crucial indicator of health (Doi, 2004; Spilker, 1996). The short-form-12 (SF-12) healthy survey, which has been globally validated in the Medical Outcomes Study, is one of the instruments used to measure the quality of life (Gandek et al., 1998), including in sub-Saharan Africa (Ohrnberger et al., 2020), Kenya (Patel et al., 2017), and Tanzania (Wagner et al., 1999; Wyss et al., 1999). To the best of the researchers' knowledge, the QOL questionnaire has not been evaluated in relation to dietary patterns in Tanzania or anywhere else. The main objective of this study is to analyze the relationship between dietary patterns and QOL in selected areas of Tanzania. The dietary habits of the selected areas were identified along with their association with wealth and mutual assistance.

5.2 Methods

5.2.1 Research Area and Data Collection

Data collection was focused on three main regions in Tanzania: Dodoma, Lindi, and Iringa. The data were collected in four rural areas with different nutritional statuses, environments, livelihoods, and ethnic and cultural backgrounds. The average number of food groups consumed is also below average (MoHCDGEC et al., 2018; Tanzania, 2011). The dietary pattern observed in Dodoma is comparable to the healthy dietary pattern of the traditional-inland and that of the coastal Lindi is comparable to the traditional-coast dietary pattern (Keding et al., 2011). Dodoma, Lindi, and Iringa regions had high levels of stunting in children, with incidence values of 56%, 54%, and 52%, respectively, as of 2010 (Tanzania, 2011) but have decreased to 37%, 24%, and 36%, respectively, as of 2018 (MoHCDGEC et al.). In contrast, anemia among women is lower than average (28%) in Iringa (17%) and Dodoma (24%) in comparison with Lindi (33%) (Tanzania, 2011). The average number of food groups is lower than average (3.0), especially in Lindi (2.2) (Tanzania, 2011).

From these three regions, the following study areas were chosen: (1) an agro-pastoral Chinangali I village in Dodoma, which has a semiarid environment; (2) an agricultural and fishing Kijiweni village in coastal Lindi; (3) an agricultural, gathering, and hunting Malolo (M) village in inland Lindi with forests nearby; and (4) the grain-producing southern highland villages of Ifunda and Bandabichi in Iringa. Chinangali I village is frequently affected by droughts, whereas Kijiweni and Malolo villages were selected because they are examples of villages suffering from food shortages within the Lindi region.

To account for any disparities across the villages, an equal number of participants from each hamlet in the Chinangali I, Kijiweni, and Malolo villages were intentionally included from both the center and remote parts of the village. Participants were not chosen at random but rather invited by the hamlet leader or village-based research assistants due to the lack of village registration at the hamlet level. Interviews were conducted during the dry season from 13 August 2019 to 15 August

2019 in Chinangali I village, from 27 August 2019 to 29 August 2019 in Kijiweni village, and from 2 September 2019 to 4 September 2019 in Malolo village (Sakamoto et al. 2020a, b, 2021a).

One participant per household was interviewed based on a questionnaire in Swahili (detailed contents explained in the next section). The participants were adults, with no restrictions of age or health conditions. The interviewees were not limited to the household heads. This allowed women to participate, which is highly valuable since they are proactively involved in food production and cooking.

In Ifunda and Bandabichi villages, participants were mothers with small children. The questionnaires were distributed on 6, 10, and 19 June 2019 at dispensaries during their clinic visits or other public locations (Sakamoto et al., 2020c). Since the method and target participants differed from the other three villages, the data sets of Ifunda and Bandabichi villages were analyzed separately.

5.2.2 Content of the Questionnaire

The interview was based on a comprehensive questionnaire in Swahili. It included 75 questions on information about attributes (sex, age, etc.), marital status and family conditions, livelihood, groups, mutual assistance, children, health, and food intake. Questions on health were based on the standardized SF-12 (Table 5.1, Ohrnberger et al., 2020), and the translation was based on the verified Swahili SF-36 (Patel et al., 2017; Wagner et al., 1999). Food groups were determined based on the *Tanzania Food Composition Tables* (Table 5.2) (Lukmanji et al., 2008), and the weekly intake frequency of each food group was noted (Mizoguchi et al., 2004; Tsunoda et al.,

Table 5.1 Subjective evaluation of SF-12, consisting of two components and eight subscales (Formulated from Patel et al., 2017; Wagner et al., 1999; Wyss et al., 1999)

Components	Subscales		Questions
Physical Component Summary (PCS)	PF	Physical Functioning	Moderate activities (carrying water, washing clothes, carrying children) heavy activities (climbing a steep mountain)
	RP	Role Physical	Accomplished less work due to physical problems were limited in kinds of activities
	BP	Body Pain	Pain interferes with work
	GH	General Health	Present health situation
Mental Component Summary (MCS)	VT	Vitality	Have a lot of energy
	SF	Social Functioning	Health interference with social activities
	RE	Role Emotional	Accomplished less due to emotional problems less careful than usual
	MH	Mental Health	Felt calm and peaceful felt downhearted

Table 5.2 Food groups used in dietary pattern analysis

No	Food groups	Foods examples
1	Stable foods	Cereals (rice, maize, sorghum, millet), tubers (cassava, sweet potatoes), bananas, etc.
2	Vegetables	Leafy vegetables, okra, tomato, onion, cucumber, pumpkin, guard, eggplant, carrot, mushroom, etc.
3	Meat	Beef, goat, chicken, goat, duck, wild meat, etc.
4	Fish	Fish, including sardines (*dagaa*)
5	Dairy foods	Milk, yogurt, eggs
6	Pulse	Kidney beans, chickpeas, cowpeas, Bambara groundnuts, hyacinth beans, etc.
7	Seeds	Coconuts, groundnuts, sesame, pumpkin seeds, sunflower seeds, etc.
8	Fruits	Mangos, banana, guava, papaya, watermelon, papaya, orange, tangerine, wild fruits, avocado, etc.
9	Oil	Sunflower oil, palm oil, vegetable oil, etc.
10	Salt	Salt (sea, inland, and industrial)
11	Sugar	Sugar, sugarcane, soft drinks

2015), while the 24-h recall is a common method. This questionnaire attempted to uncover the overall habitual intake within 1 week. Questions on groups and mutual assistance were formulated regarding *Measuring Social Capital* (Narayan et al., 2004). A self-evaluation of wealth/poverty within the village was conducted in this study to reveal the self-perceptions of villagers (Narayan et al., 2000). Other questions were formulated based on the author's previous questionnaires (Sakamoto, 2020). The questionnaire was pretested in Lindi and Dodoma (Ohmori et al., 2020) and adjusted.

Ethical approval was granted by Utsunomiya University (H18–0008). Participants were informed about the research in advance, and oral and written consent was obtained from each participant before the interviews. The Tanzania Commission for Science and Technology (COSTECH) granted permission to conduct the research.

5.2.3 Determination of Dietary Patterns

Dietary patterns were generated from the consumption of the 11 different food groups (Table 5.2). Although intake frequencies during both the dry and rainy seasons were obtained, only information from the dry season was used since the interview was conducted during the dry season. Furthermore, the questions from the SF-12 and those related to food and financial mutual assistance pertained to the recent month. The difference in intake frequency between seasons has already been reported using a similar data set as this study (Muto et al., 2022), and the results were found to vary in the rainy season. Both factor analysis (FA) using the unweighted least square method and PCA were implemented. The results in the rotated factor matrix were compared. FA was selected as the method with the best interpretability of the dietary pattern using unweighted least square estimation with reference to previous research (Keding et al., 2011).

Factor scores per dietary pattern were generated and further analyzed using a previously described method (Keding et al., 2011). A high positive factor score represents a high level of correspondence with a given dietary pattern; a high negative score represents low or no correspondence (Keding et al., 2011). The correlations of dietary pattern scores with wealth, mutual relations, and each subscale of the SF-12 QOL indicators were evaluated. Participants were divided into quintiles for each dietary pattern, with the first quintile indicating no consumption and the fifth quintile indicating high consumption of the respective dietary pattern. The following analysis was further implemented for each dietary pattern to understand its relation with geographic location, health, and mutual assistance: mean and median values of continuous parameters and percentage of participants for categorical parameters. The Kruskal–Wallis test was used to check the significant differences between quintiles of each pattern, while the Jonckheere–Terpstra test and Kendall tau were used to assessing the differences in trends. All statistical analyses were performed using IBM SPSS Statistics version 25 (IBM Corp., Armonk, NY, USA).

5.3 Results

5.3.1 Characteristics of the Study Participants

The mean age of the respondents was 39.7 years (standard deviation: SD 17.7), and 75.5% of the respondents were women. The majority (95.5%) of the respondents from Ifunda and Bandabichi villages were women, and they were the youngest among all villages, with a mean age of 28.4 years. Farming accounted for the majority of respondents' livelihoods across all villages (88.3%), followed by business (8.3%) and pastoralism (4.8%, multiple choice). Ifunda and Bandabichi villages had the lowest percentage of residents farming (76.6% compared to 97.7% in Malolo, 96.3% in Chinangali I, and 94.0% in Kijiweni villages) and the greatest percentage of residents engaged in business (13.8%), whereas Chinangali I village had the highest percentage of residents engaged in pastoralism (11.1%). The question used a multiple-choice approach, and some residents had multiple livelihoods. Major ethnic groups are indicated in Table 5.3.

Almost half of the respondents from Malolo village (44.3%) and Kijiweni village (48.1%) considered themselves relatively poor, while only 14.8% of respondents from Ifunda and Bandabichi villages perceived themselves as poor. Approximately 33.3–61.4% of all respondents reported providing food to others. In the villages of Ifunda and Bandabichi, 61.4% of residents reported providing food to others, 55.0% received financial support, and 65.6% provided financial support. These percentages were higher than those observed in Malolo village, where only 18.4% and 12.6% of

Table 5.3 Basic characteristics of participants in the researched villages

	Chinangali I village	Malolo village	Kijiweni village	Ifunda and Bandabichi villages	Total
n	81	88	84	171	424
Mean age ± SD	45.9 ± 18.0	54.4 ± 18.5	41.0 ± 13.8	28.4 ± 10.3	39.7 ± 17.7
Percentage women	69.3%	59.8%	64.6%	95.5%	75.5%
Occupation					
Farming	96.3%	97.7%	94.0%	76.6%	88.3%
Business	11.1%	0.0%	3.6%	13.8%	8.3%
Pastoralism	11.1%	3.4%	2.4%	3.6%	4.8%
Ethnic group	Gogo 95.1%	Mwera 98.9%	Mwera 61.9% Makonde 17.9%	Hehe 59.6% Bena 15.2%	Mwera 33.0% Hehe 24.5% Gogo 18.2%

SD standard deviation

Table 5.4 Education and social capital of participants in the researched villages

	Chinangali I village (%)	Malolo village (%)	Kijiweni village (%)	Ifunda and Bandabichi villages (%)	χ^2-test *p* value
Subjectively/relatively "poor" within the village	24.7	44.3	48.1	14.8	<0.001
Food support received from others	25.0	27.3	28.6	36.9	n.s.
Provided for others	33.3	34.1	46.4	61.4	<0.001
Financial support received from others	30.9	18.4	35.7	55.0	<0.001
Provided for others	37.0	12.6	26.5	65.6	<0.001
Perception of villagers as helping each other	80.9	74.7	73.4	75.0	n. s.

the participants claimed to receive and provide financial support, respectively. Nevertheless, the majority of participants had perceptions of villagers as helping each other across all villages (Table 5.4).

5.3.2 QOL in Each Village

Table 5.5 shows the Physical Component Summary (PCS), Mental Component Summary (MCS), and subscale scores for the villages. Malolo village generally had statistically lower evaluation scores than the other villages ($p < 0.001$). A lower

Table 5.5 Subjective health QOL SF-12 scores

	Subscale score	All	Chinangali I village	Malolo village	Kijiweni village	Ifunda and Bandabichi villages	ANOVA *p*-value
PCS Physical Component Summary (PCS)		43.9 ± 10.9	44.6 ± 12.0	36.7 ± 10.1	46.4 ± 12.3	46.2 ± 7.9	<0.001
	PF	45.4 ± 11.4	45.5 ± 12.2	39.4 ± 11.8	47.9 ± 11.4	47.4 ± 9.4	<0.001
	RP	38.7 ± 16.2	40.1 ± 16.7	28.4 ± 15.0	45.0 ± 13.9	40.4 ± 15.2	<0.001
	BP	42.9 ± 13.6	46.3 ± 13.0	36.0 ± 13.0	41.1 ± 15.7	46.0 ± 11.2	<0.001
	GH	39.2 ± 11.6	38.3 ± 11.7	32.0 ± 9.2	39.7 ± 13.2	43.5 ± 9.7	<0.001
Mental Component Summary (MCS)		41.2 ± 13.1	43.1 ± 15.5	35.2 ± 10.7	40.5 ± 13.3	44.0 ± 11.6	<0.001
	VT	49.1 ± 14.4	51.1 ± 15.7	41.3 ± 10.5	49.1 ± 15.0	52.5 ± 13.7	<0.001
	SF	45.3 ± 11.2	46.7 ± 10.1	43.3 ± 10.2	44.6 ± 12.6	46.2 ± 11.5	n.s.
	RE	30.9 ± 20.0	32.2 ± 21.9	20.8 ± 17.9	33.7 ± 18.6	34.6 ± 19.1	<0.001
	MH	45.1 ± 12.8	47.2 ± 14.9	39.7 ± 9.8	44.1 ± 13.6	47.7 ± 11.6	<0.001

The scores are calculated based on a study on SF-12 by Patel et al.

ANOVA of variance, *BP* Body Pain, *GH* General Health, *MCS* Mental Component Summary, *MH* Mental Health, *n.s.* not significant, *PCS* Physical Component Summary, *PF* Physical Functioning, *RE* Role Emotional, *RP* Role Physical, *SF* Social Functioning, *VT* Vitality subjective evaluation score, which will be elaborated on in Chap. 6, may be associated with older age.

5.3.3 Characteristics of Dietary Patterns and Locations

In Chinangali I, Kijiweni, and Malolo villages, four dietary patterns accounted for 58.4% of the variance (Table 5.6). In this analysis, factor 1, which was referred to as the traditional-inland dietary pattern, was dominated by vegetables and, to a lesser extent, staple foods. Factor 2, which was identified as the traditional-coast dietary pattern, was characterized by fish, sweets, and to some extent, nuts. Factor 3, which referred to the pulse dietary pattern, was characterized by pulses and salt. Factor 4, which was also known as the animal product dietary pattern, was characterized by meat, milk, oil, and to some extent, fruits.

Dietary patterns were significantly associated with geographic location (Table 5.7). Patterns that had the highest percentage of the fifth quintile in the geographic location are indicated here. Analysis of quintiles within patterns indicated that most Kijiweni village respondents followed Factor 2 (fifth quintile 97.9%, $p < 0.001$). Saltwater fish is commonly eaten as a relish in coastal Kijiweni village, while tea with sugar is also commonly consumed for breakfast. Most of the participants from Malolo village followed Factor 3 (pulses, fifth quintile 85.1%, $p < 0.001$). Located in the inland southeast with moderate rainfall, pulses such as

Table 5.6 Rotated component matrix of food groups and total variance explained in three villages

Factor	1	2	3	4
Dietary pattern	Traditional-inland	Traditional-coast	Pulse	Animal products
Total	2.152	1.848	1.404	1.017
Variance (%)	19.560	16.803	12.760	9.247
Cumulative (%)	19.560	36.363	49.123	58.370
Food groups				
Vegetable	**1.016**	0.000	−0.209	0.058
Staple	0.330	0.013	0.107	0.105
Fish	−0.370	**0.694**	−0.088	0.040
Sugar	−0.135	**0.625**	0.071	0.256
Nuts	0.106	0.305	0.023	−0.091
Pulse	−0.086	−0.081	**0.647**	−0.064
Salt	0.046	0.303	**0.542**	0.038
Meat	0.071	−0.028	0.019	**0.590**
Dairy	0.044	−0.007	−0.036	0.480
Oil	0.178	−0.150	0.329	0.418
Fruits	−0.059	0.201	−0.165	0.279

The extraction method is factor analysis using generalized least squares; the rotation method is Oblimin with Kaiser normalization. Rotation converged in 11 iterations. Food groups with higher loadings than 0.5 that largely characterize the respective dietary patterns are shown in bold

Table 5.7 Villages with highest percentage of dietary pattern in the fifth quintile in Kijiweni, Malolo, and Chinangali I villages

Village	Factor	Dietary pattern	*n*	Fifth quintile	Percentage (%)	*p*
Kijiweni	2	Traditional-coast	48	47	97.9	<0.001
Malolo	3	Pulse	47	40	85.1	<0.001
Chinangali I	4	Animal products	48	30	62.5	<0.001
Chinangali I	1	Traditional-inland	48	27	56.3	<0.001

Table 5.8 Rotated component matrix of food groups and total variance explained in Ifunda and Bandabichi villages

Factor	1	5	4
Dietary pattern	Traditional-inland	Purchase	Animal products
Total	4.315	39.228	39.228
Variance (%)	1.798	16.349	55.676
Cumulative (%)	1.003	9.119	64.695
Food groups			
Staple	0.988	0.012	0.022
Vegetable	0.359	0.352	0.160
Sugar	0.154	**0.836**	−0.073
Oil	−0.137	**0.811**	0.093
Salt	0.065	**0.800**	−0.032
Meat	−0.005	−0.096	**0.753**
Fish	0.100	−0.153	**0.730**
Pulse	−0.011	0.062	**0.713**
Nuts	−0.125	0.220	**0.656**
Dairy	0.003	0.011	**0.592**
Fruits	0.185	0.163	0.376

The extraction method is factor analysis using generalized least squares; Rotation method: Oblimin with Kaiser normalization. Rotation converged in seven iterations

Food groups with higher loadings than 0.5 that largely characterize the respective dietary patterns are in bold

cowpeas, chickpeas, red kidney beans, and velvet beans are common foods. Participants in Chinangali I village followed Factor 4 (animal product, fifth quintile 62.5%, $p < 0.001$) and Factor 1 (traditional-inland, fifth quintile 56.3%, $p < 0.001$). Located in the semiarid inland of Tanzania, vegetables, both fresh and dried, made into a sticky relish called *mlenda,* are the main relish to accompany stiff porridge *ugali* of maize, millet, and sorghum. Among the Gogo, an agro-pastoralist society, only a minority own cows and have access to milk and meat.

In the separate FA for Ifunda and Bandabichi villages, three factors accounted for 64.695% of the variance (Table 5.8). There were three dietary patterns characterized by factors in the two villages. Factor 1 was dominated by staple foods and, to some extent, by vegetables and was referred to as a traditional-inland dietary pattern.

Factor 5, defined by "purchase," was characterized by sugar, oil, and salt (purchase pattern) and was distinct from the patterns in the other three villages. Factor 4 was characterized by animal products, namely, meat, fish, pulse, nuts, milk, and to some extent, fruits.

5.3.4 Correlations and Associations Between Dietary Patterns and Wealth and Mutual Relations

In the Chinangali I, Kijiweni, and Malolo villages, Factor 4 (animal products) was significantly associated with a relative subjective wealth perception among the participants. The majority (89.1%) of participants in the fifth quintile ($p < 0.001$) did not consider themselves poor within the community. Factor 1 (traditional-inland) was also associated with wealth status to a lesser extent, where 60.9% of participants in the fifth quintile ($p = 0.009$) did not consider themselves poor within the community. Factor 2 (traditional-coast) was significantly associated with participants who assisted people outside their family with food (fifth quintile 60.4%, $p = 0.014$).

In Ifunda and Bandabichi villages, Factor 4 (animal products) was similarly associated with wealth, where 94.4% of the participants in the fifth quintile ($p = 0.021$) did not consider themselves poor within the community, and 83.3% in the fifth quintile provided food assistance to others ($p = 0.046$). Factor 5 (purchase) was associated with access to money, and 94.4% in the fifth quintile provided monetary assistance to others ($p = 0.034$).

5.3.5 Correlations and Associations Between Dietary Patterns and QOL

In Chinangali I, Kijiweni, and Malolo villages, Factor 2 was significantly and positively correlated and had differences between medians with MCS, PF, RP, GH, VT, RE, and MH. Factor 4 was also significantly correlated and had differences between medians with MCS and BP. Significant correlations and differences between median values were found in Ifunda and Bandabichi villages between Factor 3 and MCS, BP, and VT (Table 5.10).

Traditional-inland dietary patterns showed significant positive correlations with MCS, Social Functioning, and MH in Chinangali I, Kijiweni, and Malolo villages (Table 5.11 Factor 1) and with BP in Ifunda and Bandabichi villages (Table 5.12 Factor 1) but not in other tests.

5.4 Discussion and Conclusions

The dietary patterns observed in this study were similar to those of a previous study (Keding et al., 2011) but with some variations. Traditional-inland dietary patterns in this research did not include oil as an important food group, and emphasis was placed on vegetables in Chinangali I village, which is a semiarid central village, and on staple foods in Ifunda and Bandabichi villages, which are grain-growing southern highland villages. Traditional-coast dietary patterns emphasized the consumption of fish and sugar in Kijiweni village. The geographic differences could have contributed to the disparity (southeast and northeast). Due to its coastal location, Kijiweni village may have also favored the consumption of fish.

The inclusion of sugar is in line with the caution of a previous study on the transition of dietary patterns on the coast (Keding et al., 2011). Pulse patterns often have a negative effect on vegetable consumption, as indicated by previous research (Keding et al., 2011). This research included high salt intake as part of the pulse dietary pattern. Fish, pulses, nuts, and dairy foods were consumed in Ifunda and Bandabichi villages, while dairy products and oil were consumed in the villages of Chinangali I, Kijiweni, and Malolo. Chinangali I, Kijiweni, and Malolo villages did not have a purchase dietary pattern; instead, it was only common in Ifunda and Bandabichi villages and consisted of salt, sugar, and oil. The analysis indicated that participants with a high intake of animal meat, including fish, had high subjective health QOL, especially with regard to MH. According to Moreau and Garaway (2018), both freshwater and saltwater fish are significant suppliers of protein.

The results of this research are limited to the dry season. However, the following points can be confirmed based on previous research: Given that the prior seasonal analysis of a neighboring village showed no significant seasonal variation in fish intake (Ohmori et al., 2020), similar results would be expected throughout the year. Unlike previous research (FAO et al., 2021), the animal meat product (excluding fish) dietary pattern was prevalent in Chinangali I village, which is a semiarid central village, and in Ifunda and Bandabichi villages, which are southern highland villages. However, similar to previous research, the animal product dietary pattern was related to the respondents' subjective wealth (Keding et al., 2011, 2012). While this study analyzed the results from the dry season, emphasis on animal products and their relation to wealth may have a stronger effect in the rainy season, when the intake of milk increases significantly (Ohmori et al., 2020). The results need to be taken with caution since protein intake is associated with higher BMI and obesity (Bliznashka et al., 2020b), and validation of the SF-36 indicates that people with higher socioeconomic status have higher mean scale scores than those of lower status (Wagner et al., 1999).

The behavior of sharing food with others was prevalent among those with animal meat products and coastal-traditional dietary patterns. This could imply that people

Table 5.9 Social indicators with highest percentage of dietary pattern in the fifth quintile

Social indicators	Factor	Dietary pattern	*n*	Fifth quintile	Percentage (%)	*p*
Kijiweni, Malolo, and Chinangali I villages						
Not poor	4	Animal products	46	41	89.1	<0.001
Not poor	1	Traditional-inland	46	28	60.9	0.009
Providing food support for others	2	Traditional-coast	48	29	60.4	0.014
Ifunda and Bandabichi villages						
Not poor	4	Animal products	18	17	94.4	0.021
Providing food support for others	4	Animal products	18	15	83.3	0.046
Providing monetary support for others	5	Purchase pattern	18	17	94.4	0.034

Table 5.10 Averages of the first and fifth quintiles of QOL by factor

	First quintile	Fifth quintile	p^a
Three villages factor 2 (traditional-coast)			
MCS	34.866	42.578	0.036
PF	38.459	47.057	0.000
RP	33.999	44.395	0.000
GH	31.712	38.689	0.000
VT	44.395	50.108	0.000
RE	21.054	33.451	0.000
MH	39.529	47.034	0.000
Three villages factor 4 (animal products)			
MCS	33.808	42.232	0.028
BP	34.180	48.809	0.001
Ifunda and Bandabichi villages factor 3 (animal products)			
MCS	38.999	49.376	0.034
BP	42.986	52.281	0.000
VT	42.487	57.518	0.048

BP Body Pain, *GH* General Health, *MCS* Mental Component Summary, *MH* Mental Health, *PF* Physical Functioning, *QOL* Quality of Life, *RE* Role Emotional, *RP* Role Physical, *VT* Vitality
[a]Kruskal–Wallis Test

who can afford to eat meat from animals and fish share food with others. Traditional-inland dietary patterns showed significant positive correlations with MCS, Social Functioning, and MH in Chinangali I, Kijiweni, and Malolo villages (Table 5.9

Table 5.11 Correlations between dietary patterns and subjective health QOL in the three villages

Subjective health QOL dietary pattern		Physical Component Summary (PCS)					Mental Component Summary (MCS)				
			PF	RP	BP	GH		VT	SF	RE	MH
Traditional-inland (factor 1)	Pearson correlation	−0.033	−0.003	−0.087	0.120	0.004	**0.135***	0.103	**0.138***	−0.033	**0.213****
	Sig. (2-tailed)	0.614	0.964	0.182	0.067	0.949	**0.039**	0.114	**0.035**	0.619	**0.001**
	n	235	235	235	235	235	**235**	235	**235**	235	**235**
Traditional-coast (factor 2)	Pearson correlation	**0.187****	**0.248****	**0.217****	0.086	**0.186****	**0.180****	0.160*	0.092	**0.207****	**0.177****
	Sig. (2-tailed)	**0.004**	**0.000**	**0.001**	0.189	**0.004**	**0.006**	0.014	0.158	**0.001**	**0.007**
	n	**235**	**235**	**235**	235	**235**	**235**	235	235	**235**	**235**
Pulse (factor 3)	Pearson correlation	−0.088	−0.002	−0.104	−0.080	−0.019	0.039	0.012	0.040	−0.027	0.043
	Sig. (2-tailed)	0.181	0.970	0.112	0.222	0.768	0.547	0.855	0.540	0.680	0.509
	n	235	235	235	235	235	235	235	235	235	235
Animal products score (factor 4)	Pearson correlation	**0.143***	**0.210****	0.069	**0.258****	0.070	**0.190****	0.110	**0.209****	**0.183****	**0.172****
	Sig. (2-tailed)	**0.028**	**0.001**	0.295	**0.000**	0.287	**0.003**	0.091	**0.001**	**0.005**	**0.008**
	n	**235**	**235**	235	**235**	235	**235**	235	**235**	**235**	**235**

BP Body Pain, *GH* General Health, *MCS* Mental Component Summary, *MH* Mental Health, *PCS* Physical Component Summary, *PF* Physical Functioning, *QOL* Quality of Life, *RE* Role Emotional, *RP* Role Physical, *SF* Social Functioning, *VT* Vitality

*Bold: Correlation is significant at the 0.05 level (2-tailed)

**Bold: Correlation is significant at the 0.01 level (2-tailed)

Table 5.12 Correlations between dietary patterns and subjective health QOL in Ifunda and Bandabichi Villages

Subjective health QOL dietary pattern		PCS	MCS	PF	RP	BP	GH	VT	SF	RE	MH
Traditional-inland (factor 1)	Pearson correlation	0.003	0.165	0.051	−0.020	**0.232***	0.034	0.051	−0.025	0.135	0.191
	Sig. (2-tailed)	0.977	0.120	0.630	0.852	**0.028**	0.748	0.634	0.814	0.204	0.072
	n	90	90	90	90	**90**	90	90	90	90	90
Purchase (factor 5)	Pearson correlation	−0.052	0.057	−0.123	0.023	0.194	−0.152	−0.071	0.040	0.052	0.064
	Sig. (2-tailed)	0.630	0.592	0.247	0.831	0.067	0.154	0.503	0.707	0.625	0.549
	n	90	90	90	90	90	90	90	90	90	90
Animal products (factor 4)	Pearson correlation	**0.227***	**0.329****	0.100	0.170	**0.404****	0.151	**0.374****	0.063	**0.293****	0.184
	Sig. (2-tailed)	**0.031**	**0.002**	0.348	0.110	**0.000**	0.157	**0.000**	0.557	**0.005**	0.083
	n	**90**	**90**	90	90	**90**	90	**90**	90	**90**	90

BP Body Pain, *GH* General Health, *MCS* Mental Component Summary, *MH* Mental Health, *PCS* Physical Component Summary, *PF* Physical Functioning, *QOL* Quality of Life, *RE* Role Emotional, *RP* Role Physical, *SF* Social Functioning, *VT* Vitality

*Bold: Correlation is significant at the 0.05 level (2-tailed)

**Bold: Correlation is significant at the 0.01 level (2-tailed)

Factor 1) and with BP in the Ifunda and Bandabichi villages (Table 5.10 Factor 1). However, the correlations were not significant for other tests. The results did not contradict previous research (Keding et al., 2011). However, subjective QOL evaluation may not be as sensitive to lifestyle diseases as measurements of BMI or hemoglobin. The role of wild foods was not considered in this chapter but is covered in Chap. 10 about Chinangali I, Kijiweni, and Malolo villages (Sakamoto et al., 2021b).

Acknowledgments Our appreciation goes to all participants and assistants in the villages and permission from the Government of Tanzania. The contribution of research assistants in Tanzania and students at Utsunomiya University is acknowledged. The Swahili version of the SF-36 was generously shared by Dr. Anita Wagner and Dr. Barbara Gande.

Sakamoto was responsible for the conceptualization of the study, questionnaire drafting, fieldwork, data collection and analysis, and drafting and editing of the manuscript. Ohomori was responsible for the conceptualization, quality control of data collection, SF-12 scoring, and the review and editing of the manuscript. Kaale was responsible for reviewing the article as a nutrition specialist based in Tanzania. Kato was responsible for reviewing the manuscript as a researcher specializing in Tanzania. The authors declare that there are no conflicts of interest.

The research is supported by the Japanese Government, JSPS KAKENHI 18H03438 and 18H00776, an overseas training program for female faculty members, at Utsunomiya University.

References

Bhagtani, D., Augustus, E., Haynes, E., Iese, V., Brown, C. R., Fesaitu, J., Hambleton, I., Badrie, N., Kroll, F., Saint-Ville, A., Samuels, T. A., Forouhi, N. G., Benjamin-Neelon, S. E., Unwin, N., & On Behalf of The CFaH Team. (2022). Dietary patterns, food insecurity, and their relationships with food sources and social determinants in two Small Island Developing States. *Nutrients, 14*, 2891. https://doi.org/10.3390/nu14142891

Bliznashka, L., Blakstad, M., Berhane, Y., Tadesse, A., Assefa, N., Danaei, G., Canavan, C. R., Hemler, E. C., & Fawzi, W. (2020a). Household-level double burden of malnutrition in Ethiopia: A comparison of Addis Ababa and the rural district of Kersa. *Public Health Nutrition, 24*(18), 6354–6368.

Bliznashka, L., Danaei, G., Fink, G., Flax, V. L., Thakwalakwa, C., & Jaacks, L. M. (2020b). Cross-country comparison of dietary patterns and overweight and obesity among adult women in urban sub-Saharan Africa. *Public Health Nutrition, 24*(6), 1–110.

Cochrane, N., & D'Souza, A. (2015). *Measuring access to food in Tanzania: A food basket approach, EIB-135*. Department of Agriculture, Economic Research Service. Retrieved May 20, 2022, from https://www.ers.usda.gov/webdocs/publications/43932/51864_eib135.pdf?v=42053

Corsi, D. J., Finlay, J. E., & Subramanian, S. V. (2011). Global burden of double malnutrition: Has anyone seen it? *PLoS One, 6*(9), e25120.

Da Corrêa, R. S., Vencato, P. H., Rockett, F. C., & Bosa, V. L. (2017). Dietary patterns: Are there differences between children and adolescents? *Ciencia & Saude Coletiva, 22*(2), 553–562. https://doi.org/10.1590/1413-81232017222.09422016

Doi, Y. (2004). Introduction: Conceptual issues on quality of life (QOL) and importance of QOL research. *Journal of the National Institute of Public Health, 53*(3), 176–180.

FAO, IFAD, UNICEF, WFP, & WHO. (2021). *The state of food security and nutrition in the world 2021: Transforming food systems for food security, improved nutrition and affordable healthy diets for all*. FAO.

Gandek, B., Ware, J. E., Aaronson, N. K., Leplege, A., Prieto, L., & Sullivan, M. (1998). Cross-validation of item selection and scoring for the SF-12 health survey in nine countries results from the IQOLA project. *Journal of Clinical Epidemiology, 51*(11), 1171–1178.

Keding, G. (2016). Nutrition transition in rural Tanzania. In H. K. Biesalski & R. E. Black (Eds.), *Hidden hunger. Malnutrition and the first 1,000 days of life: Causes, consequences and solutions. World rev Nutr diet* (pp. 68–81). Karger.

Keding, G. B., Msuya, J. M., Maass, B. L., & Krawinkel, B. (2011). Dietary patterns and nutritional health of women: The nutrition transition in rural Tanzania. *Food and Nutrition Bulletin, 32*(3), 218–226.

Keding, G. B., Msuya, J. M., Maass, B. L., & Krawinkel, M. B. (2012). Relating dietary diversity and food variety scores to vegetable production and socioeconomic status of women in rural Tanzania. *Food Security, 4*, 129–140.

Kinabo, J., Mamiro, P., Dawkins, N., Bundala, N., Mwanri, A., Majili, Z., Jumbe, T., Kulwa, K., Mamiro, D., Amuri, N., & Ngowi, & M, Msuya, J. (2016). Food intake and dietary diversity of farming households in Morogoro region, Tanzania. *African Journal of Food, Agriculture, Nutrition and Development, 76*, 16045.

Lukmanji, Z., Hertzmark, E., Mlingi, N., Assey, V., Ndossi, G., & Fawzi, W. (2008). *Tanzania food composition tables*. Muhimbili University of Health and Allied Sciences, Tanzania Food and Nutrition Centre, & Harvard School of Public Health. Retrieved October 30, 2022, from https://cdn1.sph.harvard.edu/wp-content/uploads/sites/30/2012/10/tanzania-food-composition-tables.pdf

Madzorera, I., Blakstad, M. M., Bellows, A. L., Canavan, C. R., Mosha, D., Bromage, S., Noor, R. A., Webb, P., Ghosh, S., Kinabo, J., Masanja, H., & Fawzi, W. W. (2021). Food crop diversity, women's income-earning activities, and distance to markets in relation to maternal dietary quality in Tanzania. *The Journal of Nutrition, 151*(1), 186–196.

Mazengo, M. C., Simell, O., Lukmanji, Z., Shirima, R., & Karvetti, R.-L. (1997). Food consumption in rural and urban Tanzania. *Acta Tropica, 68*(3), 313–326.

Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC), Ministry of Health (MoH), Tanzania Food and Nutrition Centre (TFNC), National Bureau of Statistics (NBS), Office of the Chief Government Statistician (OCGS) and UNICEF. (2018). *Tanzania national nutrition survey using SMART methodology (TNNS) 2018*. MoHCDGEC, MoH, TFNC, NBS, OCGS, and UNICEF. Retrieved May 20, 2022, from https://www.unicef.org/tanzania/media/2141/file/Tanzania%20National%20Nutrition%20Survey%202018.pdf

Mizoguchi, K., Takemi, Y., & Adachi, M. (2004). Relationship between and positive perception toward work and the dietary habits of young male workers. *The Japanese Journal of Nutrition and Dietetics, 62*(5), 269–283.

Moreau, M.-A., & Garaway, C. J. (2018). Fish rescue us from hunger: The contribution of aquatic resources to household food security on the Rufiji river floodplain, Tanzania. *East Africa Human Ecology, 46*, 831–848.

Muto, M., Sakamoto, K., Ohmori, R., & Tsuda, K. (2022). Regional and seasonal differences of food intake frequency in 4 areas of Tanzania. *Center for the Multicultural Public Sphere (CMPS) Annual Report*, 166–176.

Narayan, D., Chambers, R., Shah, M. K., & Petesch, P. (2000). *Voices of the poor: Crying out for change*. Oxford University Press for the World Bank. Retrieved May 20, 2022 from https://openknowledge.worldbank.org/handle/10986/13848

Narayan, D., Jones, V. N., & Woolcock, M. (2004). *Measuring social capital: An integrated questionnaire*. World Bank. Retrieved May 20, 2022, from http://documents.worldbank.org/curated/en/515261468740392133/Measuring-social-capital-an-integrated-questionnaire

Ntwenya, J. E., Kinabo, J., Msuya, J., Mamiro, P., & Majili, Z. S. (2015). Dietary patterns and household food insecurity in rural populations of Kilosa District, Tanzania. *PLoS One, 10*(5), e0126038.

Ohmori, R., Sakamoto, K., & Tsuda, K. (2020). Association between food intake and health-related quality of life in East Africa: From pilot study in two regions of Tanzania. *Journal of the School of Regional Design, Utsunomiya University, 7*, 35–42.

Ohrnberger, J., Anselmi, L., Fichera, E., & Sutton, M. (2020). Validation of the SF12 mental and physical health measure for the population from a low-income country in sub-Saharan Africa. *Health and Quality of Life Outcomes, 18*, 78.

Patel, A. R., Lester, R. T., Marra, C. A., van der Kop, M. L., Ritvo, P., Engel, L., Karanja, S., & Lynd, L. D. (2017). The validity of the SF-12 and SF-6D instruments in people living with HIV/AIDS in Kenya. *Health and Quality of Life Outcomes, 15*, 143.

Sakamoto, K. (2020). *Factors influencing child survival in Tanzania: Comparative analysis of diverse deprived rural villages*. Springer.

Sakamoto, K., Khemmarath, P., Ohmori, R., & Maro, A. C. (2020b). Health, livelihoods, and food intake in coastal southeast Tanzania: From questionnaire interviews in Kijiweni village, Lindi region. *Journal of the School of International Studies, Utsunomiya University, 50*, 11–29.

Sakamoto, K., Khemmarath, P., Ohmori, R., & Maro, A. C. (2021a). Health, livelihoods, and food intake in inland southeast Tanzania: From questionnaire interviews in Malolo village, Lindi region. *Journal of the School of International Studies, Utsunomiya University, 51*, 15–34.

Sakamoto, K., Ohmori, R., & Okui, A. (2020c). Situation of women and children in southern Tanzania: From questionnaires in Ifunda, Iringa with focus on food-intake and health. *Journal of the School of International Studies, Utsunomiya University, 49*, 61–78.

Sakamoto, K., Ohmori, R., & Tsuda, K. (2020a). Health, livelihoods, and food intake of children and adults in central Tanzania: From questionnaire interviews in Chinangali I village, Chamwino district, Dodoma region. *Journal of the School of Regional Design, Utsunomiya University, 7*, 43–63.

Sakamoto, K., Ohmori, R., & Tsuda, K. (2021b). Correlation between intake of wild food in 3 areas of Tanzania: Analysis from semi-arid central and inland/coastal southeast. *Journal of International Development Studies, 30*(2), 93–112.

Spilker, B. (1996). *Quality of life and Pharmacoeconomics in clinical trials*. Lippincott-Raven.

Tanzania National Bureau of Statistics and ICF Macro. (2011). *2010 Tanzania demographic and health survey: Key findings*. NBS and ICF Macro. Retrieved May 20, 2022 https://www.dhsprogram.com/pubs/pdf/SR183/SR183.pdf

Tsunoda, N., Inayama, T., Hata, K., & Oka, J. (2015). Vegetable dishes, dairy products and fruits are key items mediating adequate dietary intake for Japanese adults with spinal cord injury. *Spinal Cord, 53*, 786–790.

Wagner, A. K., Wyss, K., Gandek, B., Kilima, P. M., Lorenz, S., & Whiting, D. A. (1999). Kiswahili version of the SF-36 health survey for use in Tanzania: Translation and tests of scaling assumptions. *Quality of Life Research, 8*(1/2), 101–110.

Wyss, K., Wagner, A. K., Whiting, D., Mtasiwa, D. M., Tanner, M., Gandek, B., & Kilima, P. M. (1999). Validation of the Kiswahili version of the SF-36 health survey in a representative sample of an urban population in Tanzania. *Quality of Life Research, 8*, 111–120.

Chapter 6
Social Capital and Subjective "Poverty" Contribute to People's Subjective Health, But Financial Support Does Not

Reiko Ohmori, Tamahi Kato, and Kumiko Sakamoto

Abstract Various social factors need to be considered to improve people's health. To capture these factors, multiple regression analysis on subjective health was implemented against various factors, including social capital, food/financial social support, food intake frequency, education, and subjective relative poverty, collected through firsthand questionnaire interviews with 424 respondents in four rural villages of Tanzania (Dodoma, Iringa, and inland/coastal Lindi regions). The perception that villagers help each other was significantly related to subjective physical health in a Muslim coastal Lindi village ($p < 0.05$). This finding confirmed previous research in other parts of Africa that social capital contributes to health evaluation. Those who considered themselves "poor" had a tendency to have better subjective physical health in a semiarid Dodoma village ($p < 0.05$). Traditional inland dietary patterns with staple foods and vegetables that the relatively "poor" eat may be a contributing factor. Both providing and receiving financial support had a negative effect on subjective physical health (providing support in a semiarid Dodoma village) and subjective mental health (in Lindi: receiving in an inland village and providing in a coastal village). Receiving food assistance was a negative factor for subjective physical health (Iringa villages), but providing it was a positive factor for subjective mental health (Lindi coastal village).

Keywords Social determinants of health (SDH) · Subjective health · Social capital · Mutual assistance · East Africa · Social support

---

R. Ohmori (✉)
School of Regional Design, Utsunomiya University, Utsunomiya, Japan
e-mail: rohmori@cc.utsunomiya-u.ac.jp

T. Kato
Center for African Area Studies, Kyoto University, Kyoto, Japan

K. Sakamoto
School of International Studies, Utsunomiya University, Utsunomiya, Japan
e-mail: ksaka@cc.utsunomiya-u.ac.jp

K. Sakamoto et al. (eds.), *Changing Dietary Patterns, Indigenous Foods, and Wild Foods*, https://doi.org/10.1007/978-981-99-3370-9_6

6.1 Social Capital and Social Support as Social Determinants of Health

Mutual relations and wealth make a difference in health and influence food intake. This chapter analyzes how mutual relations and wealth influence health, which is one of the major topics of this book.

"The solid facts" issued by the World Health Organization (WHO) indicate that it is not only medical factors but also social determinants of health (SDH), which are conditions in places where people live, learn, work, and so on, that influence health risks and outcomes (WHO, 2003). As an example of SDH, the social gradient explains that people in the lower social layer usually experience at least twice the risk of serious illness and premature death as those near the top. Regarding social support and capital, social isolation and exclusion are associated with increased rates of premature death. A community with high levels of social cohesion leads to low rates not only of coronary heart disease but also greater protective health (WHO, 2003).

The impact of social capital on health outcomes has been reported in various disciplines, such as sociology, economics, political science, and public health (De Silva et al., 2005; Kawachi & Kennedy, 1997; Murayama et al., 2012; Uphoff et al., 2013). Most research has found positive effects of social capital in the form of higher levels of trust, reciprocity, and civic engagement on health outcomes (Field, 2008; Kawachi et al., 1999; Subramanian et al., 2002). The definition of social capital is based on Putnam (1993, 2000) and Bourdieu (1986). Based on both concepts, several studies on social capital and health outcomes have been conducted (for Putnam: Musalia (2016); for Bourdieu: Carpiano (2006, 2007)).

In sub-Saharan Africa, empirical research on social capital that analyzes its relation to health is limited, except for several studies conducted in South Africa (Cramm & Nieboer, 2011; Ramlagan et al., 2013), Ghana (Avogo, 2013; Bisung et al., 2018), and Kenya (Goodman et al., 2017; Musalia, 2016). These studies show that social capital is generally associated with better health outcomes. Avogo (2013) suggests that in Ghana, social support predicts better self-rated health, while informal social control and direct participation do not; social control is associated with the likelihood of reporting illnesses within the last 6 months; direct participation in voluntary groups has the opposite effect; and women had lower predicted probabilities of better self-rated health and higher probabilities of reporting illnesses in the last 6 months compared with men. In his econometric analysis using Afrobarometer data, Musalia (2016) reports that social capital was significantly associated with anxiety/worry and physical health in Kenya. Individual trust was associated with a 6% reduction in the likelihood of physical health problems. Conversely, generalized trust was associated with a 37% reduction in anxiety/worry, while individual trust was associated with a 5% reduction in anxiety/worry. Both individual-level trust and generalized trust were associated with better health outcomes in Kenya. Bisung et al. (2018) suggest that women with some community participation were less likely to report poor health than those who reported low participation, and women in Ghana who did not report tense relations with other community members were less likely to report poor health than women who had tense relations. According to these previous studies in Ghana and Kenya, social support and trust were positively associated with health, whereas participation had mixed effects on health.

Research on factors influencing child survival in rural Tanzania indicated that food sharing within the community had a positive association with child survival (Sakamoto, 2017, 2020). However, food sharing was not inclusive, especially in food-deficit, semiarid central Tanzania and to some extent in coastal areas in the southeast, but was inclusive in relatively food-sufficient rural North Zanzibar. On the other hand, financial support for medicine in coastal areas in southeastern Tanzania had a negative effect on child survival: such financial support was only provided when the child was very sick (Sakamoto, 2017, 2020). Social support had a positive association in research in Ghana and Kenya, but the above research on child survival in Tanzania indicated that there were differences between food support and monetary support among geographic areas. However, the effects on the health of adults are unknown.

The objective of this chapter is to clarify the association between subjective health and social determinants of health, especially social capital, food/financial social support, and subjective relative wealth/poverty, as well as food intake and education, through surveys of four villages with different environments in Tanzania.

6.2 Characteristics of Study Participants and Research Method

6.2.1 Research Sites and Participants

The participants of the analysis included 424 people: 171 from Ifunda and Bandabichi villages, Iringa district, Iringa region (a granary area in inland south); 81 from Chinangali I village, Chamwino district, Dodoma region (an inland central semi-arid area); 88 from Malolo village, Ruangwa district, Lindi region (an inland area in the southeast); and 84 from Kijiweni village, Lindi district, Lindi region (a coastal area in the southeast).

The average age and standard deviation of study subjects in Ifunda/Bandabichi, Chinangali I, Malolo, and Kijiweni villages were 28.4 ± 10.2, 45.8 ± 18.0, 54.4 ± 18.5, and 41.0 ± 13.8, respectively (Table 6.1). The ratio of females was 95.5%, 69.3%, 59.8%, and 64.6%; the ratio of Muslim or Christian was 7.4% or 90.8%, 3.7% or 96.3%, 11.4% or 88.6%, and 98.8% or 1.2%; the ratio of people who had attained an education above the elementary school level was 95.8%, 75.0%, 89.8%, and 72.6%; and the average number and standard deviation of household members were 4.6 ± 2.0, 4.5 ± 2.0, 3.4 ± 1.8, and 4.1 ± 1.7 in Ifunda/Bandabichi, Chinangali I, Malolo, and Kijiweni villages, respectively. Comparing the four villages, the proportion of farmers was highest in Malolo village; the proportion of

Table 6.1 Characteristics of study participants

	All	Ifunda/ Bandabichi village	Chinangali I village	Malolo village	Kijiweni village
Number	424	171	81	88	84
Age	39.7 ± 17.7	28.4 ± 10.2	45.8 ± 18.0	54.4 ± 18.5	41.0 ± 13.8
Sex					
Female (%)	75.5	95.5	69.3	59.8	64.6
Male (%)	24.5	4.5	30.7	40.2	35.4
Religion					
Islam (%)	25.8	7.4	3.7	11.4	98.8
Christianity (%)	73.5	90.8	96.3	88.6	1.2
Other (%)	0.7	1.8	0.0	0.0	0.0
Educational background (above primary school attainment) (%)	85.9	95.8	75.0	89.8	72.6
Number of household members	4.2 ± 2.0	4.6 ± 2.0	4.5 ± 2.0	3.4 ± 1.8	4.1 ± 1.7
Occupation					
Farming (%)	88.3	76.6	96.3	97.7	94.0
Business (%)	8.3	13.8	11.1	0.0	3.6
Livestock keeping (%)	4.8	3.6	11.1	3.4	2.4
Other (%)	6.9	9.6	6.2	6.8	2.4

Data of “Age” and “Number of Household Members” expressed as the mean ± standard deviation

businesspeople was highest in Ifunda and Bandabichi villages; the proportion of those keeping livestock was highest in Chinangali I village; and other occupations were in Ifunda and Bandabichi villages.

6.2.2 Research Method

Questionnaire interviews were implemented in four villages from June to September 2019: June to July 2019 in Ifunda and Bandabichi villages (Sakamoto et al., 2020a); August 2019 in Chinangali I village (Sakamoto et al., 2020b); and September 2019 in Kijiweni village (Sakamoto et al., 2020c) and Malolo village (Sakamoto et al., 2021). Research permits were obtained from the Tanzania Commission for Science and Technology (COSTECH), and research ethics were followed in accordance with the rules and regulations of Utsunomiya University (permission granted as H18-0008), such as asking prior approval to interview.

The subjective health score and its contributing factors were analyzed in the four villages. Subjective health was measured by the Swahili version of the SF (Short-Form)-12 (Wagner et al., 1999; Wyss et al., 1999; Patel et al., 2017), consisting of the Physical Components Summary (PCS, calculated from PF: Physical

Functioning; RP: Role Physical; BP: Body Pain; GH: General Health) and Mental Components Summary (MCS, calculated from VT: Vitality; SF: Social Functioning; RE: Role Emotional; MH: Mental Health) based on the questionnaire. The ten indicators were statistically analyzed to understand their contribution to PCS and MCS.

The food intake frequency of eight food groups was defined as "2 or more times a day," "once a week," "4 to 6 times a week," and "fewer than 3 times a week" for staple foods and vegetables and as "daily", "4 to 6 times a week," "2 to 3 times a week," and "once or less a week" for meat, fish, dairy foods, pulses, nuts, and fruits based on previous studies (Mizoguchi et al., 2004; Tsunoda et al., 2015). The category "Never eat" was added to reflect the diversity of foods in Tanzania. In our analysis, food intake frequency (0–4 points) was calculated as a total of 32 points for the dry and rainy seasons. Respondents were also asked about the frequency with which food was obtained from the forest during times of food shortage.

Social factors evaluated as social determinants of health were attainment of secondary education, subjectively relatively "poor" (based on self-evaluation as "poor," "average," or "rich") within the village, food and monetary assistance (receipt, provision), and perceiving villagers as helping each other.

The PCS, MCS, and food intake frequency scores are expressed as mean ± standard deviation. One-way ANOVA, Tukey's post hoc test for the comparison of subjective health score and food intake frequency, and the Chi-square test for the living environment in four villages were conducted. A multiple linear regression was calculated to predict PCS or MCS score based on food intake frequency during the dry and rainy seasons, educational background, obtaining foods from the forest when food was insufficient, subjectively relatively "poor" within the village, food support from and for others, financial support from and for others, and perceiving villagers as helping each other. All statistical analyses were performed by using IBM SPSS Statistics ver. 26 (IBM Japan Inc., Tokyo, Japan).

6.3 Social Factors Affecting Subjective Health

6.3.1 Regional Comparison of Subjective Health

The PCS of the subjective health score was significantly higher in Ifunda and Bandabichi villages (46.2 ± 7.9), Chinangali I village (46.2 ± 7.9), and Kijiweni village (46.4 ± 12.3) than in Malolo village (36.7 ± 10.1) ($p < 0.001$, Fig. 6.1). The MCS was also significantly higher in Ifunda and Bandabichi villages (44.0 ± 11.6), Chinangali I village (43.1 ± 15.5), and Kijiweni village (40.5 ± 13.3) than in Malolo village (35.2 ± 10.7) (Ifunda and Bandabichi, Chinangali I: $p < 0.001$ and Kijiweni: $p < 0.05$, Fig. 6.2). Both results for Malolo village in the inland Lindi region were relatively low compared to those of the other village sites.

For each subscale score of PCS, PF and RP were highest in Kijiweni village (47.9 ± 11.4, 45.0 ± 13.9), BP in Chinangali I village (46.3 ± 13.0), and GH in

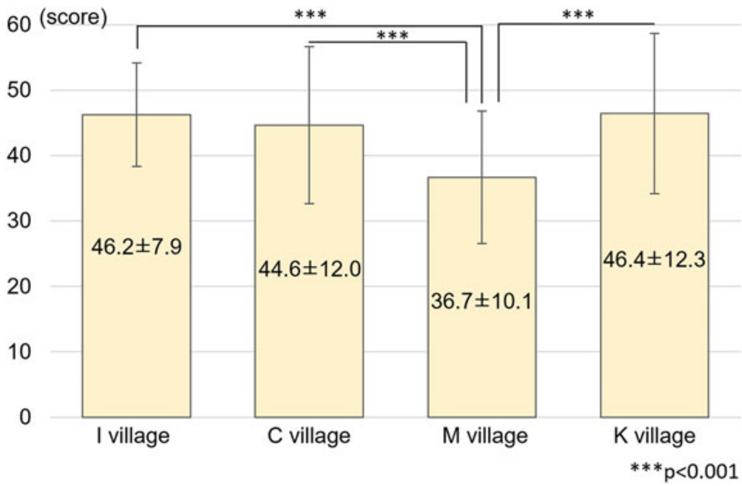


Fig. 6.1 Regional comparison of subjective health: Physical Component Summary (PCS) *I* Ifunda and Bandabichi village, Iringa district, Iringa region. *C* Chinangali I village, Chamwino district, Dodoma region. *M* Malolo village, Ruangwa district, Lindi region in the southeast. *K* Kijiweni village, Lindi district, Lindi region

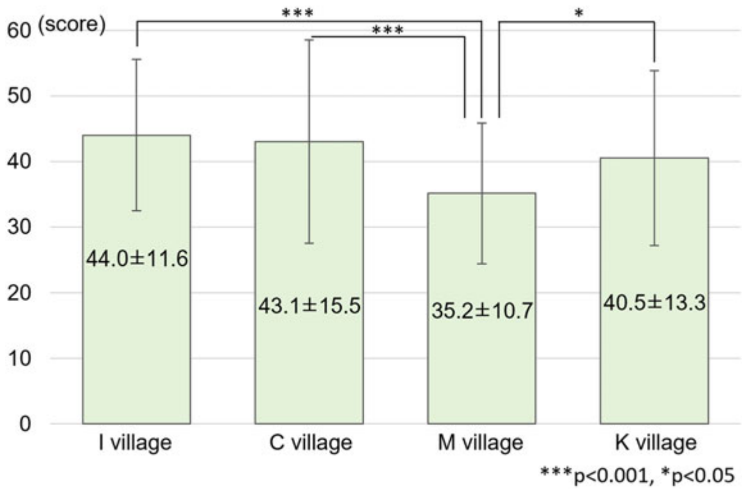


Fig. 6.2 Regional comparison of subjective health: Mental Component Summary (MCS). *I* Ifunda and Bandabichi village, Iringa district, Iringa region. *C* Chinangali I village, Chamwino district, Dodoma region. *M* Malolo village, Ruangwa district, Lindi region in the southeast. *K* Kijiweni village, Lindi district, Lindi region

Ifunda and Bandabichi villages (43.5 ± 9.7). VT, SF, RE, and MH, which are subscales of MCS, were highest in Ifunda and Bandabichi villages (VT, 52.5 ± 13.7; RE, 34.6 ± 19.1; MH, 47.7 ± 11.6), except SF, which was 46.7 ± 10.1 in Chinangali I village (Table 6.2).

6.3.2 Regional Comparison of Food Intake Frequency Score

No significant difference was observed in the food intake frequency score during the dry season (Fig. 6.3). The results showed that there was a significant difference between Chinangali I village (14.1 ± 3.8), which is in Dodoma, and Kijiweni village (16.1 ± 3.8), which is in the coastal Lindi region, during the rainy season ($p < 0.05$, Fig. 6.4). Although there is no disparity in food intake frequency among the four regions during the dry season, there is a difference in the rainy season.

6.3.3 Living Environment in the Four Villages

Some of the major social components that were analyzed as the environment in four villages are shown in Table 6.3. Regarding educational background, 88.4%, 73.1%, 88.6%, and 72.6% of participants had graduated primary school and 48.2%, 7.7%, 3.4%, and 3.6% of participants had graduated secondary school in Ifunda/Bandabichi, Chinangali I, Malolo, and Kijiweni villages, respectively. The ratio of secondary school graduates was highest in Ifunda and Bandabichi villages (48.2%). The proportion of people who obtained foods from the forest when food was insufficient was higher in Malolo and Kijiweni villages (65.5%, 54.2%) than in Ifunda/Bandabichi and Chinangali I villages (14.8%, 24.7%). There were very few respondents who felt they were relatively poor within the village in Iringa (14.8%) in comparison to other villages, especially Kijiweni village (48.1%). The support of food and financial support from/for others in Ifunda and Bandabichi villages were higher than those in other villages. In Malolo village, financial support from/for others was the lowest among the villages (18.4%). The perception of villagers as helping each other was not significantly different among the four villages.

6.3.4 Factors Affecting Subjective Health in the Four Villages

Tables 6.4 and 6.5 summarize the data regarding the associations between PCS or MCS as subjective health and each social factor obtained by the multiple regression analysis. Among the four villages, being subjectively relatively "poor" within the

Table 6.2 Subscale score of subjective health in four villages

Subscale score	All	Ifunda and Bandabichi village	Chinangali I village	Malolo village	Kijiweni village	ANOVA *p* value
Physical Component Summary (PCS)						
Physical Functioning (PF)	45.4 ± 11.4	47.4 ± 9.4	45.5 ± 12.2	39.4 ± 11.8	47.9 ± 11.4	<0.001
Role Physical (RP)	38.7 ± 16.2	40.4 ± 15.2	40.1 ± 16.7	28.4 ± 15.0	45.0 ± 13.9	<0.001
Body Pain (BP)	42.9 ± 13.6	46.0 ± 11.2	46.3 ± 13.0	36.0 ± 13.0	41.1 ± 15.7	<0.001
General Health (GH)	39.2 ± 11.6	43.5 ± 9.7	38.3 ± 11.7	32.0 ± 9.2	39.7 ± 13.2	<0.001
Mental Component Summary (MCS)						
Vitality (VT)	49.1 ± 14.4	52.5 ± 13.7	51.1 ± 15.7	41.3 ± 10.5	49.1 ± 15.0	<0.001
Social Functioning (SF)	45.3 ± 11.2	46.2 ± 11.5	46.7 ± 10.1	43.3 ± 10.2	44.6 ± 12.6	n.s.
Role Emotional (RE)	30.9 ± 20.0	34.6 ± 19.1	32.2 ± 21.9	20.8 ± 17.9	33.7 ± 18.6	<0.001
Mental (MH)	45.1 ± 12.8	47.7 ± 11.6	47.2 ± 14.9	39.7 ± 9.8	44.1 ± 13.6	<0.001

Data are expressed as the mean ± standard deviation
n.s. no significant difference

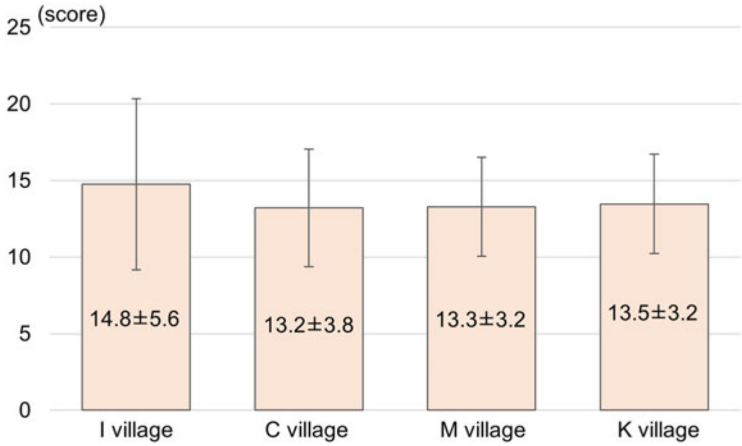


Fig. 6.3 Regional comparison of food intake frequency scores in the dry season. *I* Ifunda and Bandabichi village, Iringa district, Iringa region. *C* Chinangali I village, Chamwino district, Dodoma region. *M* Malolo village, Ruangwa district, Lindi region in the southeast. *K* Kijiweni village, Lindi district, Lindi region

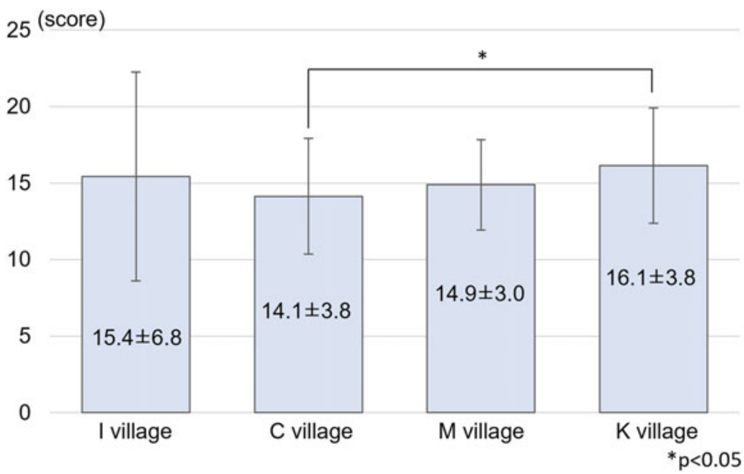


Fig. 6.4 Regional comparison of food intake frequency scores in the rainy season. *I* Ifunda and Bandabichi village, Iringa district, Iringa region. *C* Chinangali I village, Chamwino district, Dodoma region. *M* Malolo village, Ruangwa district, Lindi region in the southeast. *K* Kijiweni village, Lindi district, Lindi region

Chinangali I village was significantly positively associated with PCS ($\beta = 0.39$, $p < 0.05$). In Kijiweni village, "perception of villagers as helping each other" was also associated with PCS ($\beta = 0.33$, $p < 0.05$).

Comparing the relative magnitude of the effects of different explanatory variables, the strongest factors affecting PCS in Ifunda and Bandabichi villages were

Table 6.3 Living environment in the four villages

	Ifunda and Bandabichi villages (%)	Chinangali I village (%)	Malolo village (%)	Kijiweni village (%)	χ^2-test *p* value
Educational background					
Primary school attainment	88.4	73.1	88.6	72.6	<0.005
Secondary school attainment	48.2	7.7	3.4	3.6	<0.001
Obtaining foods from the forest when food was insufficient	37.8	27.3	65.5	54.2	<0.001
Subjectively relatively "poor" within the village	14.8	24.7	44.3	48.1	<0.001
Food support					
Receiving from others	36.9	25.0	27.3	28.6	n.s.
Providing for others	61.4	33.3	34.1	46.4	<0.001
Financial support					
Receiving from others	55.0	30.9	18.4	35.7	<0.001
Providing for others	65.6	37.0	12.6	26.5	<0.001
Perception of villagers as helping each other	75.0	80.9	74.7	73.4	n.s

n.s. no significant difference

food intake frequency score during the dry season ($\beta = 0.22$), which was positive, and receiving food assistance ($\beta = -0.28$), which was negative. In Chinangali I village, the positive factors were self-perceived "poverty" ($\beta = 0.39$) and food intake frequency score during the dry season ($\beta = 0.22$), and the negative factor was financial support for others ($\beta = -0.29$). The food intake frequency score during the dry season in Malolo village and the rainy season in Kijiweni village was the strongest negative factor affecting PCS ($\beta = -0.20$ and -0.28, respectively).

None of the factors was statistically significant for MCS, but there were some relationships. The strongest positive or negative factor affecting MCS in Ifunda and Bandabichi villages was perceiving villagers as helping each other ($\beta = 0.32$) or food intake frequency score during the dry season ($\beta = -0.24$). In Chinangali I village, the food intake frequency score during the dry season ($\beta = 0.35$) was a positive factor, although it was a negative factor during the rainy season ($\beta = -0.31$). In Malolo village, the food intake frequency score during the dry season ($\beta = 0.22$) was a positive factor, and financial support from others ($\beta = -0.22$) was a negative factor. In Kijiweni village, food support for others ($\beta = 0.23$) was a positive factor, but financial support for others ($\beta = -0.23$) was a negative factor.

Table 6.4 Analysis of factors affecting physical component summary (PCS)

	All		Ifunda and Bandabichi villages		Chinangali I village		Malolo village		Kijiweni village	
	β	p value	β	p value	β	p value	β	p value	β	p value
Food intake frequency score										
Dry season	0.05	n.s.	0.22	n.s.	0.22	n.s.	−0.20	n.s.	−0.08	n.s.
Rainy season	−0.02	n.s.	0.16	n.s.	0.13	n.s.	0.12	n.s.	−0.28	n.s.
Educational background	0.04	n.s.	−0.11	n.s.	0.04	n.s.	−0.15	n.s.	0.08	n.s.
Obtaining food from the forest when food was insufficient	−0.07	n.s.	−0.05	n.s.	0.08	n.s.	0.05	n.s.	−0.02	n.s.
Subjectively relatively "poor" within the village	0.12	n.s.	−0.21	n.s.	0.39	<0.05	0.15	n.s.	−0.002	n.s.
Food support										
Receiving from others	−0.11	n.s.	−0.28	n.s.	−0.09	n.s.	−0.03	n.s.	−0.13	n.s.
Providing for others	−0.02	n.s.	0.17	n.s.	0.04	n.s.	−0.16	n.s.	0.10	n.s.
Financial support										
Receiving from others	0.01	n.s.	−0.01	n.s.	0.17	n.s.	−0.15	n.s.	−0.13	n.s.
Providing for others	0.03	n.s.	−0.14	n.s.	−0.29	n.s.	0.18	n.s.	−0.03	n.s.
Perception of villagers as helping each other	0.10	n.s.	−0.08	n.s.	0.06	n.s.	0.18	n.s.	0.33	<0.05
R^2	0.06	n.s.	0.17	n.s.	0.34	n.s.	0.12	n.s.	0.20	n.s.
Adjusted R^2	0.02		−0.08		0.17		−0.001		0.06	
VIF	1.096–1.823		1.237–1.941		1.321–2.784		1.120–1.625		1.113–1.906	

n.s. no significant difference

Table 6.5 Analysis of factors affecting mental component summary (MCS)

	All		Ifunda and Bandabichi villages		Chinangali I village		Malolo village		Kijiweni village	
	β	*p* value	β	*p* value	β	*p* value	β	*p* value	β	*p* value
Food intake frequency score										
Dry season	0.01	n.s.	−0.24	n.s.	0.35	n.s.	0.22	n.s.	−0.18	n.s.
Rainy season	0.02	n.s.	0.16	n.s.	−0.31	n.s.	0.11	n.s.	0.12	n.s.
Educational background	0.06	n.s.	−0.05	n.s.	−0.06	n.s.	−0.02	n.s.	0.13	n.s.
Obtaining foods from the forest when food was insufficient	−0.11	n.s.	−0.12	n.s.	0.11	n.s.	0.07	n.s.	−0.19	n.s.
Subjectively relatively "poor" within the village	0.11	n.s.	0.03	n.s.	0.13	n.s.	0.03	n.s.	0.16	n.s.
Food support										
Receiving from others	0.03	n.s.	0.06	n.s.	0.04	n.s.	0.14	n.s.	0.08	n.s.
Providing for others	0.07	n.s.	0.11	n.s.	−0.08	n.s.	−0.01	n.s.	0.23	n.s.
Financial support										
Receiving from others	−0.01	n.s.	−0.20	n.s.	0.20	n.s.	−0.22	n.s.	0.03	n.s.
Providing for others	0.04	n.s.	0.06	n.s.	−0.04	n.s.	0.01	n.s.	−0.23	n.s.
Perception of villagers as helping each other	−0.10	n.s.	0.32	n.s.	−0.04	n.s.	−0.03	n.s.	−0.03	n.s.
R^2	0.05	n.s.	0.11	n.s.	0.12	n.s.	0.12	n.s.	0.18	n.s.
Adjusted R^2	0.01		−0.17		−0.10		0.001		0.03	
VIF	1.096–1.823		1.237–1.941		1.321–2.784		1.120–1.625		1.113–1.906	

n.s. no significant difference

6.4 Discussion and Conclusions

This chapter analyzed the association between subjective health and social factors in four rural villages of Tanzania, a topic that has not been sufficiently reported, especially for adults in Tanzania. There were two statistically significant results associated with subjective physical health.

First, the positive relation between subjective physical health and “perceiving villagers as helping each other” was confirmed to be significant in Kijiweni village in the coastal Lindi region. “Perception of villagers as helping each other” was also positively related to the mental component summary in Ifunda and Bandabichi villages, although the correlation was not significant. This finding is in line with previous research in Ghana (Avogo, 2013) and Kenya (Musalia, 2016), where social capital contributed to physical health: social support contributed to self-rated better health in Ghana, and social capital was associated with physical health. Comparing the characteristics in the four research villages (Table 6.1), the majority are Muslim in Kijiweni village (98%), whereas they are Christians in other villages. This background may be an additional factor influencing how the perception of mutual help within the village makes a difference in people’s physical health.

Second, another significant positive factor influencing the subjective physical health score was relative subjective poverty in Chinangali I village. That is, those who perceived themselves as “poor” had tendencies to have a better self-evaluation of physical health. While this may seem to be a contradictory result, it provides additional evidence for the healthy “traditional inland” dietary pattern with a focus on staple foods and vegetables discussed by Keding et al. (2011), elaborated in Chap. 12, and mentioned in Chaps. 2, 3, 5, and 13. Another explanation may be the livelihood in the village. Chinangali I village is an agro-pastoral society where a minority (Table 6.1: 11% of the respondents) keep livestock. It is typically considered that cattle owners are “rich.” Owning cattle may increase the intake of protein from the cattle (milk or meat) but decrease the intake of vegetables and increase the risk of disease from livestock.

In Chinangali I village, providing financial support for others is negatively related to subjective physical health and receiving from others is positively related to subjective physical health, although the correlation is not significant. According to previous research in a neighboring semiarid village in the Dodoma region, financial support for health services was much more common than for food, although the most typical reason for financial support was to buy food in other rural villages (Sakamoto, 2020, p.183).

Additionally, in Chinangali I village, the food intake frequency score in the dry season had a positive relation to subjective physical health, although it was not statistically significant. Food intake frequency score and MSC were positively related in the dry season and negatively related in the rainy season. The semiarid Dodoma region has frequent food deficits, which may be one of the reasons that food intake may be related to health. On the other hand, the mixed positive and negative relationship, also common to other villages, may exist because various food groups are included in the food intake, which was discussed in Chap. 5.

In Ifunda and Bandabichi villages, receiving food assistance from others was a negative factor associated with subjective physical health, although the correlation was not statistically significant. This may be because the Iringa region, where Ifunda and Bandabichi villages are located, is known as the main maize-producing region and is a breadbasket in Tanzania. In such an environment, there may be a gap between the minority who are in need of receiving food assistance and the majority who have access to food.

In Kijiweni village, subjective mental health was positively related to providing food support for others but negatively related to providing financial support for others. In Malolo village, subjective mental health was negatively related to financial support from others. According to research in rural Zambia (Sugiyama, 2007), food is considered to be a commodity to be shared that follows the "path for food", but money is basically individual and personal property that follows a different "path for money." A similar perspective may be prevalent in Kijiweni village and Ifunda/Bandabichi villages, differentiating how the respondents feel about receiving/providing food or money. Providing food support may be a form of casual support, but both receiving and providing financial support may be a mental burden to the recipient and provider. Additionally, receipt of financial support may have had more urgency, already deteriorating subjective mental health.

The findings presented in this chapter confirmed that social capital contributed to the health of adults in Tanzania, as seen in previous research in Africa. Among mutual supports, financial support had negative effects on health, whereas food support had positive effects on health, a finding that has not been provided in previous research. Relative subjective poverty had a positive effect in Chinangali I village, which will be further elaborated in Chap. 12 and has already been mentioned in Chaps. 2, 3, 5, and 13.

6.5 Study Limitations

Our research in this chapter has several limitations. First, the average age was much lower in Ifunda and Bandabichi villages and higher in Malolo village than in other villages because of the age distribution of respondents. This point may have resulted in higher or lower subjective health scores than in the other villages.

Second, sampling methods of data differed by each village. In Ifunda and Bandabichi villages, the percentage of young women was higher than in other villages because answers to the questionnaire were given during maternal and child health checkups, which may have affected the health scores. Finally, the survey was implemented in the dry season, and the food intake in the rainy season was reported based on recall. This may have affected the answers on food intake in the rainy season.

However, the significant results are for Chinangali I and Kijiweni villages, and the findings not related to food intake can therefore be considered to be uninfluenced by this limitation. Other results that are not significant and have limitations may need further studies for clarification.

Acknowledgments The residents of the villages (for answering questions and providing information), Dr. Anita Wagner and Dr. Barbara Gande (for sharing the Swahili version of SF-36), Ms. Nobuko Tsubaki, Mr. Micheal Chimosa, Ms. Anna Maro (research coordinators), and Ms. Ayusa Okui are highly appreciated. We also thank the students for their data inputting to enable data analysis. This study was supported by Grant-in-Aid for Scientific Research 18H03438 and the Interdisciplinary Research Grant from School of Regional Design at Utsunomiya University.

Ohmori was responsible for the conceptualization, data check, data analysis, and the initial and final manuscript. Kato was responsible for the literature review and editing of the manuscript. Sakamoto was responsible for the conceptualization, interviews, field data collection and coordination, data input coordination, data check, interpretation of the analyzed data, and editing of the manuscript.

References

Avogo, W. A. (2013). Social capital, civic engagement, and self-rated health in Ghana. *African Population Studies, 27*(2), 188–202. https://doi.org/10.11564/27-2-440

Bisung, E., Kangmennaang, J., & Luginaah, I. (2018). Neighborhood structural differences and women,s mental health: An empirical study in Accra, Ghana. *Quality of Life Research, 27*(3), 661–671.

Bourdieu, P. (1986). The forms of capital. In J. E. Richardson (Ed.), *Handbook of theory for sociology of education*. Greenwood Press.

Carpiano, R. M. (2006). Toward a neighborhood resource-based theory of social capital for health: Can Bordieu and sociology help? *Social Science & Medicine, 62*(1), 165–175. https://doi.org/10.1016/j.socscimed.2005.05.020

Carpiano, R. M. (2007). Neighborhood social capital and adult health: An empirical test of a Bourdieu-based model. *Health and Place, 13*(3), 639–655. https://doi.org/10.1016/j.healthplace.2006.09.001

Cramm, J. M., & Nieboer, A. P. (2011). The influence of social capital and socioeconomic conditions on self-rated health among residents of an economically and health-deprived South African township. *International Journal for Equity in Health, 10*, 51. https://doi.org/10.1186/1475-9276-10-51

Field, J. (2008). *Social Capital* (2nd ed.). Routledge.

Goodman, M. L., Johnson, T. M., Guillot-Wright, S., Porter, K. A., Keiser, P. H., & Gitari, S. (2017). How do Kenyan orphan girls experience less meaningful lives and how much does it matter for 'health'? *Quality of Life Research, 26*(6), 1551–1559. https://doi.org/10.1007/s11136-017-1511-y

Kawachi, I., & Kennedy, B. P. (1997). The relationship of income inequality to mortality: Does the choice of indicator matter? *Social Science & Medicine, 45*(7), 1121–1127. https://doi.org/10.1016/s0277-9536(97)00044-0

Kawachi, I., Kennedy, B. P., & Glass, R. (1999). Social capital and self-rated health: A contextual analysis. *American Journal of Public Health, 89*(8), 1187–1193. https://doi.org/10.2105/ajph.89.8.1187

Keding, G. B., Msuya, J. M., Maass, B. L., & Krawinkel, M. B. (2011). Dietary patterns and nutritional health of women: The nutrition transition in rural Tanzania. *Food and Nutrition Bulletin, 32*(3), 218–226. https://doi.org/10.1177/156482651103200306

De Silva, M. J., McKenzie, K., Harpham, T., & Huttly, S. R. (2005). Social capital and mental illness: A systematic review. *Journal of Epidemiology Community Health, 59*(8), 619–627. https://doi.org/10.1136/jech.2004.029678

Mizoguchi, K., Yukari, T., & Miyuki, A. (2004). Relationship between a positive perception toward work and the dietary habits of young male workers. *The Japanese Journal of Nutrition and Dietetics, 62*(5), 269–283.

Murayama, H., Fujiwara, Y., & Kawachi, I. (2012). Social capital and health: A review of prospective multilevel studies. *Journal of Epidemiology, 22*(3), 179–187. https://doi.org/10.2188/jea.je20110128

Musalia, J. (2016). Social capital and health in Kenya: A multilevel analysis. *Social Science & Medicine, 167*, 11–19. https://doi.org/10.1016/j.socscimed.2016.08.043

Patel, A. R., Lester, R. T., Marra, C. A., van der Kop, M. L., Ritvo, P., Engel, L., Karanja, S., & Lynd, L. D. (2017). The validity of the SF-12 and SF-6D instruments in people living with HIV/AIDS in Kenya. *Health and Quality of Life Outcomes, 15*(1), 143. https://doi.org/10.1186/s12955-017-0708-7

Putnam, R. D. (1993). *The prosperous community: Social capital and public life*. American Prospect, Retrieved December 1, 2022, from http://faculty.washington.edu/matsueda/courses/590/Readings/Putham%201993%20Am%20Prospect.pdf

Putnam, R. D. (2000). *Bowling alone: The collapse and revival of American community*. Simon & Shuster.

Ramlagan, S., Peltzer, K., & Phaswana-Mafuya, N. (2013). Social capital and health among older adults in South Africa. *BMC Geriatrics, 13*, 100. https://doi.org/10.1186/1471-2318-13-100

Sakamoto, K. (2017). Does mutual assistance contribute to child survival? Comparative analysis of influencing factors in child mortality in 3 areas of Tanzania. *Journal of African Studies, 9*, 1–17. https://doi.org/10.11619/africa.2017.92_1

Sakamoto, K. (2020). *Factors influencing child survival in Tanzania: Comparative analysis of diverse deprived rural villages*. Springer.

Sakamoto, K., Ohmori, R., & Okui, A. (2020a). Situation of women and children in southern Tanzania: From questionnaires in Ifunda, Iringa with focus on food-intake and health. *Journal of the School of International Studies, Utsunomiya University, 49*, 61–78. http://hdl.handle.net/10241/00012115

Sakamoto, K., Ohmori, R., & Tsuda, K. (2020b). Health, livelihoods, and food intake of children and adults in central Tanzania: From questionnaire interviews in Chinangali I village, Chamwino district, Dodoma region. *Regional Design Science, 7*, 43–64. http://hdl.handle.net/10241/00012127

Sakamoto, K., Parinya, K., Ohomori, R., & Maro, A. C. (2020c). Health, livelihoods, and food intake in coastal southeast Tanzania: From questionnaire interviews in Kijiweni village, Lindi region. *Journal of the School of International Studies, Utsunomiya University, 50*, 11–29. http://hdl.handle.net/10241/00012361

Sakamoto, K., Parinya, K., Ohmori, R., & Anna, C. M. (2021). Health, livelihoods, and food intake in inland southeast Tanzania: From questionnaire interviews in Malolo village, Lindi region. *Journal of the School of International Studies. Utsunomiya University, 51*, 15–34. http://hdl.handle.net/10241/00012361

Subramanian, S. V., Kim, D. J., & Kawachi, I. (2002). Social trust and self-rated health in US communities: A multilevel analysis. *Journal of Urban Health, 79*(4 Suppl 1), S21–S34. https://doi.org/10.1093/jurban/79.suppl_1.s21

Sugiyama, Y. (2007). 'Path for money', 'path for food', and 'path for respect' [in Japanese]. In N. Haruka (Ed.), *Money and resources* (pp. 147–187). Kobundo.

Tsunoda, N., Inayama, T., Hata, K., & Oka, J. (2015). Vegetable dishes, dairy products and fruits are key items mediating adequate dietary intake for Japanese adults with spinal cord injury. *Spinal Cord, 53*(11), 786–790.

Uphoff, E. P., Pickett, K. E., Cabieses, B., Small, N., & Wright, J. (2013). A systematic review of the relationships between social capital and socioeconomic inequalities in health: A contribution to understanding the psychosocial pathway of health inequalities. *International Journal for Equity in Health, 12*, 54. https://doi.org/10.1186/1475-9276-12-54

Wagner, A. K., Wyss, K., Gandek, B., Kilima, P. M., Lorenz, S., & Whiting, D. (1999). A Kiswahili version of the SF-36 health survey for use in Tanzania: Translation and tests of scaling assumptions. *Quality of Life Research, 8*(1–2), 101–110. https://doi.org/10.1023/a:1026441415079

World Health Organization. (2003). *Social determinants of health: The solid facts* (2nd ed.) Retrieved December 1, 2022, from https://apps.who.int/iris/handle/10665/326568

Wyss, K., Wagner, A. K., Whiting, D., Mtasiwa, D. M., Tanner, M., Gandek, B., & Kilima, P. M. (1999). Validation of the Kiswahili version of the SF-36 health survey in a representative sample of an urban population in Tanzania. *Quality of Life Research, 8*(1–2), 111–120. https://doi.org/10.1023/a:1026431727374

Part III
Case Studies: Changing Dietary Patterns and Implications on Health

Part III introduces case studies where changes in dietary patterns are apparent. Chapter 7 takes up Dar es Salaam city, where fast population growth and urbanization have visible implications for dietary patterns and serious malnutrition-related problems. Chapter 8 further analyzes the high food production rural villages in the southern highlands (Ifunda and Bandabichi villages, Iringa region) based on the data set analyzed in Part II. Chapter 9 discusses the coastal Lindi region, which is in transition to a purchase dietary pattern. It further analyzes the data set of the coastal bushland village in the southeast (Kijiweni village) analyzed in Part II and introduces a pilot questionnaire to school children in town.

Chapter 7
Growth with Disparity in a Rich Diverse City: Case of the Economic Capital Dar es Salaam

Lilian Daniel Kaale, Tamahi Kato, and Kumiko Sakamoto

Abstract The population and economy are growing faster in urban areas than in rural areas across the world. Dar es Salaam, the ninth fastest-expanding urban center worldwide, is one of the cities anticipated to grow to a megacity by 2030 and is likely to set the course for Tanzania's urban destiny. According to the 2022 Census, Dar es Salaam is now home to 8.7% (5,383,728) of Tanzania's entire population. The economy of Dar es Salaam is driven by manufacturing, information and communication, wholesale and retail trade, construction, and hotels and restaurants. It serves as Tanzania's primary commercial and economic hub due to its location along the Indian Ocean Coast. Furthermore, Dar es Salaam is one of the cities with significant disparities in a wealthy, diversified population. There are differences in the eating patterns and preferences among Dar es Salaam citizens as a result of these inequities. Malnutrition-related problems are also worsening as a result of gender, age, wealth, and preference as well as social, cultural, and traditional norms, a lack of resources, individual expertise, and other factors. To address these issues, the government should implement reasonable urbanization city legislation and policies as well as food and nutrition initiatives.

Keywords Dar es Salaam · Urban areas · Economic growth · Malnutrition · Dietary patterns

L. D. Kaale (✉)
Department of Food Science and Technology, University of Dar es Salaam, Dar es Salaam, Tanzania
e-mail: elykaale@gmail.com; dlilian@udsm.ac.tz

T. Kato
Center for African Area Studies, Kyoto University, Kyoto, Japan

K. Sakamoto
School of International Studies, Utsunomiya University, Utsunomiya, Japan
e-mail: ksaka@cc.utsunomiya-u.ac.jp

K. Sakamoto et al. (eds.), *Changing Dietary Patterns, Indigenous Foods, and Wild Foods*, https://doi.org/10.1007/978-981-99-3370-9_7

7.1 Introduction

This chapter introduces the situation of Dar es Salaam city as an urban example of changing dietary patterns. The case study provides a good example of food diversity and malnutrition issues in urban areas, setting the environment for a balanced discussion of the book's topic of changing dietary patterns.

By 2050, there will be 2.5 billion more people living in urban areas than there were in 2014 (Leyna et al., 2017). The majority of urban inhabitants are expected to reside in small settlements, and approximately one in eight urban residents will live in mega-cities with populations of more than 10 million inhabitants (Leyna et al., 2017). Moreover, the urbanization of African cities is accelerating, with a growing demand for basic needs. In Tanzania, urbanization emerged after Tanzania's independence in 1961, particularly in the 1967–1978 period (Wenban-Smith et al., 2016). Dar es Salaam has been mentioned by a number of researchers as an excellent example of urban centers where almost all new population growth is going on and where two-thirds of the world's 9 billion population will be in 2050 (Leyna et al., 2017; Todd et al., 2019; Wegerif, 2017; Wegerif & Wiskerke, 2017). One of the cities predicted to become a megacity by 2030 is Dar es Salaam (Leyna et al., 2017). It is the ninth fastest-growing urban center worldwide (Wegerif & Wiskerke, 2017) and is probably going to guide Tanzania's urban future (Todd et al., 2019).

Dar es Salaam means "Haven of Peace" (*Dari* = roof, *salama* = peace) in the Swahili language. The city was established by Sultan Majid of Muscat in 1857, and later, German colonialism was established, following the shift of its capital from Bagamoyo to Mzizima (Mkalawa & Haixiao, 2014). The city has a rich historical background and was under Arab, German, and British protectorates before obtaining independence in the 1960s. It consists of the following five districts: Kinondoni, Ilala, Temeke, Kigamboni, and Ubungo (Fig. 7.1). While the country's population density is only 51 people per km^2, the city has a population density of 3133 km^2 (Malekela & Nyomora, 2018).

Dar es Salaam was the third fastest-expanding urban region in Africa between 1990 and 2010, with an annual growth rate of 4.67% (Mkalawa & Haixiao, 2014; Nkurunziza, 2013). More than one-third of Tanzania's urban population lives in Dar es Salaam (UN-Habitat., 2009). The population is both comparatively youthful and predicted to rise from today's approximately 5.4 million (Tanzania, 2022), and by 2030, Dar es Salaam is expected to have more than 10 million inhabitants (Krüger et al., 2021), which will make Dar es Salaam one of the largest cities in the world (Nyyssölä et al., 2021). In contrast to other developed cities where urbanization was the product of industrialization, Dar es Salaam's urbanization has been the result of population expansion (Mkalawa & Haixiao, 2014). According to Wenban-Smith et al. (2016), from 1957 to 2012, the population of the mainland increased by 5 times, that of the regional capitals by 19 times, and that of Dar es Salaam by 34 times. These scenarios are distinct from what occurred in Europe during the industrial revolution.

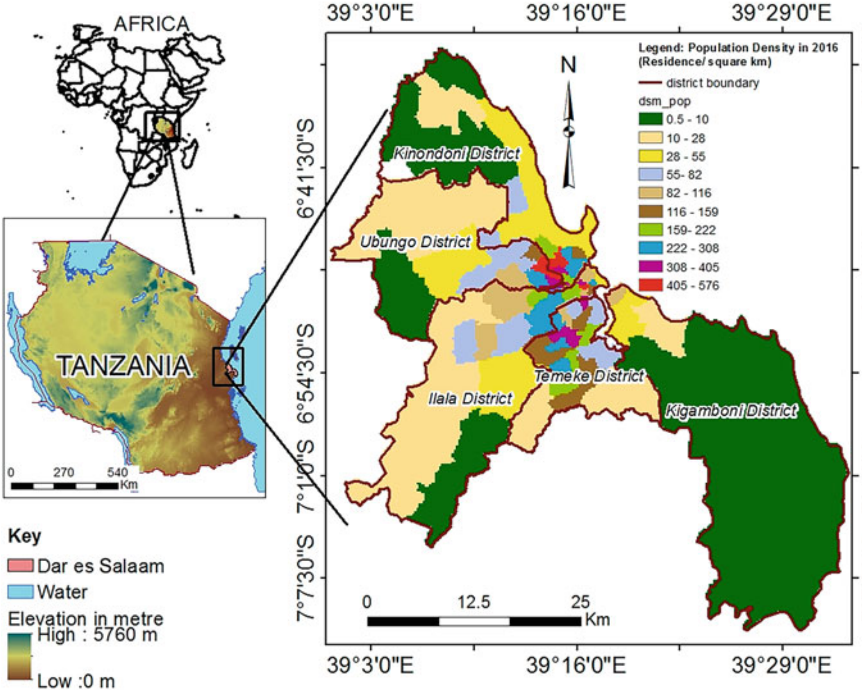


Fig. 7.1 A map showing the population density of the Dar es Salaam region in 2016 (National Bureau of Statistics, Tanzania, 2016)

Despite the economic contribution of the city to the nation, more than 70% of its residents live in unplanned settlements (Nkurunziza et al., 2012). These residents lack adequate housing, access to safe and clean water, or affordable sanitation, and many of them cannot even afford three daily meals. For example, the expansion of informal settlements in cities has made it difficult to provide residents with services and access to facilities (Fig. 7.2). In Tanzania, informal settlements are home to two-thirds of the urban population (Wenban-Smith et al., 2016). People who live in informal settlements endure a variety of hardships, including overcrowding, a lack of resources to offer basic services, health risks, and criminality (Wenban-Smith et al., 2016). Due to its high density of inhabitants per km^2 and informal settlement, Dar es Salaam is also one of the regions most vulnerable to climate change, particularly floods. The Jangwani valley, which is also known as the Msimbazi River basin, is vulnerable to flooding. This area is home to approximately 27% of the city's residents (Krüger et al., 2021). Even with low, moderate, or large amounts of rainfall, the inhabitants in this area face heavy flooding endangering their houses, infrastructure, health, and even lives (Krüger et al., 2021).

Nevertheless, the economic growth in Tanzania and particularly in Dar es Salaam region does not benefit all classes, and the benefits are not evenly distributed. For

Fig. 7.2 Example of informal settlements at Tegeta ward, Kinondoni district in Dar es Salaam (photo by Kaale)

instance, there is a significant gap between the rich and the poor regarding access to basic needs such as enough food, health care, clean and safe water, and housing. Unfortunately, both classes experience malnutrition because rich and middle-class people (those with adequate incomes) are unaware of nutritious foods and adequate feeding practices (AFPs), while people in the lower socioeconomic classes lack access to nutritious foods and thus are unable to follow the required feeding practices. Different diseases, notably noncommunicable diseases (NCDs), have been greatly influenced by food preferences, a lack of knowledge of the nutrition of food, and adequate feeding practices. Rich people prefer foods that provide status and pleasure, such as processed foods (a lot of salt, oil, and sugar). On the other hand, there are some people, rich and middle class, who have become conscious about their health based on necessity and/or education and information disseminated. Dar es Salaam is a place where great diversity and disparities can be seen and where food intake makes a difference in people’s health.

7.2 Economic Growth and Its Contribution to Country GDP

Dar es Salaam is the national manufacturing and commercial center, education, and culture and is full of diversity. The economy of Dar es Salaam is driven by manufacturing, information and communication, financial and insurance services, wholesale and retail trade, construction, and hotels and restaurants. Dar es Salaam is home to most embassies,[1] which means that the city receives a variety of foreign currencies that aid in economic development. Furthermore, due to its geographical location along the Indian Ocean Coast and the nature of the city, it serves as Tanzania's main commercial and economic hub and accounts for 17% of the nation's GDP (Nyyssölä et al., 2021). The largest sectors of employment in Dar es Salaam are service work, shop, and stall sales work (20%), street vending and related work (14%), and crafts and related work (14%) (Forsythe et al., 2017). On the other hand, the major sectors nationwide are farming (63%), elementary occupations (6%), and service work, shop, and stall sales work (6%) (Forsythe et al., 2017). Nine percent of the country's population lives in Dar es Salaam (Tanzania, 2022), which also accounts for more than 17% of the country's GDP (UN-Habitat., 2009). According to (Mkalawa & Haixiao, 2014), Dar es Salaam's population increase is correlated with the city's GDP growth because of its geographic location, the accessibility of social services, and local and foreign investments in both business and industry. The work by Treichel (2005) reported an increased divergence in the average monthly incomes in Dar es Salaam, where a person with a tertiary education earns 10 times the amount earned by a person with no education, in contrast to rural areas, where this ratio is only 2 times the amount. In comparison to the capital cities of Dodoma, Kigoma, and Singida, Dar es Salaam had an almost threefold higher GDP per capita in 2015 (Tanzania, 2015). However, the GDP at current prices for Dar es Salaam region reached TSh 15,631,679 million (US $6689.26 million) in 2015, which was 4 times the total GDP of 2007 (4,174,004 million equivalent to US $1786.18 million) (Todd et al., 2019). Population growth boosts economic development, which benefits a country's economy, according to a study by Loiboo et al. (2021). The same study reported that population expansion has a negative impact on a country's economy since it causes a number of issues. There is a correlation between Dar es Salaam's population growth, economy, and transportation, according to a study by Mkalawa and Haixiao (2014).

The port city's prime position on the Indian Ocean coast has made it the top logistical service provider for both the nation and its neighboring landlocked nations (Tanzania, 2021). The Business Registration and Licensing Agency (BRELA) in Dar es Salaam, which is the center for official business registration, is responsible for 89.8% of all national collections (Todd et al., 2019). Dar es Salaam is also Tanzania's top manufacturing hub, accounting for 58.5% of all manufactured items' value in 2017 (Todd et al., 2019; UN-Habitat., 2009). Higher average incomes in Dar es Salaam result in higher purchasing power. Dar es Salaam households mainly obtain food through purchasing, 97% and 77% for other urban areas compared to rural households, which derive on average of 58% from subsistence agriculture (Critchlow et al., 2021). On the other hand, cell phone ownership is 95% in Dar es Salaam, 84% in other urban areas, and 57% in rural areas, whereas 48% of refrigerators are owned by Dar es Salaam residents, 15% by other urban

[1] Some have moved to the capital Dodoma.

residents, and 2% by rural residents (Worrall et al., 2017). Due to its location between Zanzibar, Morogoro, and northern and southern Tanzania, Dar es Salaam is a location for tourism. Tanzania is connected to the rest of the world through its international airport located in Dar es Salaam city, while the railway station links the city to other regions and neighboring countries. The introduction of a bus rapid transit system (BRT) called Dar-es-Salaam Rapid Transit (DART) is advantageous for the city since the current public transportation *daladala* is inefficient and unpredictable. These connections contribute to population and economic growth through business, industry, and tourism as well as immigrants (Lwoga & Kessy, 2013; Mkalawa & Haixiao, 2014).

7.3 Malnutrition and Health Status of Dar es Salaam Citizens

Undernutrition and overnutrition are both components of malnutrition. One of the leading causes of mortality and morbidity worldwide is malnutrition (Ismail et al., 2020; Kiduanga & Shomari, 2016). Underweight, wasting, stunting, and micronutrient deficits are all terms used to describe undernutrition. This is a diet lacking based on the recommended dietary allowances (RDAs) that the body needs for good health. Additionally, there are extrinsic factors that contribute to undernutrition, such as poor childcare, poor sanitation, and insufficient access to clean water and health facilities. Overnutrition can be characterized as a lack of knowledge of adequate feeding practices (AFPs) based on RDAs, such as eating more food than the body needs and consuming unhealthy foods (made out of salt, sugar, and animal fat, which contain high amounts of saturated fatty acids and artificial food additives). These issues increase the chance of developing NCDs (high blood pressure, diabetes, heart disease, stroke, and some cancers). Malnutrition is still a serious public health concern, especially in sub-Saharan Africa and Southeast Asia, where it causes more than 90% of all nutrition-related illnesses (Ismail et al., 2020; Kiduanga & Shomari, 2016). Health, chronic diseases, and level of economic output are all negatively impacted by malnutrition (Cordeiro et al., 2021). According to research, malnutrition is linked to poverty, a lack of access to a healthy diet, consuming more than one's body requires, a lack of access to sanitation and health care, and underlying ailments (Alderman et al., 2006; Hurtig, 2009; Kiduanga & Shomari, 2016). Tanzania is one of the ten worst-affected nations in the world. High prevalence rates of malnutrition, which were declining in Tanzania but are currently rising, are probably a result of food crises. Given that Tanzania has one of the worst rural–urban disparities in malnutrition, this presents public health concerns (Cordeiro et al., 2021). In the country, 34.7% of children under the age of 5 suffer from chronic or severe malnutrition (IRS, 2017). Tanzania (2018) reports on different forms of malnutrition, including anemia (59%), stunting (42%), vitamin A deficiency (33%), low birth weight (7%), and wasting (5%), prevailing among children aged 6–59 months.

7.3.1 Overnutrition of Dar es Salaam Citizens

Obesity and overweight in Tanzania impact 50% of the adult population and are serious problems for the nation's health. Women are more likely to be overweight or obese than males (Mosha et al., 2021). A survey carried out in Tanzania revealed that 31.7% of women aged 15–49 were overweight and 11.5% were obese (Tanzania, 2018). Overnutrition is most common in Dar es Salaam (Cockx et al., 2017). The rise in overnutrition appears to be a result of Dar es Salaam's growing wealth, which has led to a more sedentary lifestyle and higher calorie intake (Mosha et al., 2021; Pallangyo et al., 2020). According to Mosha et al. (2021), older age, informal work, and intermediate-to-high socioeconomic class were all linked to overweight and obesity in women in Dar es Salaam. Additionally, concerns have been expressed about the types, methods, and food additives used in the preparation of dishes, particularly those provided by street women food vendors (SWFVs), also known as "*mama ntilie*" in Swahili, as well as high, medium, and small restaurants in Dar es Salaam. The food composition, particularly that offered by the SWFVs, includes grains (maize, sorghum, and rice), starchy roots (cassava), and pulses (primarily beans). The worst thing about developing nations, such as Tanzania, is how they adopt Western culture while ignoring traditional ones. In Tanzania, those who reside in urban areas such as Dar es Salaam have moved from the consumption of healthy, traditional, and unprocessed foods to cheap, unhealthy, and processed foods that contain high amounts of salt, sugar, artificial food additives, and animal fat that is high in saturated fatty acids. In addition, a shift from a conventional to a modern food marketing system is beginning to coincide with Tanzania's urbanization development. After the government passed a regulation requiring supermarkets to put national agricultural food products on their food product lists, barely 20% of agricultural produce is sold in supermarkets (Wenban-Smith et al., 2016).

Nutritional deficiencies, unhealthy diets, and NCDs are all strongly related (Branca et al., 2019). Cardiovascular conditions and diabetes mellitus (DM) are the main NCDs influenced by nutrition. Dietary origin is the primary risk factor for cardiovascular diseases (CVDs) worldwide. In Tanzania, the prevalence of these NCDs is increasing, and they are responsible for the deaths of 15–28% of males and 14–27% of women between the ages of 15 and 59 (MOHSW, 2014). The study conducted in Dar es Salaam by Pallangyo et al. (2020), which involved over 6000 people aged between 20 and 70, showed that more than 88% were physically inactive, 4.7% had a history of diabetes, 18.1% had high blood pressure and 32–34% were obese.

The unethical marketing of children's food is another issue that contributes to NCDs, especially among young people. The labeling procedures now used on commercially produced supplementary foods supplied in Tanzania are insufficient and frequently do not follow the best practices or national legal requirements (Sweet et al., 2016): for instance, pizza, burgers, and energy drinks, among other foods and drinks. Most children between the ages of 5 and 17 prefer these kinds of foods. Some of the ingredients used to produce these kinds of foods must be imported and frozen, which compromises the quality of the final product. Snacks such as crisps are another category of foods that are detrimental. Children under 5 are the biggest consumers of these foods. These foods contain a significant amount of saturated fatty acids from animal fat, salt, and sugar, as well as artificial food additives that raise the risk of NCDs, especially cancer, diabetes, and CVDs. Juices in particular have been identified as particularly lethal because they are produced with artificial food additives that greatly increase the risk of NCDs. Unfortunately, some Tanzanians hold the incorrect assumption that being obese is advantageous because they equate it with wealth. Higher incidences of NCDs and risk factors for them, such as eating unhealthily, are linked to lower levels of education.

7.3.2 Undernutrition of Dar es Salaam Citizens

Undernutrition, on the other hand, continues to be one of Tanzania's largest problems. An estimated 450,000 children in Tanzania are acutely malnourished or wasted, with over 100,000 suffering from the most severe form of acute malnutrition (IRS, 2017). The prevalence of stunting and underweight in the nation has, however, been consistently declining since 1996. Nonetheless, between 1999 and 2016, the prevalence of wasting remained essentially unchanged. The Tanzania Demographic and Health Survey report showed that the prevalence of chronic undernutrition (stunting) was 34.4%, acute malnutrition (wasting) was 4.5%, and underweight was 13.6% (Khamis et al., 2020). The prevalence of undernourishment, severe food insecurity, and stunted growth in children under the age of 5 years is 25.0%, 23.8%, and 31.8%, respectively (Tanzania, 2021). Dar es Salaam was the only area on Tanzania's mainland with the lowest prevalence of stunting (14.6%) and wasting (1.2%) (Tanzania, 2017). A study conducted in Ilala, one of Dar es Salaam Districts, reported that the prevalence of chronic undernutrition and morbidity was high, while child-feeding practices were inadequate (Kulwa et al., 2006). This is because as more mothers enter the workforce, caretakers are becoming increasingly crucial in terms of feeding and caring for children. The lack of accessible, affordable public transportation and the heavy traffic around Dar es Salaam city present another significant obstacle for most women.

7.3.3 Strategies Implemented by the Government to Fight Malnutrition

The government has created and executed numerous measures to lower malnutrition. A new National Multisectoral Nutrition Action Plan (NMNAP) 2016–2021 was created and adopted across the nation in 2016, replacing the national nutrition survey (NNS). The NMNAP's midterm aim for the minimum acceptable diet was achieved with a prevalence of 30% versus a target of 25% (Tanzania, 2018). A healthy diet is one of the strategies for preventing and controlling NCDs in the Health Sector Strategic Plan (HSSP), which runs from July 2015 to June 2020 (Tanzania, 2018). Other initiatives include infant and young child feeding (IYCF) guidelines, sanitation, deworming, vitamin A supplements, and health education (Kejo et al., 2018). Malnutrition still poses a significant problem in Tanzania despite these initiatives.

7.4 Food Culture, Consumer Preference, and Patterns in Dar es Salaam Region

Common diets in sub-Saharan Africa consist of one or two staple foods, the most common of which are maize, cassava, yam, sweet potato, and banana (Forsythe et al., 2017). This is accompanied by pulse, animal products, and green leafy vegetables as well as fruits. However, there is a significant impact on these practices, food consumption habits, and consumer preferences as a result of rapid population growth. Urban residents have abandoned their traditional way of life, especially in regard to eating traditional meals. Instead, they prefer processed foods, which are generally linked to NCDs. This is a result of globalization, which has altered the eating habits and patterns in many African countries, particularly in urban areas, and permitted the movement of processed foods and other goods (Kinabo, 2003) as well as increased sedentary lifestyles and adoption of a Western diet (Forsythe et al., 2017; Kinabo, 2003; Oniang'o et al., 2003; Pallangyo et al., 2020).

According to the study of Wenban-Smith et al. (2016), rising per capita earnings also cause changes in consumption patterns. Wealth groups have been observed to purchase animal-sourced foods in various markets and to prefer certain retail goods (Baker et al., 2016). Offal and mixed pieces for beef, live birds, mixed pieces for chicken, and raw milk for dairy have been reported as the preferred product forms (Baker et al., 2016). The majority of Dar es Salaam residents prefer to eat *ugali*, which is made from de-husked (*sembe*) or non-de-husked (*dona*) maize flour and is served with animal products (meat, milk, etc.), pulse, fish, poultry, and green leafy vegetables. The study conducted in Dar es Salaam by Forsythe et al. (2017) found that women consumed more rice and banana, and men consumed more maize and cassava. The diversity of the staple crops consumed is also influenced by the state of migration. Residents in urban areas are much more dependent on money, whereby income-earning activities and higher education become a priority to afford and choose the type of food to consume (Hurtig, 2009). For example, Wang et al. (2021) demonstrated that a rise in household income in Dar es Salaam considerably increased the intake of meals from animal sources. Low-income earners, particularly men, in Dar es Salaam purchase food from SWFVs to experience different flavors and culinary variations while saving money on food materials, cooking fuel, and preparation time (Kinabo, 2003). Additionally, because of the hectic schedules at work, the majority of employees choose ready-to-eat meals. Urban areas have a convenient demand for food that is not influenced by seasonal or environmental conditions (Hurtig, 2009). For instance, Dar es Salaam region can attain 6% of its food sufficiently, and 94% of the food is obtained from other regions and imports from other countries (Bank of Tanzania (BOT), 2018; Kinabo, 2003).

The availability of a large range of ready-to-eat and processed meals for urban dwellers to purchase from local markets, grocers' stores, supermarkets, or street women food vendors further influences the dietary pattern and feeding practices (Wegerif, 2017). Dar es Salaam is home to a large number of supermarkets (such as Mlimani City, Shoppers' plaza, etc.), eateries (such as KFC and Pizza hut), neighborhood markets (such as the Mwanayamala, Mabibo, and Kariakoo markets), SWFVs, shops, and grocery stores that provide a wide range of foods and food products and influence food choices (Cockx et al., 2017). According to Majili et al. (2017), Dar es Salaam residents consume more energy-dense foods such as cereals, oil/fats, and sugar than foods such as fruits, vegetables, and protein-rich foods such as fish, eggs, meat, and poultry. The following will clarify this: The existence of classes, low, middle, and high, causes the distribution of eating patterns and preferences to vary between the classes. In all classes, education on feeding practices is highly missing. The above-described eating habits are also influenced by food accessibility and availability.

Food culture shapes people's nutritional preferences and establishes values and norms for feeding behavior (Hurtig, 2009; Mwaseba et al., 2016). This varies depending on one's ethnic background; for example, the Chagga tribe chooses plantain soup ("Mtori") and drinks Mbege (a beer made of banana and finger millet), whereas the Sukuma prefers stiff porridge ("Ugali"). However, Dar es Salaam has experienced a different situation due to its citizens' national origins and the city's population's adoption of a wide range of foods. In addition, what is provided in SWFVs, restaurants, and hotels also has a significant role in determining eating habits and preferences. For instance, Dar es Salaam inhabitants like plantain soup for breakfast.

Furthermore, Dar es Salaam inhabitants do not have a tradition of including vegetables or fruits in their meals, although they are easily accessible and plentiful everywhere in the city (Fig. 7.3). According to Kagaruki et al. (2022), Dar es Salaam inhabitants view fruits and vegetables as luxury items that may be enjoyed in addition to meals rather than as a necessary part of the diet.

7.5 Conclusion

Dar es Salaam, the ninth fastest-expanding urban center worldwide, is one of the cities anticipated to grow to a megacity by 2030 and is likely to set the course for Tanzania's urban destiny. The city's economy, income, health, access to social and public services, way of life, eating habits, and feeding practices have all been impacted by Dar es Salaam's rapid population growth as a result of urbanization, which has further worsened disparities. Furthermore, a number of issues related to

Fig. 7.3 Varieties of fruits in Dar es Salaam, Tanzania (photo by Kaale)

malnutrition are worsening because of social, cultural, and traditional norms, a lack of resources, individual knowledge, gender, age, income, and preference. Aside from creating new demands on health systems, the city's rapid population growth will also exacerbate problems with food security. The DART system needs to be improved throughout the entire city to guarantee sustainability and reliable transportation. The government should put in place sensible urbanization city regulations and policies as well as food and nutrition initiatives to decrease these challenges. Children's care centers (CCCs) should be established all across the city to address the problem of childhood malnutrition. This should also involve educating individuals in charge of children's care on proper parenting and nutrition practices.

Acknowledgment Kaale is responsible for conceptualization, drafting, editing, and revising of the chapter. Kato has contributed to reviewing and editing the chapter. Sakamoto is responsible for conceptualization, editing, and revising the chapter. All the authors have gone through the final manuscript and accepted it.

References

Alderman, H., Hoogeveen, H., & Rossi, M. (2006). Reducing child malnutrition in Tanzania: Combined effects of income growth and program interventions. *Economics and Human Biology, 4*(1), 1–23. https://doi.org/10.1016/j.ehb.2005.07.001

Baker, D., Mtimet, N., Pica-Ciamarra, U., & Nsiima, L. (2016). Consumers' preferences for animal-source foods and retail outlets: The case of Tanzania. *African Journal of Agricultural and Resource Economics, 11*(3), 197–210.

Bank of Tanzania (BOT). (2018). *Bank of Tanzania consolidated zonal economic performance report for the year ending June 2018*, 3(2), Dar es Salaam. Retrieved December 20, 2022, from http://www.bot.go.tz

Branca, F., Lartey, A., Oenema, S., Aguayo, V., Stordalen, G. A., Richardson, R., Arvelo, M., & Afshin, A. (2019). Transforming the food system to fight non-communicable diseases. *BMJ (Online), 364*, l296. https://doi.org/10.1136/bmj.l296

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-University of Greenwich* (No. 390). *LICOS discussion paper*.

Cordeiro, L. S., Otis, N. P., Sibeko, L., & Nelson-Peterman, J. (2021). Rural-urban disparities in the nutritional status of younger adolescents in Tanzania. *PLoS One, 16*, 1–14. https://doi.org/10.1371/journal.pone.0261480

Critchlow, A., Lynch, Z., Gammon, S., Byrne, O., & Cobb, S. (2021). *The reality of and solutions for food insecurity in Dar es Salaam*. Cambridge Development Initiative.

Forsythe, L., Njau, M., Martin, A., Bechoff, A., & Tomlins, K. (2017). Staple food cultures: A case study of cassava ugali preferences in Dar es Salaam, Tanzania. *Natural Resources Institute and CGIAR Research Program on Roots, Tubers and Bananas (RTB). RTB Working Paper*. Retrieved December 20, 2022, from http://gala.gre.ac.uk/id/eprint/22350/

Hurtig, R. (2009). *Food habit transitions in the urban areas of low-income countries*. Södertörn University. Retrieved February 12, 2023 http://www.diva-portal.org/smash/get/diva2:284805/FULLTEXT01.pdf

IRS. (2017). *Overcoming the challenges of under-nutrition in Tanzania through 2021: Reflecting on trends, questions, and future scenarios for urgent nutrition action* (p. 9). Inter-Agency Regional Analysts Network (IRAN).

Ismail, A., Darling, A. M., Mosha, D., Fawzi, W., Sudfeld, C., Sando, M. M., Noor, R. A., Charles, J., & Vuai, S. (2020). Prevalence and risk factors associated with malnutrition among adolescents in rural Tanzania. *Tropical Medicine and International Health, 25*(1), 89–100. https://doi.org/10.1111/tmi.13331

Kagaruki, G. B., Mahande, M. J., Kreppel, K. S., Mbata, D., Kilale, A. M., Shayo, E. H., Mfinanga, S. G., & Bonfoh, B. (2022). Barriers to the implementation, uptake and scaling up of the healthy plate model among regular street food consumers: A qualitative inquiry in Dar-es-Salaam city, Tanzania. *BMC Nutrition, 8*(1), 1–16. https://doi.org/10.1186/s40795-022-00589-6

Kejo, D., Mosha, T. C. E., Petrucka, P., Martin, H., & Kimanya, M. E. (2018). Prevalence and predictors of undernutrition among underfive children in Arusha district, Tanzania. *Food Science & Nutrition, 6*(8), 2264–2272. https://doi.org/10.1002/fsn3.798

Khamis, A. G., Mwanri, A. W., Kreppel, K., & Kwesigabo, G. (2020). The burden and correlates of childhood undernutrition in Tanzania according to composite index of anthropometric failure. *BMC Nutrition, 6*(1), 1–13. https://doi.org/10.1186/s40795-020-00366-3

Kiduanga, J., & Shomari, A. (2016). Urban agriculture: Critical issues of land administration for expansion of the farming of vegetables in Dar es Salaam. *Journal of the Geographical Association of Tanzania, 37*(1), 1–14.

Kinabo, J. (2003). A case study of Dar es Salaam city, Tanzania. In *FAO technical workshop on "Globalization of food systems: Impacts on food security and nutrition"*.

Krüger, F., Titz, A., Arndt, R., GroB, F., Mehrbach, F., Pajung, V., Suda, L., Wadenstorfer, M., & Wimmer, L. (2021). The bus rapid transit (BRT) in Dar es Salaam: A pilot study on critical infrastructure, sustainable urban development and livelihoods. *Sustainability (Switzerland), 13*(3), 1–30. https://doi.org/10.3390/su13031058

Kulwa, K. B. M., Kinabo, J. L. D., & Modest, B. (2006). Constraints on good child-care practices and nutritional status in urban Dar-es-Salaam, Tanzania. *Handbook of Environmental Chemistry, 5*, 236–244. *Water Pollution*. https://doi.org/10.1177/156482650602700306

Leyna, G. H., Berkman, L. F., Njelekela, M. A., Kazonda, P., Irema, K., Fawzi, W., & Killewo, J. (2017). Profile: The Dar es Salaam health and demographic surveillance system (Dar es Salaam HDSS). *International Journal of Epidemiology, 46*(3), 801–808. https://doi.org/10.1093/IJE/DYW324

Loiboo, D., Luvanda, E., & Osoro, N. (2021). Population and economic growth in Tanzania. *Tanzanian Journal of Population Studies and Development, 28*(2), 20–42.

Lwoga, N. B., & Kessy, E. T. (2013). Development of cultural heritage tourism in Dar es Salaam city centre: Demand perspective. *Eastern African Journal of Hospitality, Leisure and Tourism, 1*(1), 45–61. Retrieved December 20, 2022, from https://www.cabdirect.org/cabdirect/abstract/20173088816

Majili, S., Pacific, R., & Bundala, N. (2017). Nutrient adequacy of foods consumed among adult population residing in urban parts of Dar-es-Salaam, Tanzania. *International Journal of Innovative Research and Development, 6*(12), 8–13.

Malekela, A. A., & Nyomora, A. (2018). Food security: The role of urban and peri-urban agriculture. A case of Dar es Salaam city, Tanzania centre for climate change studies. University of Dar es Salaam, , 13(2), 50–62.

Mkalawa, C. C., & Haixiao, P. (2014). Dar es Salaam city temporal growth and its influence on transportation. *Urban, Planning and Transport Research, 2*(1), 423–446. https://doi.org/10.1080/21650020.2014.978951

MOHSW. (2014). National nutrition strategy July 2021/12-June 2015/16. *Ministry of health and social welfare*, (June), 1–66.

Mosha, D., Paulo, H. A., Mwanyika-Sando, M., Mboya, I. B., Madzorera, I., Leyna, G. H., Msuya, S. E., Bärnighausen, T. W., Killewo, J., & Fawzi, W. W. (2021). Risk factors for overweight and obesity among women of reproductive age in Dar es Salaam, Tanzania. *BMC Nutrition, 7*(1), 37. https://doi.org/10.1186/S40795-021-00445-Z

Mwaseba, D. J. B., Kaarhus, R., & Mvena, Z. S. K. (2016). Food culture and child-feeding practices in Njombe and Mvomero districts, Tanzania. *Journal of Eastern Africa Studies, 10*(2), 325–342. https://doi.org/10.1080/17531055.2016.1184834

National Bureau of Statistics (Tanzania). (2016). *Dar es Salaam Demographic Statistics in 2016*. Retrieved from https://www.nbs.go.tz/index.php/en/

Nkurunziza, A. (2013). Sustainable transport in Dar-es-Salaam: The potential for BRT and cycling from a user perspective. *ITC Dissertation, 23*, 180. Retrieved December 20, 2022, from http://www.itc.nl/library/papers_2013/phd/nkurunziza.pdf

Nkurunziza, A., Zuidgeest, M., Brussel, M., & van Maarseveen, M. (2012). Modeling commuter preferences for the proposed bus rapid transit in Dar-es-Salaam. *Journal of Public Transportation, 15*(2), 95–116. https://doi.org/10.5038/2375-0901.15.2.5

Nyyssölä, M., Kelsall, T., & Ndezi, T. (2021). Dar es Salaam: City scoping study. *African Cities Research Consortium*. Retrieved February 12, 2013, from https://www.african-cities.org/wp-content/uploads/2021/12/ACRC_Dar-es-Salaam_City-Scoping-Study.pdf

Oniang'o, R., Mutuku, J., & Malaba, S. (2003). Contemporary African food habits and their nutritional and health implications. *Asia Pacific Journal of Clinical Nutrition, 12*(3), 231–236. Retrieved December 20, 2022, from https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=8db314cd97a6a88ba484af039aa98d4d0fb8c2a3

Pallangyo, P., Mkojera, Z. S., Hemed, N. R., Swai, H. J., Misidai, N., Mgopa, L., Bhalia, S., Millinga, J., Mushi, T. K., Kabeya, L., Omar, A., Kaijage, A., Mulashani, R., Mosha, S., Mwapinga, F., & Janabi, M. (2020). Obesity epidemic in urban Tanzania: A public health calamity in an already overwhelmed and fragmented health system. *BMC Endocrine Disorders, 20*(1), 147. https://doi.org/10.1186/S12902-020-00631-3

Sweet, L., Pereira, C., Ford, R., Feeley, A. B., Badham, J., Mengkheang, K., Adhikary, I., Gueye, N. Y. S., Coly, A. N., Makafu, C., & Zehner, E. (2016). Assessment of corporate compliance with guidance and regulations on labels of commercially produced complementary foods sold in Cambodia, Nepal, Senegal and Tanzania. *Maternal & Child Nutrition, 12*, 106–125. https://doi.org/10.1111/mcn.12268

Tanzania, United Republic. (2015). *Country Profile 2015: United Republic of Tanzania*. Population policy compendium.

Tanzania, United Republic. (2017). *Comprehensive food security and nutrition assessment*. Retrieved February 12, 2023, from https://www.ipcinfo.org/fileadmin/user_upload/ipcinfo/docs/IPC_Tanzania_AFI_Situation_2018Feb.pdf

Tanzania, United Republic. (2018). *Tanzania national nutrition survey 2018*, (June 2019), 1–8.

Tanzania, United Republic. (2021). Report on the implementation of the Istanbul programme of action for LDCs for the decade 2011–2020. *World Population Policies 2017*, 420–421, https://doi.org/10.18356/9789210049702c197

Tanzania, United Republic. (2022). *Preliminary results of population and housing census 2022*. Dar es Salaam.

Todd, G., Msuya, I., Levira, F., & Moshi, I. (2019). City profile: Dar es Salaam, Tanzania. *Environment and Urbanization Asia, 10*(2), 193–215. https://doi.org/10.1177/0975425319859175

Treichel, V. (2005). Tanzania's growth process and success in reducing poverty. *IMF Waking Paper, 05*(35), 555–582. https://doi.org/10.5089/9781451860542.001

UN-Habitat. (2009). *Tanzania: Dar es Salaam city profile*. Retrieved December 20, 2022, from https://unhabitat.org/sites/default/files/download-manager-files/Tanzania%20Dar%20es%20Salaam%20Urban%20Profile.pdf

Wang, P., Tran, N., Enahoro, D., Chan, C. Y., Shikuku, K. M., Rich, K. M., Byrd, K., & Thilsted, S. H. (2021). Spatial and temporal patterns of consumption of animal-source foods in Tanzania. *Agribusiness, 38*(2), 328–348. https://doi.org/10.1002/agr.21729

Wegerif, M. C. A. (2017). *Feeding Dar es Salaam: A symbiotic food system perspective*. Wageningen University.

Wegerif, M. C. A., & Wiskerke, J. S. C. (2017). Exploring the staple foodscape of Dar es Salaam. *Sustainability (Switzerland), 9*(6), 1081. https://doi.org/10.3390/SU9061081

Wenban-Smith, H., Faße, A., & Grote, U. (2016). Food security in Tanzania: The challenge of rapid urbanisation. *Food Security, 8*(5), 973–984. https://doi.org/10.1007/S12571-016-0612-8

Worrall, L., Colenbrander, S., Palmer, I., & Makene, F. (2017). *Better urban growth in Tanzania: Preliminary exploration of the opportunities and challenges. Coalition for urban transitions*. Retrieved December 20, 2022, from https://urbantransitions.global/wp-content/uploads/2019/08/NCE2017-Better-Urban-Growth-Tanzania_final.pdf

Chapter 8
High Maize Productive Rural Inland Areas: Ample Staple Food, But What About Health?

Tamahi Kato, Kumiko Sakamoto, Reiko Ohmori, Ayusa Okui, and Parinya Khemmarath

Abstract The Iringa region in the southern highland is considered one of the major maize-producing regions of Tanzania. This chapter elaborates on this region based on questionnaire interviews with 171 respondents, mostly women (96%). Even at the household level, these villagers rarely have seasons of food deficiency, with only 1 month when more than 25% of respondents are food-insufficient. However, women who receive financial support have low subjective health evaluations in General Health (GH), Physical Functioning, Role Physical (RP), Role Emotional, and Vitality, among all eight quality of life (QOL) subjective health indicators based on the SF (Short Form)-12 survey, indicating wealth disparities. On the other hand, wealthier people who helped others with money when they needed money have a risk of lifestyle diseases associated with consuming large amounts of oil, salt, and sugar. The regression analysis finds that the frequencies of eating staple foods and vegetables have a positive effect on QOL health indicators (body pain and RP), which suggests that a balanced diet is important for QOL. The positive effects of staple foods and vegetable consumption on good self-rated health have been found in previous studies.

Keywords Subjective health · QOL · Disparities · Balanced diet · Lifestyle disease

T. Kato (✉)
Center for African Area Studies, Kyoto University, Kyoto, Japan

K. Sakamoto
School of International Studies, Utsunomiya University, Utsunomiya, Japan
e-mail: ksaka@cc.utsunomiya-u.ac.jp

R. Ohmori
School of Regional Design, Utsunomiya University, Utsunomiya, Japan
e-mail: rohmori@cc.utsunomiya-u.ac.jp

A. Okui · P. Khemmarath
Center for the Multicultural Public Sphere of Utsunomiya University, Utsunomiya, Japan

K. Sakamoto et al. (eds.), *Changing Dietary Patterns, Indigenous Foods, and Wild Foods*, https://doi.org/10.1007/978-981-99-3370-9_8

8.1 Introduction

Within the overall objective of the book to understand changing patterns, indigenous foods, and wild foods in Tanzania, this chapter provides a case study from the inland area of major maize production. The chapter looks closely at a case study to understand the health and nutrition situation of the villages, their social context, and the possible contribution of wild foods in the major maize production setting.

8.1.1 Introduction to the Southern Highland, Iringa Region, and Ifunda Village

Iringa region was the site of the first pilot project of the UNICEF/WHO nutrition program called "The Iringa Nutrition Programme" that started in the 1980s, which is a community-based program to improve the nutritional status of women and children. The program employs an approach to seeking to identify the causes of and solutions to malnutrition at the household and community levels. Information on the nutritional status (weight-for-age) of children was monitored. This method was considered successful and has been expanded for use not only nationwide in Tanzania but also globally (Pelletier & Jonsson, 1994). In addition, the southern highland is considered to cultivate ample food. However, the Iringa region has the fourth highest percentage of severely stunted children and the fifth highest percentage of stunted (=chronically undernourished) children in Tanzania according to the 2015/2016 *Tanzania Demographic Health Survey (TDHS)* (Tanzania NBC & ICF Macro, 2016).

In terms of both infant mortality rate (59.8 infant deaths per 1000 live births) and under-5 mortality rate (90.7 deaths of children under 5 years old per 1000 live births), Iringa had the second highest values, followed by Kagera, as of the 2012 Census (Tanzania NBS & OCGS, 2015).

While DHS 2015/2016 indicates that the women in Iringa delivered in public health facilities at a relatively high rate (73.2%, the sixth highest percentage in the country) and received antenatal care from doctors at a relatively high rate (12.2%, the fourth highest percentage), Straneo et al. (2016) suggest that the less educated women in Iringa with less access to health facilities have been left out of antenatal care. Additionally, DHS 2015/2016 indicated that Iringa has the second highest percentage of respondents who consider HIV/AIDS to be the most serious health problem in the country. Various studies (Beckham et al., 2021; Mantsios et al., 2018; Saleem et al., 2016) have researched HIV prevention and how women's lives are affected by HIV in Iringa. However, the available baseline information is not sufficient to understand and explain the situation of the Iringa region, which will be one of the objectives of this chapter.

The research took place in the Ifunda ward, Iringa district, Iringa region, and collected information on respondents from Ifunda (63%) and Bandabichi (35%)

villages of the same ward and women from Ibumila (1%) and Malandege (0.6%) villages from other wards in Iringa district who used the health services in the Ifunda ward. The location of Ifunda is approximately 40 km from Iringa city. The population of Ifunda ward is 12,199 (as of 2012), that of Ifunda village is 2630 (673 households), and that of Bandabichi is 3067 (811 households, as of 2018). The majority are members of the Hehe ethnic group, who are famous for fighting the Germans during colonial rule. Ifunda also welcomed Polish refugees during the Nazi invasion, and this relationship has continued today as Polish people contribute to the Ifunda Technical Secondary School.

The research area, Iringa district, has an infant mortality rate and under-5 mortality rate of 56.1 and 84.7, respectively, which are slightly lower than the regional averages (Tanzania NBS & OCGS, 2015).

8.2 Methodology

The questionnaire interview was based on a comprehensive questionnaire in Swahili. The interview included 75 questions about the respondents, their marriage and family, livelihood, groups, mutual assistance, children, health and food intake. Questions on subjective health are based on the standardized SF-12, and the Swahili translation has been based on the verified Swahili SF-36 (Wyss et al., 1999). The method for evaluating subjective health used the SF-12 (Gandek et al., 1998; Patel et al., 2017; Ware, 1995) to measure the health of adults. Questions on food intake frequency were based on research in Japan (Tsunoda et al., 2015) and adjusted to food in Tanzania based on *Tanzania Food Composition Tables* (Lukmanji et al., 2008) and discussions with nutrition specialists in Tanzania. Questions on groups and mutual assistance were formulated with reference to *Measuring Social Capital* (Grootaert et al., 2004). Other questions were formulated based on the authors' previous questionnaire interviews (Sakamoto, 2007, 2008, 2015a, b, 2020). The questionnaires were targeted to mothers with small children and young women, especially mothers, and were completed on the day when mothers came to weigh their children.

To measure the correlations between food intake frequency, subjective health, and other factors, Spearman correlation was utilized since these variables are nonparametric (Beatty & SpringerLink, 2018). To analyze the relationships between these variables, regression analysis was also utilized (Wooldridge, 2013).

8.3 Health of Adults

8.3.1 About the Respondents

Most (95.5%) of the respondents are women, as targeted. The majority of the respondents were in their 20s (55.0%), followed by those in their 30s (21.1%)

(Table 8.1). The majority ethnic groups were the Hehe (59.6%), followed by the Bena (15.2%), Kinga (2.9%), Wanji (2.9%), and Nyiha (2.3%) (Table 8.2). There were two respondents from the Luguru, Makonde, Pare, and Romani ethnic groups and one respondent each from the Kifumi, Matengo, Ndali, Ngoni, Nyakyusa, Pagwa, Sagala, Siyamu, and Zanaki, indicating a variety of ethnic groups.

Only 19.2% participated in their initiation, but most of them studied in schools (95.8%) (Table 8.3). Among those who went to school, the majority went to elementary schools (88.4%), and among these, 43.0% finished their school education by graduating elementary school, while 48.2% progressed to secondary school. Some (1.8%) went to madras (Islamic schools), and others (6.1%) went to other schools, including one university and two higher technical schools.

In general, 52.2% considered that they had good health, 21.4% fair, and 22.0% very good. Only 1.9% answered that they had excellent health, and 2.5% had poor health (Table 8.4 Q1). In relation to moderate activities, 60.8% said that their health did not limit their activities at all, 29.7% said that their health limited them slightly, and 9.5% said that their health limited their activities very much (Table 8.4 Q2). Regarding heavy activities, 58.5% considered that their health did not limit their activities at all, 27.6% considered that their health limited them slightly, and 13.8% considered that their health limited them very much (Table 8.4 Q3).

Table 8.1 Age of respondents (Sakamoto et al., 2020)

	n	%
10s	9	5.3
20s	94	55.0
30s	36	21.1
40s	8	4.7
60s	2	1.2
80s	1	0.6
Unknown	21	12.3
Total	171	100.0

The total of each percentage value does not sum up to 100%, as each value is rounded to the first decimal place

Table 8.2 Ethnic group of respondents (Sakamoto et al., 2020)

Ethnic groups	*n*	%
Hehe	102	59.6
Bena	26	15.2
Kinga	5	2.9
Wanji	5	2.9
Nyiha	4	2.3
Other	17	9.9
n.a.	12	7.0
Total	171	100.0

The total of each percentage value does not sum up to 100%, as each value is rounded to the first decimal place
n.a. no answer

Table 8.3 Did you study in school? (Sakamoto et al., 2020)

	n	%
Study in school: yes	158	95.8
Elementary only: yes	52	43.0
Elementary all: yes	107	88.4
Secondary: yes	55	48.2
Madras: yes	2	1.8
Other: yes	7	6.1

Table 8.4 Dimensions of subjective health evaluation (Sakamoto et al., 2020)

		Answer (%)				
Question	Excellent	Very good	Fair	Good	Poor	Total
Q1	1.9	22.0	21.4	52.2	2.5	100
	Very limited		Limited a little		Not limited at all	Total
Q2	9.5		29.7		60.8	100
Q3	13.8		27.6		58.5	100
	Accomplished less				Accomplished much	Total
Q4	51.7				48.3	100
Q5	38.4				61.6	100
	Limited				Not limited	Total
Q6	54.7				45.3	100
	Less careful than usual				Not less careful than usual	Total
Q7	42.3				57.7	100
	Extremely	A great deal	Moderately	Slightly	Not at all	Total
Q8	1.4	10.9	26.5	19.0	42.2	100
	None of the time	Some of the time		Most of the time	All of the time	Total
Q9	7.0	34.3		21.7	37.1	100
Q10	35.9	41.4		10.9	11.7	100
Q11	4.4	38.5		17.0	40.0	100
Q12	38.1	45.3		9.4	7.2	100

Q1: Subjective general health
Q2: Did your health limit moderate activities?
Q3: Did your health limit heavy activities?
Q4: Did you accomplish less than you would like?
Q5: Were you limited in the kind of work or other activities you could perform?
Q6: Did you accomplish less than you would like because of emotional problems?
Q7: Were you less careful than usual because of emotional problems?
Q8: How much did pain interfere with your normal work?
Q9: Have you felt calm and peaceful?
Q10: Have you felt downhearted and blue?
Q11: Do you have a great deal of energy?
Q12: How much of the time has your physical health or emotional problems interfered with your social activities?

However, relatively more respondents felt that they accomplished less than they would like (51.7%) in comparison to those who disagreed with this statement (48.3%) (Table 8.4 Q4). On the other hand, more than half were not limited in the kind of work or activities they could perform (61.6%), a considerably greater percentage than that of those who were limited (38.4%) (Table 8.4 Q5).

Regarding emotional problems, more than half felt that they accomplished less than they would like (54.7%), while 45.3% of respondents did not feel this way (Table 8.4 Q6). However, more than half indicated that they were not less careful than usual (57.7%) in comparison to those who felt that they were less careful (42.3%) due to emotional problems (Table 8.4 Q7). Many of the respondents indicated that pain did not interfere with their normal work at all (42.2%), 10.9% indicated that it interfered a great deal, 26.5% moderately, 19.0% slightly, and 1.4% extremely (Table 8.4 Q8).

In regard to feelings, 37.1% felt calm and peaceful all the time, 21.7% most of the time, 34.3% some of the time, and 7.0% none of the time (Table 8.4 Q9). Of the respondents, 35.9% felt downhearted and blue none of the time, 41.4% some of the time, 10.9% most of the time, and 11.7% all of the time (Table 8.4 Q10). Among the respondents, 40.0% felt that they had high energy all of the time, 17.0% most of the time, 38.5% some of the time, and 4.4% none of the time (Table 8.4 Q11).

Regarding physical health or emotional problems interfering with social activities, 38.1% reported that this interference occurred none of the time, 45.3% some of the time, 9.4% most of the time, and 7.2% all the time (Table 8.4 Q12).

Scores of subjective health were calculated in reference to the SF-12 (Hays, 2004; Ware, 1995) (Fig. 8.1). According to the calculation, the score ranges from 34.38 to 52.74. The score for vitality is the highest, and the score for role emotional is the lowest.

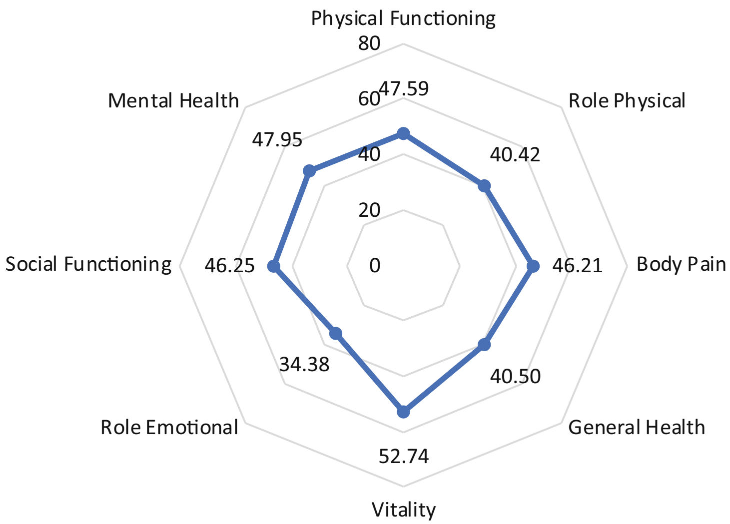


Fig. 8.1 Subjective health evaluation of adults (Sakamoto et al., 2020)

8.3.2 Quantity and Balance of Food Intake

The typical staple food was maize (92.0%), followed by tubers (50.0%), rice (42.7%), bananas (38.0%), cassava (23.3%), millet (22.0%), wheat (21.9%), and sorghum (18.0%) (Table 8.5). Other foods, such as *kande* (cooked maize and beans), cowpea (*kunde*), fruits, and vegetables, were mentioned, and four respondents specifically mentioned taro (*maghimbi*), which can be classified as a tuber. Two respondents indicated *ugali*, stiff porridge, which is a typical preparation of maize, and other main foods.

For relish, 86.2% of the respondents indicated vegetables, 53.8% fish, 40.7% meat, 38.6% milk, and 26.9% pulses (Table 8.5). Other specific responses included vegetables such as carrots (four respondents) and ladies' fingers, cowpea (two respondents), and small fish, which have been counted in their respective categories.

By season, many people eat vegetables and staple foods almost every day in both the dry and rainy seasons. Salt, sugar, and oil are also consumed almost every day, more frequently than staple foods on average (Figs. 8.2 and 8.3). Fruits are eaten more than 2 or 3 days a week. Fish, milk, wild foods, seeds, meat, and pulses are eaten more than once a week (in order from most to least frequently) during the dry season. The frequency does not drastically change in the rainy season and increases on average and for all categories except vegetables. The order of average frequency changes in the rainy season, and people eat/drink milk, fish, seeds, pulses, meat, and wild foods in order of from most to least frequent.

During the dry season, 36.8% of the respondents eat staple foods more than twice a day, 14.6% eat these foods once every day, 17.4% 4–6 days a week, 27.1% once a week or less, and 4.2% do not eat these foods (Table 8.6). For vegetables, 46.5% eat them more than twice a day, 22.5% every day, 16.2% 4–6 days a week, 12.0% once a week or less, and 2.8% do not eat vegetables.

As for meat, 44.8% eat meat once or less than once a week and 38.5% eat it 2–3 days a week (Table 8.7). As for fish or small fish, 51.5% eat fish 2–3 days a week, and 33.1% eat it once or less a week. For milk, 35.6% drink milk once or less a week, and 28.1% drink it 2–3 days a week. Approximately one-third (34.8%) eat pulses, 30.4% eat seeds, and 35.1% eat fruits 2–3 days a week in the dry season. Approximately one-third (29.2%) do not eat wild foods, but 15% eat these foods

Table 8.5 What kinds of staple food/relish do you eat? (%) (Sakamoto et al., 2020)

Staple foods (%)		Relish (%)	
Rice	42.7	Meat	40.7
Maize	92.0	Fish	53.8
Sorghum	18.0	Milk	38.6
Millet	22.0	Pulses	26.9
Wheat	21.9	Vegetables	86.2
Cassava	23.3	Others	4.1
Tubers	50.0		
Bananas	38.0		
Others	4.7		

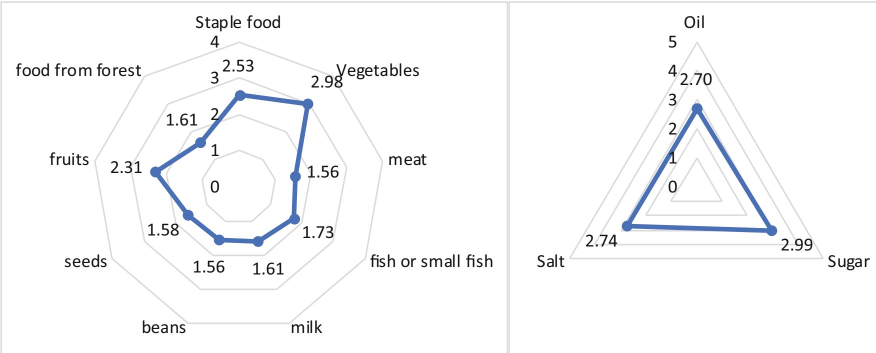


Fig. 8.2 Dry season: how many times do you eat (..)? (Sakamoto et al., 2020). For staple foods, vegetables, oil, salt and sugar: 4 = More than twice a day; 3 = Once every day; 2 = 4–6 days a week; 1 = Fewer than 3 days a week; 0 = Do not eat. For other food: 4 = Every day; 3 = 4–6 days a week; 2 = 2, 3 days a week; 1 = Once or less than once a week; 0 = Do not eat

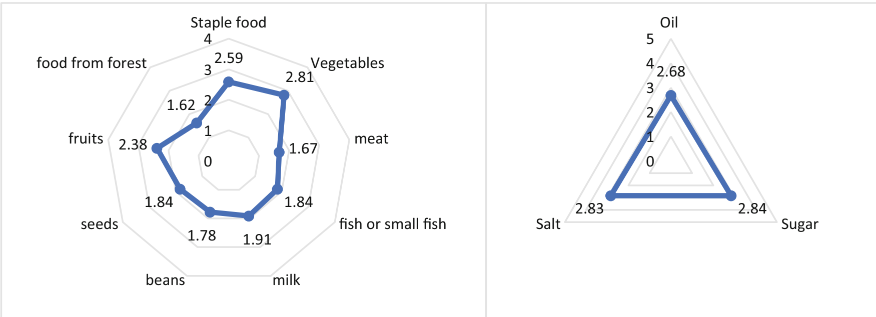


Fig. 8.3 Rainy season: how many times do you eat (..)? (Sakamoto et al., 2020). For staple foods, vegetables, oil, salt and sugar: 4 = More than twice a day; 3 = Once every day; 2 = 4–6 days a week; 1 = Fewer than 3 days a week; 0 = Do not eat. For other foods: 4 = Every day; 3 = 4–6 days a week; 2 = 2, 3 days a week; 1 = Once or less than once a week; 0 = Do not eat

every day. The difference becomes steeper during the rainy season, when 32.0% do not eat wild foods, but 20.8% eat them every day (Table 8.8). In the dry season, 35.5% use oil and 43.2% use salt every day, and 37.1% use sugar 4–6 days a week; 29.2% do not eat wild foods, 26.7% do not eat seeds, and 18.5% do not eat pulses.

During the rainy season, 31.3% eat staple foods more than twice a day, 25.2% once a day, and 20.6% 4–6 days a week (Table 8.9). As for vegetables, 42.2% eat them more than twice a day, and 23.0% eat them 4–6 days a week.

Table 8.6 During the dry season: how many times do you eat staple foods and vegetables? (Sakamoto et al., 2020)

	Staple foods	Vegetables
Do not eat	4.2	2.8
Fewer than 3 days a week	27.1	12.0
4–6 days a week	17.4	16.2
Once every day	14.6	22.5
More than 2 times a day	36.8	46.5
Total	100.0	100.0

The total of each percentage value does not sum up to 100%, as each value is rounded to the first decimal place

Table 8.7 During the dry season: how many times do you eat (. . .)? (Sakamoto et al., 2020)

	Meat	Fish or small fish	Milk	Pulse	Seeds	Fruits	Foods from forest	Oil	Salt	Sugar
Do not eat	6.3	4.6	17.0	18.5	26.7	6.0	29.2	7.2	4.3	5.0
Once or less than once a week	44.8	33.1	35.6	31.1	21.5	18.7	22.6	11.6	5.0	10.7
2–3 days a week	38.5	51.5	28.1	34.8	30.4	35.1	21.9	20.3	20.9	18.6
4–6 days a week	7.7	6.2	8.1	7.4	10.4	18.7	10.9	25.4	26.6	37.1
Every day	2.8	4.6	11.1	8.1	11.1	21.6	15.3	35.5	43.2	28.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

The total of each value does not sum up to 100, as each value is rounded to the first decimal place

As for meat, 44.4% eat meat once or less than once a week, and 34.1% eat it 2–3 days a week (Table 8.8). As for fish, 42.6% eat fish 2–3 days a week, and 33.3% eat it once or less. In total, 35.2% of the respondents drink milk once or less than once a week, and 25.8% drink milk 2–3 days a week; 31.5% eat pulses 2–3 days a week, 28.4% eat seeds 2–3 days a week, and 29.8% eat fruits 2–3 days a week. In total, 38.4% of the respondents use oil more than twice a day, 40.5% use salt twice a day, and 36.5% use sugar twice a day; 32.0% do not eat from the forest, 21.6% do not eat seeds, and 17.3% do not eat pulses.

The majority (88.4%) considered that they had sufficient food when they were pregnant and that their children had enough breast milk (92.1%) and enough food (83.9%). In addition, the majority (60.8%) considered that they had sufficient food. Food shortage was not a major issue for the majority throughout the year (Fig. 8.4), and even in February, during the rainy season, when it is generally considered that less food is available, 67% had enough food. The harvest season of maize is from July to September, when 84–88% of the respondents had enough food, which matches with the general understanding. The average number of months of food

Table 8.8 During the rainy season: how many times do you eat (. . .)? (Sakamoto et al., 2020)

	Meat	Fish or small fish	Milk	Pulse	Seeds	Fruits	Foods from forest	Oil	Salt	Sugar
Do not eat	5.6	5.4	10.9	17.3	21.6	5.6	32.0	8.0	4.0	4.8
Once or less than once a week	44.4	33.3	35.2	26.8	20.7	23.4	20.8	13.6	11.9	11.1
2, 3 days a week	34.1	42.6	25.8	31.5	28.4	29.8	20.8	19.2	20.6	16.7
4–6 days a week	8.7	9.3	7.8	9.4	11.2	9.7	5.6	20.8	23.0	31.0
Every day	7.1	9.3	20.3	15.0	18.1	31.5	20.8	38.4	40.5	36.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

The total of each value does not sum up to 100, as each value is rounded to the first decimal place

Table 8.9 During rainy season: how many times do you eat (. . .)? (Sakamoto et al., 2020)

	Staple foods	Vegetables
Do not eat	6.1	3.7
Fewer than 3 days a week	16.8	13.3
4–6 days a week	20.6	23.0
Once every day	25.2	17.8
More than 2 times a day	31.3	42.2
Total	100.0	100.0

The total of each value does not sum up to 100, as each value is rounded to the first decimal place

sufficiency was 9.8 months (Table 8.10). Fifty-two respondents had food throughout the year, 48 for 11 months, 12 for 10 months, 13 for 6 months, and one for 0 months.

According to the responses, many people eat vegetables and staple foods almost every day. Salt, sugar, and oil are also eaten almost every day, more frequently than staple foods on average. Fruits are eaten more than 2–3 days a week. Fish, milk, wild foods, seeds, meat, and pulses are consumed more than once a week (in order from most to least frequently consumed) during the dry season. This frequency does not drastically change in the rainy season but, rather, increases on average for all categories except vegetables. The order of average frequency of consumption changes in the rainy season, when people eat/drink milk, fish, seeds, pulse, meat, and wild foods in order from most to least frequently consumed. The practice of eating wild foods differs among the respondents: 29.2% do not eat wild foods, but 15.3% eat them every day. The difference becomes steeper during the rainy season, when 32.0% do not eat wild foods, but 20.8% eat them every day.

The fact that the intake of meat, fish, and milk decreases during the dry season was not something that the people were aware of in their daily lives, nor were the dispensary nurse and health workers aware of this pattern. However, further

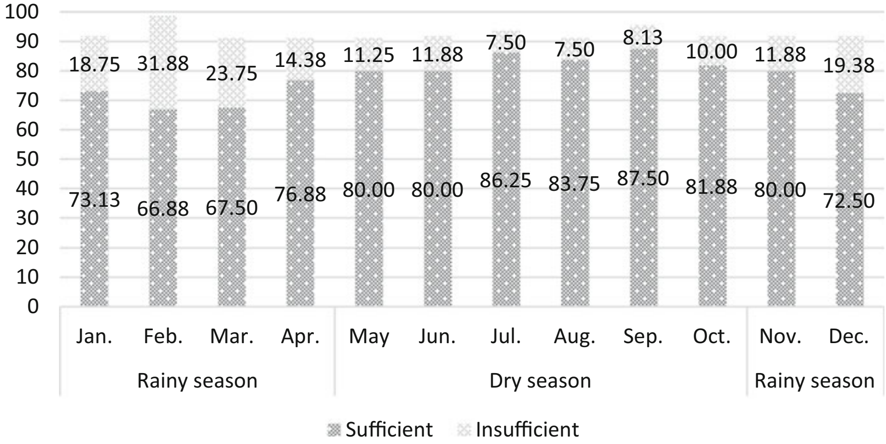


Fig. 8.4 Food sufficiency/insufficiency in 2018 (%) (Sakamoto et al., 2020)

Table 8.10 Total food sufficient months (Sakamoto et al., 2020)

No. of months	0	1	2	3	4	5	6	7	8	9	10	11	12
No. of households	1	5			4	2	13	5	9	9	12	48	52

interviews by the authors with the health workers revealed various explanations centering on the seasonal income and consumption of the villagers. A health worker indicated that villagers may buy less meat and fish during the dry season due to the lack of money. Another health worker indicated that farmers do obtain money during August–October during the dry season by selling maize, potatoes, and pulses, but they may lack money if men use up the money for buying alcohol. During the rainy season, there are expenditures such as fertilizers and school expenses in January. A different health worker indicated that since there are ample opportunities for casual labor in the rainy season, villagers obtain income, and some of them buy meat and fish. During the dry season, the expenditures are not as high, so they are able to buy vegetables.

However, there were a few concerns regarding the questionnaire, especially in relation to the results for seasonal food intake. The answers suggest that questions about the sufficiency or insufficiency of food during months of the year 2018 and questions about the frequency of intake of various food categories during dry and rainy seasons may have been difficult to answer for some due to the way they were asked. One question about the food sufficiency during the months of the year 2018 asked respondents to respond by entering an “X” (or an “O”), but some answered it with a tick. On the questions about the frequency of intake of various food categories, some respondents may have become tired and did not answer for the situation in the rainy season. The categorization of the frequency and the categorization of foods may also have been difficult. Therefore, the results need to be interpreted with caution.

8.4 Wild Foods and Their Benefits

As mentioned above, the frequency of people eating wild foods differs between the dry and rainy seasons: A total of 29.2% of respondents indicated that they do not eat wild foods and 15.3% indicated that they do eat these foods every day in the dry season, while 32.9% indicated that they do not eat wild foods, and 20.8% indicated that they eat these foods every day in the rainy season. Meanwhile, when food was insufficient, 37.8% eat wild foods. Thus, it seems that during the rainy season, when food is insufficient, people who eat wild foods eat them more frequently than during the dry season. Wild foods can address an insufficiency of food as there are various trees in the forest whose fruits ripen in different seasons.

Additionally, when food was insufficient, 26.7% decreased the number of meals. Some (17.4%) sold livestock, and 9.4% of respondents' children ate at relatives' or neighbors' homes (Table 8.11). Thus, the wild foods helped ease the difficulties of living when food was insufficient.

8.5 Livelihood, Marriage, and Family

8.5.1 Livelihood

The majority of respondents are farmers (76.6%), but 13.8% do business, 3.6% are pastoralists, and a few are employees (2) or waiting to be recruited (3). Although 96.5% did not consider themselves pastoralists, 43.9% had some kind of livestock. Only six respondents had cattle, and the number of cattle ranged from one to ten (Table 8.12). Five respondents had goats; four of them had only one goat, but one respondent had nine goats. Approximately half (51) of the respondents had chickens: 29 respondents had 1 chicken; five respondents each had 5 and 10 chickens; and one respondent each had 3, 4, 12, 20, 30 and 50 chickens. Others had ducks (three respondents), pigs (three respondents), sheep, and guinea pigs (*simbilisi*, one respondent).

The majority had a farm (73.5%) and/or a garden (60.4%). The major crop was maize (97.5%), but a few respondents cultivated cassavas, potatoes (*viazi*), kidney beans (*maharage*, two respondents each), rice and sorghum (one respondent each). The majority cultivated for food (94.7%), and some cultivated food for business

Table 8.11 Behavior when food was insufficient (%) (Sakamoto et al., 2020)

	Yes	No
Did you gather wild foods?	37.8	62.2
Did you decrease the number of meals?	26.7	73.3
Did you sell livestock?	17.4	82.6
Did your children eat at relatives' or neighbors' homes?	9.4	90.6

(3.8%). The majority answered that they have sufficient food in the house these days to last a year (69.8%).

8.5.2 *Marriage and Family*

Among the respondents, 74.8% had the experience of being married. The majority (76.6%) decided their marriage on their own, but 23.4% had their marriage decided by their parents (Table 8.13). Most (67.9%) of their families received bridewealth: 86% of them received money and 54.2% livestock. The average monetary value of bridewealth was Tsh 743,182, ranging from Tsh 20,000 to Tsh 9,000,000. The most frequent amount of livestock received was two cows, which was indicated by 21 respondents, and ranged from 1 to 5, but possibly 10 or 20 (if respondents who did not specify the type of livestock were referring to cattle) (Table 8.14). Others received chickens in numbers ranging from one to seven or combinations of chickens, goats, cattle, and sheep.

Presently, the majority of respondents (63.9%) were married, but 20.8% were unmarried, 9.0% were separated, 2.8% were divorced, and 3.5% were widowed. Most (88.6%) of their marriages were monogamous, but six of the husbands had two wives, one had four wives, and another had six wives. The majority (70.3%) lived with their spouse or partner. An average of 4.55 people lived in the same house, ranging from 1 to 14, and the most common number of people was 3 (39 respondents), followed by 4 (33 respondents), 5 (21 respondents), and 6 (20 respondents). Most of the respondents (86, 61.9%) had 1 child under 5 in the house, followed by 2 (25.2%) and up to 7.

As for the nutritional status (weight) of their children under the age of 5, 73.2% of respondents considered it sufficient, 8.7% considered that it could become insufficient, and 2.4% considered it insufficient. A total of 15.7% did not know their children's nutritional status. Among the respondents, 10.3% had experienced the death of a child under 5: 8 (4.9%) respondents had lost 1 child, 4 (2.5%) respondents had lost 2 children, and 1 (0.6%) respondent had lost 3. Most of them (6, 40.0%) did not know the reason, but 2 each (13.3%) indicated malaria, pneumonia, and jaundice, and 1 indicated convulsion at pregnancy.

Table 8.12 Do you have livestock? (Sakamoto et al., 2020)

	0	1	2	3	4	5	6	9	10	12	20	30	50	Total
Do you have livestock? 0 no, 1 yes	83	65												148
How many livestock do you have?														
Cattle		2		1	1		1		1					6
Goat		4						1						5
Chicken		29	6	1	1	5			5	1	1	1	1	51

Table 8.13 Decision about marriage and bridewealth (%) (Sakamoto et al., 2020)

	Yes/1	No/2
Have you ever been married?	74.8	25.2
Who decided about your marriage?(1). Parents, (2). Yourself	76.6	23.4
Has your family or yourself received or paid bridewealth?	67.9	32.1
Did they receive/pay money as bridewealth?	86.0	14.0
Did they receive/pay livestock as bridewealth?	54.2	45.8

Table 8.14 Number of livestock for bridewealth (Sakamoto et al., 2020)

	1	2	3	4	5	6	7
Cattle	4	21	4	4	3		
Chicken	1	2			3		1

Table 8.15 Mutual assistance outside the family (%) (Sakamoto et al., 2020)

	Yes	No
Within this month, has anyone outside of your family helped you when you needed food?	36.9	63.1
Within this month, have you helped anyone outside of your family when they needed food?	61.4	38.6
Within this month, has anyone outside of your family helped you when you needed money?	55.0	45.0
Within this month, have you helped anyone outside of your family when they needed money?	65.6	34.4
Do you think people in this village help each other?	75.0	25.0

8.6 Social Capital and Decision-Making

Many (33.9%) respondents joined one group in the community, followed by two groups for 7.3% of respondents, and three groups for 0.8%. Meanwhile, more than half of the respondents do not join the groups in the community. The most popular group for participation is a savings and borrowing group (57.9%), followed by agriculture (36.8%) and religious groups (1.3%).

The majority of respondents generally help each other, especially with money, with 55.0% having been helped and 65.6% providing help (Table 8.15). Meanwhile, the majority of respondents provided help in the form of food (61.4%), and less than half (36.9%) had received food. This is probably since the majority have enough food and thus do not require help in acquiring sufficient food. People also tend to emphasize that they help others, rather than being helped. The majority (75.0%) think that people help each other in the village.

In the majority of households, husbands/men and wives/women make decisions together, especially in deciding where to send a child when s/he is sick (91.5%), followed by decisions on the usage of crops (84.6%) and the usage of income (81.9%) (Table 8.16).

Table 8.16 Decision-making within households (%) (Sakamoto et al., 2020)

	The use of the crop	The use of income	Where to send a child when s/he is sick
Wife/woman only	9.0	9.4	6.7
Husband/man only	6.4	10.0	1.8
Husband/man and wife/woman	84.6	81.9	91.5

The total of each percentage value does not sum up to 100%, as each value is rounded to the first decimal place

8.7 Food Intake Frequency and Subjective Health

The Spearman correlation analysis shows that in the dry season, the frequency of eating vegetables has a weak positive correlation (coefficient = 0.327) with body pain, at less than 0.1% significance (Table 8.17). The frequency of eating meat also has a weak positive correlation (0.266) with general health, at a 0.2% significance. The frequency of eating fish has a weak positive correlation (0.205) with role emotional, at a 2.5% significance.

In the regression analysis of general health and frequency of eating meat, there was no statistical significance of the results (Table 8.18). With regard to the frequency of eating staple foods, the more frequently women ate staple foods, the less they had pain interfering with their normal work (Table 8.19). The greater they had sufficient food in the house currently to last a year, the less they had pain interfering with their normal work. A similar relationship on the interference of pain with their normal work was also found in the eating of vegetables (Table 8.20).

Additionally, the more frequently women eat vegetables, the less they experienced a feeling of accomplishing less than they would like as a result of their physical health, with a p value of 0.03 (Table 8.21).

In the analysis of the Spearman correlation between the manifestation of health/nutrition status and other factors, the age of women had a weak positive relationship (coefficient = 0.272) with having experienced the death of children under 5, at less than 0.1% significance (Table 8.22).

Self-evaluation of family situation (poor = 1, average = 2, rich = 3) has a weak negative relationship (−0.205) with having experienced the death of a child under 5, at 1.6% significance, and a weak positive relationship (0.201) with having sufficient food in the house currently to last a year, at 1.8% significance, and a weak positive relationship (0.216) with frequency of eating fish or small fish, at 2.2% significance (Table 8.23).

Self-evaluation of family situation has a weak positive relationship (0.247) with helping provide food to anyone outside the family, at the 0.4% significance level (Table 8.24).

Table 8.17 Spearman correlation between food intake and subjective health (dry season)

		Frequency of eating staple foods	Frequency of eating vegetables	Frequency of eating meat	Frequency of eating fish
General health	Corr. Coefficient	−0.037	−0.043	0.266**	0.164
	Significance	0.667	0.619	0.002	0.067
	n	139	136	137	125
Physical functioning	Corr. Coefficient	0.198*	0.012	0.063	0.055
	Significance	0.024	0.894	0.482	0.553
	n	131	127	128	117
Role physical	Corr. Coefficient	0.106	0.167	−0.015	0.143
	Significance	0.229	0.060	0.865	0.122
	n	131	128	131	118
Role emotional	Corr. Coefficient	0.164	0.175*	0.168	0.205*
	Significance	0.060	0.047	0.055	0.025
	n	132	129	131	119
Body pain	Corr. Coefficient	0.157	0.327**	0.185*	0.128
	Significance	0.074	<0.001	0.036	0.167
	n	131	128	129	117
Mental health	Corr. Coefficient	0.037	−0.088	0.108	0.106
	Significance	0.679	0.323	0.222	0.253
	n	130	127	129	118
Vitality	Corr. Coefficient	0.022	0.015	0.198*	0.140
	Significance	0.810	0.869	0.028	0.142
	n	125	121	123	112
Social functioning	Corr. Coefficient	−0.009	0.094	−0.034	0.002
	Significance	0.918	0.300	0.702	0.980
	n	128	124	126	114

* The correlation coefficient is significant (two-tailed) at the 5% level
** The correlation coefficient is significant (two-tailed) at the 1% level

8.8 Understanding the Challenges and Potential in the Area

Iringa region had high mortality at all ages, and this case study of Ifunda also indicated a high incidence of death of children under five. The study also underlined the general understanding of the Iringa region as having ample food, especially maize. Meanwhile, when food was insufficient, the study found that more than a

Table 8.18 Regression analysis of general health and frequency of eating meat

General health	Coef.	Std. Err.	t	$p > t$	[95% Conf.	Interval]
Frequency of eating meat	0.173	0.108	1.60	0.114	−0.043	0.389
Age	−0.005	0.009	−0.59	0.554	−0.023	0.012
Studied in secondary school	0.071	0.190	0.37	0.709	−0.307	0.449
Ever been married	−0.068	0.235	−0.29	0.774	−0.538	0.402
Sufficient food in the house	0.017	0.196	0.09	0.930	−0.373	0.408
Helped provide food outside the family	0.322	0.202	1.60	0.115	−0.081	0.726
Constant	2.615	0.386	6.78	0.000	1.845	3.386

Table 8.19 Regression analysis of body pain and frequency of eating staple foods

Body pain	Coef.	Std. Err.	t	$p > t$	[95% Conf.	Interval]
Frequency of eating staple foods	0.314	0.114	2.76	0.01	0.087	0.542
Age	−0.023	0.014	−1.72	0.09	−0.051	0.004
Studied secondary	−0.415	0.310	−1.34	0.19	−1.035	0.206
Ever been married	−0.541	0.369	−1.46	0.15	−1.279	0.197
Sufficient food in the house	0.708	0.301	2.35	0.02	0.107	1.309
Helped provide food outside family	0.387	0.288	1.34	0.18	−0.189	0.962
Constant	3.620	0.570	6.35	0.00	2.482	4.759

Table 8.20 Regression analysis of body pain and frequency of eating vegetables

Body pain	Coef.	Std. Err.	t	$p > t$	[95% Conf.	Interval]
Frequency of eating vegetables	0.388	0.119	3.26	< 0.01	0.150	0.626
Age	−0.018	0.013	−1.39	0.17	−0.043	0.008
Studied secondary	−0.101	0.286	−0.35	0.72	−0.672	0.470
Ever been married	−0.298	0.343	−0.87	0.39	−0.984	0.389
Sufficient food in the house	0.713	0.298	2.39	0.02	0.117	1.310
Helped provide food outside family	0.154	0.279	0.55	0.58	−0.403	0.711
Constant	2.889	0.624	4.63	0.00	1.642	4.135

third of respondents consume wild foods, especially in the rainy season, and these foods help address the insufficiency of food and the difficulties in living.

The correlation analysis revealed that the frequency of eating meat has a considerable positive correlation with general health. The regression analysis revealed that the more frequently women eat vegetables, the less they have the experience of accomplishing less than they would like as a result of their physical health. This finding seems to be related to the results of the correlation analysis, which shows that the frequency of eating vegetables has a considerable positive correlation with body

Table 8.21 Regression analysis of role physical and frequency of eating vegetables

Role physical	Coef.	Std. Err.	t	$p > t$	[95% Conf.	Interval]
Frequency of eating vegetables	0.488	0.218	2.24	0.03	0.051	0.925
Age	0.005	0.023	0.23	0.82	−0.041	0.052
Studied secondary	−0.232	0.519	−0.45	0.66	−1.268	0.805
Ever been married	−0.861	0.653	−1.32	0.19	−2.167	0.444
Sufficient food in the house	0.071	0.544	0.13	0.90	−1.016	1.158
Helped provide food outside family	0.206	0.525	0.39	0.70	−0.844	1.256
Constant	2.156	1.124	1.92	0.06	−0.092	4.403

Table 8.22 Spearman correlation between nutrition/health situation and other factors

		Nutrition of children under five	Children under five died	Sufficient food in the house
Age	Corr. Coefficient	0.012	0.272**	0.125
	Significance	0.9	< 0.001	0.138
	n	113	147	143
Ethnic group	Corr. Coefficient	0.038	−0.049	0.089
	Significance	0.68	0.545	0.276
	n	120	155	152
Elementary only	Corr. Coefficient	−0.105	0.107	−0.009
	Significance	0.318	0.253	0.927
	n	92	117	116
Secondary	Corr. Coefficient	0.149	−0.152	0.026
	Significance	0.172	0.114	0.786
	n	86	110	109

** The correlation coefficient is significant (two-tailed) at the 1% level

pain. The more frequently women ate staple foods, the less they had pain interfering with their normal work. In addition, the greater the extent to which they had sufficient food in the house currently to last a year, the less they had pain interfering with their normal work. These relationships on the interference of pain with their normal work were the same for the eating of vegetables. Thus, food sufficiency and a balanced diet have a positive relationship with better subjective health. In addition, among the food categories, eating staple foods and vegetables seems to have a positive relationship with subjective health in body pain and role physical. The study found that the average frequency of meat consumption is the lowest among all the food categories, with vegetables having the second highest frequency (salt is the highest) in the dry season. The positive effects of staple food and vegetable consumption on good self-rated health were found in the study of Sakamoto et al. (2021)

Table 8.23 Spearman correlation between nutrition/poverty situation and food intake

		Frequency of eating staple foods	Frequency of eating vegetable	Frequency of eating meat	Frequency of eating fish	Situation of family
Nutrition of children under five	Corr. Coefficient	0.107	0.015	−0.088	−0.096	0.029
	Significance	0.253	0.876	0.356	0.328	0.760
	n	116	115	112	106	113
Under five children died	Corr. Coefficient	−0.162	−0.138	−0.106	0.049	−0.205*
	Significance	0.056	0.106	0.214	0.583	0.016
	n	141	139	140	127	139
Sufficient food in the house	Corr. Coefficient	0.142	0.134	0.094	−0.011	0.201*
	Significance	0.095	0.122	0.275	0.907	0.018
	n	139	135	136	124	138
Situation of family	Corr. Coefficient	0.153	−0.036	0.11	0.216*	1
	Significance	0.093	0.698	0.234	0.022	<0.001
	n	121	118	119	112	142

* The correlation coefficient is significant (two-tailed) at the 5% level

Table 8.24 Spearman correlation between nutrition/poverty situation and social capital

		Anyone outside your family helped you with food	You helped provide food to anyone outside your family	Anyone outside your family helped you with money	You helped anyone outside your family with money	People help each other in the village
Nutrition of children under five	Corr. Coefficient	−0.058	−0.087	−0.074	0.033	−0.008
	Significance	0.527	0.34	0.423	0.718	0.931
	n	121	123	119	120	117
Under five children died	Corr. Coefficient	0.046	−0.089	−0.038	−0.024	−0.050
	Significance	0.573	0.281	0.648	0.772	0.556
	n	153	149	148	149	143
Sufficient food in the house	Corr. Coefficient	−0.037	0.111	−0.043	0.177*	0.076
	Significance	0.651	0.18	0.606	0.032	0.364
	n	151	148	146	147	143
Situation of family	Corr. Coefficient	0.06	0.247**	0.176*	0.199*	0.051
	Significance	0.49	0.004	0.044	0.022	0.562
	n	136	135	131	133	129

* The correlation coefficient is significant (two-tailed) at the 5% level
** The correlation coefficient is significant (two-tailed) at the 1% level

of more than 1700 Japanese adults and by Kurotani et al. (2018) in their systematic literature review. Xazela et al. (2017) studied the meat consumption of a rural population of approximately 500 South Africans and found that most consumers (64%) were aware of nutritional balance issues, and most of them (88%) recognized that meat is a rich protein component in their diet, which was one of the motives of meat consumption. This understanding might be similar in the case of Iringa.

The relatively sufficient food in Iringa addresses the problem of acute malnutrition (wasting) but not necessarily chronic malnutrition (stunting) or mortality. Stunting is likely to be the result of a lack of protein. Because of the general lack of protein in the villages, the more frequently women eat meat, the more they experience subjective general health, as mentioned above. Regarding mortality, it is difficult to draw conclusions since it is a manifestation of various factors, such as sickness (including high HIV prevalence). Frequent usage of salt, sugar, and oil (which is more frequent than eating staple foods) could be one of the factors negatively influencing health.

Acknowledgments First, we would like to thank the women of Ifunda village for answering the questionnaires and Mr. Luca Sanga for assistance in writing them. We would also like to thank Dr. Anita Wagner and Dr. Barbara Gande for sharing the Swahili version of their SF-36. Appreciation goes to Dr. Onesmo Mella for checking and advising on the original Swahili questionnaire and to Dr. Joyceline Kaganda for her advice on the food categories at the initial stage.

Thanks to Mr. Kenta Idenoue and Ms. Mai Kikuchi for inputting the questionnaire results, Ms. Yuki Fujiya for inputting and double checking the data, and Mr. Parinya Khemmarath for inputting, double checking, and compiling the data. We thank all those who were involved; the authors have checked and corrected their work and are fully responsible for the final compilation and reporting.

The research is supported by the Japanese Government, JSPS Grants-in-Aid for Scientific 76 Research (KAKENHI): mainly "Possibilities of wild edible plants and traditional meals in East Africa (18H03438)", partly supported by 18H00776 and 15H05139, and the research assistance system of the Office for Promotion of Gender Equality, Utsunomiya University.

Among the authors, Kato was responsible for data analysis, drafting and editing the manuscript. Sakamoto and Ohmori were responsible for formulating the questionnaire. Okui was responsible for overseeing the registration of the questionnaire and providing information on the local context. Ohmori was responsible for evaluating the responses on health and food intake. Sakamoto was responsible for the formulation and conceptualization of the questionnaire, supervising the input/checking of data, and editing the manuscript. All authors have gone through the manuscript and provided contributions and accepted the final version.

References

Beatty, W., & SpringerLink. (2018). *Decision support using nonparametric statistics*. Springer International Publishing: Imprint. Springer.

Beckham, S. W., Stockton, M., Galai, N., Davis, W., Mwambo, J., Likindikoki, S., & Kerrigan, D. (2021). Family planning use and correlates among female sex workers in a community empowerment HIV prevention intervention in Iringa, Tanzania: A case for tailored programming. *BMC Public Health, 21*(1), 1377.

Gandek, B., Ware, J. E., Aaronson, N. K., Apolone, G., Bjorner, J. B., Brazier, J. E., Bullinger, M., Kaasa, S., Leplege, A., Prieto, L., & Sullivan, M. (1998). Cross-validation of item selection and scoring for the SF-12 health survey in nine countries results from the IQOLA project. *Journal of Clinical Epidemiology, 51*(11), 1171–1178.

Grootaert, C., Narayan, D., Jones, V. N., & Woolcock, M. (2004). *Measuring social capital: An integrated questionnaire*. World Bank.

Hays, R. D. (2004). SAS Code for scoriong 12-item health survey version 2.0. Retrieved from https://labs.dgsom.ucla.edu/hays/files/view/docs/programs-utilities/sf12v2-1.sas.txt

Kurotani, K., Nakade, M., & Takimoto, H. (2018). Consumption of meals consisting of grain, fish and meat, and vegetable dishes and the relation with nutritional or health status among the Japanese population: A systematic review. *Eiyōgaku zasshi, 76*(4), 77–88.

Lukmanji, Z., Hertzmark, E., Mlingi, N., Assey, V., Ndossi, G., & Fawzi, W. (2008). *Tanzania food composition tables*. Muhimbili University of Health and Allied Sciences, Tanzania Food and Nutrition Centre, & Harvard School of Public Health. Retrieved October 30, 2022, from https://cdn1.sph.harvard.edu/wp-content/uploads/sites/30/2012/10/tanzania-food-composition-tables.pdf

Mantsios, A., Shembilu, C., Mbwambo, J., Likindikoki, S., Sherman, S., Kennedy, C., & Kerrigan, D. (2018). 'That is how we help each other': Community savings groups, economic empowerment and HIV risk among female sex workers in Iringa, Tanzania. *PLoS One, 13*(7), e0199583.

Patel, A. R., Lester, R. T., Marra, C. A., Kop, M. L. V. D., Ritvo, P., Engel, L., Karanja, S., & Lynd, L. D. (2017). The validity of the SF-12 and SF-6D instruments in people living with HIV/AIDS in Kenya. *Health and Quality of Life Outcomes, 15*, 143.

Pelletier, D. L., & Jonsson, U. (1994). The use of information in the Iringa nutrition programme: Some global lessons for nutrition surveillance. *Food Policy, 19*(3), 301–313.

Sakamoto, K. (2007). Mutual assistance and gender under the influence of cash economy in Africa: Case study from rural southeast Tanzania. *Journal of the Faculty of International Studies, Utsunomiya University, 23*, 33–54.

Sakamoto, K. (2008). Mutual assistance and gender under the influence of cash economy in Africa, part 2: Case study from inland rural southeast Tanzania. *Journal of Faculty of International Studies, Utsunomiya University, 25*, 25–43.

Sakamoto, K. (2015a). Situation of women and children in central Tanzania: Preliminary report from a questionnaire interview in Majeleko Village, Dodoma. *Journal of the Faculty of International Studies, Utsunomiya University, 39*, 133–150.

Sakamoto, K. (2015b). Situation of women and children in southeast Tanzania: Preliminary report from a questionnaire interview in Mchinga II Village, Lindi. *Journal of the Faculty of International Studies, Utsunomiya University, 39*, 151–170.

Sakamoto, K. (2020). *Factors influencing child survival in Tanzania: Comparative analysis of diverse deprived rural villages*. Springer.

Sakamoto, K., Ohmori, R., & Okui, A. (2020). Situation of women and children in southern Tanzania: From questionnaires in Ifunda, Iringa with focus on food-intake and health. *Journal of the School of Internatiolnal Studies, Utsunomiya University, 49*, 61–78.

Sakamoto, T., Inamura, Y., & Hayami, N. (2021). Association between frequency of meal consumption consisting of grain, fish and meat, and vegetable dishes and self-rated health in Japanese adults: Data from "The survey of attitude toward shokuiku". *Japanese Journal of Health Education and Promotion, 29*(4), 348–354.

Saleem, H. T., Surkan, P. J., Kerrigan, D., & Kennedy, C. E. (2016). Childbearing experiences following an HIV diagnosis in Iringa, Tanzania. *Qualitative Health Research, 26*(11), 1473–1482.

Straneo, M., Fogliati, P., Pellis, I., Goodman, C., Riva, D. D., Kisika, F., Mpuya, E., & Putoto, G. (2016). On the way to universal coverage of maternal services in Iringa rural district in Tanzania. Who is yet to be reached? *African Health Sciences, 16*(2), 420–428.

Tanzania, United Republic, National Bureau of Statistics (NBC), & ICF Macro. (2016). *Tanzania demographic and health survey and malaria indicator survey 2015/2016*. Retrieved February 12, 2023, from https://dhsprogram.com/pubs/pdf/fr321/fr321.pdf

Tanzania, United Republic, National Bureau of Statistics (NBC), & Office of Central Government Statistician (OCGS), Ministry of State President's Office, State House and Good Governance, Zanzibar. (2015). *Mortality and health*. Retrieved February 12, 2023, from https://s3-eu-west-1.amazonaws.com/s3.sourceafrica.net/documents/117930/Mortality-and-Health-Monograph.pdf

Tsunoda, N., Inayama, T., Hata, K., & Oka, J. (2015). Vegetable dishes, dairy products and fruits are key items mediating adequate dietary intake for Japanese adults with spinal cord injury. *Spinal Cord, 53*(11), 786–790.

Ware, J. E. (1995). *SF-12: How to score the SF-12 physical and mental health summary scales* (Vol. 2). The Health Institute.

Wooldridge, J. M. (2013). *Introductory econometrics* (5th ed.). South-Western.

Wyss, K., Wagner, A. K., Whiting, D., Mtasiwa, D. M., Tanner, M., Gandek, B., & Killima, P. M. (1999). Validation of the Kiswahili version of the SF-36 health survey in a representative sample of an urban population in Tanzania. *Quality of Life Research, 8*, 111–120.

Xazela, N., Hugo, A., Marume, U., & Muchenje, V. (2017). Perceptions of rural consumers on the aspects of meat quality and health implications associated with meat consumption. *Sustainability (Basel, Switzerland), 9*(5), 830.

Chapter 9
Coastal Traditional and Changing Dietary Patterns: Protein From Fish and Pulses as Well as Patterns of Purchased Food

Anna Calisti Maro, Lilian Daniel Kaale, Parinya Khemmarath, Kumiko Sakamoto, and Reiko Ohmori

Abstract The limited production of staple foods in Tanzania's coastal regions is changing dietary habits toward patterns of purchased food. However, the availability of high-quality protein found in seafoods makes these locations advantageous for the local indigenous population. This chapter presents findings from surveys conducted in the Lindi region of southeastern Tanzania with 84 adults in the coastal settlement of Kijiweni and 96 schoolchildren at Raha Leo Elementary School in the coastal town. Both studies showed a high frequency of fish consumption, ensuring a year-round intake of protein compared to other inland rural areas. Correlation analysis of research on school children indicated that frequent intake of pulses may have a negative effect on children's health ($p < 0.005$). One-fourth of the respondents in Kijiweni village experienced childhood death, and 16% had moderately underweight children. The former percentage was lower, and the latter was higher compared to those in other investigated villages. Food shortages were widespread, especially in the rainy season, but wild fruits, tubers, and vegetables were also utilized. Regarding the subjective assessment of health, vitality was high (49.10), and role emotional was low (30.92), similar to other villages. Vitality had correlations with assisting others with food (correlation coefficient 0.218, $p = 0.049$).

A. C. Maro
Department of Community Development, Lindi, Tanzania

L. D. Kaale
Department of Food Science and Technology, University of Dar es Salaam, Dar es Salaam, Tanzania
e-mail: elykaale@gmail.com; dlilian@udsm.ac.tz

P. Khemmarath
Center for the Multicultural Public Sphere of Utsunomiya University, Utsunomiya, Japan

K. Sakamoto (✉)
School of International Studies, Utsunomiya University, Utsunomiya, Japan
e-mail: ksaka@cc.utsunomiya-u.ac.jp

R. Ohmori
School of Regional Design, Utsunomiya University, Utsunomiya, Japan
e-mail: rohmori@cc.utsunomiya-u.ac.jp

K. Sakamoto et al. (eds.), *Changing Dietary Patterns, Indigenous Foods, and Wild Foods*, https://doi.org/10.1007/978-981-99-3370-9_9

Keywords Lindi · Coast · Sea · Tanzania · Protein

9.1 Introduction to the Coastal Southeast

The agricultural production of staple foods in the Lindi region, particularly in the coastal regions, is very low, but as stated in Chap. 2, the region is moving toward patterns of purchased food. This example provides a typical illustration of a changing dietary pattern in rural communities, which is one of the main topics of this book. The correlation between mutual relations and health evaluations in Chap. 6 also indicated that in the coastal community of Kijiweni village, those who regarded villagers as supporting each other and those who provided food for others had better health evaluations. This chapter further investigates a case study from this village, along with a pilot survey from Raha Leo Elementary School in the coastal community of Lindi Municipal. To comprehend the challenges and potentials of the coastal southeastern Lindi region, the case study introduces health, contents, and the balance of food consumption, wild food intake, livelihood, and social capital.

9.1.1 Coastal Lindi Region

In terms of gross domestic product (GDP), the regional economy of Lindi makes a very small contribution to the national economy, accounting for only approximately 2% of GDP (Tanzania, 2019). As a large contributor to the regional GDP, agriculture plays a vital part in the economy of Lindi, where 81% of households are engaged in agricultural activities (Tanzania, 2019). The main cash crops in Lindi are cashew nuts, coconuts, sesame, groundnuts, sunflower, onions, and tomatoes, while the main food crops are cassava, maize, pulse, paddy rice, and sorghum (Pauw, 1994; Sakamoto, 2009; Tanzania, 2019). Production data also indicate that cassava is the primary food crop produced in the Lindi region, followed by maize and paddy (Cochrane & D'Souza, 2015). Additionally, due to local food preferences, there is very low production of horticultural crops such as onions, tomatoes, and Amaranthus (*mchicha*) (Tanzania, 2017). Fishing is another activity that is performed along the shores of the Indian Ocean and around small lakes (Rutamba and Nkowe) in the Lindi region. Furthermore, the existence of beautiful beaches along the Indian Ocean with a variety of fish species, including coelacanths, as well as the Tendaguru Paleontological Site, makes the Lindi region an attractive tourist destination. Tendaguru is famous among historians and archaeologists because of its dinosaur fossils, which are among the earliest and longest reptilian creatures to have ever lived (Tanzania, 2017). The contribution of these economic activities in Lindi—which provide access to vital nutrients, including proteins, vitamins, and minerals—to the local population's health is not very clear.

The Lindi region has a high rate of chronic malnutrition or stunting (measured by height-for-age) of children under 5, at 54% in 2010 (Tanzania NBS and ICF Macro, 2011), which decreased to 36.2% in 2014 (TFNC, 2014) and 23.8% in 2018 (Tanzania MoHCDGEC et al., 2018), For acute malnutrition or wasting (measured by weight-for-height) of children, Lindi was at 2.9% below the average as of 2014 (TFNC, 2014), which further decreased to 1.9% in 2018 (Tanzania MoHCDGEC et al., 2018). The proportion of underweight of children is at 11.0% as of 2014 (TFNC, 2014), which is also below the average. The under-5 mortality rate (U5MR) of the Lindi region was high at 217.0 per 1000 births in the 2002 Census (Tanzania, 2006) but was reduced to 65.0 per 1000 births in the 2012 Census (Tanzania, 2015). However, the U5MR of Lindi district is 71.7 per 1000, which is higher than the national average (Tanzania, 2015). The infant mortality rate (IMR) of the Lindi region is 47.0 per 1000 births, slightly lower than the national average, but that of Lindi district is 50.7, which is above the national average (Tanzania, 2015).

9.1.2 Kijiweni Village

Kijiweni village, which is located on the Lindi district coast and has experienced food shortages, was chosen to study the situation of the villagers' health, livelihoods, food intake, and use of wild foods. The village is approximately 72 km away from Lindi town on the coast and is accessed by a road extending from the Mchinga villages, which lie along the road that connects Lindi with Dar es Salaam (Fig. 9.1a, b).

There is a diversity of greenery throughout the area. Mangroves, which are protected, are found in the sea and along the coast. There are sand patches along the coast with vegetation that supports a variety of edible wild foods. The Dimba forest reserve, which is home to endemic species, is in the vicinity of the village.

The village has a lengthy history. It has served as a major hub for the export of ivory and gold from the interior to Zanzibar and the Arab world. Additionally, there is a historical rock depicting the connection between Mozambique and Tanzania during the German colonial era. The village existed before the 1965 Ujamaa Villagization. In 1982, the housing area had been eroded by ocean water; therefore, the majority of the homes were relocated to the current location at a higher sea level. In 2014, a local famine necessitated the distribution of food aid (maize) to the populace.[1]

Kijiweni village has 482 households with 1110 women and 736 men. The details are presented in Table 9.1. The analysis and results of a survey study that was conducted between 25 and 27 September 2019 (Sakamoto et al., 2020a) among 84 participants (53 women, 30 men, 1 unknown) are introduced after Sect. 9.3.2. The numbers of respondents are indicated in Table 9.2.

[1] Based on field research in the village in September 2019.

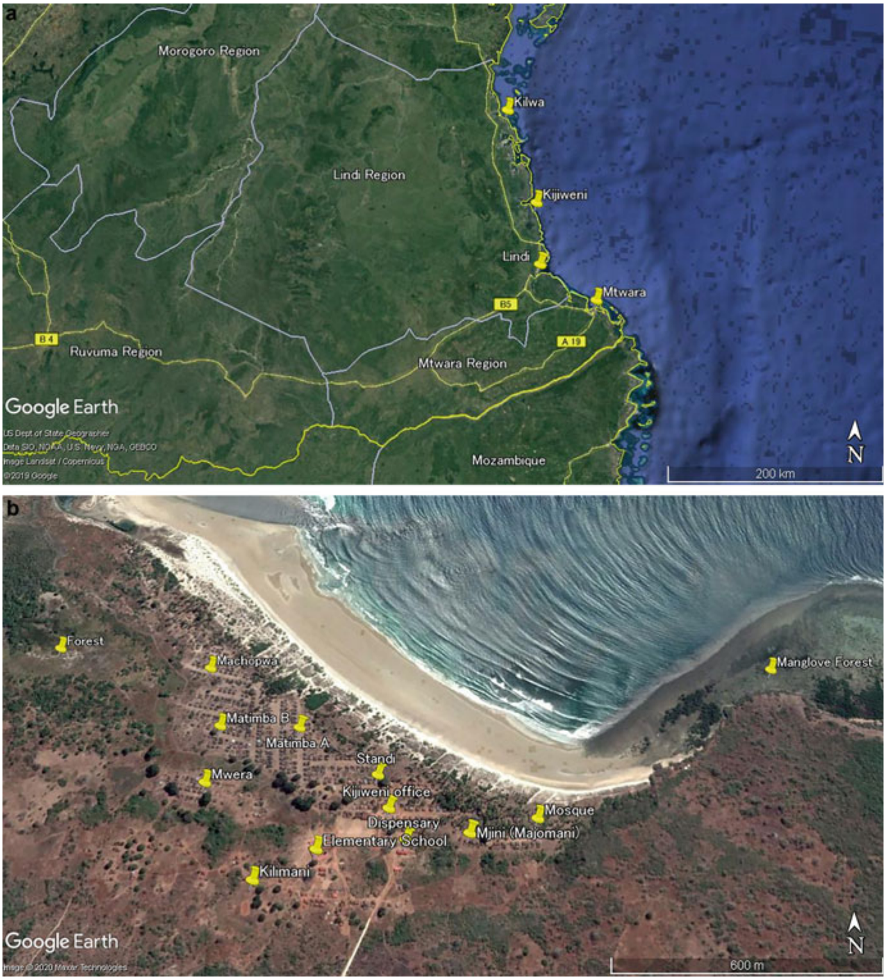


Fig. 9.1 Maps of Kijiweni village. (**a**) Kijiweni village in Lindi region, Tanzania. (**b**) Hamlets in Kijiweni village

9.2 Food Intake and Health Situation From a Pilot Study in Raha Leo Elementary School, Lindi City

Children in elementary school have not been thoroughly studied as much as children under 5 in terms of nutrition and health. The findings of a preliminary study evaluating the subjective health situation of 96 primary school pupils in Lindi city through a questionnaire are presented here as a baseline (Sakamoto et al., 2021). The questionnaire was formulated with reference to Tsunoda et al. (2015), Mizoguchi et al. (2004), and Tanzania MUHAS et al. (2008).

Table 9.1 Household, population, and sample of each hamlet

Name of hamlet	Households	Population			Sample	
		Women	Men	Total	*n*	%
Stendi	82	214	124	338	12	14.3
Mwera	88	201	172	373	12	14.3
Matimba A	97	224	107	331	12	14.3
Matimba B	60	157	87	244	12	14.3
Mjini (Majomani)	47	106	75	181	12	14.3
Machopwa	64	114	99	213	12	14.3
Kilimani	44	94	72	166	12	14.3
Total	482	1110	736	1846	84	100.0

The percentages do not add up to 100 because they are rounded up

Table 9.2 Age and sex group

Age groups	Women	Men	Unknown	Total	%
10s	1	0	0	1	1.2
20s	10	6	0	16	19.0
30s	13	12	0	25	29.8
40s	15	3	0	18	21.4
50s	2	6	0	8	9.5
60s	7	1	1	9	10.7
70s	2	0	0	2	2.4
Unknown	3	2	0	5	6.0
Total	53	30	1	84	100.0

According to the study, pupils consumed staple foods on average less than once per day in both seasons, which is concerning if the pupils' answers were accurate. In addition, although the school is located in a town, pupils in primary school frequently eat a variety of wild foods. More research is needed to comprehend the potential of wild foods in relation to pupils' health. Furthermore, the study revealed that pupils frequently ate foods with salt and sugar, which may have a negative effect on their health. Food is heavily promoted to children, and the majority of the items are sweet breakfast cereals, soft drinks, candy, salty snacks, and fast foods that are calorie-dense, nutritionally deficient, and high in added saturated fat and/or trans-fat, sugar, or sodium. Children's knowledge of food and brands, preferences, requests, purchases, and eating habits are influenced by the marketing of harmful foods.

Regarding the health assessment, several pupils experienced issues including (1) difficulties waking up or morning sickness, (2) lack of appetite, and (3) physical fatigue. Some of these issues were related to dietary habits. Pulse consumption was strongly correlated (Spearman) with (1: correlation coefficient 0.273, $p = 0.009$ in the dry season) and (3: 0.211, $p = 0.046$ in the rainy season); individuals with larger intakes experienced these problems (Sakamoto et al., 2021). According to Kaale et al. (2022), pulses contain a variety of bioactive substances that have been categorized as antinutritional factors (ANFs), mostly because they negatively affect nutrient digestibility and bioaccessibility when they are not thoroughly cooked or well processed (Alphonce et al., 2020). Evidence is also derived from in vitro studies conducted in the Lindi region that showed that a diet rich in cereals with the addition of pulses and green vegetables had high total iron content but low bioavailability (Tatala et al., 1998). Therefore, more research is needed to better understand the effects of pulse consumption or the circumstances of children who consume many pulses and experience challenges such as (1) morning sickness and (2) physical fatigue. Furthermore, foods high in sugar and fat that pupils reported eating were significantly connected with health problems (1).

On the other hand, the same issue was somewhat correlated with the consumption of wild foods and the consumption of *matembele* (*Ipomoea batatas*): those with a high consumption of wild foods and *matembele* did not experience problem (1). *Matembele* is a type of green vegetable largely consumed in the southeastern, southern, and central parts of Tanzania, and there are also wild varieties (*Matembele pori*, *Ipomoea* sp.). Wild vegetables contain some potential nutrients, such as proteins and minerals (Sakamoto et al., 2022).

These findings are based on a preliminary survey study and analysis. It is necessary to conduct additional research to draw conclusions that can lead to practical solutions. It is vital to conduct more research on the identification and determination of the nutritional potential of wild foods in the Lindi region.

9.3 Adults' and Children's Health

This section summarizes the results of a survey study on the health of adults and children.

9.3.1 Health of Adults Based on Quality of Life Evaluation Based on SF-12

A Kiswahili-verified global quality-of-life indicator was used to evaluate and study adult health, SF (short-form)-12 (Wyss et al., 1999). The detailed definitions are indicated in Table 5.1 of Chap. 5.

[GH: General Health] The term "general health" refers to a condition of total physical, mental, and social well-being rather than simply the absence of illness or disability. Understanding the body's functioning and what it needs to maintain health is another important aspect of general health. Most respondents indicated that their health was fair (48%), followed by good health (28%), very good health (15%), and poor health (10%). None of them believed that their health was excellent. According to the results, the majority of people in the Lindi region consider their health to be fair (Fig. 9.2a).

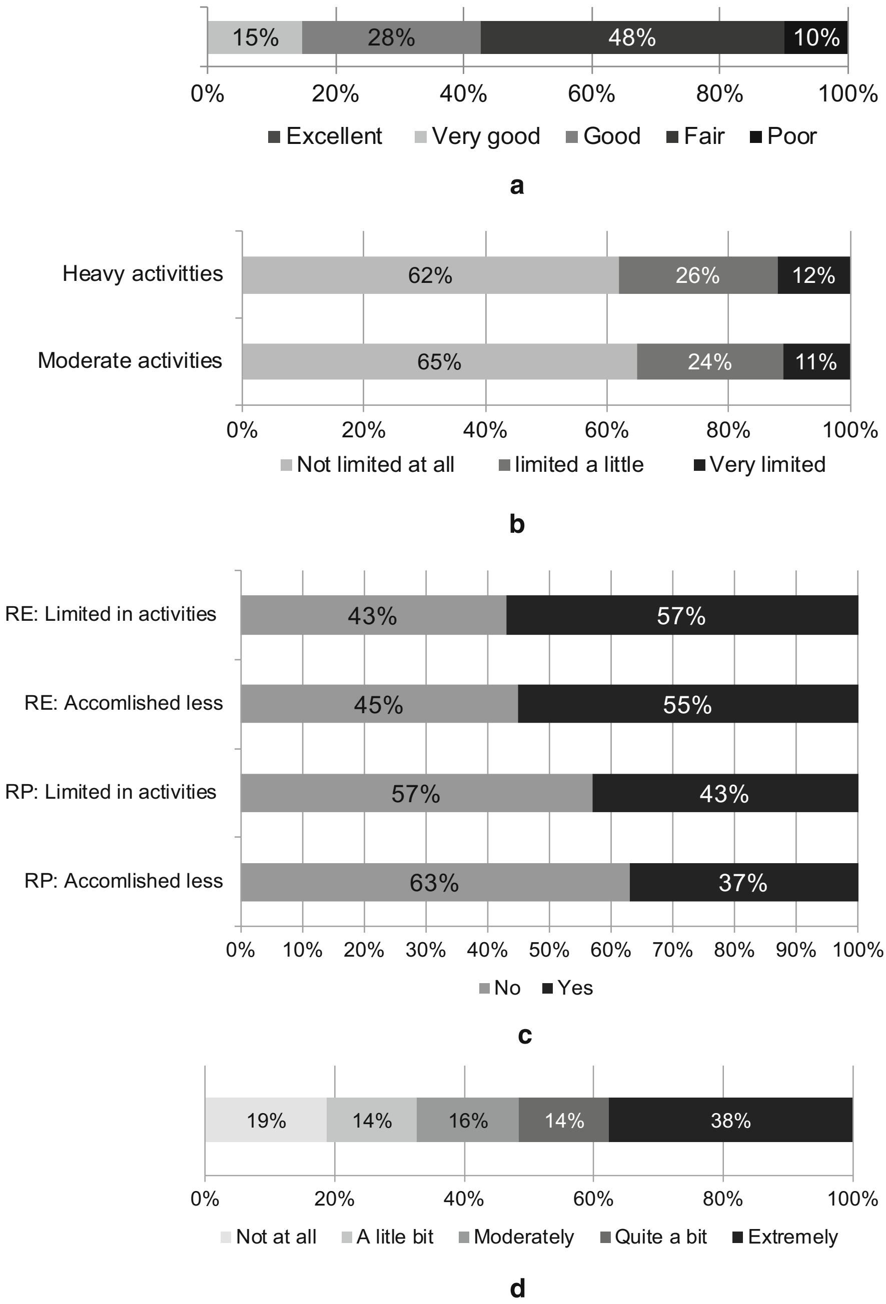


Fig. 9.2 Health of adults based on quality of life (QOL) evaluation according to the SF-12. (**a**) General Health (GH). (**b**) Physical Functioning (PH). (**c**) Role Emotional (RE) and Role Physical (RP). (**d**) Body Pain (BP). (**e**) Social Function (SF), Vitality (VT), and Mental Health (MH). (**f**) Summary of SF-12 evaluation

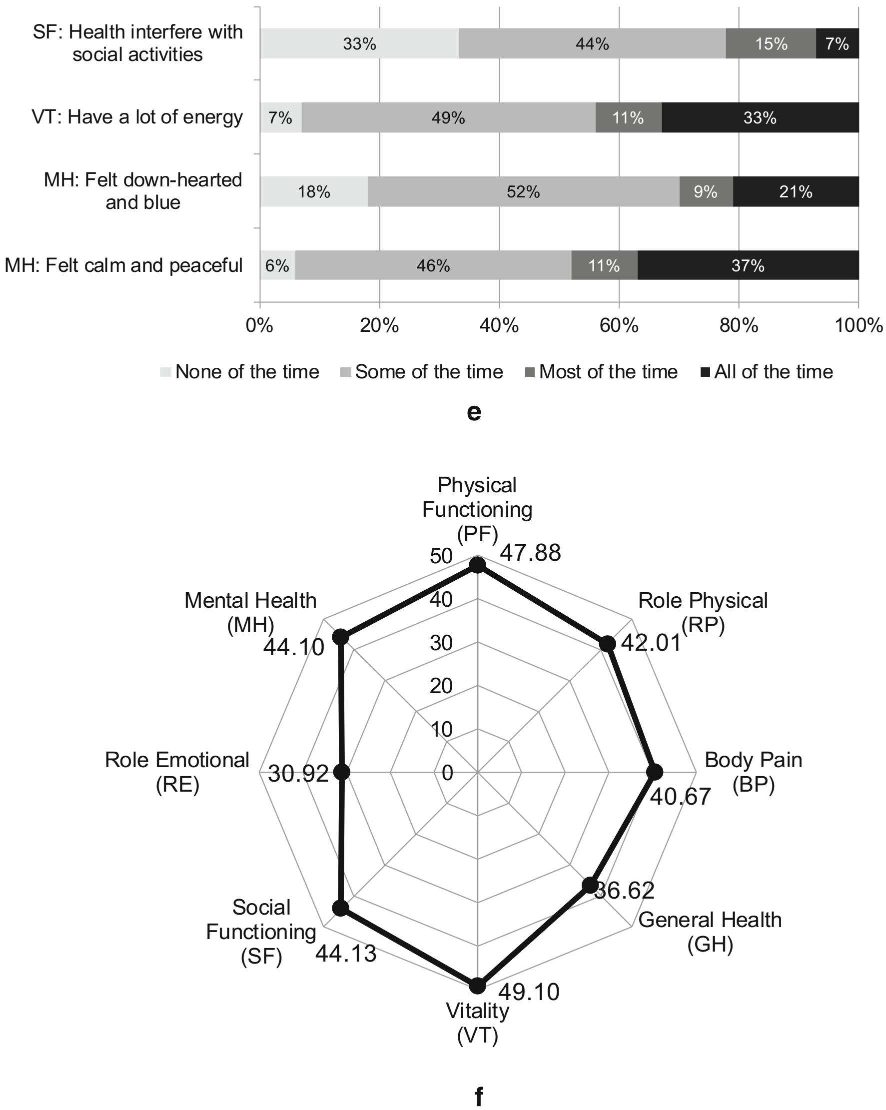


Fig. 9.2 (continued)

[PF: Physical Functioning] In terms of moderate activities, 65% of respondents felt completely unrestricted, 24% somewhat restricted, and 11% severely restricted due to physical problems. Regarding the ability to engage in heavy activities, 62% had no restrictions, 26% had some restrictions, and 12% had very strict restrictions due to physical problems such as sickness and injuries (Fig. 9.2b).

[RP: Role Physical] Thirty-seven percent (37%) believed that their performance of tasks and everyday activities over a month was below expectations due to physical

health issues. Furthermore, a greater number of respondents had restrictions in the kind of work or activities (43%) (Fig. 9.2c).

[RE: Role Emotional] Regarding emotional issues, marginally more respondents (55%) felt they did less than they would have liked to compared to those who disagreed (45%). Furthermore, more than half indicated that they worked less carefully than usual (57%) due to emotional problems in comparison to those who felt that they worked carefully (43%) (Fig. 9.2c).

[BP: Body Pain] Thirty-eight percent (38%) of respondents indicated that pain had an impact on their ability to carry out their regular tasks. However, 19% indicated that it had no impact (Fig. 9.2d).

[MH: Mental Health] In terms of feelings, 46% reported experiencing quiet and peace occasionally, 37% always, 11% almost constantly, and 6% never. Fifty-two percent (52%) of the people reported feeling depressed and blue occasionally, 21% reported feeling this way all of the time, 18% reported they never felt blue, and 9% reported feeling this way most of the time (Fig. 9.2e).

[VT: Vitality] Forty-nine percent of respondents reported having high energy occasionally, 33% reported having it always, 11% reported having it most of the time, and 7% reported having no energy at all (Fig. 9.2e).

[SF: Social Functioning] Forty-four percent of respondents indicated that health interfered with social activities occasionally, 33% indicated that it did not, 15% said it happened frequently, and 7% indicated that it happened always when it came to physical or emotional issues interfering with social activities (Fig. 9.2e).

Fig. 9.2f is a summary of the SF-12 scores derived from the above results. In Kijiweni, VT (49.10) and PF (47.88) had the highest scores, followed by SF (44.13), MH (44.10), RP (42.01), and BP (40.67). RE (30.92) had the lowest score, followed by GH (36.62).

9.3.2 Children's Survival and Underweight

In the sample, 25% of respondents had experienced the death of a child under 5: 12 respondents (18%) lost one child, two respondents (3%) lost two children, and two respondents (3%) lost five children. The majority of them (11, 65%) were unable to identify the cause of a child's death. However, there were respondents who mentioned a newborn's death, malaria, convulsion, kidney issue, gait difficulty, and accident caused by falling.

Regarding the underweight of children under 5, 69% thought it was "excellent/ sufficient" (green), 16% thought it was "average" but may become "insufficient" (gray), and none thought it was "poor/insufficient" (red). Sixteen percent, or seven respondents, were unsure about the nutritional status of their children.

9.4 Quantity and Balance of Food Intake

The most common staple foods were maize (86%), sorghum (85%), cassava (79%), and rice (52%), followed by bananas (37%), wheat (36%), millet (30%), and other tubers (29%). Ninety-five percent of respondents indicated that fish or sardines were the main accompaniments for their staple foods, followed by 67% who reported eating pulses, 63% vegetables, 20% milk, and 15% meat.

The frequency of consumption of various food groups during each season is depicted in Fig. 9.3. Thirty-seven percent of the participants reported eating staple foods more than twice daily from June to November, which is the dry season (Fig. 9.3a). Fifty-nine percent of the people who participated in the survey study reported consuming vegetables fewer than 3 days a week, and 65% of the people

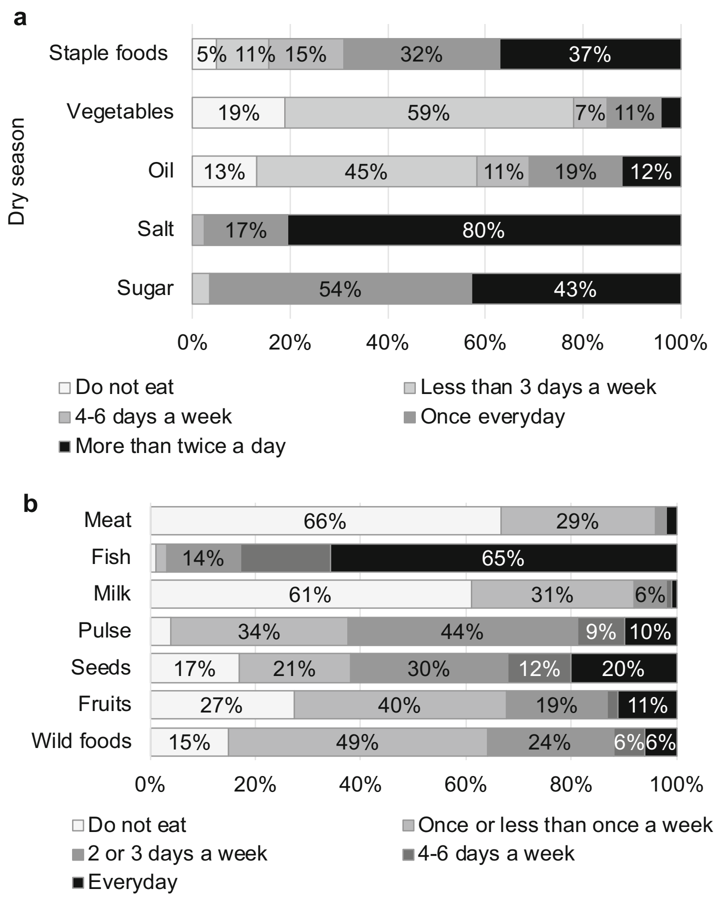


Fig. 9.3 Frequency of food by season. (**a, b**) Frequency of food in the dry season. (**c, d**) Frequency of food in the rainy season

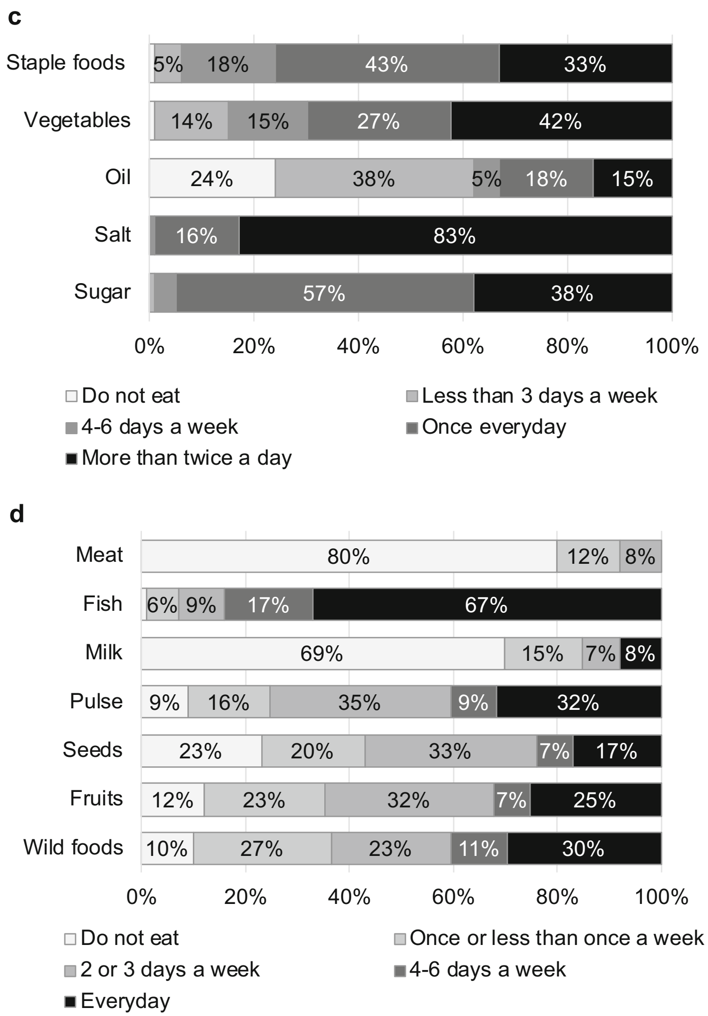


Fig. 9.3 (continued)

indicated that they regularly ate fish or sardines every day. In terms of pulses, 44% consumed them two or three times a week, and 30% consumed seeds two or three times a week. Furthermore, 66% of respondents indicated that they did not eat meat, and 61% indicated that they did not drink milk. Forty percent of respondents reported fruit consumption once or less than once a week in the dry season.

Eighty percent of respondents use salt more than twice a day, 54% use sugar once a day, and 45% use oil fewer than three times per week in the dry season. The majority (25, 89%) utilize traditional sea salt, whereas only a few (3, 11%) use commercial salt purchased from retail shops.

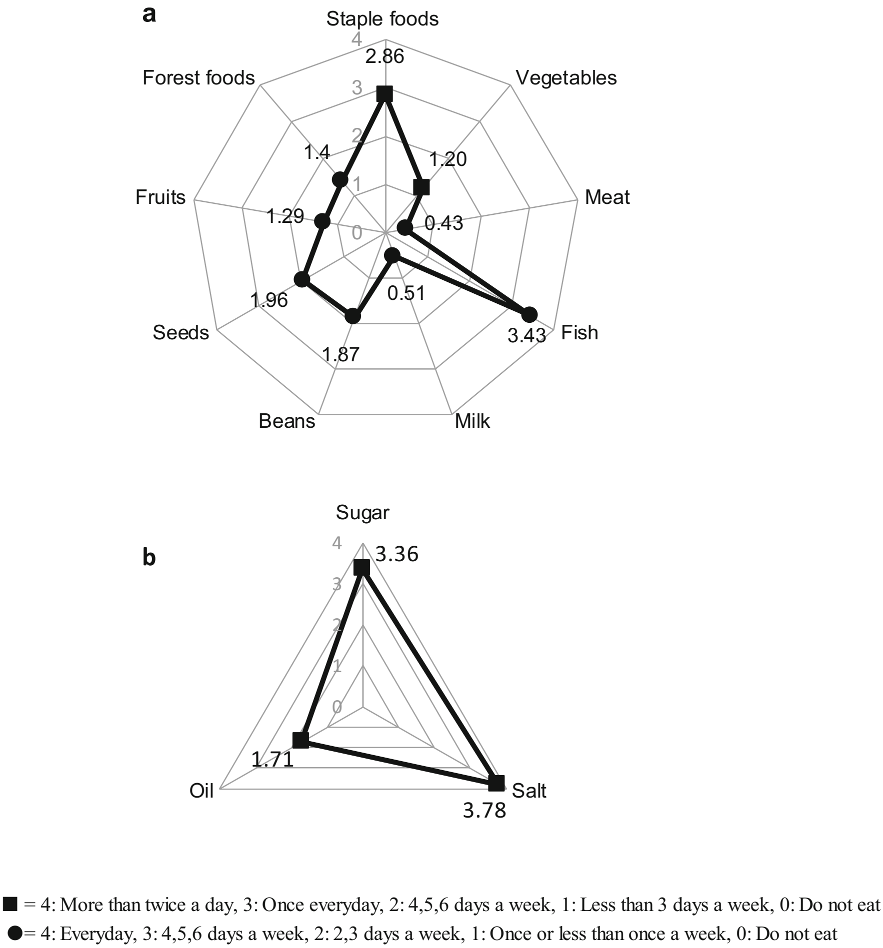
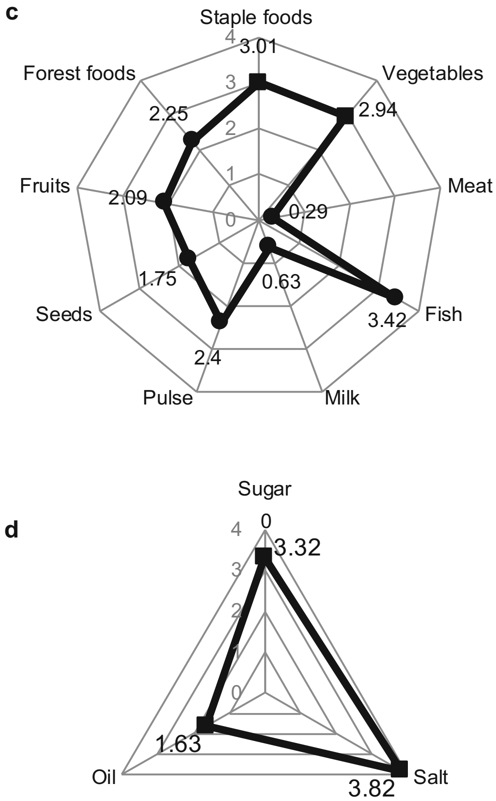


Fig. 9.4 Average food intake by season. (**a, b**) Average food intake in the dry season. (**c, d**) Average food intake in the rainy season

In the rainy season (Fig. 9.3b), 43% of the participants reported eating staple foods once every day, 42% reported consuming vegetables more than twice a day, and 67% indicated that they regularly eat fish or sardines every day. In terms of pulses, 35% consumed them two or three times a week, and 32% ate them every day. Regarding seeds, 33% consumed them two or three times a week. Furthermore, 80% of respondents indicated that they did not eat meat, and 69% indicated that they did not drink milk. Fruit consumption was reported by 32% who ate it 2 or 3 days a week in the rainy season. Eighty percent of respondents use salt more than twice a day, 57% use sugar once a day, and 38% use oil fewer than three times per week in the rainy season.

Figure 9.4 presents the average scores by season, indicating the frequent consumption of fish throughout the season. The quantity and diversity of food



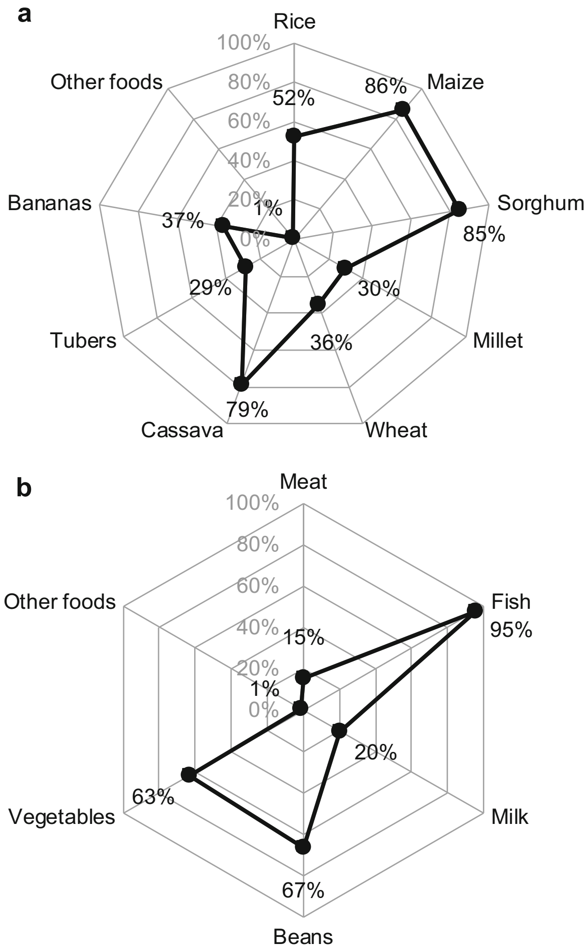
■ = 4: More than twice a day, 3: Once everyday, 2: 4,5,6 days a week, 1: Less than 3 days a week, 0: Do not eat
●= 4: Everyday, 3: 4,5,6 days a week, 2: 2,3 days a week, 1: Once or less than once a week, 0: Do not eat

Fig. 9.4 (continued)

consumption in the Lindi region demonstrate a clear nutrient balance and the presence of the essential foods needed by humans in the villagers' diets. Despite the fact that the study found that people are eating more meals high in carbohydrates than other foods, they balanced out their carbohydrate intake with foods higher in nutrients, such as protein, particularly fish. Milk has not been a common commodity in the Lindi region, where tsetse fly infestations have prevented the expansion of cattle rearing. The presence of this pest has prevented milk and beef from being common commodities.

The primary foods and relishes consumed in Kijiweni village are shown in Fig. 9.5. The most popular staple foods are maize (86%) and sorghum (85%), followed by cassava (79%) and rice (52%). Fish (95%) is the most popular type of

Fig. 9.5 Food and relish intake



relish, followed by pulses (67%) and vegetables (63%). These findings reflect the frequent intake of fish in both the dry season and the rainy season (Figs. 9.3, 9.4).

The respondents' reported months of food sufficiency and insufficiency are shown in Fig. 9.6. There are food deficits during the rainy season, especially in March and February. It is worth noting that respondents reported consuming more staple foods during the rainy season (Fig. 9.4b), when food availability is thought to be inadequate.

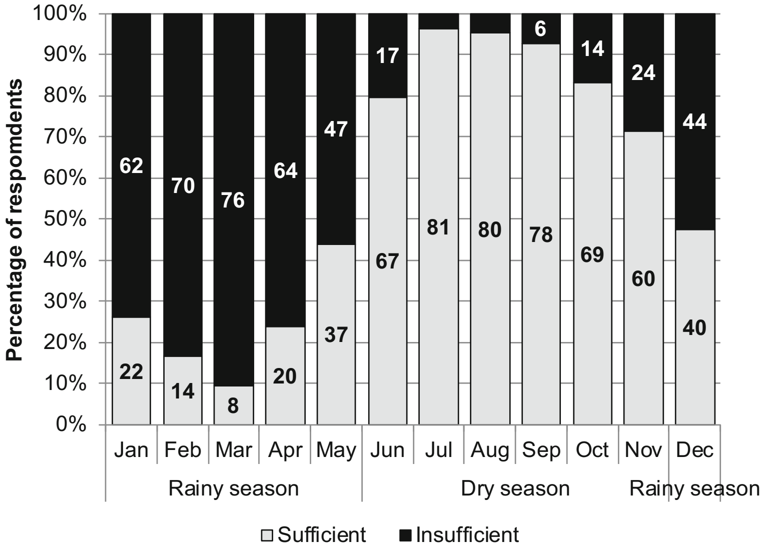


Fig. 9.6 Food sufficiency in 2018

9.5 Wild Food Intake

Forty-nine percent of people consume foods from the forest once a week or less in the dry season. Major wild foods consumed are staple foods such as **ming'oko**[2] (*Dioscorea hirtiflora* ssp. *orientalis*, 12 respondents) and **uwanga/ulanga** (*Tacca leontopetaloides*, 10), as well as fruits such as **makoe** (*Hyphaene coriacea*, six respondents). **Uwanga** is processed to make powder made from starch. Previously considered a famine meal, it is now available for domestic consumption when combined with sugar and coconuts or sent to Zanzibar to form the well-known sweet *harua*. Additionally, people eat the vegetable ***mboga pwani*** (*Sesuvium portulacastrum*, according to three respondents), which grows on ocean rocks (Table 9.3).

Thirty percent regularly consume wild foods from the forest in the rainy season. Fruits such as **vitoro** (*Landolphia kirkii*, 11 respondents) and **usofu** (*Uvaria lucida*, 11 respondents) are two examples. Additionally, people eat vegetables such as **lilende** (*Corchorus aestuans*) (Table 9.3).

[2]Local plant names are in **bold**.

Table 9.3 Wild foods indicated in the questionnaire

Local name	*Scientific name*	Type of foods	Foods in hunger	Dry season	Vegetable in the rainy season	Rainy season	Total
Mtoro, Vitoro	*Landolphia kirkii*	Fruit	2	5		11	18
Msofu, Usofu	*Uvaria lucida*	Fruit	1	4		11	16
Mkoe, Makoe	*Hyphaene coriacea*	Fruit		6			6
Mabungo	*Landolphia parvifolia*	Fruit		2		3	5
Ububudu	*Grewia* sp.	Fruit	2			2	4
Matonga	*Strychnos spinosa*	Fruit		2		2	4
Lipwawa	*Flagellaria guineensis*	Fruit	1			1	2
Matopetope	*Annona senegalensis*	Fruit				1	1
Ufuru	*Vitex sp.*	Fruit			1	1	2
Mabibo	*Anacardium occidentale*	Fruit		1			1
Ming'oko	*Dioscorea hirtiflora subsp. orientalis*	Staple	2	12		1	15
Uwanga, **Ulanga**	*Tacca leontopetaloides*	Staple	1	10			11
Lilende	*Corchorus aestuans*	Vegetable		3	3	6	12
Mboga pwani	*Sesuvium portulacastrum*	Vegetable		3		1	4
Mtolilo	(unidentified)	Vegetable		1	1	2	4

Bold: Local plant names, Bold italics: Swahili plant names

9.6 Livelihood, Marriage, and Family

Majority (94%) responded that they are farming and 4% responded that they are in business. Fishery is also common, but most answered that they are farmers when they are engaged in both.

The respondents identified themselves as either Mwera or Makonde. Alternatively, or informally, they identified themselves as Machinga, a hybrid of the two groups found in Mchinga II village. One characteristic of being a Machinga is that not everyone speaks the language of their ethnic group, such as the Mwera language. There are also minority ethnic groups, as indicated in Table 9.4.

Ninety-nine percent (99%) of the respondents had been married at some point. The majority (82%) of people chose their spouse on their own; however, 18% let

Table 9.4 Ethnic groups

Ethnic groups	*n*	%
Mwera	52	61.9
Makonde	15	17.9
Makua	3	3.6
Yao	3	3.6
Machinga (Mwera-Makonde)	2	2.4
Matumbi	2	2.4
Hehe	1	1.2
Sambaa	1	1.2
Unknown	5	6.0
Total	84	100.0

The total percentage value does not sum up to 100%, as each value is rounded to the first decimal place

their parents make the decision. All of the families received bridewealth in monetary form, and only 9% received bridewealth in the form of livestock such as chickens or goats.

The average amount of bridewealth was TSh 114,541, with values ranging from TSh 32 (by a Mwera woman born in 1954) to TSh 1000,000 (by a Makonde woman born in 1995). Nine percent of respondents reported receiving livestock, mostly chickens, as bridewealth, in addition to the monetary form of bridewealth. The common numbers of livestock as bridewealth are 10 chickens (2 respondents, 2%) and six chickens (2 respondents, 2%) (Table 9.5). The average number of chickens is 7.90, and the average number of goats is 5.55.

The majority of the respondents (73%) were married at the time of the survey, while 10% of them were single, 10% were divorced, and 6% were widowed. The majority of their marriages were monogamous (69%), but 21% (13 respondents) of the husbands had two wives, 5% (3) had three wives, and another 2% (1) had four wives. Most people (79%) shared a residence with their partners. The average number of residents per household was 4.05, with a range from 1 to 10. Four (30%) were the most prevalent number of occupants per household, followed by three (18%), five (16%), two (11%), six (11%), one (6%), seven (6%), and ten (1%) (Table 9.6). One child under 5 was present in the homes of over half of the respondents (35 respondents, 47%), followed by two children (5, 7%) and up to three children.

9.7 Social Capital and Decision-Making

The majority of respondents indicated that men and women make joint decisions in the home on the following matters: children's health issues such as which hospital to send sick children to (84%), followed by the use of crops (77%), and the use of income (73%). As indicated in Table 9.7, the majority of respondents (73%)

Table 9.5 Numbers of livestock (bridewealth and ownership)

English translation	*n*	Avg.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	20	Total
How many chickens did your family receive for bridewealth?							1	2				2					1	1	7
How many goats for bridewealth?				1															1
How many chickens do you have?	31	7.90	3	2	2	1	3	7	1			3	2	1			4	2	31
			10%	6%	6%	3%	10%	23%	3%			10%	6%	3%			13%	6%	100%
How many goats do you have?	11	5.55	2	1	2	1	1	1		1					1		1		11
			18%	9%	18%	9%	9%	9%		9%					9%		9%		100%

Table 9.6 Number of household members

English translation	*n*	Avg.	1	2	3	4	5	6	7	. . .	10	Total
How many people live in your house?	82	4.05	5	9	15	25	13	9	5		1	82
			6%	11%	18%	30%	16%	11%	6%		1%	100%

Table 9.7 Mutual relations in Kijiweni village

Answer	No		Yes	
Question	*n*	%	*n*	%
Within this month, has anyone outside your family helped you when you needed food?	60	71	24	29
Within this month, have you helped anyone outside of your family when they needed food?	45	54	39	46
Within this month, has anyone outside your family helped you when you needed money?	54	64	30	36
Within this month, have you helped anyone outside your family when they needed money?	61	73	22	27
Do you think people in this village help each other?	21	27	58	73

Table 9.8 Vitality (VT) and helping others with food

	VT				
Within this month, have you helped anyone outside of your family when they needed food?	27.63	37.69	57.82	67.86	Total
No	**5**	**23**	4	11	43
Yes	1	17	**5**	**16**	39
Total	6	40	9	27	82

VT Vitality

indicated that the villagers help one another, although the majority of the respondents indicated that no one outside of the family has helped them with food (71%) or money (64%) within this month. Helping others is also not as common, but helping others with food (46%) is more common than helping others with money (27%). Additionally, more respondents indicated that they receive help in the form of money (36%) than those who responded that they help with money (27%). This may be explained by the fact that 52% of respondents view their wealth as average and 48% as poor. In other words, individuals who think their wealth is average may be aiding those who think they are poor. Only 13% of people belonged to groups with objectives such as borrowing and saving (Table 9.7).

Correlation analysis (Spearman) between the above mutual relations and SF-12 scores was performed. The only association was between “VT” and “helping others with food” (correlation coefficient 0.218, $p = 0.049$). As indicated in Table 9.8, more respondents with vitality help others with food.

To summarize this section, the majority of respondents tend to make decisions with their partners; for example, decisions are made jointly regarding children’s illnesses, followed by decisions about crops and income. These results are comparable to those from the Dodoma region discussed in Chap. 12 (Sakamoto et al., 2021) and Iringa region discussed in Chap. 8 (Sakamoto et al., 2020b). Despite the fact that few people were truly helped or given food or money, the majority of respondents perceived that the villagers supported one another. These results concurred with earlier research from the Dodoma and Iringa regions. However, one thing that distinguishes this village from others is the fact more respondents indicated that they receive financial assistance than those who indicated that they provide financial assistance to others. Furthermore, having vitality is associated with helping others with food.

9.8 Understanding the Challenges and Potentials of the Coastal Lindi Region

9.8.1 Malnutrition of Children

Although the nutrition status of the children in the Lindi region is improving, the research findings based on respondents of various age groups confirmed that Kijiweni village had a higher rate of underweight than the regional average. Additionally, the investigation confirmed what was already widely believed: that the village lacked sufficient food. However, the number of women who experienced child deaths was lower than that in previous studies, where nearly half of the women experienced child deaths in all three research villages, namely Mchinga village (Lindi region), Majeleko village (Dodoma region), and Chaani Masingini village (Zanzibar) (Sakamoto, 2020).

When compared to the communities of the Dodoma and Iringa regions covered in Chaps. 8 and 12, how are these outcomes reported in this chapter? According to the findings of the Lindi survey, 17 respondents (or 25%) reported having lost a child before the age of 5. This brings the total number of child deaths to 26. Compared to 68 children, or 49% of the population, in Chinangali I village in the Dodoma region, this percentage is significantly lower. In a study conducted in Chinangali I, the average age of the respondents was 45.83 years (Sakamoto et al., 2020c), which is comparable to the 41.04 years in the present study.

Children with moderate underweight made up 16% of the population. Although the cutoff point is likely to deviate from the national figures, it is higher than the 13% national average, the 11% average for the Lindi region, and the 12% target. Even taking into account that 10% of respondents to the Dodoma study did not know the nutritional status of their children, the percentage of children who are moderately underweight was lower than in the Lindi region. In the Ifunda, Iringa region, a comparable study revealed that 2% of children were severely underweight and 9% were moderately underweight (Sakamoto et al., 2020b). Although Iringa had more severe cases, the percentage of underweight was higher in the present research.

9.8.2 Food Intake, Health, and Wild Foods of Adults

In 2018, the majority of people had insufficient food from January to May and December during the rainy season, which was better than Dodoma but worse than Iringa. However, the frequency of food intake increased in the rainy season when food was insufficient, which was different from other research areas. Fish consumption was exceptional, and the study listed 18 wild foods, including the sea vegetable ***mboga pwani*** (*Sesuvium portulacastrum*). Subjective health by SF-12 indicated high VT and low RE, as in other areas.

According to widespread consensus, seafood consumption in this community was exceptional compared to that in other inland villages. Furthermore, consumption was significantly lower in the dry season and higher in the rainy season, which was inconsistent with the food insufficiency season and other results in other areas. According to the health assessment, the inhabitants had high VT and low RE, similar to other villages in other regions. It was also observed that receiving financial assistance was more common than disbursing it to others among the respondents.

In Chap. 2, coastal villages were indicated to have risks related to transitioning to patterns of purchased food. The wild food ***uwanga***, an ingredient in the well-known Zanzibar snack *harua*, is also enjoyed as a snack in this village when combined with sugar and coconut. This provides example of how the use of wild foods has contributed to the rise in sugar consumption. However, access to seafood and sea vegetables provides an opportunity for people to have a healthy diet. Utilization of such local resources is recommended for a healthy diet in the coastal areas of the Lindi region.

9.8.3 Mutual Assistance

The analysis in this chapter revealed that those who assisted others in Chinangali village had high self-evaluation of VT. This finding is consistent with the finding in Chap. 6 that those who helped others with foods had high self-evaluation in their physical health but further specified the subscales. According to Chap. 6, those who believed that their community supported one another were healthier. It is worth noting that the food assistance provided by those with vitality to others in need has a positive effect on improving not only the food deficiency of the specific person who has been helped but also in creating a good environment leading to people's positive evaluation of their health.

Acknowledgments First, we would like to thank the women and men of Kijiweni village for answering the questionnaires; the village, district, and regional government for welcoming this research; and COSTECH for permission. Mr. Ally Hassani Mushangani (Village Executive Officer), Mr. Yusuf J. Jerashi, Mr. Tite R. Mzungu, Mr. Hafidhia A. Msusa, Mr. Hamisi A. Gudi, Mr. Juma M. Mkuweni, and Mr. Salumu A. Mkomi were part of a team responsible for interviewing the villagers. Mr. Frank M. Mbago and Mr. Masayuki Hayashi also accompanied us to Kijiweni village and identified major edible plants in the village. Mr. Tsuda Katsunori formulated the maps of the village.

We would also like to thank Dr. Anita Wagner and Dr. Barbara Gande for sharing the Swahili version of their SF-36. Thanks to the students who assisted in inserting and double checking the data insert, Mr. Stanislaus Acquah and Ms. Arai Naho for inserting and double checking the data insert, and Ms. Hoang Anne for inserting work. With considerable appreciation for those who were involved, the authors have checked and corrected their work, and the authors are fully responsible for the final compilation and reporting.

Among the authors, Maro was responsible for implementing the questionnaire and directly supervising the interviews, providing information on the region, and drafting the first manuscript. Kaale was responsible for the review, revision, and editing of the manuscript. Sakamoto was responsible for planning the research; formulation of the questionnaire; overall supervision of the implementation of the questionnaire and input/checking of data; supervision of the formulation of tables and diagrams; and the revision of the manuscript. Khemmarath was responsible for inputting, double checking, and compiling the questionnaire responses; calculating the SF-12; formulating most of the diagrams in the manuscript; and assisting in drafting the manuscript. Ohmori was also responsible for the planning of the research, formulation of the questionnaire, advising on the evaluation of the response on health and food intake, especially as a nutrition expert, and supervision in scoring the SF-12. All authors have gone through the manuscript and provided contributions and accepted the final manuscript.

The research is supported by the Japanese Government, JSPS Grants-in-Aid for Scientific Research (KAKENHI): mainly "Possibilities of wild edible plants and traditional meals in East Africa (18H03438)," partly supported by 25284171 and 18H00776; and the research assistance system of the Office for Promotion of Gender Equality, Utsunomiya University.

References

Alphonce, S., Kaale, L. D., Millinga, F., & Rweyemamu, L. M. P. (2020). Enrichment of fermented cassava meal 'mchuchume' with micronutrient ingredients from soya bean flour and *Moringa oleifera* leaves powder. *Journal of the Science of Food and Agriculture, 101*, 3575–3581.

Cochrane, N., & D'Souza, A. (2015). *Measuring access to food in Tanzania*. USDA Economic Research Service Retrieved October 23, 2022, from https://www.ers.usda.gov/webdocs/publications/43932/51864_eib135.pdf?v=2057

Kaale, L. D., Siddiq, M., & Hooper, S. (2022). Lentil (*Lens culinaris* Medik) as nutrient-rich and versatile food legume: A review. *Legume Science, 1–11*, e169. https://doi.org/10.1002/leg3.169

Mizoguchi, K., Takemi, Y., & Adachi, M. (2004). Relationship between a positive perception toward work and the dietary habits of young male workers. *The Japanese Journal of Nutrition and Dietetics, 62*(5), 269–283. Retrieved from https://www.jstage.jst.go.jp/article/eiyogakuzashi1941/62/5/62_5_269/_article/-char/en

Pauw, E. D. (1994). *Development of land use planning and land tenure in Tanzania*. FAO. Technical support service project TSS1 URT/94/02T.

Sakamoto, K. (2009/2021). *Social development, culture, and participation: Toward theorizing endogenous development in Tanzania*. Shumpusha.

Sakamoto, K. (2020). *Factors influencing child survival in Tanzania: Comparative analysis of diverse deprived rural villages*. Springer.

Sakamoto, K., Khemmarath, P., Ohmori, R., & Maro, A. C. (2020a). Health, livelihoods, and food intake in coastal southeast Tanzania: From questionnaire interviews in Kijiweni village, Lindi region. *Journal of the School of International Studies, Utsunomiya University, 50*, 11–29. Retrieved from http://hdl.handle.net/10241/00012361

Sakamoto, K., Ohmori, R., & Okui, A. (2020b). Situation of women and children in southern Tanzania: From questionnaires in Ifunda, Iringa with focus on food-intake and health. *Journal of the School of International Studies, Utsunomiya University, 49*, 61–78.

Sakamoto, K., Ohmori, R., & Tsuda, K. (2020c). Health, livelihoods, and food intake of children and adults in central Tanzania: From questionnaire interviews in Chinangali I village, Chamwino district, Dodoma region. *Journal of the School of Regional Design, Utsunomiya University, 7*, 43–63.

Sakamoto, K., Khemmarath, P., Ohmori, R., & Maro, A. C. (2021). Food intake and health of school children in southeast Tanzania: Preliminary questionnaire in Raha Leo elementary school, Lindi Municipal. *Journal of the School of International Studies, Utsunomiya University, 52*, 27–38. Retrieved from http://hdl.handle.net/10241/00012958

Sakamoto, K., Kaale, L., & Ohmori, R. (2022). Nutrient content of seven African wild leafy vegetables in semiarid Tanzania. *Journal of International Development Studies, 54*, 17–28.

Tanzania. United Republic of. (2006). *Infant and child mortality report, Census 2002* (Vol. 4). National Bureau of Statistics.

Tanzania, United Republic of. (2015). *Mortality and health*. National Bureau of Statistics, Ministry of Finance and Office of Chief Government Statistician, Ministry of State, President Office, State House and Good Governance. Retrieved March 27, 2016, from www.nbs.go.tz/nbs/takwimu/census2012/Mortality_and_Health_Monograph.pdf

Tanzania, United Republic of. (2017). *Medium term rolling strategic plan for the year 2016/17–2020/21*. Retrieved December 19, 2022, from http://www.lindidc.go.tz/storage/app/uploads/public/5b6/172/f0f/5b6172f0f3e54488395687.pdf

Tanzania. United Republic of. (2019). *The Master Plan for Lindi Municipality (2018–2038)*. Retrieved December 18, 2022, from 1567769286-LINDI MASTER PLAN.pdf (lands.go.tz)

Tanzania, Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC) [Tanzania Mainland], Ministry of Health (MoH) [Zanzibar], Tanzania Food and Nutrition Centre (TFNC), National Bureau of Statistics (NBS), Office of the Chief Government Statistician (OCGS) [Zanzibar], & UNICEF. (2018). *Tanzania national nutrition survey using SMART methodology (TNNS) 2018*. MoHCDGEC, MoH, TFNC, NBS, OCGS, and UNICEF. Retrieved December 19, 2022, from https://www.unicef.org/tanzania/media/2141/file/Tanzania%20National%20Nutrition%20Survey%202018.pdf

Tanzania, Muhimbili University of Health and Allied Sciences (MUHAS); Tanzania Food and Nutrition Centre (TFNC); & Harvard School of Public Health (HSPH). (2008). *Tanzania food composition tables*. Retrieved from http://ihi.eprints.org/3035/1/tanzania-food-composition-tables.pdf

Tanzania, National Bureau of Statistics (NBS) & ICF Macro. (2011). *2010 Tanzania demographic and health survey: Key findings*. NBS and ICF Macro. Retrieved September 29, 2019, from https://www.dhsprogram.com/pubs/pdf/SR183/SR183.pdf

Tatala, S., Svanberg, U., & Mduma, B. (1998). Low dietary iron availability is a major cause of anemia: A nutrition survey in the Lindi district of Tanzania. *American Journal of Clinical Nutrition, 68*(1), 171–178. https://doi.org/10.1093/ajcn/68.1.171

TFNC (Tanzania Food and Nutrition Center). (2014). *Tanzania national nutrition survey 2014*. The United Republic of Tanzania, Ministry of Health and Social Welfare. Retrieved October 1, 2016, from http://www.lishe.org/tanzania-national-nutrition-survey-2014-final-report/

Tsunoda, N., Inayama, T., Hata, K., & Oka, J. (2015). Vegetable dishes, dairy products and fruits are key items mediating adequate dietary intake for Japanese adults with spinal cord injury. *Spinal Cord, 53*, 78–790. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/25962372

Wyss, K., Wagner, A., Whiting, D., Mtasiwa, D. M., Tanner, M., Gandek, B., & Kilima, P. M. (1999). Validation of the Kiswahili version of the SF-36 health survey in a representative sample of an urban population in Tanzania. *Quality of Life Research, 8*(1–2), 111–120. https://doi.org/10.1023/A:1026431727374

Part IV
Wild Food Intake and Association with Health

Part IV focuses on wild foods and how they are related to health, also considering the respective local contexts. Chapter 10 analyzes the association between wild food intake and health based on data from 253 villagers in a semiarid agro-pastoral village in central Tanzania (Chinangali village, Dodoma), a coastal bushland village in the southeast (Kijiweni village, Lindi region), and an inland village in the southeast (Malolo village, Lindi region). Chapter 11 elaborates on the Malolo village, which had a positive association between wild food intake and Physical Function (PF). Chapter 12 further analyzes Chinangali village with a positive association between wild food intake in the rainy season and General Health (GH). Chapter 13 analyses the nutrition content of African wild leafy vegetables (AWLVs) collected in Chinangali village and provides evidence that their consumption contributes to the health of residents.

Chapter 10
Does Intake of Wild Foods Improve Subjective Health? Evidence from Three Areas of Tanzania

Kumiko Sakamoto, Reiko Ohmori, Lilian Daniel Kaale, Frank M. Mbago, Katsunori Tsuda, and Tamahi Kato

Abstract Wild foods are utilized in many developing countries, but their relationship with people's health situation has not been well researched. This chapter analyzes the correlation between the intake of wild foods and individuals' health situation based on responses from 253 villagers through questionnaire interviews in three regions of Tanzania. For health situations, the Swahili version of the global subjective evaluation SF-12 for adults was used. Correlation and multiple regression analysis were performed with other indicators related to age, sex, food production, staple food intake frequency, and subjective wealth status; cross-tabulation was implemented. In the semiarid village of Dodoma, with a generally low intake of wild foods, respondents with a higher intake of wild foods in the rainy season had a good evaluation of General Health (GH). Leafy vegetables may have positively influenced their health. In the inland village of Lindi, people who consumed more wild foods during both seasons gave their Physical Function (PF) higher ratings. The diverse variety of wild foods may have contributed to their health. The chapter

K. Sakamoto (✉)
School of International Studies, Utsunomiya University, Utsunomiya, Japan
e-mail: ksaka@cc.utsunomiya-u.ac.jp

R. Ohmori
School of Regional Design, Utsunomiya University, Utsunomiya, Japan
e-mail: rohmori@cc.utsunomiya-u.ac.jp

L. D. Kaale
Department of Food Science and Technology, University of Dar es Salaam, Dar es Salaam, Tanzania
e-mail: elykaale@gmail.com; dlilian@udsm.ac.tz

F. M. Mbago
University of Dar es Salaam Herbarium, Dar es Salaam, Tanzania

K. Tsuda
Center for the Multicultural Public Sphere of Utsunomiya University, Utsunomiya, Japan

T. Kato
Center for African Area Studies, Kyoto University, Kyoto, Japan

K. Sakamoto et al. (eds.), *Changing Dietary Patterns, Indigenous Foods, and Wild Foods*, https://doi.org/10.1007/978-981-99-3370-9_10

highlights the different correlations between villages and the positive influence of wild food intake. Recommendations for additional research on the promotion of wild food consumption for health advantages in low-consumption areas are suggested.

Keywords Wild foods · East Africa · Health · Nutrition · Intake

10.1 Introduction

Wild foods play an important role within the overall objective of the book to understand the nutrition, health, and social situation in Tanzania. This chapter analyzes the extent to which wild food intake contributes to or influences people's health in Tanzania.

10.1.1 Background and Previous Research on the Relationship Between Wild Foods and Health

The Sustainable Development Goals (SDGs) include the explicit objectives of eradicating hunger and enhancing nutritional status as global goals. *The State of Food Security and Nutrition in the World*, 2020, written by the Food and Agriculture Organization of the United Nations (FAO) and other United Nations organizations, emphasizes the crucial issue of how people can affordably obtain sufficient food and nutrition (FAO et al., 2019). As one of the ways of obtaining sufficient food and nutrition, the importance of wild foods in the world's food supply is well supported (Bharucha & Pretty, 2010). Forager and hunter-gatherer civilizations have traditionally relied solely on wild plants and animals for food. People have collected and utilized wild foods, and studies on the practices of the Usambara Mountains (Powell et al., 2013), Miombo forests (Mpasiwakomu et al., 2017), and the Sandawe people in semiarid areas (Yatsuka, 2011) have been published in Tanzania. The use of wild foods has long been noted as a method for improving nutrition using local resources, and information on wild foods and fruits in East Africa (FAO, 1983), nuts (Wickens, 1995), and wild edible plants in Tanzania (Ruffo et al., 2002) has been collected and published. Regional variations are expected given that research in five African nations, including Tanzania, has indicated that fruit consumption increases with the country level of forest cover (Rasmussen et al., 2020).

Additionally, studies have accumulated evidence showing how wild fruits and vegetables contribute to a balanced diet (Bvenura & Sivakumar, 2017) and how foods from wild trees have been a qualitative and quantitative complement to staple foods in sub-Saharan Africa, including Tanzania (Koffi et al., 2020). Studies have also shown that households that obtain foods from forests in the Uzambara Mountains have more balanced diets (Powell et al., 2011). Some research has been conducted in Tanzania on the nutritional value of wild foods, such as a nutritional

Table 10.1 Child malnutrition and mortality rates and anemia in the research regions (created from Tanzania, 2018, Tanzania, 2015)

	Year	Dodoma region	Lindi region	National average
Chronic malnutrition in children under-5, as indicated by stunting (height by age) (%)	2018	**37**	24	31.8
Underweight of children under-5 (weight by age) (%)	2018	**18**	7	14.6
Acute malnutrition and wasting in children under-5 (weight by height) (%)	2018	**3.7**	2.3	3.5
Under-5 mortality rate (per 1000)	2015	58	65	67
Anemia in women (not pregnant) aged 15–49 (%)	2018	24	**33**	28.8

Bold: above the national average

study of wild leafy vegetables in three regions of Tanzania (Msuya et al., 2009), although wild foods are rarely mentioned in Tanzania's food composition tables (Lukmanji et al., 2008).

As mentioned above, using local resources and wild foods is recognized as an effective means of improving nutrition without the need to purchasing food. In fact, the consumption of wild foods is an existing practice, and studies on the nutritional value of these wild foods are being conducted in Tanzania. However, there is only limited research on the relationship between the frequency of wild food consumption and people's health, and there is insufficient information and evidence to recommend wild foods for improving nutrition and health in Tanzania's regions in the future. Therefore, this chapter aims to examine how wild foods may contribute to people's health in different regions of Tanzania.

10.1.2 Research Areas

This chapter focuses on rural villages located in three regions of Tanzania with different nutritional and health statuses, natural environments, livelihoods, ethnic groups, and food cultures.

Nutrition and health indicators for children in Tanzania indicate that stunting (height-for-age), representing chronic malnutrition, was highest in 2010 in the Dodoma region (56%) and in the central and Lindi region (54%) in the southeast (Tanzania, 2011) but later improved in Lindi (24%) in 2018 (Table 10.1). Underweight by age of children is higher in Dodoma, at 18%, than the national average of 14.6% and than that in Lindi, at 7%. Similar trends are seen in wasting (weight-by-height), which indicates acute malnutrition. Furthermore, the under-5 mortality rates in both regions are lower than the national average (Tanzania, 2015) and have improved in recent years. On the other hand, regionally disaggregated indicators for adults are limited, with anemia among non-pregnant women aged 15–49 years being higher in Lindi, at 33%, than the national average of 28.8% and than that in Dodoma, at 24% (Table 10.1, Tanzania, 2018). In other words, as of 2018, child

Table 10.2 Major livelihoods, ethnic groups, and main foods in the research villages (created from Sakamoto et al. (2020a, b, 2021b)

Region	Dodoma	Lindi	
Area	Inland	Inland	Along the coast
District	Chamwino	Ruangwa	Lindi[a]
Village	Chinangali I	Malolo	Kijiweni
Major ethnic groups	Gogo	Mwera	Machinga[b]
Religion	Christianity	Majority Christian, minority Muslim	Muslim
Main occupation	Raising crops and livestock	Agriculture	Fishing and agriculture
Main staple foods	Maize, sorghum	Maize	Maize, sorghum
Main side dish	Vegetables, pulse	Pulses, vegetables	Fish

[a] At the time. Currently classified as Lindi City
[b] Hybrid between Mwera and Makonde

malnutrition was more common in the Dodoma region, while anemia was more common among women in the Lindi region.

The environments in each of these areas are distinctive. The Dodoma region is semiarid, with 500–750 mm annual precipitation, and frequently experiences drought in many areas, yet it is at an altitude of 900–1350 m and has cooler periods. Due to its location at an elevation of 0–900 m above sea level along the coast, the Lindi region experiences moderate annual precipitation of 750–1000 mm, is relatively hot, and is rich in vegetation; however, food shortages are frequent in many areas.

This chapter focuses on the villages in Table 10.2 from the above different health settings in the region, with preliminary research showing that wild foods are utilized to some extent. All of the sites primarily practice crop cultivation, with the exception of the Machinga, who are also a fishing civilization, and the Gogo, who are also pastoralists but with a limited number of cattle owners. Although the Mwera are farmers as well, they are historically described as hunters (Koponen, 1988).

10.1.3 Method

Based on a Swahili questionnaire containing 75 questions refined from a preliminary study on food intake status and health-related quality of life conducted in the Dodoma and Lindi regions (Ohmori et al., 2020), interviews were conducted with a total of 253 people in Chinangali I village, Dodoma region (hereafter Chinangali I village, 81 people), from 13 to 15 August 2019; in Kijiweni village along the coast of the Lindi region (hereafter Kijiweni village, 84 people) from 27 to 29 August 2019; and in inland Malolo village of the same region (hereafter Malolo village, 88 people) from 2 to 4 September 2019 (Sakamoto et al., 2020a, b, 2021b). Additionally, interviews regarding the main wild food plants used in the villages were conducted. Plants were collected and identified on the following dates: 13–15 August 2019 and 6–10 March 2020 in Chinangali I village; 14 March 2020 in Malolo village; and 27–29 August 2019 and 16 March 2020 in Kijiweni village. Selected plants were nutritionally analyzed as described in Chap. 13. Note that “wild food” in the questionnaire survey often but not exclusively refers to wild edible plants, and in Malolo village, it also includes wild animals.

In Tanzania, migration to the village centers has led to an increase in population; however, some villagers still live outside the centers. It is expected that wild foods would be utilized by households living away from the center of the village, and it is emphasized that the target population would be equally sampled from all subvillages (hamlets) rather than randomly selected from the village level where the resident registers were available.

The target population was defined as one adult per household who was home at the time of the household visit. To avoid a male bias, we did not limit the household to the head of the household, and women were encouraged because they are often actively involved in food production and meal preparation. At the time of the survey, there were no explicit exclusion criteria for age or health status other than being an adult.

This chapter focuses on the results of an analysis of the relationship between seasonal wild food consumption frequency and subjective health ratings in the three villages.

The subjective health assessment was fine-tuned and utilized based on preliminary research by extracting the SF-12, aggregated quality-of-life scales used worldwide, from the SF-36 (Wyss et al., 1999), which has already been validated in Tanzania in a Swahili version. From the questionnaire items, it is possible to calculate Physical Functioning (PF), Role Physical (RP), Body Pain (BP), and General Health (GH) for the Physical Component Summary (PCS) and Vitality (VT), Social Functioning (SF), Role Emotional (RE), and Mental Health (MH) for the Mental Component Summary (MCS) (Ohmori et al., 2020).

The frequency of food intake was defined as “daily,” “4 to 6 times a week”, “2 to 3 times a week,” and “once or less,” as used in previous studies on food intake in Japan (Mizoguchi et al., 2004; Tsunoda et al., 2015), as well as “never eat” to reflect the diversity of food in Tanzania. In the analysis, “daily” and “4 to 6 times a week” were defined as the high-frequency group, “2 to 3 times a week” as the medium-frequency group, “once or less” as the low-frequency group, and “never eat” as the no intake group.

First, after specifying the age group, sex, and other attributes of the survey participants, this chapter presents the results of the survey regarding food sufficiency/deficiency, months, staple food intake frequency, subjective wealth rating, subjective health rating, and wild food intake frequency, all of which are presumed to be related to wild food intake and health.

Second, the correlations between the participants’ PCS (PF, RP, BP, GH) and MCS (VT, SF, RE, MH) and their wild food intake status were analyzed using the

Spearman rank correlation coefficient. For wild foods, the frequency of eating wild foods during food shortages and the frequency of consumption during the dry and rainy seasons were used. After the analysis of all of the participants' data, the same correlation analysis was conducted on 220 participants, excluding 33 elderly participants (15 in Malolo village, 13 in Chinangali I village, and 5 in Kijiweni village), who are likely to be over 75 years old or older or of unknown age.

However, adult health is unlikely to be solely influenced by wild food intake. For example, age-related declines in health condition and age-related differences in utilization and intake of wild foods may have an impact on the correlation. It is also possible that adults may consume wild foods due to food scarcity and still have poor health status due to food scarcity. Therefore, correlations between the correlated indicators and age, age group, sex, number of months of food shortage or food sufficiency, and subjective poverty rating are the focus of this chapter based on the same questionnaire interview questions. Correlations between both wild food intake and health status are confirmed in relation to age, food insecurity, and poverty status.

Third, multiple regression analysis was conducted. The dependent variables were the SF-12 index of the village and the total SF-12 index of the three villages that were correlated with wild food intake. Independent variables were frequency of wild food intake, age and age group, sex, food shortage and food sufficiency months, staple food intake frequency in the dry season, and subjective wealth rating. One of the relevant indicators, such as age and age group, food shortage/sufficient months, and frequency of staple food intake during the rainy and dry seasons, was forced into the model. Correlations were checked in each model, and to avoid collinearity, indicators that were significantly related were not entered at the same time. For the frequency of staple food intake during the dry season, indicators were chosen according to the season of wild food intake frequency. An analysis of variance (ANOVA) was used to confirm significance, and R^2 was used to determine goodness of fit. The Durbin–Watson ratio was also used to check for anomalies in the residuals.

Fourth, we cross-analyzed the relationships in the three villages. SPSS (Ver. 25) was used for statistical analysis. The data type of the indicators used in the analysis, tables, and figures are indicated in Table 10.3.

On the basis of the aforementioned findings, this chapter addresses the circumstances in which wild foods and health status are related, as well as how the frequency of consuming wild foods may affect health, in light of field research conducted in various regions. The limitations of this research are then presented, followed by conclusions and future issues.

The research participants were informed of the interviews in advance in Swahili, and only if they understood and agreed to the explanation was the interview conducted after obtaining their signatures (or those of their witness in case of illiteracy). This research was reviewed and approved by the Ethics Review Committee for Research Involving Human Subjects in accordance with the Code of Ethics for Research Involving Human Subjects of Utsunomiya University (H18-0008). In Tanzania, the research was conducted after obtaining permission to conduct the research from the Commission for Science and Technology

Table 10.3 Data type of indicators used (translated from Sakamoto et al., 2021a)

Indicator	Data type	Table/Fig. in this article
Wild food intake during food shortage	Category data	Tables 10.10, 10.11, 10.13, 10.14, Fig. 10.2
Dry season, rainy season wild food intake frequency	Category → quantity, discrete data	Tables 10.10, 10.11, 10.13, 10.14, Fig. 10.2
Subjective health assessment (SF-12 health-related quality of life scale) Physical Component Summary: PF, RP, BP, GH Mental Component Summary: VT, SF, RE, MH	Quantity data, continuous data	Tables 10.8, 10.11, 10.12, 10.14, Fig. 10.2
Age	Quantity data, continuous data	Tables 10.4, 10.12, 10.13, 10.14
Age group	Categorical, discrete data	Table 10.4, 10.12, 10.13, 10.14
Sex	Category data	Table 10.5, 10.12, 10.13, 10.14
Annual food sufficiency	Category data	Tables 10.12, 10.13
Months of food sufficiency (2018)	Quantity data, discrete data	Figure 10.1, Tables 10.12, 10.13, 10.14
Staple food intake frequency during dry and rainy seasons	Category → quantity, discrete data	Tables 10.6, 10.12, 10.13
Subjective wealth rating (“poor”, “average”, or “wealthy” in the village)	Category data	Tables 10.7, 10.12, 10.13, 10.14

(COSTECH) and obtaining Class C Residence Permit for Investigators. The results of the simple compilation of the questionnaire survey were promptly compiled (Sakamoto et al., 2020a, b, 2021b) and fed back to the target areas.

10.2 Interview Respondents, Their Situations, and Wild Food Intake

10.2.1 Interview Respondents

A total of 253 people were interviewed, including 81 in Chinangali I village, 84 in Malolo village, and 88 in Kijiweni village. The age groups are shown in Table 10.4, with means of 45.8 (standard deviation ±18.0) in Chinangali I village, 53.1 (±19.0) in Malolo village, 41.0 (±13.8) in Kijiweni village, and 46.9 (±17.8) in total. The breakdown by sex is 159 women, 89 men, and 5 unknowns. The breakdown for each village is shown in Table 10.5.

Table 10.4 Age groups of research villages (revised and translated from Sakamoto et al., 2021a)

Age group	Village			Total
	Chinangali I	Malolo	Kijiweni	
10s	1	2	1	4
20s	16	9	16	41
30s	12	12	25	49
40s	19	26	18	63
50s	12	12	8	32
60s	6	7	9	22
70s	5	12	2	19
80s	3	6	0	9
90s	1	2	0	3
Unknown	6	0	5	11
Total	81	88	84	253

Table 10.5 Sex of research villages (revised and translated from Sakamoto et al., 2021a)

Sex	Village			Total
	Chinangali I	Malolo	Kijiweni	
Female	54	52	53	159
Male	23	36	30	89
No answer	4	0	1	5
Total	81	88	84	253

10.2.2 Access to Food and Subjective Wealth Rating

In the questionnaire survey, when asked whether there was sufficient food for the past year, 14 respondents (2 from Chinangali I village, 7 from Malolo village, and 5 from Kijiweni village) reported sufficiency, and 237 (79, 80, and 78 from Chinangali I, Malolo, and Kijiweni villages, respectively) reported that there was a shortage. The respondents were further asked about the sufficiency/deficiency of food production by month in each household in 2018. In all villages, most respondents experienced food shortages during the rainy season (Fig. 10.1). The number of months during which each surveyed respondent experienced food sufficiency ranges from 0 months to 12 months, with a mean value of 6.6 months (standard deviation ±2.5) in total, 6.0 (±3.1) in Chinangali I village, 6.9 (±2.1) in Malolo village, and 6.9 (±2.3) in Kijiweni village.

Since the above responses are primarily related to food production, the frequency of food intake is also shown. Table 10.6 shows the results on the weekly frequency of staple food intake in the rainy and dry seasons; except in Kijiweni village, the frequency of intake in the dry season is greater than that in the rainy season. Although appreciable variation in the frequency of food intake by season or between villages was not recognized through the means, there were significant differences according to thorough analysis of medians, as presented in Chap. 5. Malolo village had significantly higher staple food intake in the dry season than in the rainy season

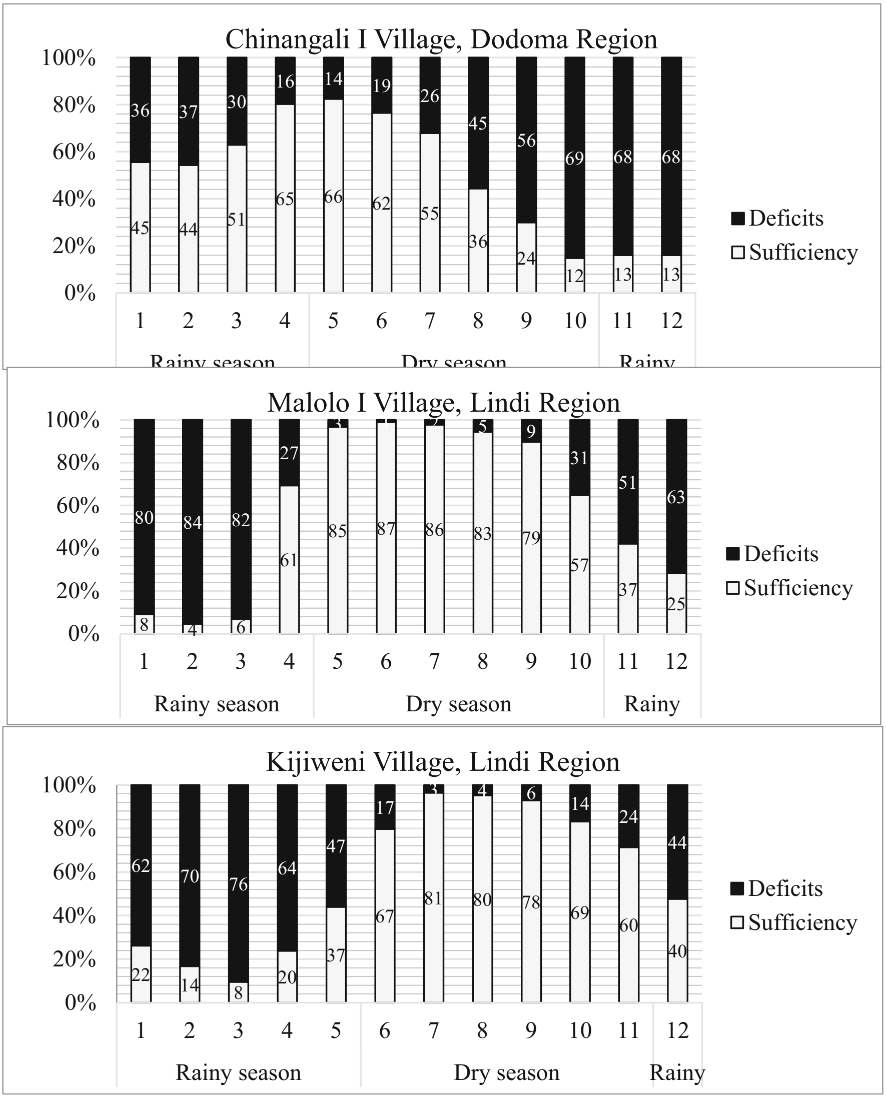


Fig. 10.1 Monthly food sufficiency and deficits in the research villages (translated from Sakamoto et al., 2021a)

(Table 5.3: $p = 0.004$). Malolo village had higher staple food intake than Kijiweni village during the dry season (Fig. 5.1: $p < 0.05$).

Table 10.7 shows the results of the respondents subjectively rating their own situation in the villages as “poor,” “average,” or “wealthy.” In all villages, none of the interviewees ranked themselves as “wealthy,” but more gave “average” responses than “poor” responses. The Chinangali I village received the highest

Table 10.6 Staple food intake frequency (translated from Sakamoto et al., 2021a)

	Frequency of staple food intake (Mean ± SD)	
Village/season	Dry season	Rainy season
Chinangali I	3.3 ± 0.9	3.2 ± 1.0
Malolo	3.3 ± 1.1	3.0 ± 1.1
Kijiweni	2.9 ± 1.2	3.0 ± 0.9
Total amount	3.2 ± 1.1	3.1 ± 1.0

Frequency of intake is as follows: 4 points = 2 or more times a day, 3 points = once a day, 2 points = 4–6 times a week, 1 point = fewer than 3 days a week (see Mizoguchi et al., 2004; Tsunoda et al., 2015), 0 points = do not eat
SD Standard deviation

Table 10.7 Subjective wealth rating: "poor," "average," or "wealthy" (Translated from Sakamoto et al., 2021a)

	Villages			
Evaluation	Chinangali I	Malolo	Kijiweni	Total
Poor	19	39	39	97
Average	58	49	42	149
Wealthy	0	0	0	0
Total	77	88	81	246

responses overall, with the Malolo and Kijiweni villages coming in second and third, respectively, based on "average" response. While Malolo and Kijiweni villages both had the same number of "poor responses," Chinangali I had the fewest.

10.2.3 Subjective Health Assessment of Surveyed Participants

From the Swahili questions on the SF-12 included in the questionnaire, a subjective health evaluation and quality of life scale was calculated. The results are shown in Table 10.8, as already mentioned and discussed in Chap. 4 and the proceeding chapters.

10.2.4 Wild Food Intake

The major wild edible plants and seasons utilized in each surveyed village are shown in Table 10.9. There are wild fruits that are limited to a specific location and season in Chinangali I village, Dodoma region, as well as edible weeds that can be harvested in fields near residents' private homes during the rainy season. There are also dry edible weeds and wild seeds, such as nuts, that are available in the dry season. In Malolo village, Lindi, there are fruits, pulses, and tubers in the dry season and wild fruits in the rainy season. The Malolo questionnaire survey also gave examples of more specific wild foods than in the other study sites, listing 5 tubers, 20 fruits, and

Table 10.8 Subjective health assessment (Quality of Life Scale) by SF-12 (translated from Sakamoto et al., 2021a)

		Villages															Total (n = 248)				
		Chinangali I (n = 80)					Malolo (n = 87)					Kijiweni (n = 81)									
SF-12		Min.	Max	Mean		SD	Min.	Max	Mean		SD	Min.	Max	Mean		SD	Min.	Max	Mean		SD
PCS	PF	22.1	56.5	45.5	±	12.2	22.1	56.5	39.6	±	11.7	22.1	56.5	48.3	±	11.1	22.1	56.5	44.2	±	12.3
	RP	20.3	27.2	40.1	±	16.7	20.3	57.2	28.5	±	15.0	20.3	57.2	45.3	±	13.8	20.3	57.2	37.6	±	16.7
	BP	16.7	57.4	46.3	±	13.0	16.7	57.4	36.1	±	13.1	16.7	57.4	41.4	±	15.6	16.7	57.4	41.0	±	14.5
	GH	18.9	62.0	38.3	±	11.7	18.9	55.5	31.9	±	9.2	18.9	62.0	40.4	±	13.1	18.9	62.0	36.6	±	11.9
MCS	VT	27.6	67.9	51.1	±	15.7	27.6	67.9	41.4	±	10.5	27.6	67.9	49.2	±	15.0	27.6	67.9	47.0	±	14.4
	SF	16.2	56.6	46.7	±	10.1	16.2	56.6	43.2	±	10.3	16.2	56.6	44.8	±	12.5	16.2	56.6	44.8	±	11.1
	RE	11.3	56.1	32.2	±	21.9	11.3	56.1	20.9	±	17.9	11.4	56.1	33.9	±	18.7	11.3	56.1	28.7	±	20.3
	MH	15.8	64.5	47.2	±	14.9	21.9	64.5	39.7	±	9.9	15.8	64.5	44.3	±	13.6	15.8	64.5	43.5	±	13.2

BP Body Pain, *GH* General Health, *MCS* Mental Component Summary, *MH* Mental Health, *PCS* Physical Component Summary, *PF* Physical Functioning, *RE* Role Emotional, *RP* Role Physical, *SD* Standard Deviation, *SF* Social Functioning, *VT* Vitality

Table 10.9 Major wild edible plants and their seasons in the research areas (translated from Sakamoto et al., 2021a)

Chinangali I village, Dodoma region

Gogo names (English)	Family names	Scientific names	Edible part	Months: 1 (Rainy season)	2	3	4	5 (Dry season)	6	7	8	9	10	11 (Rainy season)	12
Mtulu	Opiliaceae	*Opilia celtidifolia*	Leaves	■											■
Ilende (false sesame)	Pedaliaceae	*Ceratotheca sesamoides*		■	■	■	■	Dried leaves						■	■
Ilumbu/Malumbu, Hulihuli	Cucurbitaceae	*Cucumis dipsaceus*	Leaves	■	■	■	■							■	■
Chipali/Mapali, Sagula sagula	Convolvulaceae	*Ipomoea obscura*, *Ipomoea mombassana*	Leaves	■	■	■	■							■	■
Maweza	Convolvulaceae	*Ipomoea sinensis* subsp. *blepharosepala*	Leaves	■	■	■	■							■	■
Muhilile	Capparaceae	*Cleome hirta*	Leaves	■	■	■	■							■	■
Mzimwe, Magagome	Capparaceae	*Cleome gynandra*	Leaves	■	■	■	■							■	■
Sunga sunga	Compositae/ Asteraceae	*Launaea cornuta*	Leaves	■	■	■	■							■	■
Feune	Amaranthaceae	*Amaranthus graecizans* subsp. *Silvestris*	Leaves	■	■	■	■							■	■
Mzole	Tiliaceae	*Corchorus olitorius*	Leaves	■	■	■	■							■	■
Ikuwi/Makuwi (baobab)	Bombacaceae	*Adansonia digitata*	Young leaves	■	■	■	■							■	■
Mnghulwa	Loganiaceae	*Strychnos spinosa*	Fruit	■	■	■	■							■	■
Mtundwi	Olacaceae	*Ximenia caffra*	Fruit	■	■	■	■							■	■
Ngwelu	Tiliaceae	*Grewia conocarpoides*, *Grewia* sp. nov	Fruit	■	■	■	■							■	■
Mtafuta	Tiliaceae	*Grewia burtii*, *G. similis*	Fruit	■	■	■	■							■	■
Mkole	Tiliaceae	*Grewia bicolor*	Fruit	■	■	■	■							■	■
Mfulu	Verbenaceae	*Vitex payos*	Fruit	■	■	■	■	■	■						
Msena	Boraginaceae	*Cordia ovalis*	Fruit	■	■	■	■	■	■						
Mperemehe	Tiliaceae	*Grewia flavescens*	Dried fruit	■	■	■	■	■	■	■	■	■			
Mhumburu	Flacourtiaceae	*Flacourtia indica*	Fruit	■	■	■	■	■	■	■	■	■			
Ubuyu (baobab)	Bombacaceae	*Adansonia digitata*	Fruit					■	■	■	■	■	■		

(continued)

Table 10.9 (continued)

Malolo village, Lindi region				Months											
				1	2	3	4	5	6	7	8	9	10	11	12
Mwera names	Family names	Scientific names	Edible part	Rainy season				Dry season						Rainy season	
Vigongo	Anacardiaceae	*Sclerocarya birrea spp. caffra*	Fruit	■	■	■								■	■
Upilipili	Anacardiaceae	*Sorindeia madagascariensis*	Fruit	■	■	■									■
Mbinji, Mpinji	Olacaceae	*Ximenia caffra*	Fruit	■	■	■									■
Mbindimbi	Verbenaceae	*Vitex payos* var. *payos*	Fruit		■	■									
Matopetope	Annonaceae	*Annona senegalensis*	Fruit			■	■								
Matawa	Flacourtiaceae	*Flacourtia indica*	Fruit			■	■	■	■	■					
Mgurugai	Rubiaceae	*Vangueria madagascariensis*	Fruit				■	■	■						
Mabungo	Apocynaceae	*Landolphia parrifolia*	Fruit						■						
Manjichi	Loganiaceae	*Strychnos madagascariensis*	Fruit						■	■	■				
Ngangaula	Euphorbiaceae	*Ricinodendron heudelotii*	Seeds			■									
Upokoro	Tiliaceae	*Grewia forbesii*	Fruit				■								
Upupu	Papilionoideae	*Mucuna pruriens* var. *utilis*	Pulse						■						
Ming'oko	Dioscoreaceae	*Dioscorea hirtiflora* ssp. *orientalis*	Tuber					■	■						
Mpeta, Mipama, Vitundu	Dioscoreaceae	*Dioscorea cayennensis*	Tuber							■					
Angadi	Dioscoreaceae	*Dioscorea cochleari-apiculata*	Tuber										■		

(continued)

Table 10.9 (continued)

Kijiweni village, Lindi region

Mwera, Makonde names	Family names	Scientific names	Edible part	Months: 1	2	3	4	5	6	7	8	9	10	11	12
				Rainy season					Dry season						Rainy season
Lilende	Tiliaceae	*Corchorus aestuans*	Leaves	■	■	■	■	■							■
Vitoro	Apocynaceae	*Landolphia kirkii*	Fruit	■	■										
Usofi	Annonaceae	*Uvaria leptocladon*	Fruit	■	■										
Mabungo	Apocynaceae	*Landolphia parrifolia*	Fruit	■	■										
Matopetope	Annonaceae	*Annona senegalensis*	Fruit	■	■	■								■	■
Matonga	Loganiaceae	*Strychnos spinosa*	Fruit	■	■	■					■	■	■	■	
Mabibo	Anacardiaceae	*Anacardium occidentale*	Fruit	■	■	■	■							■	■
Ufuru	Verbenaceae	*Vitex strickeri*	Fruit	■	■	■	■	■							
Ukwaju	Caesalpinioideae	*Tamarindus indica*	Fruit	■	■	■	■	■							■
Lipwawa	Flagellariaceae	*Flagellaria guineensis*	Fruit	■	■	■	■	■							
Ububudu	Tiliaceae	*Grewia stuhlmannii, G. glandulosa*	Fruit		■	■	■	■	■						
Makoe (dome palm)	Palmae	*Hyphaene coriacea*	Fruit			■	■	■	■	■	■	■	■	■	■
Ming'oko	Dioscoreaceae	*Dioscorea hirtiflora* ssp. *orientalis*	Tuber	■	■	■	■	■	■	■	■	■	■	■	■
Uwanga/Ulanga	Taccaceae	*Tacca leontopetaloides*	Tuber	■	■	■	■	■	■	■	■	■	■	■	■

Bold are local names; ***Bold italics*** are Swahili names
Source: Based on August 2019 and March 2020 surveys (**questionnaires, collection, interviews, and observations**). Identification by Mbago

Table 10.10 Percentage of wild foods consumed (%) (translated from Sakamoto et al., 2021a)

		Region	Dodoma	Lindi		Total
		Village	Chinangali I	Malolo	Kijiweni	
Wild food intake during food shortage (%)			27.3	**65.5**	**54.2**	50.8
	Per week	Frequency				
Dry season wild food intake frequency (%)	4 to every day	High	7.5	6.8	**12.2**	8.8
	2 to 3	Average	18.8	21.6	**24.4**	21.6
	Less than 1 day	Low	21.3	**54.5**	**48.8**	42.0
	None	None	**52.5**	17.0	14.6	27.6
	Total		100.1	99.9	100.0	100.0
Rainy season wild food intake frequency (%)	4 to every day	High	14.7	17.4	**41.0**	24.6
	2 to 3	Average	**30.7**	19.8	22.9	24.2
	Less than 1 day	Low	25.3	**48.8**	26.5	34.0
	None	None	**29.3**	14.0	9.6	17.2
	Total	100.0	100.0	100.0	100.0	100.0

Bold: above average. Totals may not equal 100.0% due to rounding

16 wild animals, as well as pulses, mushrooms, leafy vegetables, and insects (Sakamoto et al., 2021b, p. 26). In contrast to the other study communities, Kijiweni village has ample wild edibles that are within walking range. It has fruits such as dome palm available during the rainy and partially dry seasons as well as leafy vegetables that are primarily available during the rainy season, but tubers that are available year round also make up a substantial portion of the diet.

The frequency of wild food consumption is shown in Table 10.10. In the three villages, the intake of wild foods tends to rise during the rainy season partly because there is less available food than there is in the dry season and partly because wild foods are more available during the rainy season. The two villages in the Lindi region, especially Kijiweni village, have the most frequent wild food consumption among the three regions. Wild food is more accessible than in the other villages, most likely because these foods are located closer to the residences. On the other hand, wild food is relatively scarce in the semiarid Dodoma region. This study has changed perceptions since it is during the rainy seasons that people typically anticipate the need to confront food shortages based on information on staple food production and staple food intake, but in fact, these villages have an abundance of wild foods, particularly vegetables and fruits. The availability of a variety of food has been confirmed in the researched villages in Chap. 4, and the wild foods are further specified in this chapter.

10.3 Analysis: Relationship Between Wild Food Intake and Subjective Health

10.3.1 Correlations Between Wild Food Intake and Subjective Health

Table 10.11 shows the results of the correlation analysis (Spearman) between the frequency of wild food intake and adult health status. Regarding whether they used wild foods during food shortages, the combined three villages had a negative correlation with BP.

In Malolo village, the more often people consume wild foods during the dry season, the greater the PF tends to be among the PCS. On the other hand, in Kijiweni village, the higher the frequency, the lower the RE tended to be among the MCS.

The GH in PCS tends to be higher with higher-frequency wild food consumption in Chinangali I village during the rainy season. While MH in MCS is lower, PF is higher with a higher frequency of wild food consumption in Malolo village during the dry season. In Kijiweni village, RP in PCS and VT in MCS were lower with higher-frequency wild food consumption.

The same correlation analysis was conducted for 224 participants, excluding those 75 years of age or older and 30 participants whose ages were unknown. The relationships were not significant.

10.3.2 In Relation to Age, Sex, Food Insufficiencies/Staple Food Intake, and "Poverty"

Based on the above results, we examined the relationships between the correlated health indicators and age and age group (Table 10.12). The older the respondents were in all health indicators, the worse their health status.

We subsequently investigated the relationship between the frequency of consuming wild food and age and age group in the regions and circumstances where correlations were established (Table 10.13). In Kijiweni village, there was a negative relationship between wild food intake and age group during the rainy season. No statistically significant relationship with age was found in the other regions and situations.

The overall total PF was correlated with sex (Table 10.12), confirming a trend toward higher PF in men. No association with wild food intake was observed with sex (Table 10.13).

The relationship between health indicators and whether food was sufficient during the previous year, as well as the number of months of food sufficiency (Table 10.12), revealed that in Malolo village, the health level PF was related to the number of months of food sufficiency. On the other hand, the frequency of wild food consumption had a significant relationship with food sufficiency. Specifically,

Table 10.11 Spearman's correlations between wild plant intake and health status (Translated from Sakamoto et al., 2021a)

Wild foods	Region village		Physical component summary (PCS)				Mental component summary (MCS)			
			PF	RP	BP	GH	VT	SF	RE	MH
			Physical function	Role physical	Body pain	General health	Vitality	Social functioning	Role emotional	Mental health
Wild food intake during food shortage	Dodoma Chinangali I	Correlation coefficient	−0.12	−0.14	−0.046	−0.112	−0.014	0.064	−0.222	−0.099
		Sig. (2-tailed)	0.338	0.262	0.711	0.369	0.909	0.608	0.073	0.427
		n	66	66	66	66	66	66	66	66
	Lindi Malolo	Correlation coefficient	0.092	0.142	−0.085	0.078	−0.035	0.081	0.112	−0.089
		Sig. (2-tailed)	0.398	0.189	0.432	0.47	0.749	0.456	0.302	0.411
		n	87	87	87	87	87	87	87	87
	Lindi Kijiweni	Correlation coefficient	0.043	−0.079	−0.123	−0.012	−0.123	−0.011	−0.074	−0.008
		Sig. (2-tailed)	0.701	0.482	0.272	0.912	0.276	0.92	0.512	0.942
		n	81	81	81	81	81	81	81	81
	Total	Correlation coefficient	−0.015	−0.066	**−0.130**[a]	−0.04	−0.055	0.036	−0.097	−0.065
		Sig. (2-tailed)	0.823	0.313	**0.047**	0.542	0.401	0.58	0.138	0.325
		n	234	234	**234**	234	234	234	234	234
Dry season wild food intake frequency	Dodoma Chinangali I	Correlation coefficient	0.024	0.083	0.097	0.104	0.088	0.064	0.083	−0.013
		Sig. (2-tailed)	0.83	0.462	0.391	0.359	0.436	0.572	0.465	0.908
		n	80	80	80	80	80	80	80	80
	Lindi Malolo	Correlation coefficient	**0.248**[a]	0.061	−0.018	0.19	−0.044	0.06	0.001	−0.131
		Sig. (2-tailed)	**0.02**	0.574	0.867	0.076	0.685	0.576	0.992	0.223
		n	**88**	88	88	88	88	88	88	88

(continued)

Table 10.11 (continued)

Wild foods	Region village		Physical component summary (PCS)				Mental component summary (MCS)			
			PF	RP	BP	GH	VT	SF	RE	MH
			Physical function	Role physical	Body pain	General health	Vitality	Social functioning	Role emotional	Mental health
	Lindi Kijiweni	Correlation coefficient	−0.061	−0.015	−0.049	−0.034	−0.054	−0.093	**−0.241**[a]	−0.009
		Sig. (2-tailed)	0.593	0.894	0.663	0.767	0.632	0.411	**0.032**	0.939
		n	80	80	80	80	80	80	**80**	80
	Total	Correlation coefficient	0.09	0.049	−0.057	0.104	0.039	0.019	−0.019	−0.034
		Sig. (2-tailed)	0.16	0.443	0.371	0.102	0.546	0.762	0.771	0.596
		n	248	248	248	248	248	248	248	248
Rainy season wild food intake frequency	Dodoma Chinangali I	Correlation coefficient	0.005	0.034	0.226	**0.234**[a]	0.128	0.195	−0.016	0.08
		Sig. (2-tailed)	0.964	0.77	0.051	**0.043**	0.273	0.093	0.891	0.497
		n	75	75	75	**75**	75	75	75	75
	Lindi Malolo	Correlation coefficient	**0.222**[a]	0.161	−0.08	0.05	−0.096	−0.078	0.141	**−0.216**[a]
		Sig. (2-tailed)	**0.04**	0.138	0.465	0.649	0.381	0.474	0.196	**0.046**
		n	**86**	86	86	86	86	86	86	**86**
	Lindi Kijiweni	Correlation coefficient	−0.078	**−0.256**[a]	−0.092	−0.061	**−0.245**[a]	−0.206	−0.111	−0.161
		Sig. (2-tailed)	0.488	**0.021**	0.415	0.591	**0.027**	0.065	0.324	0.151
		n	81	**81**	81	81	**81**	81	81	81
	Total	Correlation coefficient	**0.153**[a]	0.098	−0.011	**0.148**[a]	0.061	0.019	0.122	−0.013
		Sig. (2-tailed)	**0.017**	0.127	0.864	**0.021**	0.343	0.771	0.059	0.846
		n	**242**	242	242	**242**	242	242	242	242

[a] Bold indicates a significant correlation coefficient at the 5% level (two-sided)
[b] Bold indicates a significant correlation coefficient at the 1% level (two-sided)

Table 10.12 Correlations (Spearman) between health indicators and age, sex, food sufficiency, frequency of staple food intake, and wealth (translated from Sakamoto et al., 2021a)

Region Village	SF-12		Age	Age-group	Sex	Annual food sufficiency	Months of food sufficiency	Staple food intake frequency in the dry season	Staple food intake frequency in the rainy season	Subjective wealth rating
Dodoma Chinangali I	GH	Correlation coefficient	**−0.320**[a]	**−0.310**[a]	0.065	0.165	0.140	0.122	−0.123	**0.392**[a]
		Sig. (2-tailed)	**0.005**	**0.007**	0.577	0.141	0.214	0.282	0.275	**0**
		n	**75**	**75**	77	81	81	79	80	**77**
Lindi Malolo	PF	Correlation coefficient	**−0.526**[a]	**−0.499**[a]	0.01	−0.066	**0.241**[b]	**0.213**[b]	−0.027	**0.226**[b]
		Sig. (2-tailed)	**0**	**0**	0.926	0.543	**0.024**	**0.046**	0.8	**0.034**
		n	**88**	**88**	87	87	**88**	**88**	88	**88**
	MH	Correlation coefficient	**−0.343**[a]	**−0.338**[a]	−0.026	−0.161	0.091	0.156	−0.109	0.013
		Sig. (2-tailed)	**0.001**	**0.001**	0.815	0.137	0.402	0.148	0.31	0.905
		n	**88**	**88**	87	87	88	88	88	88
Lindi Kijiweni	RP	Correlation coefficient	**−0.327**[a]	**−0.287**[a]	0.048	−0.071	−0.025	−0.103	−0.075	−0.069
		Sig. (2-tailed)	**0**	**0**	0.485	0.3	0.717	0.13	0.27	0.315
		n	**219**	**219**	210	217	219	217	216	212
	VT	Correlation coefficient	**−0.181**[a]	**−0.155**[b]	0.038	0.083	−0.028	0.020	0.067	0.006
		Sig. (2-tailed)	**0.007**	**0.022**	0.582	0.225	0.683	0.768	0.326	0.932
		n	**219**	**219**	210	217	219	217	216	212
	RE	Correlation coefficient	**−0.296**[a]	**−0.265**[a]	0.040	−0.006	−0.027	−0.044	−0.070	−0.027
		Sig. (2-tailed)	**0**	**0**	0.568	0.928	0.696	0.521	0.305	0.698
		n	**219**	**219**	210	217	219	217	216	212

(continued)

Table 10.12 (continued)

Region Village	SF-12		Age	Age-group	Sex	Annual food sufficiency	Months of food sufficiency	Staple food intake frequency in the dry season	Staple food intake frequency in the rainy season	Subjective wealth rating
Total	PF	Correlation coefficient	**−0.445**[a]	**−0.413**[a]	**0.179**[a]	−0.035	0.116	−0.062	−0.074	**0.131**[b]
		Sig. (2-tailed)	**0**	**0**	**0.005**	0.579	0.067	0.329	0.243	**0.041**
		n	**240**	**240**	**246**	249	251	249	248	**244**
	BP	Correlation coefficient	**−0.278**[a]	**−0.264**[a]	0.089	−0.009	0.037	**0.145**[b]	0.108	0.114
		Sig. (2-tailed)	**0.000**	**0.000**	0.164	0.881	0.556	**0.022**	0.09	0.075
		n	**240**	**240**	246	249	251	**249**	248	244
	GH	Correlation coefficient	**−0.431**[a]	**−0.425**[a]	0.111	0.094	0.081	0.000	−0.048	0.074
		Sig. (2-tailed)	**0.000**	**0.000**	0.082	0.138	0.201	0.997	0.455	0.248
		n	**240**	**240**	246	249	251	249	248	244

[a] Bold indicates a significant correlation coefficient at the 1% level (two-sided)
[b] Bold indicates a significant correlation coefficient at the 5% level (two-sided)

Table 10.13 Correlations (Spearman) between wild food intake frequency and age, sex, food sufficiency, staple food intake frequency, and wealth in correlated areas and situations (translated from Sakamoto et al., 2021a)

Wild foods	Region Village		Age	Age-group	Sex	Annual food sufficiency	Months of food sufficiency	Staple food frequency in the dry season	Staple food intake frequency in the rainy season	Subjective wealth rating
Wild food intake during food shortage	Total	Correlation coefficient	0.049	0.034	−0.007	−0.043	0.112	−0.026	−0.037	**−0.135**[a]
		Sig. (2-tailed)	0.463	0.616	0.918	0.515	0.087	0.693	0.571	**0.041**
		n	225	225	231	234	236	234	234	**230**
Dry season wild food intake frequency	Lindi Malolo	Correlation coefficient	−0.194	−0.198	−0.104	−0.18	0.107	0.045	0.093	0.142
		Sig. (2-tailed)	0.071	0.064	0.339	0.096	0.323	0.679	0.388	0.185
		n	88	88	87	87	88	88	88	88
	Lindi Kijiweni	Correlation coefficient	−0.038	−0.065	−0.089	−0.081	**0.162**[a]	−0.022	−0.003	−0.073
		Sig. (2-tailed)	0.579	0.337	0.199	0.237	**0.016**	0.747	0.967	0.291
		n	219	219	210	217	**219**	217	216	212
Rainy season wild food intake frequency	Dodoma Chinangali I	Correlation coefficient	−0.152	−0.167	−0.065	0.103	0.157	0.002	0.064	0.063
		Sig. (2-tailed)	0.213	0.171	0.590	0.378	0.18	0.986	0.587	0.601
		n	69	69	71	75	75	73	75	71
	Lindi Malolo	Correlation coefficient	−0.049	−0.037	0.003	−0.092	0.204	−0.158	**−0.238**[a]	−0.032
		Sig. (2-tailed)	0.653	0.738	0.978	0.405	0.060	0.146	**0.028**	0.768
		n	86	86	86	85	86	86	**86**	86

(continued)

Table 10.13 (continued)

Wild foods	Region Village		Age	Age-group	Sex	Annual food sufficiency	Months of food sufficiency	Staple food frequency in the dry season	Staple food intake frequency in the rainy season	Subjective wealth rating
	Lindi Kijiweni	Correlation coefficient	−0.131	**−0.137**[a]	−0.107	−0.072	0.079	**−0.136**[a]	−0.124	**−0.180**[b]
		Sig. (2-tailed)	0.058	**0.047**	0.127	0.300	0.251	**0.049**	0.073	**0.01**
		n	212	**212**	204	210	212	**210**	210	**205**
	Total	Correlation coefficient	**−0.135**[a]	**−0.138**[a]	−0.056	−0.049	**0.128**[a]	−0.108	−0.125	−0.096
		Sig. (2-tailed)	**0.04**	**0.035**	0.388	0.450	**0.045**	0.093	0.052	0.139
		n	**233**	**233**	239	242	**244**	242	242	237

[a] Bold indicates a significant correlation coefficient at the 5% level (two-sided)
[b] Bold indicates a significant correlation coefficient at the 1% level (two-sided)

months of food sufficiency were correlated with dry season wild food intake frequency in Kijiweni and with rainy season wild food intake frequency in all three villages (Table 10.13). That is, the more months of food sufficiency, the more wild food was consumed during the dry season. Based on these results, there was no apparent offsetting combination of the relationship between wild food intake and health status.

To complement the above information on food production, we also checked the relationship with the actual frequency of staple food intake in Malolo village. PF and the total BP of the three villages were positively correlated with the frequency of staple food intake during the dry season (Table 10.12). With regard to the frequency of wild food intake, a relationship was found in Malolo and Kijiweni villages (Table 10.13). There was a negative correlation between the frequency of consuming staple foods during the rainy season and the frequency of consuming wild foods during the same season in Malolo village. Similarly, in Kijiweni village, there was a negative correlation between the frequency of consuming staple foods during the dry season and the frequency of consuming wild foods during the rainy season.

Finally, we checked the relationship between subjective poverty/wealth ratings. Based on a self-assessment of respondents' own situation as (1) "poor," (2) "average," or (3) "wealthy," there was a relationship between self-perception as "poor" and poor health status in GH in Chinangali I village, PF in Malolo village, and PF for a total of three villages (Table 10.12). Those who considered themselves "poor" tended to consume more wild foods during food shortages in the three villages combined and more frequently in Kijiweni village during the rainy season (Table 10.13).

Based on the above results, there was no apparent offsetting combination of the relationship between wild food intake status and health status.

10.4 Multiple Regression Analysis

Multiple regression analysis was performed on the correlated indicators in Table 10.11, and the final model including wild food intake frequency is shown in Table 10.14.

10.4.1 Chinangali I Village, Dodoma Region

Multiple regression analysis was conducted with GH in Chinangali I village as the dependent variable and wild food intake frequency during the rainy season, age group, months of food sufficiency, sex, staple food intake frequency during the rainy season, and subjective wealth rating as independent variables. When all independent variables were included, only the age group was significant in the first model ($p = 0.005$). In the model excluding age group, only subjective wealth rating was

Table 10.14 Multiple regression analysis with subjective health rating as the dependent variable (translated from Sakamoto et al., 2021a)

			Significant	95% confidence interval			ANOVA		
Models (village SF)	Partial regression coefficient	Standardized regression coefficient	(*p*)	Lower	Upper	VIF	(*p*)	R^2	Durbin—Watson ratio
Model 1 (Chinangali I GH)							0.040	0.04	1.79
(constant)	34.71		0.000	30.51	38.91				
Rainy season wild food intake frequency	2.64	0.24	0.040	0.13	5.15	1			
Model 2 (Malolo PF)							0.011	0.07	1.86
(constant)	34.63		0.000	30.27	38.99				
Dry season wild food intake frequency	4.03	0.27	0.011	0.96	70.93	1			
Model 3 (Malolo PF)							0.000	0.37	1.93
(constant)	45.38		0.000	35.39	55.37				
Age	−0.32	−0.51	0.000	−0.43	−0.21	1.01			
Rainy season wild food intake frequency	2.71	0.22	0.010	0.5	4.91	1			
Subjective wealth rating	6.65	0.2	0.029	0.5	8.8	1.01			
Model 4 (Malolo MH)							0.015	0.10	1.75
(constant)	34.64		0.000	27.2	41.07				
Rainy season wild food intake frequency	−2.35	−0.23	0.032	−4.48	−0.21	1.02			
Months of food sufficiency	1.15	0.24	0.024	0.16	2.14	1.02			
Model 5 (Kijiweni RP)							0.000	0.21	1.86
(constant)	66.2		0.000	56.04	80.36				
Rainy season wild food intake frequency	−4.99	−0.3	0.005	−8.43	−1.55	1			
Age group	−0.45	−0.37	0.001	0.71	−0.2	1			

Model 6 (Kijiweni VT)							0.026	0.06	2.02
(constant)	55.74		0.000	48.9	62.58	1			
Rainy season wild food intake frequency	−3.57	−0.25	0.026	−6.7	−0.44				
Model 7 (Kijiweni RE)							0.027	0.06	1.87
(constant)	39.25		0.000	30.94	47.55				
Dry season wild food intake frequency	−5.86	−0.25	0.027	−11.05	−0.68	1			
Model 8 (Total PF)							0.000	0.13	0.62
(constant)	23.56		0.000	16.15	30.97				
Subjective wealth rating	6.43	0.26	0.000	3.33	9.54	1.02			
Sex	5.58	0.22	0.010	2.44	8.72	1			
Rainy season wild food intake frequency	1.86	0.16	0.013	0.39	3.32	1.02			
Model 9 (Total BP)							0.000	0.13	1.81
(constant)	55.49		0.000	50.19	60.79				
Age	−3.8	−0.13	0.039	−7.4	−0.2	1.01			
Wild food intake during food shortage	−0.27	−0.32	0.000	−0.37	−0.16	1.01			

BP Body Pain, *GH* General Health, *MH* Mental Health, *PF* Physical Functioning, *RE* Role Emotional, *VT* Vitality significant ($p = 0.002$). When regression analysis was performed excluding subjective wealth rating, the model including the frequency of wild food intake during the rainy season was not significant along with the other indicators, and only the model with only one indicator was significant (Model 1). Although significant ($p = 0.040$), the fit was poor ($R^2 = 0.04$).

10.4.2 Malolo Village, Lindi Region

Multiple regression analysis was conducted with PF in Malolo village as the dependent variable and the frequency of wild food intake during the dry season and age, sex, annual food sufficiency, subjective wealth rating, and frequency of staple food intake during the dry season as independent variables. When all independent variables were included, only age ($p = 0.000$) and subjective wealth rating ($p = 0.014$) were significant and established. When analyzed with indicators other than age, the frequency of wild food intake during the dry season ($p = 0.026$) and subjective wealth rating ($p = 0.029$) were significant and established ($p = 0.000$). Regression analysis of the two indicators that were significant ($p = 0.000$) was conducted, but only the frequency of wild food consumption during the dry season was significant ($p = 0.018$), while subjective wealth rating was not ($p = 0.061$). All independent variables were significant, and only Model 2, with only one indicator, included the frequency of wild food intake during the dry season. The model was significant ($p = 0.011$), but the fit was poor ($R^2 = 0.07$).

Multiple regression analysis was also conducted with PF as the dependent variable and wild food intake frequency during the rainy season and age, sex, annual food sufficiency, subjective wealth rating, and staple food intake frequency during the rainy season as independent variables. After including all independent variables, the results were established with age ($p = 0.000$), subjective wealth rating ($p = 0.015$), and frequency of wild food intake during the rainy season ($p = 0.029$) being significant ($p = 0.000$). Model 3 ($p = 0.000$) was the result of the analysis with significant factors. The goodness of fit was $R^2 = 0.37$, which is higher than that of Models 1 and 2.

With MH as the dependent variable, the analysis was conducted with the frequency of wild food intake during the rainy season and the above indicators. When all independent variables were included, age ($p = 0.000$) and frequency of staple food intake during the rainy season ($p = 0.033$) were significant and established ($p = 0.004$). Model 4 is the result of removing these variables and seeking a model that includes the frequency of wild food intake during the rainy season. The model was significant ($p = 0.015$, $R^2 = 0.10$), with a negative effect of the frequency of wild food intake during the rainy season ($p = 0.032$) in conjunction with the number of months with food sufficiency ($p = 0.024$).

10.4.3 Kijiweni Village, Lindi Region

Multiple regression analysis was conducted with RP in Kijiweni village as the dependent variable and multiple regression analysis with frequency of wild food intake during the rainy season and age group, sex, months of food sufficiency, frequency of staple food intake during the rainy season, and subjective wealth rating as independent variables. When all factors were included, age group ($p = 0.005$) and frequency of wild food intake during the rainy season ($p = 0.011$) were significant and established ($p = 0.002$). Model 5 was analyzed again based on the independent variables that were found to be significant ($p = 0.005$) and was also established ($p = 0.000$, $R^2 = 0.21$), with age group ($p = 0.005$) and frequency of wild food intake during the rainy season ($p = 0.005$) being significant.

With VT as the dependent variable, multiple regression analysis was performed based on the frequency of wild food intake during the rainy season and similar indices. A significant correlation was not established when all independent variables were entered ($p = 0.168$), and only sex was significant ($p = 0.030$) and established when implemented on indices other than frequency of staple food intake and age during the rainy season ($p = 0.048$). However, when the analysis was implemented with frequency of wild food intake during the rainy season and sex as independent variables, a correlation was established ($p = 0.014$), but only the former was significant ($p = 0.028$), whereas the correlation with sex was not ($p = 0.071$). Finally, the model including the frequency of wild food intake during the rainy season was established by a single indicator as per Model 6 ($p = 0.026$, $R^2 = 0.06$).

Multiple regression analysis was conducted with RE as the dependent variable, with frequency of wild food intake during the dry season and age group, sex, months of food sufficiency, frequency of staple food intake during the dry season, and subjective wealth rating as independent variables. When all factors were included, age ($p = 0.007$) and sex (0.046) were significant and established ($p = 0.009$). Model 7 was established with only the frequency of wild food intake during the dry season ($p = 0.027$, $R^2 = 0.06$), as the frequency of wild food intake during the dry season was significant, and a model in combination with the other independent variables was sought but was not established.

A similar multiple regression analysis model was established for the dataset excluding the elderly population, which was similarly significant by correlation: with RP as the dependent variable, the model was established with age group ($p = 0.001$) and frequency of wild food intake during the rainy season ($p = 0.005$) as independent variables ($p = 0.000$, $R^2 = 0.214$). When RE was the dependent variable, the model was established with only the frequency of wild food intake in the dry season ($p = 0.037$) as the independent variable ($p = 0.037$, $R^2 = 0.058$). When VT was the dependent variable, the model was established with only the frequency of wild food intake in the rainy season ($p = 0.021$) as the independent variable ($p = 0.\ 021$, $R^2 = 0.049$).

10.4.4 Total of Three Villages

Multiple regression analysis was conducted with GH as the dependent variable, wild food intake frequency during the rainy season, and age group, sex, annual food sufficiency, staple food intake frequency during the rainy season, and subjective wealth rating as independent variables. The last two factors were analyzed except for the frequency of staple food intake during the rainy season to avoid collinearity, and the model was significant only for age group ($p = 0.000$). No significant model was established for wild food intake frequency alone.

The results of the analysis with PF as the dependent variable and similar factors forced in were established with age group ($p = 0.000$), sex ($p = 0.001$), and subjective wealth rating ($p = 0.006$) being significant ($p = 0.000$). The results of the analysis for nonage groups were established with sex ($p = 0.000$), subjective wealth rating ($p = 0.000$), and frequency of wild food consumption during the rainy season ($p = 0.017$) being significant ($p = 0.000$). After the factors that were found to be significant were entered, subjective wealth rating ($p = 0.000$), sex ($p = 0.010$), and frequency of wild food intake during the rainy season ($p = 0.013$) were again significant and established ($p = 0.000$, $R^2 = 0.13$, Model 8).

After introducing BP as the dependent variable and factors except subjective wealth rating, which is correlated with several factors, as independent variables, age was significant ($p = 0.000$). After inserting age and wild food intake during food shortages, both age ($p = 0.039$) and wild food intake during food shortages ($p = 0.000$) were significant, and the model was established ($p = 0.000$, $R^2 = 0.13$, Model 9).

10.5 Cross-Analysis

Cross-analysis and graphing of the frequency of wild food intake with the selected health indicators for which the correlation was significant in Table 10.11 are shown in Fig. 10.2. In Chinangali I village, Dodoma, the higher the frequency of wild food intake during the rainy season, the higher the GH rating. When the frequency of wild food intake was high, GH was above normal, and when it was not consumed, respondents gave the lowest GH rating. In Malolo village, Lindi, the higher the frequency of wild food consumption, especially during the rainy season, the less restricted physical function (PF) tended to be. On the other hand, the higher the frequency of wild food consumption, the more problems the respondents had in terms of mental health. In Kijiweni village along the coast of the state, the higher the frequency of wild food intake during the rainy season, the lower the RP tended to be. The results for RE were mixed.

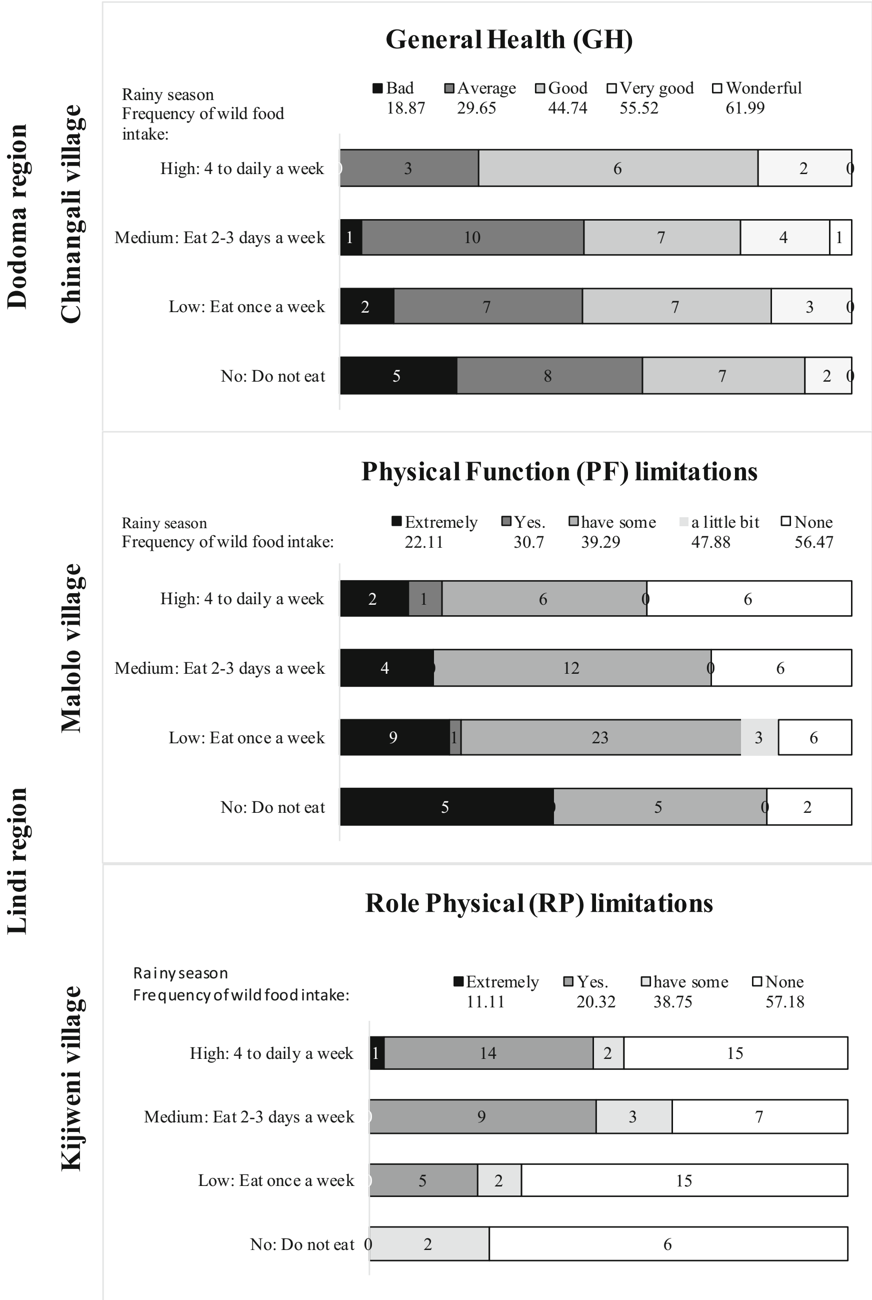


Fig. 10.2 Wild food intake frequency and limitation in the Physical Component Summary (PCS) (translated and summarized from Sakamoto et al., 2021a)

10.6 Discussion

10.6.1 The Case of Chinangali I Village, Dodoma Region

In Chinangali I village, although the GH of PCS was stronger for age and subjective wealth rating (Table 10.14, multiple regression analysis), a certain influence of the frequency of wild food intake during the rainy season was observed in the multiple regression, correlation, and cross-analysis. In Chinangali I village, food is scarce during the rainy season, but edible weeds and fruits are collected and may have been used to maintain health. This practice may have helped to maintain the health of the villagers. In this village, edible weeds that grow wild in fields near houses are commonly used as side dishes. An analysis of the main and characteristic leafy vegetables among those edible weeds showed that they were extremely high in calcium and iron, among other nutrients.[1] This result is consistent with the accumulated evidence of many studies on the high nutritional value of leafy vegetables in Africa (Schönfeldt & Pretorius, 2011; Uusikua et al., 2010; van Jaarsveld et al., 2013); previous studies showing prominently high iron content in Dodoma region of Tanzania (Msuya et al., 2009) are further discussed in Chaps. 12 and 13. The use of iron-rich edible weeds in the Dodoma region may be a contributing factor to the low rate of anemia among women in Tanzanian as a whole, despite the region's frequent famine.

Fruits are also harvested in the rainy season but are available at a limited time during the rainy season, in limited quantities, and often in areas far from homes. Wild fruits can be an added asset, but it is difficult to imagine that the health benefits can be realized at a significant level.

Note that Chinangali I village has a higher frequency of wild food intake in the rainy season than in the dry season, according to Table 10.9, but not necessarily higher than that in other regions. Chinangali I village in the semiarid Dodoma region has more limited food from forests than other areas, especially during the dry season, and this difference in intake is consistent with a previous study (Rasmussen et al., 2020) that showed that more forested areas have higher fruit intake. In light of the effects of wild foods, the recommendation to consume wild food should be based on further research. However, in Chinangali I village and in the Dodoma region, edible weeds from the rainy season are dried and consumed on a daily basis as a common side dish during the dry season. In the questionnaire interview, the respondents may not have recognized fresh and dried edible weeds as "wild food" and may have answered that they "do not eat" wild food even if they ate edible weeds. The possibility that there is a link between wild food consumption and health status by the elderly in later life cannot be ruled out since no relationship was found when correlation analysis was conducted excluding the elderly in later life.

[1] Further discussed in Chap. 13.

10.6.2 The Case of Malolo Village, Lindi Region

In Malolo village, correlation, multiple regression, and cross-analysis showed that PF, one of the PCSs, was associated with the frequency of wild food intake in the dry and rainy seasons, although it was strongly influenced by age. In Malolo village, respondents who frequently consumed the aforementioned variety of wild foods may have maintained higher physical functioning. The effect of the frequency of wild food intake during the rainy and dry seasons may not necessarily be sufficient to compensate for food shortages but may also have an effect. Despite this, more extensive use of wild food intake is worth considering in the future, as wild plant intake is less frequent than in other regions. However, it is possible that respondents who have the physical ability to travel to forests to secure wildlife and collect wild plants may consume wild food more frequently.

There was a negative correlation between staple food and wild food intake frequency during the rainy season (Table 10.12). Multiple regression analysis indicates that PF is influenced by the frequency of wild food intake during the rainy season, along with younger age and a subjective perception of being "wealthy". In terms of correlations, the number of months of food sufficiency and higher frequency of staple food intake were also found to be related to PF (Table 10.11). In other words, in addition to recommending continued intake of wild food, measures for poverty reduction and food security are also needed. In addition to age, multiple regression analysis of MH, one of the MCSs, showed that the frequency of staple food intake in the rainy season had a strong influence, but the frequency of wild food intake in the rainy season, along with the number of months of food sufficiency, also had a negative effect. This may indicate that the reduced food production and frequency of staple food intake during the rainy season and the situation of having to consume wild foods may be a psychological burden.

Since no relationship was found in the correlation analysis when elderly individuals were excluded, the possibility that there is a link between wild food intake and health status in elderly individuals cannot be ruled out.

10.6.3 The Case of Kijiweni Village, Lindi Region

In Kijiweni village, RP, one of the PCSs, was found to have a negative effect on both age and frequency of wild food intake during the rainy season. Furthermore, wild food intake was not always practiced by the older age groups.

All of the above correlations and multiple regression analysis were also confirmed in the model excluding elderly individuals, confirming that the trend is not characteristic of elderly individuals. However, the number of elderly individuals excluded in Kijiweni village was limited to five persons.

Based on the above, the possibility that more frequent consumption of wild foods may result in lower MCS (RE, VT) and daily function (RE, RP) will be discussed, from direct to indirect interpretations.

The first issue is the possibility of harmful and toxic wild foods. Among the wild foods listed in Table 10.9, tubers of ***uwanga*** (*Tacca lentopetaloides*) contain a bitter poison. The detoxicated powder is reportedly used as starvation food or as a snack mixed with sugar and spice and baked. The village also exports it to the island of Zanzibar as an ingredient for making a sweet sticky confection called *halua*. On the other hand, the same plant is also found in Malolo village in the same region but is not eaten as a favorite, while **angadi** (*Dioscorea cohleari-apiculata*), a root vegetable that is also poisonous, is eaten. ***Uwanga*** is a candidate for a specific wild food that may be harmful to adult health, but since the population is often aware of its toxicity and has an established method of detoxification, it is doubtful that toxicity actually remains. One possible indirect effect associated with ***uwanga*** may be the intake of excessive sugar.

Second, many wild edibles are found near dwellings, and the toxicity of wild foods due to soil and water contamination also needs to be considered. At the same time, the accessibility of wild foods near dwellings, even in poor health, may also accentuate the negative relationship.

Additionally, RE is an effect of the frequency of wild food intake during the dry season, so it is possible that it did not necessarily contribute to health by supplementing nutritional deficiencies.

The health degrees that were suggested to be affected were related to MCS and daily functioning, so it is difficult to determine whether wild food intake actually had a direct impact. Perception toward wild foods may have influenced the result. There is a need to understand these perceptions and/or consider the possible negative effects of wild food intake as a risk, rather than unconditionally encouraging it.

10.6.4 Total and Overall Perspective of the Three Villages

In all three villages, PF, one of the PCSs, was strongly influenced by age and sex, but the frequency of wild food intake during the rainy season was also found to be affected along with sex and subjective wealth rating in the multiple regression analysis. This result suggests that the participants may maintain PF by supplementing their nutritional intake with wild foods during the rainy season, a time of food scarcity. On the other hand, it is also possible that participants with higher PF are able to take advantage of their ability to forage for wild foods. In addition to frequency of wild food intake, being young, male, and "wealthy" also contributes, making it difficult to conclude that wild food intake alone improves PF. Incidentally, while sex may have a direct effect due to the sex role division of labor, we cannot rule out the possibility that men responded by flaunting their PF as an indirect effect.

For the overall trend, PCSs such as GH and PF showed a positive relationship with wild food intake frequency, while MCSs (such as MH, VT, and RE) and PCSs (such as RP and BP) showed a negative relationship with wild food intake frequency. While the benefits of wild food intake are relatively easy to explain in the former case, the harms in the latter case are difficult to verify due to many indirect factors.

10.7 Limitations and Conclusion

10.7.1 Limitations of This Study

The health effects of wild foods have been analyzed and discussed in this chapter based on the responses of the participants through the interview questionnaire survey, and the following limitations should be noted.

First, the dependent variable, the subjective health indicator SF-12, which has been validated in Kiswahili among the versions used globally, is a subjective health indicator and is not diagnostic of health status. In addition, the exclusion criteria do not exclude participants whose health or diet may be affected, such as pregnant and nursing women, persons suffering from chronic or acute diseases, and persons with disabilities.

In addition to wild food intake frequency, age, food sufficiency, staple food intake frequency, and subjective poverty/wealth ratings were analyzed together as independent variables affecting health, but since health is the result of many influencing factors, it is not possible to include them all in the scope of analysis in this chapter.

Age is a factor that strongly influences subjective health indicators, but with the exception of the late elderly, there is no correlation between health and wild food consumption in any of the villages except for Kijiweni village. Since wild food may be actively consumed by the elderly in the other two villages, a different approach is needed to determine the impact of wild food intake on health, as it cannot be addressed by simply excluding the elderly in the later stages of life.

Regarding the frequency of wild food and staple food intake, the survey was conducted during the dry season, so the frequency during the dry season is relatively accurate, but the average frequency during the rainy season is based on a retrospective recall of a week; thus, there is room for error. In particular, for wild foods, the frequency may vary depending on the time of year when they can be collected, even during the rainy season, but this point was not considered. Although age may be a factor that influences memory as a retrospective bias, it is necessary to consider the possibility that the correlation may have been due to bias when the results exclude the elderly in the later stages of life. The subjective health indicators cover the most recent month, and the wild food intake covers the most recent week during the dry season, so there is some overlap; however, the timing may not overlap for the rainy season. In addition, since this study only examined the frequency of intake and did not collect data on quantity, an assessment of whether the quantity is sufficient needs to be performed separately.

Regarding food shortages and sufficiency, specific years and months were specified, and respondents were asked to respond based on their retrospectives as to whether they had produced food, but it cannot be said that the respondents' memories were completely free of errors. Since food production and diet may not always coincide perfectly, information on the frequency of staple foods was also supplemented with information on the frequency of staple food intake during the dry and rainy seasons, the accuracy of which is discussed above.

Because the survey emphasizes respondents' subjective ratings[2] and leaves the definitions of "poor," "average," and "wealthy" ratings to the respondents, they do not necessarily correspond to ratings based on monthly income, expenditures, or assets. Health measures are also subjective and may be interrelated if health status is also included in the wealth rating. However, the interviews were conducted by visiting the interviewees' homes, making it difficult to answer questions that deviate from prominent assets other than cash.

10.7.2 Conclusions and Future Issues

This chapter discussed the relationship between wild food intake and health, a topic rarely discussed in previous studies. Specifically, we explored the relationship between wild food intake frequency and adult health in three regions of Tanzania in different environments and obtained results that varied by region, considering age, sex, food scarcity, staple food intake frequency, and subjective wealth rating. Wild food intake was higher in the villages of Malolo and Kijiweni, where forests and rainfall are abundant, but the importance of edible weeds in village Chinangali I in the semiarid region was also suggested.

In Kijiweni village, Lindi region, where wild food is available close to homes, the trend of lower multiple MCS, daily functioning (RE, RP), and BP in adults with higher wild food intake frequency needs to be confirmed, including the potential effects of toxic plants, harmful environmental pollution, or villagers' perceptions toward wild food. On the other hand, in Chinangali I village, Dodoma region, a semiarid inland village, and in Malolo village, Lindi region, a village with forests a short distance away, the results suggest that the frequency of wild food consumption may have a positive effect on health. In Malolo village, the year-round availability of a wide variety of wild foods may contribute to the adults' PF. However, the frequency of wild food intake in these two areas is rather low compared to that in other areas. Further confirmation and encouragement of the beneficial consumption of wild foods could contribute to people's health. However, the study has the

[2]For example, in participatory poverty analyses, such as Narayan et al. (2000), emphasis is placed on the perspectives and assessments of the poor themselves.

abovementioned limitations, and further research is needed to more rigorously understand the impact of wild food consumption on human health.

Acknowledgments The participants (for answering questions and providing information), Dr. Anita Wagner and Dr. Barbara Gande (for sharing the Swahili version of SF-36), Ms. Nobuko Tsubaki and Mr. Michael Chimosa (Dodoma wild leafy vegetable collection), Ms. Anna Maro (research and information), Ms. Atsuko Isoda, Mr. Haruo Miyata, and Ms. Yoko Ishii (comments in presentations at the national and spring meetings of the Japan Society for International Development), Mr. Parinya Khemarrath (information compilation assistance), and Mr. Masayuki Hayashi (accompanying field survey) are appreciated. This research was supported by Grant-in-Aid for Scientific Research 18H03438, 18H00776, and 15H05139, and the JST Utsunomiya University Female Researcher Dispatch Program.

References

Bharucha, Z., & Pretty, J. (2010). The roles and values of wild foods in agricultural systems. *Philosophical Transactions of the Royal Society B Biological Sciences, 365*, 2913–2926. https://doi.org/10.1098/rstb.2010.0123

Bvenura, C., & Sivakumar, D. (2017). The role of wild fruits and vegetables in delivering a balanced and healthy diet. *Food Research International, 99*(1), 15–30.

FAO. (1983). *Food and fruit-bearing forest species*. FAO. Retrieved January 24, 2021, from http://www.fao.org/3/ap367e/ap367e00.pdf

FAO, IFAD, UNICEF, WFP, WHO. (2019). *The state of food security and nutrition in the world 2019*. FAO.

Koffi, C., Lourme-Ruiz, A., Houria, D., Bouquet, E., Dury, S., & Gautier, D. (2020). The contributions of wild tree resources to food and nutrition security in sub-Saharan African drylands. *International Forestry Review, 22*(1), 64–82.

Koponen, J. (1988). *People and production in late precolonial Tanzania*. Finnish Society for Development Studies.

Lukmanji, Z., Hertzmark, E., Mlingi, N., Assey, V., Ndossi, G., & Fawzi, W. (2008). *Tanzania food composition tables (TFCT)*. Muhimbili University of Health and Allied Sciences, Tanzania Food and Nutrition Centre, & Harvard School of Public Health. Retrieved January 24, 2021, from https://www.hsph.harvard.edu/nutritionsource/food-tables/

Mizoguchi, K., Yukari, T., & Miyuki, A. (2004). Relationship between a positive perception toward work and the dietary habits of young male workers. *The Japanese Journal of Nutrition and Dietetics, 62*(5), 269–283.

Mpasiwakomu, A. R., Nyomora, A. M. S., & Gimbi, A. A. (2017). Diversity and utilization of wild edible plant species from Uvinza Miombo woodlands, Tanzania. *Huria, 24*(3), 150–168.

Msuya, J. M., Mamiro, P. S., & Weinberger, K. (2009). Iron, zinc and β-carotene nutrients potential of noncultivated indigenous iron, zinc, and β-carotene nutrients potential of noncultivated indigenous vegetables in Tanzania. *Acta Horticulturae, 806*(26), 217–222. https://doi.org/10.17660/ActaHortic.2009.806.26

Narayan, D., Patel, R., Schafft, K., Rademacher, A., & Koch-Schulte, S. (2000). *Voices of the poor: Can anyone hear us?* World Bank Group.

Ohmori, R., Sakamoto, K., & Tsuda, K. (2020). Associations between food intake and health-related quality of life in East Africa. *Journal of the School of Regional Design, 7*, 36–42.

Powell, B., Hall, J., & Johns, T. (2011). Forest cover, use and dietary intake in the east Usambara mountains, Tanzania. *International Forestry Review, 13*(3), 305–317.

Powell, B., Maundu, P., Kuhnlein, H. V., & Johns, T. (2013). Wild food from farm and forest in the east Usambara mountains. *Ecology of Food and Nutrition, 52*(6), 451–478.

Rasmussen, L. V., Fagan, M. E., Ickowitz, A., Wood, S. L. R., Kennedy, G., Powell, B., Baudron, F., Gergel, S., Jung, S., Smithwick, E. A. H., Sunderland, T. C. H., Wood, S., & Rhemtulla, J. M. (2020). Forest pattern, not just amount, influences dietary quality in five African countries. *Global Food Security, 25*(100331). Retrieved February 4, 2021, from https://www.sciencedirect.com/science/article/abs/pii/S2211912419300021

Ruffo, C. K., Birne, A., & Tengnäs, B. (2002). *Edible wild plants of Tanzania*. Regional Land Management Unit (RELMA).

Sakamoto, K., Ohmori, R., & Tsuda, K. (2020a). Health, livelihoods, and food intake of children and adults in central Tanzania. *Regional Design Science, 7*, 43–64.

Sakamoto, K., Parinya, K., Ohomori, R., & Maro, A. C. (2020b). Health, livelihoods, and food intake in coastal southeast Tanzania. *Journal of the School of International Studies, Utsunomiya University, 50*, 11–29.

Sakamoto, K., Ohmori, R., & Tsuda, K. (2021a). Correlation between intake and wild food and health in 3 areas of Tanzania: Analysis from semi-arid central and inland/coastal southeast. *Journal of International Development Studies, 30*(2), 93–112.

Sakamoto, K., Parinya, K., Maro, A. C., & Ohmori, R. (2021b). Health, livelihoods, and food intake in inland southeast Tanzania. *Journal of the School of International Studies, Utsunomiya University, 51*, 15–34.

Schönfeldt, H. C., & Pretorius, B. (2011). The nutrient content of five traditional South African dark green leafy vegetables. *Journal of Food Composition and Analysis, 24*(8), 1141–1146. https://doi.org/10.1016/j.jfca.2011.04.004

Tanzania, Government of the United Republic of, University of Dodoma, development partners & UNICEF. (2018). *Tanzania national nutrition survey using SMART methodology (TNNS) 2018*. MoHCDGEC, MoH, TFNC, NBS, OCGS, UNICEF. Retrieved September 17, 2016, from https://www.unicef.org/tanzania/reports/tanzania-national-nutrition-survey-2018

Tanzania, National Bureau of Statistics & ICF Macro. (2011). *2010 Tanzania demographic and health survey*. NBS & ICF Macro.

Tanzania, United Republic of. (2015). *Mortality and health*. Ministry of Finance & Office of the Chief Government Statistician, Ministry of State, President Office, State House & Good Governance. Retrieved March 27, 2016, from www.nbs.go.tz/nbs/takwimu/census2012/Mortality_and_Health_Monograph.pdf

Tsunoda, N., Inayama, T., Hata, K., & Oka, J. (2015). Vegetable dishes, dairy products and fruits are key items mediating adequate dietary intake for Japanese adults with spinal cord injury. *Spinal Cord, 53*, 78–790.

Uusikua, N. P., Oelofsea, A., Duodu, K. G., Bester, M. J., & Faber, M. (2010). Nutritional value of leafy vegetables of sub-Saharan Africa and their potential contribution to human health. *Journal of Food Composition and Analysis, 23*(6), 499–509.

van Jaarsveld, P., Faber, M., Heerden, I. V., Wenhold, F., Rensburg, W. J. V., & Averbeke, W. (2013). Nutrient content of eight African leafy vegetables and their potential contribution to dietary reference intakes. *Journal of Food Composition and Analysis, 33*(1), 77–84. https://doi.org/10.1016/j.jfca.2013.11.003

Wickens, G. E. (1995). *Edible nuts*. FAO. Retrieved January 24, 2021, from http://www.fao.org/3/a-v8929e.pdf

Wyss, K., Wagner, A. K., Whiting, D., Mtasiwa, D. M., Tanner, M., Gandek, B., & Kilima, P. M. (1999). Validation of the Kiswahili version of the SF-36 health survey in a representative sample of an urban population in Tanzania. *Quality of Life Research, 8*(1–2), 111–120.

Yatsuka, H. (2011). Relationships between C*eratotheca sesamoides* and the Sandawe in semi-arid area in Tanzania: Preservation and sharing of the dry leaves. *African Studies, 78*, 25–41.

Chapter 11
Case of Inland Forest Vicinities in Tanzania: General Low Health Evaluation But Higher for Those Who Access Variety of Wild Foods?

Kumiko Sakamoto, Lilian Daniel Kaale, Anna Calisti Maro, Parinya Khemmarath, Reiko Ohmori, Frank M. Mbago, and Tamahi Kato

Abstract What are the vulnerability and strengths of living in forest vicinities? Malolo village, Lindi region in southeast inland Tanzania, has a relatively low health evaluation. This chapter elaborates on comprehensive field research and questionnaire interviews with 88 women and men in the village. Subjective health by SF-12 indicated high Social Functioning (SF) and Vitality (VT) and low Role Emotional (RE); high VT and low RE are common with other areas. However, people eat a variety of foods according to seasons, and those who had access to wild foods had a high evaluation of their health. This chapter introduces the health and nutrition situation, social context, some of the main wild foods, and their potential benefits. The participants identified 28 plants and 17 animals as edible wild foods that they utilized, which was outstanding in comparison to other research areas. Malolo

K. Sakamoto (✉)
School of International Studies, Utsunomiya University, Utsunomiya, Japan
e-mail: ksaka@cc.utsunomiya-u.ac.jp

L. D. Kaale
Department of Food Science and Technology, University of Dar es Salaam, Dar es Salaam, Tanzania
e-mail: elykaale@gmail.com; dlilian@udsm.ac.tz

A. C. Maro
Department of Community Development, Lindi region, Tanzania

P. Khemmarath
Center for the Multicultural Public Sphere, Utsunomiya University, Utsunomiya, Japan

R. Ohmori
School of Regional Design, Utsunomiya University, Utsunomiya, Japan
e-mail: rohmori@cc.utsunomiya-u.ac.jp

F. M. Mbago
University of Dar es Salaam Herbarium, Dar es Salaam, Tanzania

T. Kato
Center for African Area Studies, Kyoto University, Kyoto, Japan

K. Sakamoto et al. (eds.), *Changing Dietary Patterns, Indigenous Foods, and Wild Foods*, https://doi.org/10.1007/978-981-99-3370-9_11

village is endowed with a rich variety of wild plants and animals near forests. The variety includes roots, fruits, vegetables, pulses, mammals, and insets, which have the potential to supplement food deficits and a balanced diet. For example, **upilipili** (*Sorindeia madagascariensis*) fruit has 107 mg/100 g of vitamin C, which is above the daily required nutrients of a 30-year-old woman.

Keywords Tanzania · Wild food · Variety · QOL · Forest · East Africa

11.1 Introduction

This chapter presents a case study from the inland forest vicinities, which fits with the overall objective of the book to understand changing dietary patterns, indigenous foods, and wild foods in Tanzania and their relation to wealth, mutual relations, and health, and with Part IV with a focus on wild foods. Although the health evaluations of adults are generally lower than in other research villages, there is evidence that people who utilize wild foods have better health, which has also been evaluated in Chap. 10. Furthermore, the analysis in Chap. 4 indicated that respondents from this village frequently ate staple foods, pulses, and meat in the dry season and vegetables and fruits in the rainy season. Sugar intake was generally low. This chapter will look closer into the case study to understand health and nutrition.

Globally, food supply, as well as food and nutrition security, is greatly influenced by wild foods. For almost 300 million people, the forest provides food and a means of subsistence in the form of non-timber forest products (NTFPs) (Bharucha & Pretty, 2010). Around the world, wild foods are an essential component of local diets, and their extensive appropriation into local food cultures raises the possibility that there is untapped potential to guarantee easy access to potential nutrients for sustainable food systems (Ekesa et al., 2022). These foods, which come from forests, help individuals have access to calories, animal and plant proteins, and essential minerals and micronutrients, such as iron and iodine, as well as vitamins A, Bs, C, D, and E (Sneyd, 2013), and demonstrate vital medical characteristics (Duguma, 2020). Furthermore, wild edible plants have historically been an essential food supply for families living in poverty and for food-insecure households in developing nations (Duguma, 2020). For example, the Batemi agro-pastoralists of Tanzania use various species as food (31 species), thirst quenchers (six species), chewing gum (seven species), flavorings (two species), and honey beer (one species) (Bharucha & Pretty, 2010), and an additional 35 wild edible plants are cultivated.

Children under the age of 5 most frequently experience malnutrition, which is a primary cause of morbidity and mortality. Malnutrition is a contributing factor in approximately 60% of under-5 child fatalities in developing countries (Mohamed & Nyaruhucha, 2022). One of the top ten most severely impacted nations worldwide is Tanzania. Tanzania has approximately 31.8% stunted children, 14.6% underweight children under 5, and 3.5% wasted children (Tanzania, 2018). Most often, income inequality, poverty, inadequate nutrition, and general political governance are the root causes of malnutrition in Tanzania. Other contributing factors indicated include low education-related ignorance, customs and traditions that are unfriendly to nutrition, and inadequate institutional capacity at all levels for nutrition (East and Southern Africa, 2017). However, the studies by Sakamoto et al. (2021b) and Chap. 10 have demonstrated that subjective health evaluations of adults who have access to wild foods (plants and animals) are healthier than those of adults who do not. The implication of wild foods on the health of children needs to be further analyzed.

11.1.1 Methodology

The interviews were based on a comprehensive questionnaire in Swahili. It included 75 questions on the respondents, marriage and family, livelihood, groups, mutual assistance, children, health, and food intake. Questions on health are based on the standardized SF (Short Form)-12 (Ware et al., 1995), and the Swahili translation has been based on the verified Swahili SF-36 (Wyss et al., 1999). Questions on food intake frequency have been formulated based on research in Japan (Mizoguchi et al., 2004; Tsunoda et al., 2015), adjusted to the food in Tanzania based on *Tanzania food composition tables* (Lukmanji et al., 2008), and discussions with nutrition specialists in Tanzania. Questions on groups and mutual assistance have been formulated referring to *Measuring social capital* (Narayan et al., 2004). Other questions were formulated based on the author's previous questionnaire interviews (Sakamoto, 2007, 2008, 2015a, b, 2016, 2020). The questionnaire was pre-tested in Lindi, Dodoma (Ohmori et al., 2020), and Dar es Salaam and adjusted.

The questionnaire interview was implemented during 2–4 Sept. 2019 by one of the authors and seven research assistants selected in the village based on their writing capabilities. Four of the research assistants from the village were men and three were women: Total interviewers including one of the authors were four men and four women.

The interviewees were selected from all hamlets of the village to cover the whole village (Table 11.1). Eleven respondents were selected per hamlet, with a total of 88 respondents. Interviewees were selected from each household but were not limited to household heads to enable women to also respond to the questionnaire.

Research ethics were followed following the rules and regulations of Utsunomiya University (permission granted as H18-0008), such as prior explanation and consent for interviews. The percentage is calculated from the total responses to each question and not the total number of respondents. SF-12 has been calculated as elaborated in previous chapters. The results are discussed in comparison to studies in Iringa region, Dodoma region, and other parts of Lindi region discussed in other chapters.

Table 11.1 Total households and number of women and men interviewed (Sakamoto et al., 2021a)

Hamlet	Total households	Interviewed		
		Women	Men	Total
Amila	88	7	4	11
Changombe	69	6	5	11
Mashineni	28	9	2	11
Muhimbili	33	6	5	11
Mwongozo	78	8	3	11
Sokoni	33	7	4	11
Naiwego	56	4	7	11
Namitende	88	5	6	11
Total	473	52	36	88

11.1.2 Research Area

Tanzania has almost achieved its Millennium Development Goals (MDGs) for the under-5 mortality rate (U5MR), underweight, and malnutrition, and Lindi region has also shown great improvement in these indicators. However, chronic malnutrition, which Tanzania has not been able to meet the goals, also remains high in the Lindi region, above the national average.

As one of the deprived regions for child survival, Mchinga II village, located on the coast in Lindi region, has been previously researched, and factors influencing child survival have been assessed. One of the contributing factors to child survival was the use of sorghum for children's food (Sakamoto, 2020, p.96). In this respect, this research has been designed to focus on the contribution of indigenous foods and wild foods to improved nutrition and health. In discussion with authorities of Lindi region, Malolo village in Ruangwa district and Kijiweni village in Lindi municipal[1] have been identified as villages that have experienced food shortages yet have been utilizing indigenous wild foods obtainable within the area.

Within Tanzania, Lindi region has a relatively high percentage of stunting, although it decreased from 54% (2010, Tanzania NBS & ICF Macro, 2011) to 36% (2014, TFNC, 2014) and 23.8% (2018, Tanzania et al., 2018). Malolo village, situated in the inland Ruangwa district, with food shortage experience, was selected for this study on villagers' health, livelihoods, food intake, and utilization of wild foods. The results were compared with those of villages in Dodoma and Iringa regions and coastal Lindi discussed in other chapters of this book. For example, in 2018, food was insufficient among the majority from January to March and in December during the rainy season, where the situation was better than that in Dodoma but worse than that in Iringa.

Malolo village is a village in Malolo ward, Ruangwa district, Lindi region located inland. It is approximately 110 km away from Lindi town toward the west and

[1] Kijiweni village has been part of Lindi district at the time of research, but is presently incorporated as part of Lindi municipal.

Fig. 11.1 Malolo village (Sakamoto et al., 2021a)

3.5 km from the main road Nangumbu junction. The village is surrounded by Nmitende and Naiwego mountain vegetation and forests within the vicinity (Fig. 11.1, UNDP, n.d.).

Malolo village has a total population of 1420 people, consisting of 721 women and 699 men. It consists of eight hamlets indicated in Table 11.1 (see Fig. 11.2 for the location of the household in the village center). Naiwego and Namitende hamlets are located in the mountains where cars are not reachable, and it takes 2 or 3 h by foot (approximately 4–5 km). In other words, residents of the hamlets are likely to walk 2–3 h to reach schools, a dispensary, water, and a church.

Malolo village was established in 1977. The majority of individuals belong to the Mwera ethnic group, and the majority of them practice Christianity. Missionaries settled in Malolo in the past and have built an elementary school and a dispensary for the community and housing for teachers and health workers. The ward name has been taken from Malolo village since it had schools, a health center, and a church that served residents. In 1947, there was a serious food shortage (*njaa*), and people ate **angadi** (*Dioscorea cochleari-apiculata*), rat (*panya*), and bamboo shoots (***mianzi***).[2] Save the Children under the PANITA program visited the village for research in 2009–2010, working in collaboration with the food and nutrition department of Sokoine University of Agriculture.

---

[2] Local plant names are in bold, and Swahili plant/animal names are in bold italics.

Fig. 11.2 Malolo village in Ruangwa district, Lindi region, Tanzania (Sakamoto et al., 2021a)

Table 11.2 Age groups of respondents (Sakamoto et al., 2021a)

Age group	Women	Men	Total	Percentage
10s	2	0	2	2
20s	6	3	9	10
30s	11	1	12	14
40s	9	9	18	20
50s	7	9	16	18
60s	2	7	9	10
70s	10	4	14	16
80s	3	3	6	7
90s	2	0	2	2
Total	52	36	88	100
Percentage	59	41	100	

The main livelihood of the villagers is farming with some minor livestock, such as cows and chickens. Major crops are maize, sorghum, millet, cassava, and sweet potatoes. Rats have been observed to damage crops, leaving households with insufficient farm production.

They struggle with salty water, as is evident in other places such as Mbekenyera in the Ruangwa district. Most of the water comes from hand-dug wells, and the salty water is sold (costing TSh 50 as of 2020). In addition to reporting stomachaches, the dispensary reports that the villagers also experience diarrheal issues.

11.2 About the Respondents

11.2.1 Age, Sex, Ethnic Group, and Religion of the Respondents

Relatively more women were interviewed (52 respondents, 59%) than men (36 respondents, 41%). The ages of the respondents range from 19 to 97 with an average of 52.7, but 18 (20%) are in their 40s and 16 (18%) are in their 50s (Table 11.2). Most of them are Christians (78, 89%), but some are Muslims (10, 11%). All the respondents were of the Mwera ethnic group, except for one who did not answer.

All participated in their puberty initiation. The majority (79, 90%) studied in school: 78 (89%) went to elementary school, and 75 (85%) finished their education at elementary school, including three who finished Grades II and IV. Three (3%) proceeded to secondary school.

11.2.2 Livelihoods

The majority of the respondents are farmers (86 respondents, 98%), but three (3%) keep livestock as an occupation. For other occupations, two did not have a job (one of them was handicapped), while one each worked as a cook, a tailor, and a Ward representative at Council Meetings (*Diwani*). Most respondents (52, 61%) had some type of animal, including chickens, ducks, cows, pigs, goats, and pigeons, even though this was not their primary occupation (see details in Table 11.3).

Almost all of the respondents (85, 98%) had farms, but only one had a garden. The major crop was maize (86, 98%), followed by pigeon peas (63, 72%), cassava (42, 48%), sesame (32, 36%), sorghum (24, 27%), cowpea (12, 14%), peanuts (8, 9%), cashew nuts (7, 8%), rice, tomatoes, and Bambara groundnuts. Nearly all of them (87, 99%) cultivated their crops for food and some (29, 33%) for business. The majority (50, 57%) of respondents indicated that they decided on the crops together with their partners, while 29 (33%) of women and nine (10%) of men did so on their own.

The majority of respondents (84, 95%) considered buying food to be the most important use of income, followed by health (73%), clothes (72%), education (55%), and agriculture (40%). Other usages were school, food, and utensils used within the house. The majority answered that they made decisions about the use of their income together with their partners (50, 57%), but 30 respondents (34%) said that it was decided by women only, and eight (9%) said that it was by men only. Half of the respondents (49, 56%) considered their situations to be average within the village, whereas 39 (44%) considered themselves to be poor. None considered themselves to be rich.

11.2.3 Marriage and Family

The majority of respondents (80, 91%) had marriage experiences. While (76, 95%) decided on their marriage on their own, four (5%) had their marriage decided by their parents. Among those who were married, the majority (70, 92%) of their families received or paid bridewealth, mostly in the form of money (71, 93%). The average bridewealth in money was TSh 38,627, with values ranging from 40 cents to TSh 200,000. None received bridewealth in the form of livestock.

Presently, the majority of respondents are married (47, 56%), but 19% are widowed, 14% are divorced, 6% are unmarried, and 5% are separated. Most of their marriages were monogamous (78, 95%), but four (5%) of the husbands had two wives. The majority (52, 60%) lived with their spouses. The average number of people living under the same roof was 3.39, ranging from 1 to 8 people (Table 11.4). The most common number of people living under the same roof was two (24, 28%), followed by three (18, 21%) and four (14, 16%). The majority did not have children

Table 11.3 Numbers of livestock owned (Sakamoto et al., 2021a)

n	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	. . .	19	20	. . .	25	26	27	. . .	30	Total
Chicken	42	3	3	3	5	2	3	3		4	4	1	4			3	1			4		1		1		1	88
	48%	3%	3%	3%	6%	2%	3%	3%		5%	5%	1%	5%			3%	1%			5%		1%		1%		1%	100%
Ducks	79				1	1		2	1		2		2														88
	90%				1%	1%		2%	1%		2%		2%														100%
Cows	83			1	2				1										1								88
	94%			1%	2%				1%										1%								100%
Pigs	85	1	1					1																			88
	97%	1%	1%					1%																			100%
Goats	85					1							1		1												88
	97%					1%							1%		1%												100%
Pigeons	87															1											88
	99%															1%											100%

Table 11.4 Numbers of household members (Sakamoto et al., 2021a)

n	0	1	2	3	4	5	6	7	8	Total
People in the house		10	24	18	14	7	9	4	1	87
Percentage		11	28	21	16	8	10	5	1	100

under-5 living under the same roof (65, 76%), but 17 (20%) had one, and three (4%) had two.

11.3 Social Capital and Decision-Making

11.3.1 Participation in Groups

The majority of the respondents (63, 72%) were participating in one group, 12 (14%) in two groups, and three (3%) in three groups, but 10 (11%) were not participating in any groups within the community. The main objectives of the groups were religion (68, 77%), mainly through churches, savings and loans (12, 14%), and agriculture (11, 13%).

11.3.2 Mutual Assistance

Twenty-four people (27%) received assistance when they needed food within the month of the interview. Thirty people (34%) considered that they were assisting those outside of their families who required food. Furthermore, only 16 (18%) were helped by others when they needed money, and only 11 (13%) considered themselves helping other people outside of their families in the form of money. However, the majority of the respondents (65, 75%) generally considered that people in the village help each other.

11.3.3 Decision-Making and Social Capital

The majority responded that they make decisions within the household together with men and women, especially to decide where to send their sick children (64%), followed by usage of crops (57%) and usage of income (57%). However, a substantive number of respondents made decisions on their own for the use of crops (33%), the use of income (34%), and where to send their sick children (27%) in comparison to men alone.

The tendency that the majority of the respondents to make decisions with their partners and the fact that more made decisions together about children's sickness were common with the other results in a coastal village in Lindi region and inland villages in Dodoma and Iringa regions discussed in other chapters. The tendency that the majority of the respondents consider that the villagers help each other although fewer people actually helped or were helped with food or money within this month was also common to other results in other villages previously mentioned. Among the research villages, the respondents in Malolo had the highest percentage belonging to groups, specifically religious groups.

11.4 The Health of Adults and Children

To comprehend the state of both adults' health and children's health, a few factors have been examined.

11.4.1 Health of Adults

Based on the subjective health evaluation (SF-12), the following results were drawn. Figure 11.3 provides the distribution of the respondents' answers to each question related to subjective health.

11.4.1.1 GH: General Health

In general, the majority (50, 57%) of the respondents considered their health very good, while 21 (24%) thought it was good health, two (2%) fair health, and none poor health. Fifteen (17%) were considered to have excellent health (Fig. 11.3a).

11.4.1.2 PF: Physical Functioning

Regarding moderate activities, the majority (46, 52%) believed they were somewhat limited, 22 (25%) felt that they were not limited at all, and 20 (23%) were very limited. For heavy activities, such as climbing a steep mountain, 45 (51%) believed they were somewhat limited, 22 (25%) were very limited, and 21 (24%) were not limited at all (Fig. 11.3b).

11.4.1.3 RP: Role Physical

During a month, the majority of the respondents (69, 79%) felt that they accomplished work or daily activities less than their expectations due to physical health problems. The majority of the respondents were also limited in the kind of work or activities (67, 76%) (Fig. 11.3c).

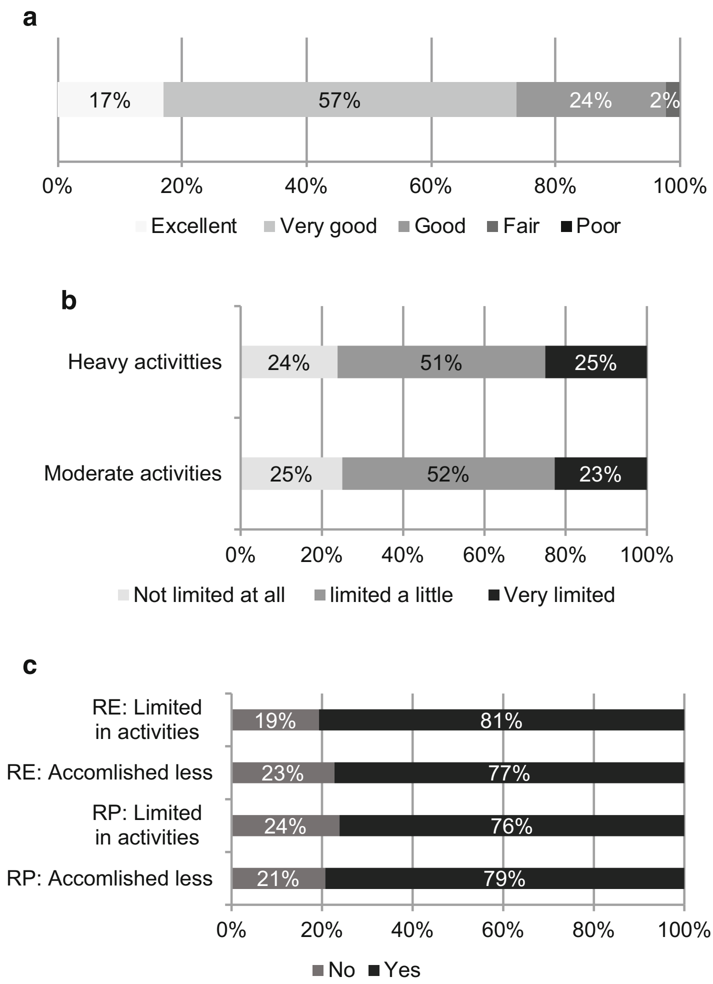


Fig. 11.3 SF-12 in Malolo Village, Lindi Region (Sakamoto et al., 2021a). (**a**) General Health (GH). (**b**) Physical Functioning (PH): Limitation in activities. (**c**) Role Emotional (RE) and Role Physical (RP): Problems with activities. (**d**) Body Pain (BP): interference in normal work. (**e**) Mental Health (MH), Vitality (VT), and Social Functioning (SF)

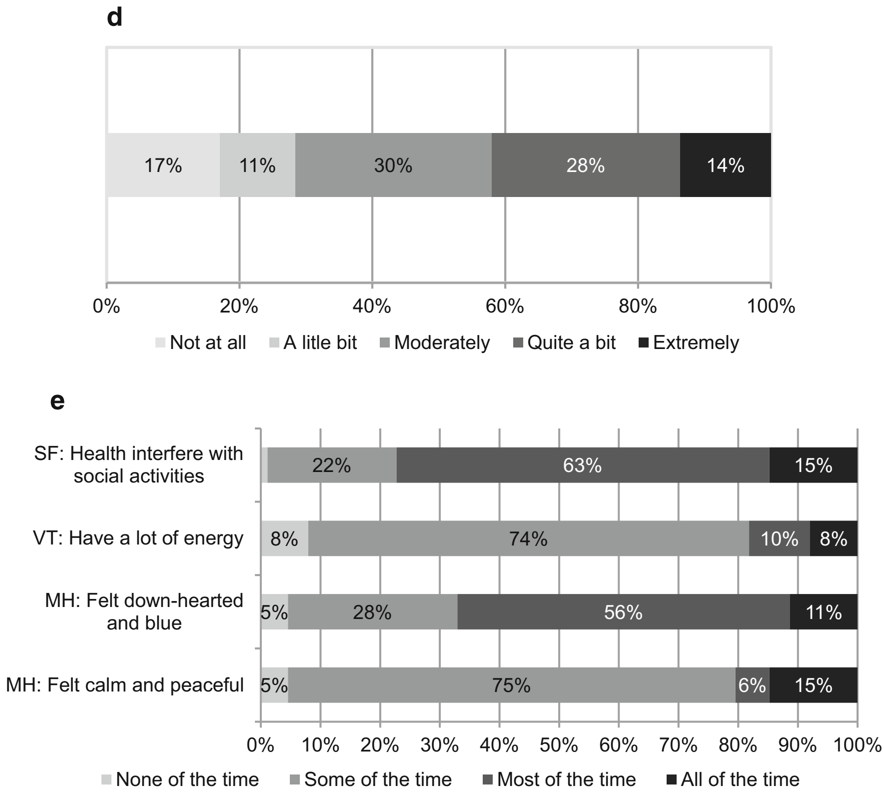


Fig. 11.3 (continued)

11.4.1.4 RE: Role Emotional

The majority felt that they accomplished less than they would like to due to emotional problems (68, 77%). Furthermore, the majority indicated that they worked less carefully than usual (71, 81%) (Fig. 11.3c).

11.4.1.5 BP: Body Pain

The evaluation of body pain was diverse among respondents. The most frequent answer was moderate body pain (26, 30%), followed by quite a bit of body pain (25, 28%). There were also respondents without body pain (15, 17%) and those with extreme body pain (12, 14%) (Fig. 11.3d).

11.4.1.6 MH: Mental Health

Regarding feelings, the majority (66, 75%) felt calm and peaceful some of the time, and 13 (15%) felt it all the time. The majority felt downhearted and blue most of the time (49, 56%), whereas 25 (28%) felt it some of the time (Fig. 11.3e).

11.4.1.7 VT: Vitality

Among the respondents, the majority (65, 74%) felt a lot of energy some of the time, while some felt it most of the time (9, 10%), all the time (7, 8%), or none of the time (7, 8%) (Fig. 11.3e).

11.4.1.8 SF: Social Functioning

Regarding physical health or emotional problems interfering with social activities, the majority (55, 63%) considered it most of the time, 19 (22%) some of the time, 13 (15%) all of the time, and one (1%) none of the time (Fig. 11.3e).

11.4.1.9 SF-12

The scores of subjective health are calculated in reference to the SF-12 (Fig. 11.4). According to the calculation, the score ranges from 20.75 to 43.26: RE is the lowest and SF is the highest.

11.4.2 Children's Nutrition, Survival, and Food Intake

11.4.2.1 Survival

Among the respondents, 24 people (38%) experienced the loss of a child before the age of 5. The number of child deaths totaled 42 children. This is lower than the percentage of 49% adding up to 68 children in Dodoma research village but higher than that in the coastal Lindi research village with 25% adding up to 26 children. However, the difference with the coastal village may be related to the age of respondents: the average age of the respondents in Malolo was 52.73 years old in comparison to 41.04 years in the coastal Lindi research village (Dodoma research village was 45.83 years).

Eleven respondents (13%) lost one child, seven respondents (8%) lost two children, four respondents (5%) lost three children, and one (1%) respondent lost five children. Most of them did not know the reason for their child's death (11, 44%), but five (20%) answered that it was malaria, nine (36%) answered sickness other

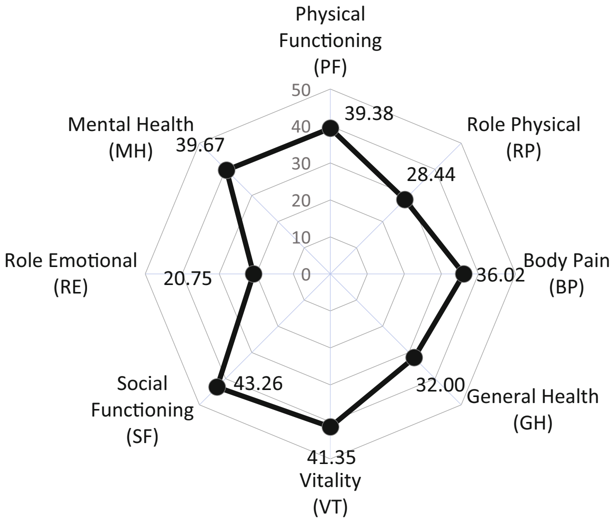


Fig. 11.4 Subjective health evaluation (Sakamoto et al., 2021a)

than malaria, and one (4%) answered other reasons. Other sicknesses were convulsion (*degedege*, 4), diarrhea (1, *kuharisha*), vomiting (*kutapika*), and stroke (1, *kupooza*).

11.4.2.2 Nutrition

Regarding the nutrition status (weight) of children under 5, 8% of children were severely underweight, 20% were moderately underweight, totaling 28% were underweight, and 20% did not know their status. Although the cutoff point is likely to be different from the national data, this is much higher than the national average of 13%, the Lindi regional average of 11%, and the MDG target of 12.5%. The percentage of underweight children was higher than 16% in the Lindi coastal research village, 11% in the Iringa research village, and 10% in the Dodoma research village. However, this may also be due to the age of the sample, as mentioned above.

11.4.2.3 Children's Food and Care

The majority considered that they had enough food during their pregnancy (71, 84%), and breastfeeding was also sufficient (72, 86%). The most common children's first food was porridge (82, 98%) from maize (54, 64%), cassava (33, 39%), sorghum (9, 11%), and rice (3, 4%). Others gave porridge from peanuts, cucumber seeds, and *Lishe*—a commercially available mix of various ingredients.

More than half (45, 54%) considered that children's food was sufficient. The majority (54, 64%) answered that both husband and wife decided together about their children when they were sick, 23 (27%) by women only, and seven (8%) by men only.

11.5 Food Sufficiency, Contents, and Balance of Food Intake

11.5.1 Food Sufficiency and Deficit

The majority considered that they had enough food during pregnancy (84%) and that children had enough breastfeeding (86%) and enough food for children (54%), although to a lesser extent. However, the majority considered that they did not have enough food throughout the year (92%). Food shortage was a major issue for the majority, especially from December to March (Fig. 11.5), and 95% did not have sufficient food in February.

Unlike the food sufficiency in Ifunda, Iringa region discussed in Chap. 8 (Sakamoto et al. (2020a), the lack of food in the rainy season and its magnitude are common in the case of Chinangali I village of Dodoma region in Chap. 12 (Sakamoto et al., 2020b). However, the peak of food insufficiency already started in October and continued in Dodoma region, whereas the peak was from January to

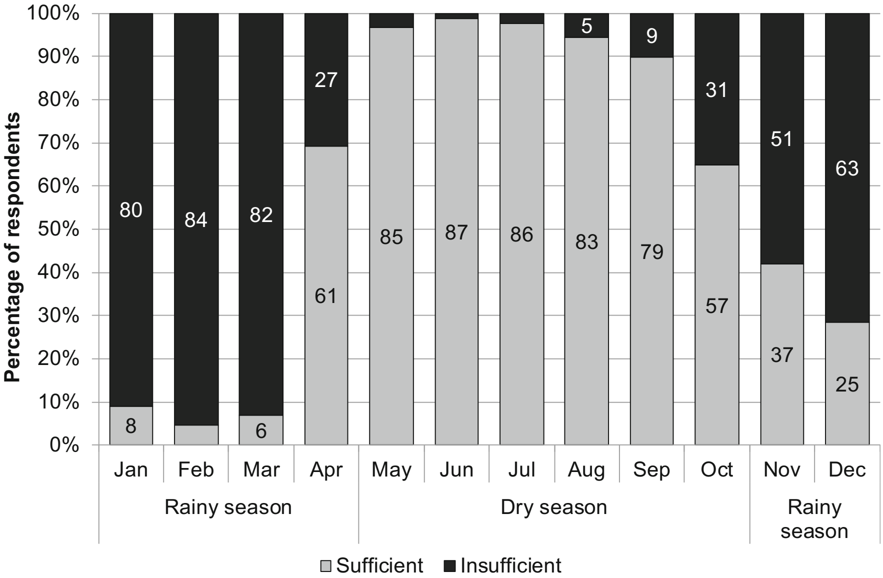


Fig. 11.5 Food sufficiency and insufficiency (Sakamoto et al., 2021a)

Table 11.5 Numbers of months with food (Sakamoto et al., 2021a)

Months with food	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
Respondents	1	0	1	1	4	8	20	18	11	16	3	0	3	86
Percentage	1	0	1	1	5	9	23	21	13	19	3	0	3	100

March in Malolo village and March in Kijiweni village of Lindi region discussed in Chap. 9 (Sakamoto et al., 2020c).

Most of the respondents (80, 92%) indicated that they did not have sufficient food to last a year. Most of them (69–99%) had sufficient food from April to October (2018). February was the month when most respondents (84, 95%) lacked food, followed by March (93%) and January (91%). The average month of food sufficiency was 6.95 months but ranged from none of the months to 12 months (Table 11.5). Twenty respondents (23%) had enough food 6 months a year, and 18 (21%) had it for 7 months.

When food is insufficient, 77 (89%) of the respondents decrease the number of their meals, 57 (67%) let children eat at relatives' or neighbors' houses, 57 (66%) obtain wild foods from the forest, and 46 (55%) sell livestock. Villagers utilize a variety of wild plants, such as **angadi**[3] (33 responses), **upupu** (*Mucuna pruriens* var. *utilis*, 19), and **mipama** (*Dioscorea cayennensis*, 12) and eat wild rats (*panya*,[4] 9) and other animals elaborated in Table 11.6.

11.5.2 Food Contents and Balance

In Malolo village, maize and cassava are the main staple foods, supplemented by bananas, rice, sorghum, and tubers (Fig. 11.6a). Pulse and vegetables are the main relish, supplemented by fish and meat (Fig. 11.6b).

The most typical staple foods are maize (86 respondents, 98%) consumed by all, followed by cassava (57, 65%), rice (36, 41%), bananas (35, 40%), sorghum (33, 38%), tubers (28, 32%), millet (15, 17%), and wheat (14, 16%). For relish, the majority ate pulses (86, 98%) and vegetables (73, 83%), followed by meat (28, 32%), milk (23, 26%), and others (5, 6%). Others eat wild foods such as rat (5), monkey (*tumbili*), and python (*chatu*).

The frequency of food intake of the various food groups in each season is indicated in Fig. 11.7. During the dry season (from May to mid-November), the majority (60, 68%) of the respondents eat staple foods more than twice a day. Pulses are eaten every day by the majority (44, 50%). Almost half (41, 47%) ate vegetables less than 3 days a week, and 22 (25%) ate vegetables more than twice a day. Fish are eaten 2 or 3 days a week by almost half of the respondents (35, 40%). Meat

[3] Local names of wild plants are in bold.

[4] Swahili names are in italics.

Table 11.6 Wild foods indicated in the questionnaire (Sakamoto et al., 2021a)

Local name	Scientific name (English)	Edible part	Foods of hunger		Dry season		Rainy season		Total
Ukwaju	*Tamarindus indica*	Fruit	1	1%	8	9%	7	8%	16
Magurugai	*Vangueria infausta* subsp. *rotundata*	Fruit			7	8%	7	8%	14
Manjichi	*Strychnos cocculoides*	Fruit	2	2%	4	4%	2	2%	8
Ubuyu, mabuyu	*Adansonia digitata*	Fruit		0%	2	2%	4	4%	6
Matondo (Mtomondo)	*Grewia* sp.	Fruit	2	2%	2	2%	1	1%	5
Mkungu, makungu	*Salacia madagascariensis*	Fruit	1	1%	1	1%	2	2%	4
Upokoro, upokoro	*Grewia* sp.	Fruit	1	1%	1	1%	1	1%	3
Upilipili	*Sorindeia madagascariensis*	Fruit			1	1%	1	1%	2
Matunda pori	(wild fruit)	Fruit			1	1%	1	1%	2
Mabungo	*Landolphia parrifolia*	Fruit					1	1%	1
Vitolo	*Landolphia kirkii*	Fruit					1	1%	1
Matopetope pori	*Annona senegalensis*	Fruit					1	1%	1
Embe	*Mangifera indica* (mango)	Fruit					1	1%	1
Hakaa, Akaa	*Maerua edulis*	Fruit					1	1%	1
Matili	*Landolphia buchananii*	Fruit			1	1%			1
Usofi	*Uvaria* sp.	Fruit	1	1%					1
Matongatonga	*Strychnos spinosa*	Fruit	1	1%					1
Yaja	*Strychnos henningsii*	Fruit	1	1%					1
Mavula (Mmula)	*Parinari curatelllifolia*	Fruit					1	1%	1
Upupu	*Mucuna pruriens* var. *utilis*	Seeds	19	21%	8	9%	10	11%	37
Lilende	*Corchorus aestuans*	Leaves					1	1%	1
Angadi	*Dioscorea cochleari-apiculata*	Tuber	33	37%	19	21%	22	25%	74
Mingoko	*Dioscorea hirtiflora* subsp. *orientalis*	Tuber	8	9%	25	28%	26	29%	59
Mipama	*Dioscorea cayennensis*	Tuber	12	13%	6	7%	8	9%	26
Vitundi	*Dioscorea* sp.	Tuber	4	4%	1	1%	2	2%	7
Mpeta, mapeta	*Dioscorea* sp.	Tuber		%	3	3%	2	2%	5

Ngwego	Unidentified	Tuber	1	1%			2	2%	3
	Plant subtotal		**87**		**90**		**105**		**282**
Panya	(rat)	Animal meat	9	10%	42	47%	35	39%	86
Nyani	(baboon)	Animal meat	6	7%	22	25%	17	19%	45
Fungo	*Civettictis civetta* (African civet)	Animal meat	1	1%	5	6%	4	4%	10
Nguruwe pori	(wild hog)	Animal meat			2	2%	3	3%	5
Bundi	(owl)	Animal meat			2	2%	3	3%	5
Sungura	(rabbit)	Animal meat	1	1%	2	2%	2	2%	5
Ngolombwe	(antelope)	Animal meat			2	2%	2	2%	4
Ngedere	(small black monkey)	Animal meat			2	2%	2	2%	4
Tumbili	(velvet monkey)	Animal meat			1	1%	2	2%	3
Komba	(bush baby: Small monkey)	Animal meat			2	2%	1	1%	3
Mbala, Mbawala	(bushbuck)	Animal meat			1	1%	1	1%	2
Kondoo mwitu	(wild sheep)	Animal meat			1	1%	1	1%	2
Kenge	(mountain lizard)	Animal meat			1	1%	1	1%	2
Kicheche	(striped polecat)	Animal meat			1	1%	1	1%	2
Chatu	(python)	Animal meat			1	1%			1
Nyama pori	(wild animal)	Animal meat			1	1%			1
Mkalati, Makalati	Unidentified	Insect	2	2%	6	7%	6	7%	14
	Animal subtotal		**19**		**94**		**81**		**194**
Uyoga	(mushroom)	Mushroom	5	6%	2	2%	5	6%	12
Total			**111**		**186**		**191**		**488**

Bold is the local name, Bold italic is the Kiswahili name. Animals and some plants have been translated from local names
Created with reference to Hetherwick (1902), Morino and Nakajima (1992), Stuart and Stuart (1997), and Wazaki (1992)
Reorganized from Sakamoto et al. (2021a) by Toshiki Hitomi

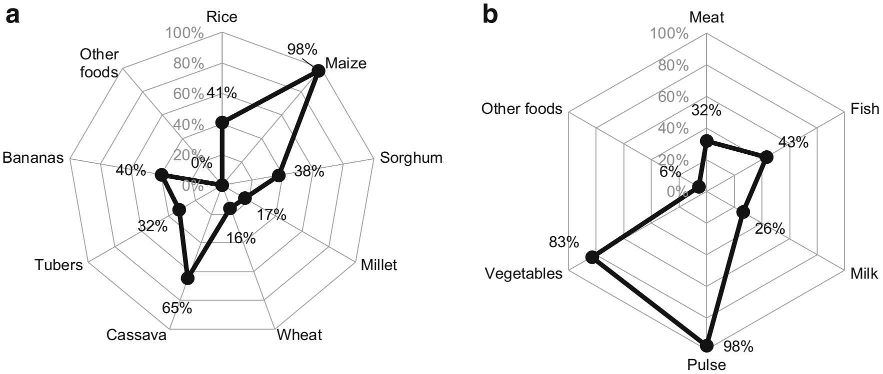


Fig. 11.6 Common foods (Sakamoto et al., 2021a). (**a**) Common staple foods. (**b**) Common relish

(52, 59%), fruits (43, 49%), and seeds (40, 45%) are eaten once or less than a week by approximately half of the respondents. Milk is not drunk by the majority (57, 65%).

In the dry season, the majority (46, 52%) of the respondents used oil more than twice a day, and most of them (80, 91%) used salt more than twice a day. Salt is 100% rock or sea salt, and none is industrial salt. Many of them (38, 43%) use sugar less than 3 days a week.

During the rainy season (from end of November to April), staple foods are eaten twice a day by half of the respondents (42, 48%), which is 20% less in comparison to the dry season. Vegetables are eaten twice a day by the majority (58, 66%), which is a 41% increase in comparison to the dry season. Fruits are eaten every day by almost half of the respondents (39, 44%) during the rainy season, which is a drastic increase from the dry season. Pulses are eaten two or three times a week by almost half (41, 47%), which is a decrease from the dry season. Meat (46, 52%), fish (31, 36%), and seeds (36, 43%) are eaten once or less than once a week by many. Milk is not drunk by the majority (59, 68%).

Salt is used by the majority (78, 89%), and oil is used by almost half (43, 49%), almost every day. Sugar is used once or less than once by 35 (40%) (Fig. 11.8).

11.6 Wild Foods and Their Benefits

Food from the forest is eaten once or less than once a week by the majority (48, 55%), 2 or 3 days a week by 19 (22%), every day by five (6%), but not eaten by some (15, 17%). The cumulative total is 186 examples, and among them, 94 were animals and 92 were plants. The most common examples of wild animals were rats (42) and baboons (22). The most common plants in the dry season were tubers of

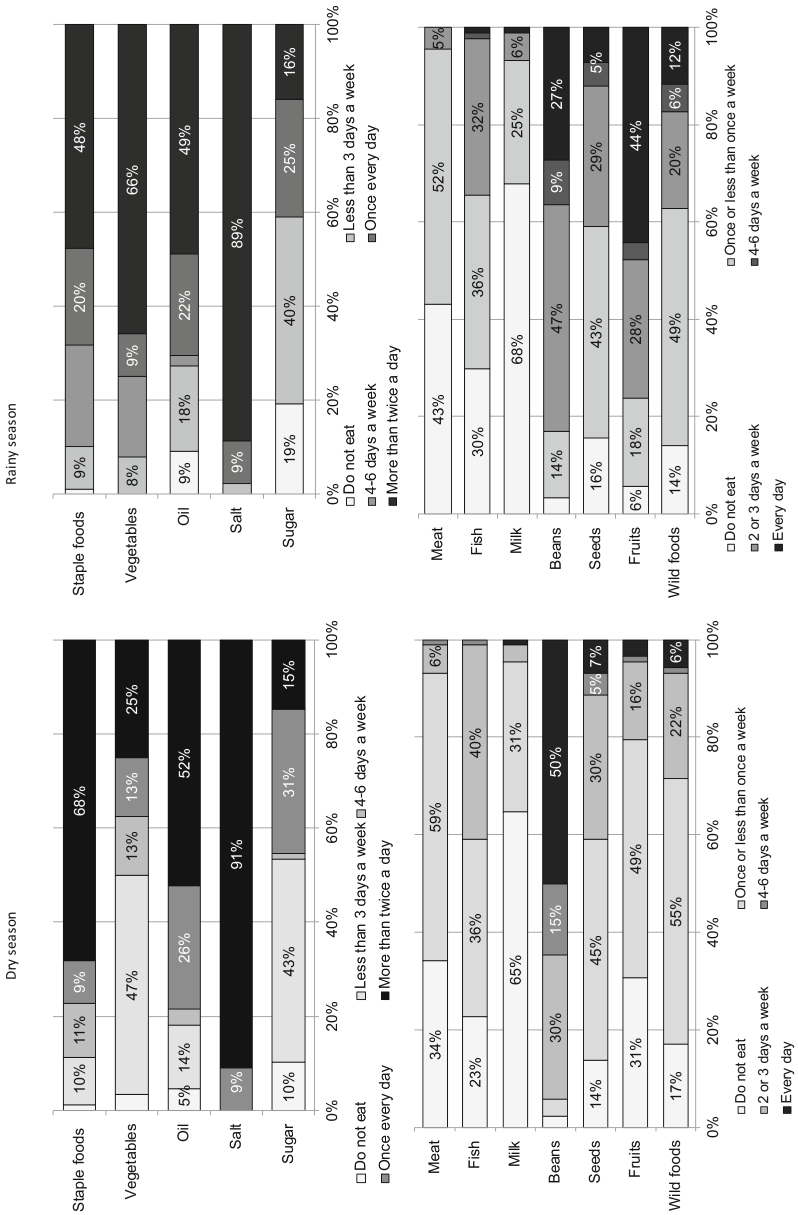
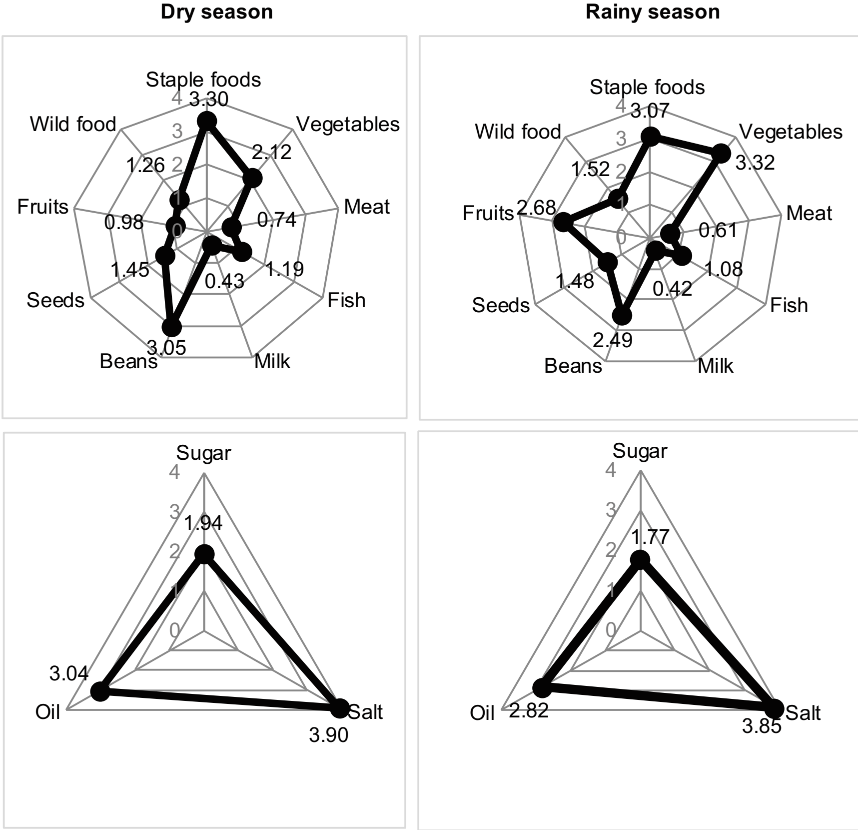


Fig. 11.7 Frequency of food consumption (Sakamoto et al., 2021a)



Note: ■ = 4: More than twice a day, 3: Once everyday, 2: 4,5,6 days a week, 1: Less than 3 days a week, 0: Do not eat
●= 4: Everyday, 3: 4,5,6 days a week, 2: 2,3 days a week, 1: Once or less than once a week, 0: Do not eat

Fig. 11.8 Average food group intake by season (Sakamoto et al., 2021a)

ming'oko (*Dioscorea hirtiflora* subsp. *Orientalis*, 25) and **angadi** (19). The full list is indicated in Table 11.6.

In the rainy season, wild foods are eaten once or less than once a week by almost half of the respondents (42, 49%), but those who eat every day increase to ten (12%) from five (6%) in the dry season. The cumulative total of examples of food from the forest increased from 186 to 191 in the rainy season, especially due to the increase in plant numbers from 92 to 110. The most common edible plants are **ming'oko** and **angadi**, followed by the beans of **upupu**. Many fruits only become available in the rainy season (Table 11.6).

The list of wild foods is extensive and includes a variety of wild animals and food. There are risks of disease with animals; therefore, caution is necessary for the preparation and thorough cooking, but it can be a valuable protein source. Fruits can be a source of vitamins. For example, the fruit of **upilipili** (*Sorindeia madagascariensis*) has 107 mg/100 g of vitamin C, which is above the daily nutrient requirements of a 30-year-old woman (Stadlmayr et al., 2019). Mango, which can be both cultivated or wild, is also rich in vitamins A and C, β-carotene, and folic acid. Tubers can be a source of calories in times of food deficiency and are utilized by many. It is noted that mushrooms, leaves, and insects are also utilized as food.

11.7 Understanding the Challenges and Potentials of the Village

Children's underweight is relatively high in Lindi region, and the results of the research confirmed and situated this village as having higher underweight than the regional average. The study also underlined the general understanding of the village as lacking food. For health evaluation, villagers had high SF and VT but low RE, as in other research villages. The chapter underlined the challenges that the village faces.

However, the consumption of wild animals and wild foods was outstanding in comparison to other research villages in Lindi and Dodoma regions discussed in other chapters. The number is also outstanding, and additionally, the variety extends from wild animals, fruits, tubers, mushrooms, and leaves. This is likely to supplement a more balanced diet for those who have access to wild foods. The variety of wild foods also explains the result in Chap. 4 that people eat a variety of food groups according to the season: staple foods, beans, and meat in the dry season, and vegetables and fruits in the rainy season. This further enriches the analysis in Chap. 10 that villagers with more wild food intake have better PF. It is also consistent with the identification of Malolo village as a village that faces food deficits but has overcome the situation based on its resilience and self-reliance. Further research is necessary to understand the contribution of wild foods to children. Nevertheless, this chapter provided evidence that the utilization of wild foods has been an asset to this village to supplement their food, contributing to health. Protein, which tends to be lacking in other parts of the country, has been supplemented by wild animals in this village. Since the intake of wild animals is controversial, further research is necessary. Nevertheless, the potential of wild foods can be further explored, and at the same time, it is also necessary to tackle the direct challenges that people face.

Acknowledgment First, we would like to thank the women and men of Malolo village for answering the questionnaires, the village, district, and regional government for welcoming this research, and COSTECH for permission. Mr. Mwalimu Mohamedi Abdalla (Village Executive Officer), Ms. Honorata Guadence Mussa, Mr. Mussa Yasini Tamba, Mr. Henry Kleophasy Nnonjella, Ms. Victoria Ismail Chaka, and Ms. Eligia Kanuth Mwambe have been part of a team to interview the villagers. Mr. Abdala Makwanda (Medical Attendant) has provided information on health issues within the village. Mr. Masayuki Hayashi also accompanied us to Malolo village and identified major edible plants in the village. Mr. Tsuda Katsunori assisted in translating the wild foods listed in the questionnaire. Mr. Frimpong Andrew Charles assisted in secretarial work as a research assistant in the process of editing the manuscript, and Mr. Toshiki Hitomi assisted in reorganizing Table 11.6.

We would also like to thank Dr. Anita Wagner and Dr. Barbara Gande for sharing the Swahili version of their SF-36. Appreciation goes to Dr. Onesmo Mella to have checked and advice on the original Swahili questionnaire and to Dr. Joyceline Kaganda to have advice on the food categories at the initial stage.

Among the authors, Sakamoto is responsible for planning the research; formulating the questionnaire; initiating and finalizing the article manuscript; and overall supervising the interviews, data input/checking, and formulating diagrams. Maro is responsible for interviews based on the questionnaire and direct supervision of the interviewing team, initial data input of all the interviews, providing information on the village, district, and region, and editing the Swahili summary. Khemmarath is responsible for double checking the data input, initial calculation, and editing of SF-12 under the supervision of Ohmori, formulating all the diagrams in the manuscript and assisting in drafting the manuscript. Ohmori is also responsible for the planning of the research, formulation of the questionnaire, and advising on the evaluation of the response on health and food intake, especially as a nutrition expert. Mbago is responsible for identifying wild plants. Kato is responsible for reviewing the manuscript with knowledge of Tanzania. All authors have gone through the manuscript and provided contributions and accepted the final manuscript.

The research is supported by the Japanese Government, JSPS Grants-in-Aid for Scientific Research (KAKENHI): mainly "Possibilities of wild edible plants and traditional meals in East Africa (18H03438)," partly supported by 25284171 and 18H00776; Overseas training program for female faculty members, and Utsunomiya University Diversity Research Environment Promotion Headquarters and Research assistance system of the Office for Promotion of Gender Equality, Utsunomiya University.

References

Bharucha, Z., & Pretty, J. (2010). The roles and values of wild foods in agricultural systems. *Philosophical Transactions of the Royal Society B, 365*, 2913–2926. https://doi.org/10.1098/rstb.2010.0123

Duguma, H. T. (2020). Wild edible plant nutritional contribution and consumer perception in Ethiopia. *International Journal of Food Science, 2020*, 2958623. https://doi.org/10.1155/2020/2958623

East and Southern Africa. (2017). *Overcoming the challenges of undernutrition in Tanzania through 2021*. Retrieved January 24, 2023, from https://www.iris-france.org/wp-content/uploads/2017/03/Tanzania-Final-report.pdf

Ekesa, B., Fongar, A., & Nasser. (2022). Access to and utilization of wild species for food and nutrition security in Teso and Acholi sub-regions of Uganda. *Frontiers in Sustainable Food System, 6*(836212), 1–16. https://doi.org/10.3389/fsufs.2022.836212

Hetherwick, A. (1902). *A handbook of the Yao language*. Society for Promoting Christian Knowledge. Retrieved July 15, 2020, from https://archive.org/details/ahandbookyaolan00hethgoog/page/n14/mode/2up

Lukmanji, Z., Hertzmark, E., Mlingi, N., Assey, V., Ndossi, G., & Fawzi, W. (2008). *Tanzania food composition tables*. Muhimbili University of Health and Allied Sciences, Tanzania Food and Nutrition Centre, & Harvard School of Public Health. Retrieved October 30, 2022, from https://cdn1.sph.harvard.edu/wp-content/uploads/sites/30/2012/10/tanzania-food-composition-tables.pdf

Mizoguchi, K., Takemi, Y., & Adachi, M. (2004). Relationship between positive perception toward work and the dietary habits of young male workers. *The Japanese Journal of Nutrition and*

Dietetics, 62(5), 269–283. Retrieved from https://www.jstage.jst.go.jp/article/eiyogakuzashi1941/62/5/62_5_269/_article/-char/en

Mohamed, T., & Nyaruhucha, C. (2022). Prevalence and factors associated with undernutrition among under-five children in Gairo district in Morogoro, Tanzania. *Tanzania Journal of Health Research, 23*(4), 1–10. https://doi.org/10.4314/thrb.v23i4.8

Morino, T., & Nakajima, H. (1992). *Suwahiri-go Jouyou 6000 go* [6000 common Swahili words]. Daigaku Shorin.

Narayan, D., Jones, V. N., & Woolcock, M. (2004). *Measuring social capital: An integrated questionnaire*. World Bank. Retrieved February 4, 2023, from http://documents.worldbank.org/curated/en/515261468740392133/Measuring-socialcapital-an-integrated-questionnaire

Ohmori, R., Sakamoto, K., & Tsuda, K. (2020). Association between food intake and health-related quality of life in East Africa: From pilot study in two regions of Tanzania. *Journal of the School of Regional Design, Utsunomiya University, 7*, 35–42. Retrieved from http://hdl.handle.net/10241/00012127

Sakamoto, K. (2007). Mutual assistance and gender under the influence of cash economy in Africa: Case study from rural southeast Tanzania. *Journal of the Faculty of International Studies, Utsunomiya University, 23*, 33–54. Retrieved from http://hdl.handle.net/10241/6481

Sakamoto, K. (2008). Mutual assistance and gender under the influence of cash economy in Africa, part 2: Case study from inland rural southeast Tanzania. *Journal of the Faculty of International Studies, Utsunomiya University, 25*, 25–43. Retrieved from http://hdl.handle.net/10241/2228

Sakamoto, K. (2015a). Situation of women and children in central Tanzania: Preliminary report from a questionnaire interview in Majeleko village, Dodoma. *Journal of the Faculty of International Studies, Utsunomiya University, 39*, 133–150. Retrieved from http://hdl.handle.net/10241/9613

Sakamoto, K. (2015b). Situation of women and children in southeast Tanzania: Preliminary report from a questionnaire interview in Mchinga II village, Lindi. *Journal of the Faculty of International Studies, Utsunomiya University, 39*, 151–170. Retrieved from http://hdl.handle.net/10241/9614

Sakamoto, K. (2016). Situation of women and children in North Unguja, Zanzibar: Preliminary report from a questionnaire interview in Chaani Masingini. *Journal of the Faculty of International Studies, Utsunomiya University, 41*, 189–208. Retrieved from http://uuair.lib.utsunomiya-u.ac.jp/dspace/handle/10241/10148

Sakamoto, K. (2020). *Factors influencing child survival in Tanzania: Comparative analysis of diverse deprived rural villages*. Springer.

Sakamoto, K., Ohmori, R., & Okui, A. (2020a). Situation of women and children in southern Tanzania: From questionnaires in Ifunda, Iringa with focus on food-intake and health. *Journal of the School of International Studies, Utsunomiya University, 49*, 69–78. Retrieved from http://hdl.handle.net/10241/00012115

Sakamoto, K., Ohmori, R., & Tsuda, K. (2020b). Health, livelihoods, and food intake of children in Chinangali I village, Chamwino district, Dodoma region. *Science of Regional Design, Utsunomiya University, 7*, 43–64. Retrieved from http://hdl.handle.net/10241/00012127

Sakamoto, K., Parinya, K., Ohmori, R., & Maro, A. C. (2020c). Health, livelihoods, and food intake in coastal southeast Tanzania: From questionnaire interviews in Kijiweni village, Lindi region. *Journal of the School of International Studies, Utsunomiya University, 50*, 11–30. Retrieved from https://www.researchgate.net/publication/352349663

Sakamoto, K., Parinya, K., Ohmori, R., & Maro, A. C. (2021a). Health, livelihoods, and food intake in inland southeast Tanzania: From questionnaire interviews in Malolo village, Lindi region. *Journal of the School of International Studies, Utsunomiya University, 51*, 15–34. Retrieved from http://hdl.handle.net/10241/00012762

Sakamoto, K., Ohmori, R., & Tsuda, K. (2021b). Correlation between intake of wild food in 3 areas of Tanzania: Analysis from semi-arid central and inland/coastal southeast. *Journal of International Development Studies, 30*(2), 93–112 (in Japanese).

Sneyd, L. Q. (2013). Wild food, prices, diets and development: Sustainability and food security in urban Cameroon. *Sustainability, 5*, 4728–4759. Retrieved from https://doi.org/10.3390/su5114728

Stadlmayr, B., McMullin, S., Innocent, J., Kindt, R., & Jamnadass, R. (2019). Priority food tree and crop food composition database. *World Agroforestry (ICRAF)*, Version 1. Retrieved January 3, 2023, from https://www.worldagroforestry.org/publication/priority-food-tree-and-crop-food-composition-database

Stuart, C., & Stuart, T. (1997). *Field guide to the larger mammals of Africa*. Struik.

Tanzania, The United Republic of, National Bureau of Statistics and ICF Macro. (2011). *2010 Tanzania demographic and health survey: Key findings*. NBS and ICF Macro. Retrieved September 29, 2019, from https://www.dhsprogram.com/pubs/pdf/SR183/SR183.pdf

Tanzania, The United Republic of, University of Dodoma, development partners and UNICEF. (2018). *Tanzania national nutrition survey using SMART methodology (TNNS)*. MoHCDGEC, MoH, TFNC, NBS, OCGS, and UNICEF. Retrieved September 17, 2016, from https://www.unicef.org/tanzania/reports/tanzania-national-nutrition-survey-2018

TFNC (Tanzania Food and Nutrition Center). (2014). *Tanzania national nutrition survey 2014*. The United Republic of Tanzania, Ministry of Health and Social Welfare. Retrieved October 1, 2016, from http://www.lishe.org/tanzania-national-nutrition-survey-2014-final-report/

Tsunoda, N., Inayama, T., Hata, K., & Oka, J. (2015). Vegetable dishes, dairy products and fruits are key items mediating adequate dietary intake for Japanese adults with spinal cord injury. *Spinal Cord, 53*, 78–790. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/25962372

UNDP. (n.d.). *Extending the coastal forest protected area subsystem in Tanzania*. Retrieved July 13, 2020, from https://www.tz.undp.org/content/tanzania/en/home/search.html?q=Costal+Forest+Protected+area

Ware, J. E., Kosinski, M., & Keller, S. D. (1995). *SF-12: How to score the SF-12 physical and mental health summary scales*. The Health Institute, New England Medical Center.

Wazaki, Y. (1992). *Kamusi ya Kiswahili-Kijapani* [Kiswahili-Japanese dictionary]. Yotokusha.

Wyss, K., Wagner, A. K., Whiting, D., Mtasiwa, D. M., Tanner, M., Gandek, B., & Kilima, P. M. (1999). Validation of the Kiswahili version of the SF-36 health survey in a representative sample of an urban population in Tanzania. *Quality of Life Research, 8*(1–2), 111–120.

Chapter 12
Traditional Semiarid Agro-Pastoral Inland Food Patterns and Society: Frequent Food Deficits But Balanced BMI and Prevention of Anemia

Kumiko Sakamoto, Reiko Ohmori, Lilian Daniel Kaale, Frank M. Mbago, Parinya Khemmarath, Katsunori Tsuda, and Tamahi Kato

Abstract In semiarid agro-pastoral villages in Dodoma region, the minority who own cattle have a relatively frequent intake of dairy products, but the majority have a "traditional-inland" dietary pattern, with emphasis on staple foods and vegetables. Previous research indicates that this diet has health benefits in preventing anemia and lifestyle diseases through a balanced BMI (body mass index). Our questionnaire interview of 81 adults in Chinangali I village indicated that a high intake of wild foods in the rainy season is associated with good health and that the self-described "poor" were healthier. These findings highlight the significant health potential of semiarid African green vegetables. This chapter elaborates on these characteristics concerning the society that supports this food system. During food shortages, people cope by consuming foraged foods, keeping livestock, performing manual labor, and selling charcoal and baobab. Additionally, it was clarified that people with wealth and cattle did not automatically help those without it. Among different wealth

K. Sakamoto (✉)
School of International Studies, Utsunomiya University, Utsunomiya, Japan
e-mail: ksaka@cc.utsunomiya-u.ac.jp

R. Ohmori
School of Regional Design, Utsunomiya University, Utsunomiya, Japan
e-mail: rohmori@cc.utsunomiya-u.ac.jp

L. D. Kaale
Department of Food Science and Technology, University of Dar es Salaam, Dar es Salaam, Tanzania
e-mail: elykaale@gmail.com; dlilian@udsm.ac.tz

F. M. Mbago
University of Dar es Salaam Herbarium, Dar es Salaam, Tanzania

P. Khemmarath · K. Tsuda
Center for the Multicultural Public Sphere of Utsunomiya University, Utsunomiya, Japan

T. Kato
Center for African Area Studies, Kyoto University, Kyoto, Japan

K. Sakamoto et al. (eds.), *Changing Dietary Patterns, Indigenous Foods, and Wild Foods*, https://doi.org/10.1007/978-981-99-3370-9_12

groups, the frequency of dairy consumption differed, but the frequency of staple foods and vegetables did not. Although there is a problem with protein deficiency among the "poor," the strength of the dietary pattern with staple foods and vegetables is an asset.

Keywords Food intake · Nutrition · Tanzania · East Africa · Livelihoods · Health

12.1 Introduction

Within the overall objective of understanding changing dietary patterns, indigenous foods, and foraged, or wild, foods in relation to wealth, mutual relations, and health in Tanzania, Part IV has focused on wild foods. The analysis of the association between wild foods and health in Chap. 10 indicated that wild food intake is beneficial for people's health during the rainy season in Chinangali I village, which is located in a semiarid area. Furthermore, the analysis between wealth evaluation and health evaluation in Chap. 6 indicated that in the same village, those who considered themselves "poor" had better health, contrary to general findings. Previous research also indicated that the dietary pattern that emphasizes staple foods and vegetables, named the "traditional-inland" pattern (Keding, 2016) in Tanzania leads to a balanced BMI (Body Mass Index) and prevents anemia. This chapter introduces the agro-pastoral society that supports this dietary pattern.

12.1.1 Benefits of Leafy Green Side Dishes and Wild Foods

12.1.1.1 The Role of Leafy Vegetables

A study of 252 women from Dodoma, northern Singida, northeastern Tanga, and other regions of Tanzania that analyzed the relationship between dietary patterns, BMI, and anemia found that people had healthy BMIs and less frequently anemia in Kongwa district of Dodoma and Singida regions and districts, where the "traditional-inland pattern", characterized by grains, oil and fat, and leafy vegetables, is prominent. On the other hand, those who had a "purchase pattern" characterized by cake, sugar, and tea had higher BMIs and a more frequent incidence of anemia with negative health impacts. The "animal products pattern," characterized by high animal meat and dairy intake, and the "pulse pattern," characterized by high pulse consumption, lacked vegetables and had relatively negative results. The "traditional-coastal pattern," characterized by fruits, nuts (coconuts), potatoes, and fish, was not as bad as the other negative consumption patterns but was not as good as the "traditional-inland pattern" (Keding et al., 2011, Keding, 2016). The results of this study indicate that the common diet in semiarid areas, where leafy vegetables are a common side dish, is healthy, especially in terms of balanced BMI and the prevention of anemia.

In addition, a survey of 666 smallholder women, with 333 smallholder women in Chamwino district of Dodoma region and 333 in Kilosa district of Morogoro region, revealed that Dodoma area had a comparatively high intake of green vegetables and appropriate intakes of vitamin A and iron (Stuetz et al., 2019). Similar findings from this study indicate that leafy vegetables consumed in semiarid Dodoma contribute to iron and vitamin A levels.

In Kilombero, eastern Tanzania, the significance of subsistence green vegetable farming and consumption has also been highlighted (Kato, 2011). In contrast, there is also discussion on improving nutritional balance through the diversification of agricultural products (Kinabo et al., 2016; Madzorera et al., 2020; Yamane et al., 2018).

12.1.1.2 Health Benefits of Edible Weeds

The Sandawe society in Dodoma has been investigated by Yatsuka (2012, p. 175), who claims that villagers are aware that "*mlenda* is high in vitamins [nutritional value]" and that they are healthier than children in town "because they consume *mlenda* with the *ugali* of millet." *Mlenda* is the general Swahili term for a side dish of sticky leafy vegetables, but in Dodoma, they mainly utilize edible weeds that grow wild on the farm. In contrast to cultivated crops, weeds can be harvested by villagers even if they are on farmland. In semiarid areas, leafy vegetables can be dried and eaten even during the dry season, which is one of the reasons for the high consumption of leafy vegetables.

According to the analysis in Chap. 10 with 253 participants in Dodoma (Chinangali I village, Chamwino district) and three coastal and inland areas of Lindi region, higher wild food intake was associated with higher subjective health ratings in both regions (Sakamoto et al., 2021). The nutritional value of edible weeds is becoming clearer, especially in South African studies (Uusiku et al., 2010; Schönfeldt & Pretorius, 2011; van Jaasveld et al., 2014). Nutritional analysis of multiple collections of edible weeds in Chinangali I village revealed high iron, calcium, and protein levels (Sakamoto et al., 2022). Furthermore, there is a large difference when compared with cultivated species. For example, wild *matembele* leaves have 100 times more iron than cultivated *matembele* in the same family and genus *Ipomoea* (*Ipomoea batata*—the same species as sweet potato) (Lukmanji et al., 2008).

All of the above indicates that leafy vegetables may contribute to people's health in Tanzania, especially in semiarid areas. While the quantity of cereal food production (Cochrane & D'Souza, 2015) is also important, and the quality of the diet needs more attention.

12.1.2 Semiarid Central, Dodoma Region and Chinangali I Village

Dodoma region had a very high under-5 mortality rate (U5MR), with 191 deaths in the 2002 census, which decreased to 57.5 in the 2012 census (Tanzania, 2015, p. 43). However, the rates of stunted and underweight children remained at 37% and 18%, respectively, as of 2018, most likely due to food insufficiency from droughts. The author's previous research was based on intensive questionnaire interviews in Majeleko village, neighboring Chinagali I, in Chamwino district, Dodoma region, and analysis of the responses identified that insufficient food for children is one of the main factors associated with child death. The risk of childhood death was lower for those who were fed a mixture of food, while it was higher for the offspring of women in arranged marriages. The survey answers also indicated that sharing food benefited child survival, but food sharing was far from a comprehensive solution. Furthermore, research indicated that utilization of sorghum, an indigenous staple food, was low, especially for children, although it had positive effects on child survival in research in Lindi region (Sakamoto, 2017, 2020).

The questionnaire was completed mainly in Chinangali I village, Chamwino district. The IMR and U5MR of Chamwino district are 58.2 and 42.5 out of 1000 births, respectively, which are slightly higher than the regional average (Tanzania, 2015). The locations of Chinangali I village and its hamlets are indicated in Fig. 12.1. The household and population of each hamlet are indicated in Table 12.1.

12.1.3 Methodology

The questionnaire interview was based on a comprehensive questionnaire in Swahili. The questions included 75 items about the respondents, marriage and family, livelihood, groups, mutual assistance, children, health, and food intake. Questions on health are based on the standardized SF (Short Form)-12, and the Swahili translation was based on the validated Swahili SF-36 (Wyss et al., 1999). Questions on food intake frequency have been based on research in Japan (Mizoguchi et al., 2004; Tsunoda et al., 2015), adjusted to foods in Tanzania based on *Tanzania Food Composition Tables* (Lukmanji et al., 2008) and discussions with nutrition specialists in Tanzania. Questions on groups and mutual assistance have been formulated with reference to *Measuring Social Capital* (Grootaert et al., 2004). Self-evaluation of being "poor", "average", or "wealth" has been questioned with reference to participatory poverty assessments (Narayan et al. 2000). Other questions were formulated based on the author's previous questionnaire interviews (Sakamoto, 2007, 2008, 2015a, 2015b). The questionnaire was reviewed by a team of interviewers consisting of villagers, researchers, and volunteers who confirmed or revised wordings based on the village reality and the quality of the Swahili. The interviewers were six villagers who were selected based on their writing capabilities, one villager

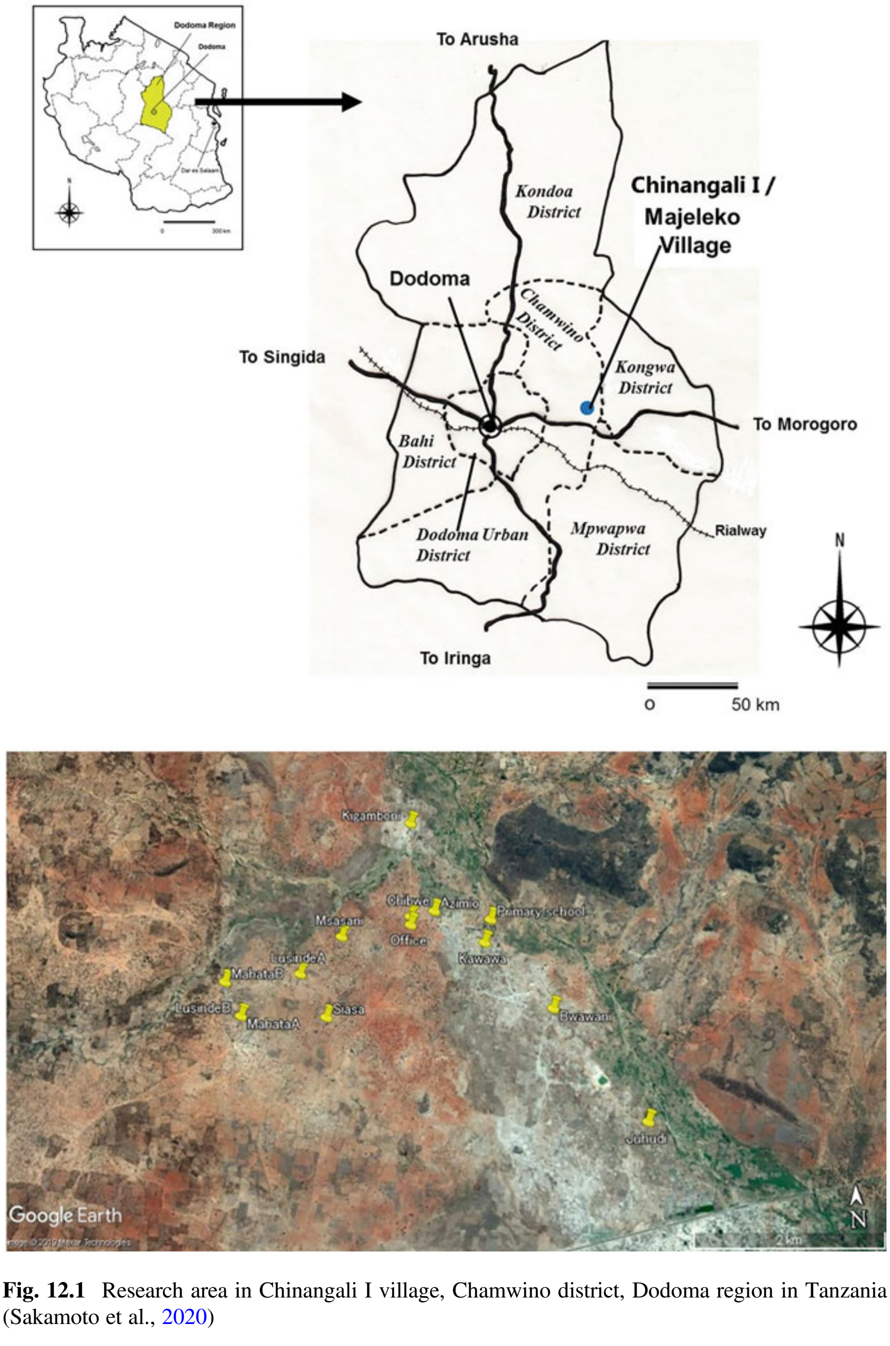


Fig. 12.1 Research area in Chinangali I village, Chamwino district, Dodoma region in Tanzania (Sakamoto et al., 2020)

Table 12.1 Household, population, and sample size from each hamlet in Chinangali I village (Sakamoto et al., 2020)

Name of hamlet	Household	Population			Sample	
		Men	Women	Total	*n*	%
Azimio	75	137	146	283	9	11.1
Bwawani	69	151	168	319	7	8.6
Chibwe	40	94	97	191	7	8.6
Juhudi	74	158	166	324	7	8.6
Kawawa	71	145	167	312	7	8.6
Kigamboni	41	77	79	156	7	8.6
Lusinde A	62	116	140	256	0	0
Lusinde B	52	120	115	235	7	8.6
Mahata A	44	85	94	179	7	8.6
Mahata B	51	96	99	195	7	8.6
Msasani	64	103	132	235	8	9.9
Siasa	70	141	159	300	8	9.9
Total	713	1423	1562	2985	81	100

from Majeleko with research assistance experience, and two Japanese volunteers, all trained and supervised by an ex-TFNC staff and the author.

The interviewees were selected from all hamlets to cover the whole village. Seven to nine households were selected per hamlet, excluding Lusinde A Hamlet due to a misunderstanding by the hamlet representative. Interviewees were selected from each household but were not limited to household heads, as household heads tended to be men, and the research team agreed that women may have more information on the research subject. The rules and regulations on research ethics followed those from Utsunomiya University (permission granted as H18-0008), such as asking for prior approval for an interview.

The registered questionnaire was inserted and checked by students of Utsunomiya University, rechecked by the authors, and compiled and analyzed using Excel and SPSS. SF-12 has been calculated as elaborated in Chaps. 5 and 6. In this chapter, the results and analysis of the responses will be utilized to describe the "traditional-inland" dietary patterns and the society that supports the system.

12.1.4 Respondents

The majority (69%) of the respondents are women as targeted but also include men (31%). The age group is diverse, ranging from 18 to 99, but many of the respondents are in their 40s (25%), followed by those in their 20s (20%, Table 12.2). Most of them identify as Christian (96%), but a minority identify as Muslim (4%). The majority ethnic group is Gogo (95%), with minorities of Hehe, Kagulu, Mwera, and Rangi (one each, Table 12.3).

Table 12.2 Age groups of respondents (Sakamoto et al., 2020)

	n	%
10s	1	1.2
20s	16	19.8
30s	11	13.6
40s	20	24.7
50s	12	14.8
60s	6	7.4
70s	5	6.2
80s	3	3.7
90s	1	1.2
Unknown	6	7.4
Total	81	100.0

Table 12.3 Ethnic groups of respondents (Sakamoto et al., 2020)

	n	%
Gogo	77	95.1
Hehe	1	1.2
Kagulu	1	1.2
Mwera	1	1.2
Rangi	1	1.2
Total	81	100.0

The total percentage does not add up but is rounded

The majority (80%) participated in their initiation and studied in school (75%). The majority went to elementary school (73%), and 65% finished their education at the elementary level, whereas 8% progressed to secondary. There was one respondent each who went to adult school, higher technical school, and university.

12.2 Health of Adults and Children

12.2.1 Subjective Health Evaluation of Adults (SF-12)

In general, 37% of respondents considered themselves to have good health. Concerning moderate activities, 59% felt that they were not limited at all. For heavy activities, 51% were not limited at all.

However, more people felt that they accomplished less than they would like (52%) than those who disagreed (48%). On the other hand, more respondents were not limited in the kind of work or activities (59%) than those who were (41%).

For emotional problems, more felt that they accomplished less than they would like (54%) than those disagreeing (46%). Those who felt that they were also less careful due to emotional problems were also more (54%) than those who were not (46%). Many of the respondents indicated that pain did not interfere with their normal work at all (46%).

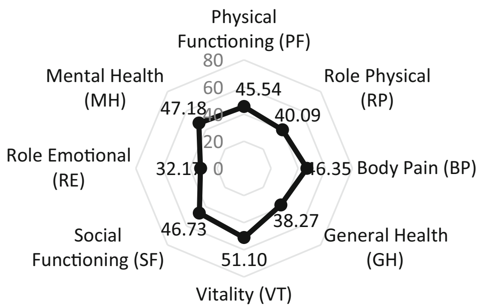


Fig. 12.2 Subjective health evaluation of adults (Sakamoto et al., 2020)

Table 12.4 Number of family members (Sakamoto et al., 2020)

Questions	Average	0	1	2	3	4	5	6	7	8	9	Total (*n*)
In the household	4.5		8	8	4	16	14	14	7	4	1	76
Children under-5	1.3	10	28	13	5	2						58
Children who died under-5	1.1	33	13	9	2	2	2	1	1			63

Regarding feelings, 46% felt calm and peaceful all the time, and 38% some of the time. Among the respondents, 44% felt a lot of energy all of the time, and 40% some of the time. Those who felt downhearted and blue none of the time were 33%, and some of the time were 43%.

The statistics for the answers to SF-12 have been calculated and are shown in Fig. 12.2. Respondents generally had a high evaluation of their own Vitality (VT 51.10). On the other hand, they had low evaluations of the Role Emotional (RE 32.17).

12.2.2 Health of Children

12.2.2.1 Under-5 Mortality

Among the respondents, 32 people (49%) experienced the loss of a child or children under 5 years of age. Thirteen respondents lost one child, nine respondents lost two children, two respondents lost three, four, or five children, and one respondent lost six or seven children (Table 12.4). The number of children's deaths totaled 68 among the 81 respondents.

This rate is similar to that of previous research in Majeleko village, where 69 women (50%) indicated that they experienced the loss of a child, adding up to 75 children among 126 women (Sakamoto, 2020). National and regional U5MR data (Tanzania, 2015) and previous research in a neighboring village (Sakamoto, 2020) indicated improvements over the years; therefore, the data also need to be assessed against age. While there has been a substantive number of children's deaths in this village, the data need to be carefully assessed because respondents include parents of various age cohorts, including a respondent claiming to be 99 years old.

Most respondents answered that the child died from malaria (70%), and 5% indicated convulsions, which some related to malaria; another 3% reported the death as accidental, and 7% did not know the reason. One respondent indicated urinary tract infection (UTI), and another indicated that the child died at birth. The majority considered the reason for death to be malaria, which is similar to the situation in a neighboring village where "fever and malaria" were considered the reason for the majority (Sakamoto, 2020). The majority (66%) answered that both husband and wife decided where to send the children when the child is sick, but some indicated that this decision was made only by men (19%) or only by women (16%).

12.2.2.2 Underweight Children Under-5

Regarding the nutrition status (weight) of children under 5, 81% reported the weight was sufficient (green), 10% reported that it was potentially insufficient (gray), 0% was insufficient (red), and 10% did not know the status. Although the cutoff point is likely to be different from national data, the percentage of underweight children under 5 is lower than the national average of 14.7% and lower than the Dodoma average of 17.8% (Tanzania, 2018, p. 44).

However, 10% of respondents did not know the nutrition status of their children under 5 years of age. It is important that mothers/parents understand the nutrition status of children so that measures can be taken by the family and community to improve them when necessary, and this is the main objective of growth monitoring. If all 10% are underweight, the complete percentage of underweight children under 5 will add up to 20%, which will be above the national target.

12.3 Food Sufficiency, Content, and Balance of Food Intake

12.3.1 Food Sufficiency

The majority considered their food supply during pregnancy to be enough (73%) and that breast milk was also sufficient (82%). The majority also considered that the amount of children's food was sufficient (67%).

However, the majority also reported that they do not have enough food these days to last a year (98%). Most respondents had enough food in April (80%) and May (83%) 2018. From October to December were the months when most respondents (84–85%) lacked food. The average number of months with food sufficiency was 6.0.

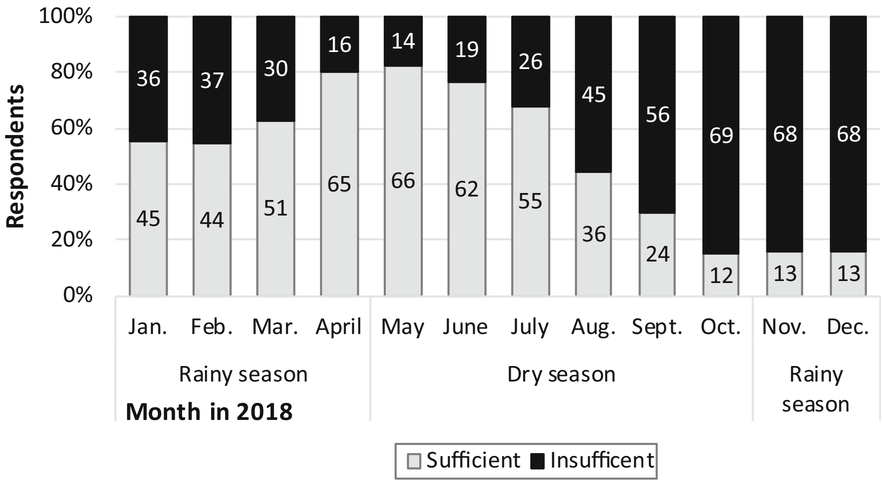


Fig. 12.3 Food sufficiency/insufficiency in 2018 (Sakamoto et al., 2020)

As frequently seen in neighboring Majeleko village, the harvest fluctuates between years depending on the weather, including obtaining sufficient rain at the right time. Furthermore, even in a year with a good harvest (2018), only 15% (12) of the respondents had sufficient food during October (Fig. 12.3).

12.3.2 Foods Eaten

The most typical staple food was maize (87%), followed by sorghum (76%), millet (52%), tubers (51%), rice (44%), cassava (39%), bananas (32%), and wheat (30%). Other foods such as pumpkin and wild fruits such as **ngwelu**[1] (Malvaceae family: *Grewia* sp. nov.), **mtafuta** (Malvaceae: *Grewia burtii*; *G. similis*), and **mfulu** (Lamiaceae: *Vitex payos*) were also indicated (Table 12.5).

Regarding other dishes, 90% of the respondents indicated they ate vegetables, 85% indicated pulses, 58% indicated meat, 50% indicated fish, and 46% indicated milk. For other dishes, wild vegetables such as *mlenda* (Pedaliaceae: *Ceratotheca sesamoides*), wild sweet potato leaves ***matembele pori***[2] (**chapali, mapali, sagula sagula**) (Convoluvulaceae: *Ipomoea obscura*), and ***tango pori*** (**ilumbu, malumbu**) (Cucurbitaceae: *Cucumis dipsaceus*) were mentioned (Table 12.5).

During the dry seasons, 59% of the respondents eat staple foods and vegetables more than two times a day. Meat is eaten by 59% once or less than once a week, fish or small fish is eaten by 50% at the same frequency, and milk is not drunk by 47%.

[1] **Bold** is local plant name in the Gogo language.

[2] ***Bold italic*** is Kiswahili plant name.

Table 12.5 Wild foods from the forest (updated from Sakamoto et al., 2020)

Wild foods from the forest (English, ***Swahili***, **Gogo**)	Family name	*Scientific name*	Part eaten	Food for hunger	Other staple foods	Other dishes	Dry season	Rainy season	Total wild foods
Baobab, ***Ubuyu***	Malvaceae	*Adansonia digitata*	Fruit	13			14	3	30
Ngwelu	Malvaceae	*Grewia* sp. nov.	Fruit	5	1			4	10
Mtafuta	Malvaceae	*Grewia burtii, G. similis*	Fruit	2	1		1	4	8
Mfulu	Lamiaceae	*Vitex payos*	Fruit	2	1		1	3	7
Mlenda, Mrenda **(Makuwi)**	Pedaliaceae	*Ceratotheca sesamoides*	Leaves			4	2	1	7
Matembele pori **(Chapali, Mapali)**	Convoluvulaceae	*Ipomoea obscura*	Leaves			2	1	1	4
Matembele pori **(Sagula sagula, Sanghala)**	Convoluvulaceae	*Ipomoea obscura*	Leaves			3			3
Matembele pori	Convoluvulaceae	*Ipomoea* sp.	Leaves			2			2
Tango pori **(Ilumbu, Malumbu)**	Cucurbitaceae	*Cucumis dipsaceus*	Leaves			3			3
Mtinhi	Euphorbiaceae	*Erythrococca bongesis*	Leaves			2			2
Baobab leaves, **Ikuwi**	Malvaceae	*Adansonia digitata*	Leaves			1			1
Mtulu	Opiliaceae	*Opilia celtidifolia*	Leaves			1			1
Chidungulilo	Asphodelaceae	*Aloe* sp.	Flowers			1			1
Safwe[a]	Fabaceae	*Vigna ungulculata*	Leaves, pulses			4[a]			0

(continued)

Table 12.5 (continued)

Wild foods from the forest (English, ***Swahili***, **Gogo**)	Family name	*Scientific name*	Part eaten	Food for hunger	Other staple foods	Other dishes	Dry season	Rainy season	Total wild foods
Mamuzo	Cucurbitaceae	*Lagenaria siceraria*	Fruit			1			1
Bottle gourd, ***Mamumunya***, **Mayungo**[a]	Cucurbitaceae	*Lagenaria siceraria*	Fruit			1[a]			0
*Root, **Mzizi***			Root	1					1
Nhundue (Nundwe, Mtundwe)	Olacaceae	*Ximenia americana*	Fruit	1					1
Rosella, **Choya**[a]	Malvaceae	*Hibiscus sabdariffa*	Flower	1[a]					0
Fruit, ***Matunda***			Fruit				1		1
Guava, ***Mpera***	Myrtaceae	*Psidium guajava*	Fruit					1	1

Bold italic words are in Swahili, **Bold** words are in the local Gogo language
[a] Not a wild food but mentioned by the respondents as a wild food

Regarding pulses, 38% of respondents eat them once or less a week, and 36% eat them 2–3 days a week. Twenty-nine percent (29%) eat seeds 2–3 days a week, and 37% eat fruit once or less a week. Foods from the forest are not eaten by 53%, but 21% eat foraged forest foods once or less per week. Some examples of wild foods in the dry season are baobab (14 responses), *Mlenda* (**makuwi ,** 2), **chapali**, and fruit (Table 12.5). Forty-four percent (44%) use oil more than two times a day, and 57% use salt at the same frequency, but 30% eat sugar or sugar cane once or less than once a week.

During the rainy season, 50% eat staple foods two times a day, and 46% eat vegetables at the same frequency. For meat, 50% eat it once or less a week, and 44% eat fish at the same frequency. Thirty-six percent do not drink milk, but 47% eat pulses 2–3 days a week. Twenty-nine percent (29%) eat seeds every day, but the same percentage of respondents does not eat seeds. Thirty-five percent (35%) eat fruit once or less. Foods from the forest are eaten 2–3 days a week by 31%. Wild fruits eaten in the rainy season are **mtafuta** (4), **ngwelu** (4), **fulu** (3), and guava (Table 12.5). The use of oil is more than two times a day at 42%, and salt is 58% for the same frequency. Sugar is not used by 31%, and baobab is not eaten by 71% in the rainy season.

The most common children's first food was maize porridge (58%), followed by sorghum porridge (49%). Others gave stiff porridge (*ugali* 4), milk (2), millet porridge (2), finger millet porridge, baobab porridge, and sweet potatoes cooked in coconuts.

12.3.3 Balance of Food Intake

According to the average response, many people eat vegetables and staple foods every day in both dry and rainy seasons. Fish and meat are eaten only less than once a week and decrease during the rainy season. However, the average frequency of milk consumption, which is drunk less than once a week (0.89), increases to more than once a week (1.14) in the rainy season, and pulses increase from more than once a week (1.51) to more than 2–3 days a week (2.14). There is also a divergence between those who eat seeds every day (29%) and those who do not (29%) during the rainy season. The intake frequency of seeds and fruit also increases. Foods from the forest, in general, are more widely represented in the diet during the rainy season, but baobab is eaten more frequently in the dry season. Respondents tend to take salt and oil every day. Consumption of sugar is approximately 4 days, 5 days, and 6 days a week, further decreasing in the rainy season. In general, respondents eat less meat and fish during the rainy season; however, they complement it with milk, pulses, and seeds.

Figure 12.4 shows the average frequency of intake of each food group from the same survey in Chinangali I village. In all seasons, staple foods, vegetables, salt and oil were consumed more frequently. This consumption pattern is consistent with the "traditional-inland pattern" characterized by leafy vegetables, cereals, and oil and

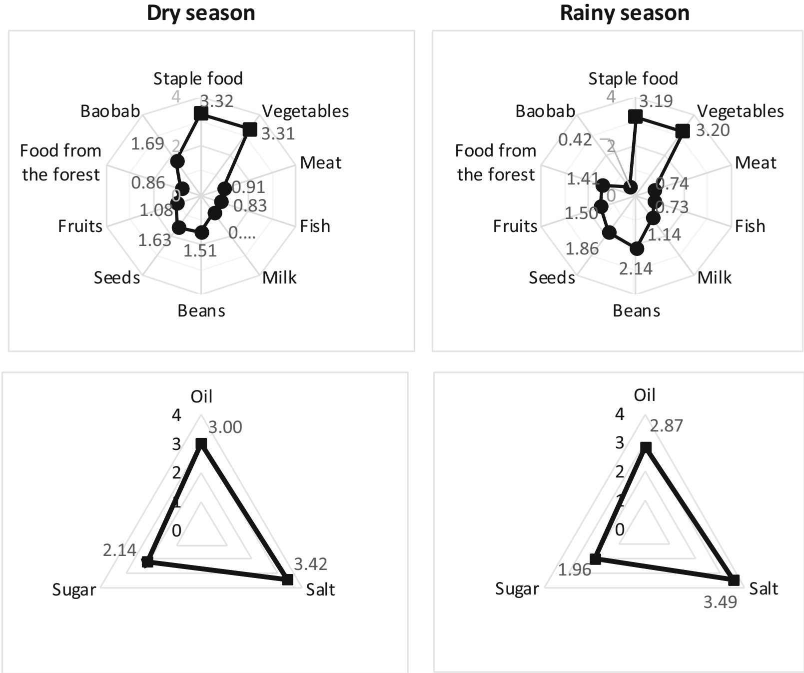


Fig. 12.4 Balance of food intake by season (Sakamoto et al., 2020) ■ = 4: more than 2 times a day, 3: once every day, 2: 4–6 days a week, 1: less than 3 days a week, 0: do not eat ● = 4: every day, 3: 4–6 days a week, 2: 2, 3 days a week, 1: once or less than once a week, 0: do not eat

fat, which have been mentioned in previous studies as healthy for preventing anemia and maintaining BMI.

12.4 Livelihood, Marriage, and Family

12.4.1 Livelihood

The majority considered their situation to be average (75%) within the village, whereas 25% considered themselves poor, and no one considered themselves rich. The majority responded that they are farmers (96%), but 11% do business, and 11% are pastoralists. Two respondents were technicians (*fundi*), and one had work related to traditional music. Although many did not consider themselves pastoralists, 55% had some kind of livestock. Twenty-one respondents had cattle, and the number ranged from 1 to 20 in the herd (Table 12.6). Seventeen respondents had goats, ranging from 1 to 20; 27 had chickens, ranging from 1 to 70; 5 respondents had

Table 12.6 Number and type of livestock received as bridewealth and owned (Sakamoto et al., 2020)

Livestock	Swahili	Major Average	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	70	Total, *n*
Bridewealth																											
Cattle	*Ngombe*	9.3	4	5	5	0	6	2	4			1		1				2	3			6	2		1		42
Goat	*Mbuzi*	6.4	6	2	4	1	2	4	1		1	2		3				1	1			1					29
Sheep	*Kondoo*	1.7	2		1																						3
Owned																											
Cattle	*Ngombe*	5.2	2	7	2	2	2	1		1		2					1					1					21
Goat	*Mbuzi*	6.6	4	1	1		3	2			1	2		1			1					1					17
Chicken	*Kuku*	8.3	6	4	2		2	2	3		1	2		1			2					1				1	27
Duck	*Bata*	7.0	1			1					1	1	1														5
Pig	*Nguruwe*	1.5	5			1																					6

ducks, ranging from 1 to 11; 6 respondents had 1 or 4 pigs (Table 12.6); 2 had 2 or 6 guineafowls (*kanga*); and 1 had 4 sheep.

The majority had a farm (98%), but few had a garden (13%). The major crops were maize (90%) and sorghum (68%). Other crops were sunflowers (74%), peanuts (30%), and sesame (18%). Some cultivated millet (*uwele*, 4, 5%), Bambara groundnuts (*njugu*, 7, 9%), cassava (2, 3%), vegetables, tomatoes, and cowpeas (*kunde*). The majority cultivated these crops as subsistence food (95%), but others cultivated them for business (56%). Some explained that it suits the environment (3, 4%), that they use sunflower as a source of oil, that they cultivate sunflower, sesame, and peanuts for business, or that they cultivate these crops to satisfy small needs. The majority answered that they made various decisions about the crop with women and men together (53%), but some decisions were made just by women (25%) or just by men (23%).

The majority considered food (96%) to be the most important use of income, followed by clothes (52%), health (51%), education (24%), and agriculture (4%). Other usages of income (6%) included purchase of soap and oil, construction, and purchase of bicycle. The majority answered that they made decisions about cash with women and men together (53%), but others answered only women made these decisions (28%) or only men (20%).

12.4.2 Coping With Food Shortages

When food is insufficient, 27% foraged for food from the forest, 32% sold livestock, and 18% had children eating at relatives or neighbors. Thirty-seven respondents indicated other methods of trading for food, such as casual labor (11), selling baobab (11), buying food (8), making charcoal and selling it (5), asking for support from children (4), engaging in business (3), moving to other areas less affected by drought (*kuhemea*, 2), and selling water (1) or tomatoes (1). Thirteen got baobab from the forest, either for food or business. Other wild foods obtained from the forest were fruits such as **ngwelu** (5), **mtafuta** (2), and **mfulu** (2) (Table 12.5).

Such food insecurity has been reported in previous research along with their coping strategies, including utilization of wild foods, selling livestock, small businesses, and charcoal sales (Tsuruta & Sugiyama, 2018). These results underlined the findings of previous research but also added the importance of collecting baobab for sale as a survival strategy.

12.4.3 Marriage and Family

Among the respondents, 96% had been married. The majority (66%) decided on their marriage partners on their own, but 34% had their marriage decided by their parents. Most of their families received a bridewealth (97%): 63% of them received money, and 69% received livestock. The average amount of the bridewealth in money was TSh220,245, ranging from TSh8,000 to TSh1,000,000. The most frequent numbers of livestock received were 5 and 20 heads of cattle, common to 6 respondents each, and the total number ranged from 1 to 23. Others received 1–20 goats or 1–3 sheep (Table 12.6).

Presently, the majority of respondents were married (67%), but 5% were unmarried, 7% were divorced, 2% were separated, and 19% were widowed. Most of their marriages were monogamous, but two of the husbands had two wives. The majority (70%) lived with their spouse or partner. An average of 4.5 people lived in the same house, but ranging from 1 to 9, and the most common number of people was 4, followed by 5 and 6. Most of the respondents had one child under 5 in the house (28), followed by 2 (13) and up to 4 children (Table 12.4). The majority make decisions within the household together with men and women, especially to decide where to send children when they are sick (66%), followed by the usage of crops (53%) and the usage of income (53%).

12.5 Participation in Groups and Mutual Assistance

To understand the social capital in the village, participation in groups and mutual assistance are explained.

12.5.1 Participation in Groups

The majority were participating in one group (53%), but 39% were not participating; 6% were in two groups, and 1% were in three groups. Many of the names of the groups that respondents participated in included Upendo, Amani, Imani, and Vikoba. Some of the objectives of the groups were savings and borrowing (26%), followed by agriculture (22%), but the majority indicated other objectives (61%). Those who specified other objectives included groups who help each other (13), assist with burial issues (8), and who sing (2).

12.5.2 Mutual Assistance

Respondents were asked whether they received or provided food or money when in need within a given period and their perceptions of whether villagers help each other, so that the mutual assistance situation could be understood. More villagers in Chinangali I village and Dodoma regions received or provided less assistance with food than people in the average situation in the two villages in Lindi region. However, more villages in Dodoma received or provided more assistance with

Table 12.7 Mutual relations in Chinangali I village, Dodoma region in comparison to villages in Lindi region

Question	Chinangali I village, Dodoma	Villages in Lindi region
In the past month, have people outside your family helped you when you needed food?	25%	28%
In the past month, have you helped anyone outside your household who needs food?	33%	40%
In the past month, when you needed cash, did anyone else help you?	31%	27%
In the past month, have you helped anyone outside your family who needs cash?	37%	19%
Do you think the villagers help each other?	81%	74%

Table 12.8 Receiving and providing food/cash assistance and helping each other

Received assistance		Provided assistance		Villagers help each other				
Food	Cash	Food	Cash	Yes	No	Total		
Yes	Yes	Yes	Yes	8	1	9	15	20
		No	Yes	1	0	1		
			No	4	1	5		
	No	Yes	Yes	1		1	5	
			No	1		1		
		No	Yes	1		1		
			No	2		2		
No	Yes	Yes	Yes	5		5	10	47
		No	Yes	5		5		
	No	Yes	Yes	7	0	7	37	
			No	3	1	4		
		No	No	17	9	26		
Total				55	12	67	67	67

money than the other regions and perceived that people help each other in general (Table 12.7).

Cross-tabulation of the various forms of mutual assistance is indicated in Table 12.8. This indicates that, first, there are a small number of villagers (8) who receive and provide food and cash assistance to others and believe that villagers help each other. In contrast, there are more villagers (17) who have not provided or received food or monetary assistance from others but believe that villagers help each other. There are also several villagers (9) in the same situation who believe that villagers do not help each other.

Other analysis indicated that those who provide assistance in the form of food or cash do not necessarily consist of people who are subjectively perceived as "wealthy" or cattle owners, a symbol of wealth in an agro-pastoral society. This was in line with previous studies in other Gogo villages. Nor did we find any situation in which people helped or received help in the form of food or cash by belonging to a group. Rather, we found a situation of mutual help with food and cash among certain people.

12.5.3 Age and Gender Differences in Mutual Assistance

Table 12.9 indicates the age range and mean of the answers to the same question. Although none of the differences were statistically significant, older villagers in comparison to younger respondents tended to perceive that they were not assisted by others with food or money, and they did not assist others with money either. However, more older respondents also tended to believe that villagers helped each other.

However, the results need to be interpreted with some caution. Since the question asks about the past month in the dry season, villagers may not have required additional food or money. The question also asked about help "outside the family." Instead of interpreting "family" as the household, respondents may have interpreted it as including extended family. If they excluded mutual assistance within the

Table 12.9 Age range and mean of perceptions of mutual relations in Chinangali I

			Age				
Question	Answer	*n*	Min.	Max.	Mean		Standard deviation
In the past month, have people outside your family helped you when you needed food?	No	57	20	99	46.18	±	17.57
	Yes	17	22	75	46.29	±	19.03
In the past month, have you helped anyone outside your household who needs food?	No	51	18	99	**46.86**	±	18.07
	Yes	24	22	85	43.63	±	17.90
In the past month, when you needed cash, did anyone else help you?	No	53	18	99	**46.21**	±	17.40
	Yes	22	20	85	44.91	±	19.63
In the past month, have you helped anyone outside your family who needs cash?	No	48	18	99	**47.96**	±	17.63
	Yes	27	20	85	42.04	±	18.23
Do you think the villagers help each other?	No	11	18	82	40.00	±	17.43
	Yes	51	20	99	**47.16**	±	19.10

Table 12.10 Receiving assistance in food by sex

	Helped with food?		
Sex	No	Yes	Total
Men	22	1	23
Women	36	17	53
Total	58	18	76

$p = 0.009$

extended family, it may have omitted the mutual assistance richly intertwined around the extended family,

Among those in mutual relations, the sex of the recipient was statistically significant in receiving assistance with food. As shown in Table 12.10, only one male respondent indicated that he had been helped with food in the past month, whereas there were 17 women. Although this may be partly because food management is in the women's sphere, there may also be a gendered dimension in the Gogo society where men find it more difficult to get help with food than women.

12.6 Frequency of Food Group Intake and Social Status/Relations

In this section, the relationship between social status or relations and food group intake is analyzed. Table 12.11 indicates the correlation between wealth (self-evaluation), livestock (in general and in cattle), participating groups (number, investment, agricultural), and mutual assistance (assisted others in cash/food, villagers help each other, assisted by others in cash/food).

12.6.1 Analysis by Food Group

Table 12.11 is interpreted here by food groups

12.6.1.1 Staple Foods and Vegetables

Staple foods showed no statistically significant relationship with wealth, group, or mutual assistance status. Vegetables also showed no correlation with frequency of intake during the dry season but were negatively correlated with perceptions that villagers help each other during the rainy season. This indicates that staple foods and vegetables are eaten by all villagers regardless of their wealth status and social relations in the rainy season. It is noted that those who believe that villagers do not help each other eat fewer vegetables in the rainy season.

12.6.1.2 Meat, Fish, and Milk

Animal protein, which is obtained mainly through livestock or cash, is closely related to the wealth and ownership of livestock. Meat intake frequency is correlated with subjective wealth rating in both seasons. This indicates that those who subjectively evaluate themselves as "average" (none answered that they were "rich") eat

Table 12.11 Correlation (spearman) between wealth, livestock, participating groups, and mutual assistance

Season	Food group		Wealth	Having livestock	Having cattle	Assist in cash	Participating groups	Investment groups	Assist in food	Villagers help each other	Agricultural group	Assisted in cash	Assisted in food
Dry season	**Staple foods**	Correlation coefficient	0.073	0.066	0.390	0.087	0.001	0.186	0.006	0.010	0.283	−0.099	−0.041
		Sig. (2-tailed)	0.532	0.578	0.080	0.446	0.990	0.222	0.958	0.939	0.059	0.384	0.724
		n	75	74	21	79	75	45	79	66	45	79	78
	Vegetable	Correlation coefficient	0.067	0.046	0.188	0.033	0.039	0.184	−0.029	−0.066	0.146	−0.173	−0.142
		Sig. (2-tailed)	0.563	0.692	0.415	0.771	0.740	0.222	0.796	0.592	0.335	0.123	0.208
		n	77	76	21	81	77	46	81	68	46	81	80
	Meat	Correlation coefficient	**0.502****	**0.266***	0.368	0.146	0.078	0.205	0.009	−0.023	−0.177	0.009	−0.150
		Sig. (2-tailed)	**0.000**	**0.021**	0.101	0.198	0.503	0.177	0.940	0.853	0.245	0.939	0.188
		n	**76**	**75**	21	80	76	45	80	67	45	80	79
	Fish	Correlation coefficient	**0.390****	0.198	−0.381	−0.027	0.013	−0.136	−0.023	0.128	−0.079	−0.112	−0.181
		Sig. (2-tailed)	**0.001**	0.088	0.088	0.812	0.910	0.369	0.842	0.303	0.604	0.325	0.111
		n	**76**	75	21	80	76	46	80	67	46	80	79
	Milk	Correlation coefficient	0.216	0.168	**0.450***	−0.011	0.086	0.110	−0.014	−0.102	0.017	−0.025	−0.100
		Sig. (2-tailed)	0.060	0.148	**0.041**	0.921	0.456	0.469	0.903	0.410	0.909	0.824	0.376
		n	77	76	**21**	81	77	46	81	68	46	81	80

(continued)

Table 12.11 (continued)

Season	Food group		Wealth	Having livestock	Having cattle	Assist in cash	Participating groups	Investment groups	Assist in food	Villagers help each other	Agricultural group	Assisted in cash	Assisted in food
	Pulses	Correlation coefficient	**0.348****	**0.342****	0.295	0.052	0.178	**0.302***	−0.045	0.031	−0.150	−0.154	−0.204
		Sig. (2-tailed)	**0.003**	**0.003**	0.194	0.654	0.134	**0.044**	0.697	0.809	0.326	0.184	0.079
		n	**72**	**72**	21	76	72	**45**	76	64	45	76	75
	Nuts	Correlation coefficient	0.009	−0.207	−0.060	0.059	0.105	−0.087	−0.090	0.079	0.002	0.071	0.111
		Sig. (2-tailed)	0.941	0.077	0.797	0.606	0.371	0.575	0.428	0.530	0.989	0.536	0.329
		n	75	74	21	79	75	44	79	66	44	79	79
	Fruit	Correlation coefficient	**0.270***	0.078	0.165	−0.023	**0.247***	0.272	0.022	−0.072	−0.218	−0.056	−0.195
		Sig. (2-tailed)	**0.019**	0.510	0.475	0.840	**0.033**	0.074	0.845	0.564	0.155	0.625	0.087
		n	**75**	74	21	79	**75**	44	79	66	44	79	78
	Wild foods	Correlation coefficient	0.060	0.174	0.243	−0.146	**0.262***	−0.117	−0.102	**−0.251***	−0.233	−0.171	**−0.248***
		Sig. (2-tailed)	0.606	0.136	0.289	0.195	**0.022**	0.437	0.367	**0.041**	0.119	0.130	**0.028**
		n	76	75	21	80	**76**	46	80	**67**	46	80	**79**
	Baobab	Correlation coefficient	0.041	−0.373	−0.417	0.171	0.005	0.238	**− 0.397***	0.340	−0.348	0.037	0.111
		Sig. (2-tailed)	0.839	0.055	0.410	0.374	0.981	0.374	**0.033**	0.122	0.186	0.847	0.565
		n	27	27	6	29	28	16	**29**	22	16	29	29

	Oil	Correlation coefficient	**0.332****	0.202	0.119	−0.040	0.076	0.048	−0.076	−0.235	−0.267	−0.165	**−0.282***
		Sig. (2-tailed)	**0.003**	0.083	0.609	0.722	0.513	0.751	0.503	0.055	0.073	0.143	**0.012**
		n	**76**	75	21	80	76	46	80	67	46	80	**79**
	Salt	Correlation coefficient	**0.360****	**0.270***	0.386	−0.217	0.094	0.104	−0.171	−0.156	0.083	**−0.316****	**−0.353****
		Sig. (2-tailed)	**0.001**	**0.018**	0.084	0.052	0.417	0.491	0.127	0.203	0.583	**0.004**	**0.001**
		n	**77**	**76**	21	81	77	46	81	68	46	**81**	**80**
	Sugar	Correlation coefficient	**0.403****	**0.287***	0.007	−0.143	0.169	0.041	−0.047	0.154	−0.229	−0.197	−0.148
		Sig. (2-tailed)	**0.000**	**0.012**	0.975	0.202	0.141	0.786	0.677	0.210	0.126	0.078	0.190
		n	**77**	**76**	21	81	77	46	81	68	46	81	80
Rainy season	**Staple foods**	Correlation coefficient	−0.078	0.001	0.010	−0.140	−0.117	0.068	−0.193	−0.040	−0.049	−0.137	−0.094
		Sig. (2-tailed)	0.504	0.995	0.965	0.215	0.314	0.652	0.086	0.750	0.745	0.226	0.410
		n	76	75	21	80	76	46	80	67	46	80	79
	Vegetable	Correlation coefficient	−0.169	0.024	−0.259	−0.022	−0.092	0.195	−0.078	**−0.275***	−0.165	−0.148	−0.018
		Sig. (2-tailed)	0.144	0.841	0.256	0.848	0.428	0.194	0.489	**0.024**	0.272	0.190	0.876
		n	76	75	21	80	76	46	80	**67**	46	80	79
	Meat	Correlation coefficient	**0.524****	0.176	0.190	−0.118	−0.100	0.148	−0.162	−0.056	−0.143	**−0.333****	**−0.332****
		Sig. (2-tailed)	**0.000**	0.132	0.409	0.299	0.390	0.325	0.151	0.654	0.345	**0.003**	**0.003**
		n	**76**	75	21	80	76	46	80	67	46	**80**	**79**

(continued)

Table 12.11 (continued)

Season	Food group		Wealth	Having livestock	Having cattle	Assist in cash	Participating groups	Investment groups	Assist in food	Villagers help each other	Agricultural group	Assisted in cash	Assisted in food
	Fish	Correlation coefficient	**0.459****	**0.266***	−0.119	–**0.254***	−0.088	−0.046	−0.171	−0.043	−0.112	–**0.292****	–**0.417****
		Sig. (2-tailed)	**0.000**	**0.022**	0.608	**0.024**	0.452	0.763	0.131	0.734	0.465	**0.009**	**0.000**
		n	**75**	**74**	21	**79**	75	45	79	66	45	**79**	**78**
	Milk	Correlation coefficient	**0.279***	0.071	**0.490***	−0.021	0.029	0.132	0.028	−0.067	0.175	−0.069	−0.070
		Sig. (2-tailed)	**0.018**	0.554	**0.028**	0.859	0.812	0.400	0.812	0.601	0.260	0.551	0.551
		n	**72**	71	**20**	76	72	43	76	63	43	76	75
	Pulses	Correlation coefficient	0.002	0.047	0.273	**0.242***	0.222	**0.318***	0.064	−0.055	−0.036	0.046	0.040
		Sig. (2-tailed)	0.984	0.690	0.244	**0.033**	0.057	**0.035**	0.578	0.666	0.815	0.692	0.731
		n	74	73	20	**78**	74	**44**	78	65	44	78	77
	Nuts	Correlation coefficient	–**0.359****	−0.154	0.010	0.060	0.050	−0.004	−0.070	−0.029	0.223	0.141	**0.258***
		Sig. (2-tailed)	**0.002**	0.200	0.965	0.609	0.673	0.979	0.548	0.818	0.142	0.224	**0.025**
		n	**72**	71	21	76	73	45	76	64	45	76	**75**
	Fruit	Correlation coefficient	0.146	0.101	0.182	0.080	**0.321****	0.019	0.043	0.105	−0.090	0.106	0.095
		Sig. (2-tailed)	0.234	0.413	0.456	0.502	**0.008**	0.905	0.721	0.430	0.576	0.378	0.428
		n	68	68	19	72	**68**	41	72	59	41	72	71

	Wild foods	Correlation coefficient	0.060	0.060	**0.498***	0.037	0.128	−0.205	0.146	−0.038	−0.158	0.013	−0.047
		Sig. (2-tailed)	0.620	0.619	**0.025**	0.753	0.289	0.181	0.212	0.762	0.306	0.912	0.693
		n	71	71	**20**	75	71	44	75	65	44	75	74
		Correlation coefficient	0.333	−0.356	−0.324	−0.163	−0.408	−0.123	0.056	0.255	−0.181	−0.109	−0.122
	Baobab	Sig. (2-tailed)	0.129	0.095	0.394	0.446	0.060	0.690	0.795	0.265	0.554	0.613	0.571
		n	22	23	9	24	22	13	24	21	13	24	24
	Oil	Correlation coefficient	**0.252***	0.205	0.214	0.020	0.133	0.249	−0.057	−0.171	**−0.403****	−0.108	−0.148
		Sig. (2-tailed)	**0.029**	0.080	0.353	0.861	0.256	0.099	0.616	0.169	**0.006**	0.343	0.197
		n	**75**	74	21	79	75	45	79	66	**45**	79	78
	Salt	Correlation coefficient	0.188	**0.325****	0.020	−0.085	−0.030	0.271	−0.052	−0.147	−0.165	**−0.260***	−0.055
		Sig. (2-tailed)	0.108	**0.005**	0.930	0.460	0.798	0.072	0.654	0.238	0.278	**0.022**	0.632
		n	74	**73**	21	78	74	45	78	66	45	**78**	77
	Sugar	Correlation coefficient	**0.514****	0.150	−0.057	−0.047	0.075	−0.049	−0.063	0.113	−0.221	−0.187	−0.177
		Sig. (2-tailed)	**0.000**	0.198	0.807	0.679	0.517	0.748	0.576	0.361	0.139	0.097	0.120
		n	**76**	75	21	80	76	46	80	67	46	80	79

**Bold indicates a correlation coefficient significant at the 1% level (two-sided)
*Bold indicates a correlation coefficient significant at the 5% level (two-sided)

more meat, whereas those who subjectively evaluate themselves as "poor" eat less. Meat intake is also positively correlated with livestock availability in the dry season. That is, those who own livestock eat meat more frequently in the dry season. In the rainy season, it is negatively correlated with receiving cash assistance and food help. Villagers who have received assistance in cash or food tend to eat less meat in the rainy season, which is the lean season.

The frequency of fish consumption was also correlated with subjective wealth ratings in both seasons. The "average" people ate more fish, whereas "poor" people ate less fish. As seen with meat, the frequency of intake in the rainy season is negatively correlated with being helped with cash and food. That is, villages that received assistance in cash or food ate less fish in the rainy season. Fish consumption frequency was negatively correlated with being helped with cash. Those who assisted others in cash also ate less fish.

The frequency of milk consumption is positively correlated with the number of cattle in both seasons. It is also positively correlated with subjective wealth ratings during the rainy season. Those who owned cattle and wealth had more access to milk.

12.6.1.3 Pulses

In the dry season, pulse intake frequency is positively correlated with subjective wealth rating and livestock availability and is also positively correlated with belonging to a savings group. "Average" villagers with livestock belonging to an investment group tended to eat more pulses, whereas "poor" villagers without livestock not belonging to investment groups tended to eat fewer pulses. In the rainy season, frequency of intake is positively correlated with belonging to a savings group and helping with cash. That is, villagers who helped others with cash while belonging to a savings group ate more pulses than those who did not.

12.6.1.4 Nuts

There is no statistically significant relationship during the dry season. During the rainy season, the frequency of rainy season intake is negatively correlated with subjective wealth rating and positively correlated with being able to help with food.

Peanuts and sunflowers[3] are the main commodities in this area. Peanuts are used to make vegetable dishes, and it is common to see villagers eating them as snacks. It may be the case that those who consider themselves "poor" and receive food assistance have a higher frequency of eating peanuts.

[3] Sunflower is used to make oil and a commodity for sale, so the case may be different from peanuts.

12.6.1.5 Wild Foods

Intake of wild foods is not strongly correlated but has a moderate relationship with the factors below. In the dry season, wild food intake is positively correlated with the number of groups that one participates in and negatively correlated with the perception that "villagers help each other" and being helped with food. That is, villagers who participate in many groups eat more wild foods, whereas those who believe that villagers help each other or who are helped with food utilize wild foods less.

Baobab intake frequency is negatively correlated with helping others with food in the dry season. In other words, those who donate food eat baobab less frequently.

During the rainy season, the number of cattle owned is correlated with the frequency of wild food intake. Cattle owners have more opportunities to gather and eat wild foods while they graze their cattle, especially in the rainy season.

12.6.1.6 Oil, Salt, and Sugar

During the dry season, frequent intake of oil, salt, and sugar is positively correlated with wealth rating. Those who consider themselves "poor" take less oil, salt, and sugar. Those who are helped with cash and food also take less salt. Having livestock is also positively correlated with the intake of salt and sugar.

During the rainy season, the intake of oil is negatively correlated with participation in agricultural groups. Those who participate in agricultural groups have less oil intake.

Salt intake is positively correlated with having livestock and negatively correlated with being assisted in cash. Those who have livestock tend to eat more salt, whereas those who are assisted in cash tend to eat less.

Intake of sugar is positively correlated with wealth rating. "Poor" villagers tend to consume less sugar.

12.6.2 Analysis by Social Status and Relations

Table 12.11 is analyzed here to understand the tendencies in food intake by social status and social relations.

12.6.2.1 Subjective Wealth Evaluation

Subjective wealth evaluation has the strongest relationship with food group intake. Meat, fish, and sugar have a strong positive correlation with wealth in both seasons, indicating that the "poor" eat less of these food items. Pulses, oil, and sugar also have a strong positive correlation in the dry season, with the "poor" eating less of them. In the rainy season, the "poor" eat more seeds and consume less oil and milk.

Wealth influences the intake of proteins, oil, salt, and sugar. It could also be the case that the villagers evaluate their status based on what they can access and eat. The "poor" are at risk of lacking animal proteins but have less risk of lifestyle disease caused by excess intake of sugar, oil, and salt.

12.6.2.2 Having Livestock

Having livestock has a strong positive correlation with eating pulses in the dry season and salt intake in the rainy season. A moderate positive correlation is seen in having livestock and meat intake in the dry season and fish intake in the rainy season. A moderate positive correlation is also seen between cattle ownership and milk intake in both seasons and wild foods in the rainy season.

Owning cattle provides direct access to milk, and grazing probably provides an opportunity to forage wild foods. Owning some kind of livestock may provide direct access to meat and access to cash to buy pulses in the dry season and fish and salt in the rainy season.

12.6.2.3 Participation Groups

The strongest negative correlation was seen in participation in the agricultural group and oil intake. Since oil intake correlates to wealth, it may be the case that relatively "poor" villagers are more likely to participate in an agricultural group.

The strongest positive correlation was seen in the number of groups participated in and the intake of fruit in the rainy season. A moderate correlation was also observed between fruit and wild foods in the dry season. Those who participate in many groups tend to eat fruit, including those from the wild, more frequently.

A moderate positive correlation was observed between participation in investment groups and pulse intake in both seasons. Participation in investment groups may either increase their income to purchase pulses or promote the production of pulses.

12.6.2.4 Mutual Relations

The strongest negative correlations in the rainy season were seen between receiving cash or food assistance with the intake of meat and fish. Those who are assisted in cash or food seem to eat less meat and fish. They most likely overlap with those who evaluate themselves as "poor." In the dry season, salt intake was most strongly negatively correlated with receiving cash and food assistance.

All other relationships were also negative. Those who assisted others in cash had a negative correlation with fish intake in the rainy season. Those who assisted others with food had a negative correlation with baobab intake in the dry season. Those who believed that villagers helped each other had a negative correlation with wild food intake in the dry season and vegetable intake in the rainy season. Those who were assisted in cash had a negative correlation with salt intake. Those who were helped with food had a negative correlation with oil and wild food intake. While it is difficult to interpret each respective case, it can broadly be indicated that those who receive assistance have a relatively low intake of food groups, and the mutual relationship with assistance is not to the extent that it increases the food intake frequency. Furthermore, the mutual relations indicated through these questions do not seem to facilitate the utilization of wild foods.

12.7 Conclusion

12.7.1 Summary

First, the questionnaire survey results underlined the situation reported in previous research on high child mortality and insufficient/fluctuating food crop availability, confirmed in the neighboring village (Sakamoto, 2020). However, present conditions of malnutrition were not as visible as the regional average would suggest (TFNC, 2014).

Second, the survey indicated how people coped with the fluctuation of harvest foods between seasons. Villagers ate foraged foods, sold livestock, performed manual work, and sold charcoal, as suggested in earlier research (Tsuruta & Sugiyama, 2018), as well as selling baobabs, as revealed in this study. Food sharing was not a common phenomenon different from the case of "path of food" among the Bemba of Zambia (Sugiyama 2007).

Third, food intake also differed among seasons. During the rainy season, residents consumed more pulses, milk, seeds, fruit, and wild foods while eating less meat, fish, and baobab. There were also individual differences in nut intake, which were generally biased toward salt but less sugar. These clear characteristics, along with the various results gained from this research, were analyzed to see their influences on people's nutrition and health situation.

12.7.2 Wealth, Mutual Relations, and the "Traditional Inland" Food Pattern

The findings and analysis showed that livestock and cow owners, as well as "ordinary" (non-"poor") villagers, more frequently consumed protein sources such as meat, fish, and milk as well as purchased goods such as oil, salt, and sugar. This agrees with previous research on Gogo households in a neighboring village (Kuroda, 2016). This provided protein to those who have livestock, but it also increased the risk of diseases linked to a sedentary lifestyle.

People who used salt less frequently were more likely to receive financial and nutritional assistance. Some people, although only approximately 30% of the total population, shared food and cash. Support is not necessarily given unilaterally from those who have wealth and cattle to those who do not.

However, there was little disparity in the frequency of staple food and vegetable intake, regardless of the economic position in society. The frequency of consumption of vegetables and staple foods did not significantly differ between "average" (non-"poor") and "poor" people. This is probably the reason why "poor" people have a good evaluation of their health, and "average" people may have more access to unhealthy food. The results confirmed that semiarid Gogo agro-pastoral peoples generally followed a healthy consumption pattern of staple foods and leafy vegetables. This fundamental pattern of consumption was supported by the utilization of edible weeds, which are consumed by both the rich and the poor, are not owned, and are always shared regardless of where they grow, including in agricultural fields. This is consistent with the healthy "traditional-inland" consumption pattern with a high frequency of staple foods and vegetable intake suggested in earlier work (Keding et al., 2011). Getting enough protein remained a challenge, but the strength of this dietary pattern needs to be acknowledged and will be further discussed in Chap. 13.

Acknowledgment First, I would like to thank the villagers of Chinangali I village for answering the questionnaires. For the interviews in Chinangali I village, Ms. Sechelela Mwaluko, Mr. John Barua, Mr. Arthor Mwaluko, Ms. Happy Madinya, Ms. Fautina Yohana, Mr. Saimoni Mungo, Dr. Onesmo Mella, Ms. Ayusa Okui, Ms. Stancey Chinyau, Ms. Miyuki Sugi, and Ms. Nobuko Tsubaki were interviewers under the supervision of Dr. Mella. Village Executive Officer (VEO) Mr. Peter M. Chiyanga and Mr. Casmir Gundo Nzullunge coordinated the interviewers and the research in the village, and other villagers also assisted in guiding interviewers to the interviewees within each hamlet.

I would also like to thank Dr. Anita Wagner and Dr. Barbara Gande for sharing the Swahili version of their SF-36. Appreciation goes to Dr. Onesmo Mella for checking and providing advice on the original Swahili questionnaire and Dr. Joyceline Kaganda for providing advice on the food categories at the initial stage.

Thanks to Ms. Yuki Fujiya, Ms. Mai Kikuchi, and Ms. Naho Arai for digitizing the questionnaire results, Ms. Hong Anh and Mr. Stanislaus Acquah for digitizing and checking the digitized work, and Mr. Kotaro Morishima for checking the digitized work. With thanks to those who were involved, the authors have double-checked and corrected their work, and the authors are fully responsible for the final compilation and reporting.

Appreciation is also given to Ms. Risa Otsubo for checking the Japanese-English Deep-L translation of a related manuscript, Mr. Andrew Charles Frimpong for editing the English version and secretarial support, and Mr. Polgahagedara Don Pubudu Sanjeewa for secretarial support.

Among the authors, Sakamoto and Ohmori are responsible for formulating the questionnaire. Sakamoto, Tsuda, and Mbago were present during the interviews in the village: Sakamoto was one of the interviewers, Tsuda collected GPS for all the hamlets for the map and collected available edible plants with Mbago, and Ohmori advised on issues related to nutrition and food intake. Sakamoto is responsible for supervising the interviews, inputting/checking data, the first and final draft of the preliminary report (Sakamoto et al., 2020) and the chapter manuscript. Ohmori is responsible for advising on input and evaluating the responses on health and food intake and calculating the SF-12. Mbago is responsible for plant identification. Tsuda is responsible for formulating the map and reviewing the local names of the edible wild foods. Mr. Parinya Khemmarath implemented the digitization, double checking, compiling, and coordination of the digitization, checking process, checking data, and providing secretarial support for Sakamoto et al. (2020). Kaale and Kato have reviewed the manuscript and edited it accordingly. All authors have reviewed the manuscript and approved it.

The research is supported by the Japanese Government, JSPS Grants-in-Aid for Scientific Research (KAKENHI): mainly "Possibilities of wild edible plants and traditional meals in East Africa (18H03438)," partly supported by 25284171 and 15H05139; and the Research assistance system of the Office for the Promotion of Gender Equality, Utsunomiya University.

References

Cochrane, N., & D'Souza, A. (2015). Measuring access to food in Tanzania: A food basket approach. In *Economic information bulletin 135*. United States Department of Agriculture. Retrieved from https://www.ers.usda.gov/webdocs/publications/43932/51864_eib135.pdf?v=42053

Grootaert, G., Narayan, D., Nyhan, J. V., Woolcock, M. (2004). *Measuring social capital: An integrated questionnaire*. World Bank Working Paper, No. 18. World Bank. Retrieved February 23, 2023, from https://openknowledge.worldbank.org/handle/10986/15033. License: CC BY 3.0 IGO.

Kato, F. (2011). Leafy vegetable production and consumption in south central Tanzania. *Research for Tropical Agriculture, 4*(2), 83–89.

Keding, G. (2016). Nutrition transition in rural Tanzania and Kenya. In H.K. Biesalski, & R.E. black (Eds.), *Hidden hunger. Malnutrition and the first 1,000 days of life: Causes, consequences, and solutions*. Nutrition transition and nutritional deficiencies in low-income countries, Basel, Karger, *World Rev Nutr Diet*, 115, 61–74. https://doi.org/10.1159/000442073.

Keding, G. B., Msuya, J. M., Maass, B. L., & Krawinkel, M. B. (2011). Dietary patterns and nutritional health of women: The nutrition transition in rural Tanzania. *Food and Nutrition Bulletin, 32*(3), 218–226. https://doi.org/10.1177/156482651103200306

Kinabo, J., Mamiro, P., Dawkins, N., Bundala, N., Mwanri, A., Majili, Z., Jumbe, T., Kulwa, K., Mamiro, D., Amuri, N., Ngowi, M., & Msuya, J. (2016). Food intake and dietary diversity of farming households in Morogoro region, Tanzania. *African Journal of Food, Agriculture, Nutrition and Development, 76*, 16045. Retrieved from http://www.suaire.sua.ac.tz/bitstream/handle/123456789/3382/Food%20intake%20and%20DDS.pdf?sequence=1&isAllowed=y

Kuroda, M. (2016). The dietary patterns and livelihood strategies of rural households in semi-arid Tanzania: Some findings from household diary survey in Majeleko, Dodoma region. In S. Maghimb, K. Sugimura, & D. G. Mwafupe (Eds.), *Endogenous development, moral economy, and globalization in agro-pastoral communities in central Tanzania*. University of Dar es Salaam Press.

Lukmanji, Z., Hertzmark, E., Mlingi, N., Assey, V., Ndossi, G., & Fawzi, W. (2008). *Tanzania food composition tables. Muhimbili University of Health and Allied Sciences, Tanzania Food and Nutrition Centre*. & Harvard School of Public Health. Retrieved October 30, 2022, from https://cdn1.sph.harvard.edu/wp-content/uploads/sites/30/2012/10/tanzania-food-compositiontables.pdf

Madzorera, I., Blakstad, M. M., Bellows, A. L., Canavan, C. R., Mosha, D., Bromage, S., Noor, R. A., Webb, P., Ghosh, S., Kinabo, J., Masanja, H., & Fawzi, W. W. (2020). Food crop diversity, women's income-earning activities, and distance to markets in relation to maternal dietary quality in Tanzania. *The Journal of Nutrition, Community, and International Nutrition, 151*, 186–196. https://doi.org/10.1093/jn/nxaa329

Mizoguchi, K., Yukari, T., & Miyuki, A. (2004). Relationship between a positive perception toward work and the dietary habits of young male workers. *The Japanese Journal of Nutrition and Dietetics, 62*(5), 269–283. Retrieved from https://www.jstage.jst.go.jp/article/eiyogakuzashi1941/62/5/62_5_269/_article/-char/en

Narayan, D., Raj, P., Kai, S., Rademacher, A., & Koch-Schulte, S. (2000). *Voices of the poor: Can anyone hear us?* World Bank Group. Retrieved from http://documents.worldbank.org/curated/en/131441468779067441/Voices-of-the-poor-can-anyone-hear-us

Sakamoto, K. (2007). Mutual assistance and gender under the influence of cash economy in Africa: Case study from rural southeast Tanzania. *Journal of the Faculty of International Studies, Utsunomiya University, 23*, 33–54. Retrieved from http://hdl.handle.net/10241/6481

Sakamoto, K. (2008). Mutual assistance and gender under the influence of cash economy in Africa, part 2: Case study from inland rural southeast Tanzania. *Journal of the Faculty of International Studies, Utsunomiya University, 25*, 25–43. Retrieved from http://hdl.handle.net/10241/2228

Sakamoto, K. (2015a). Situation of women and children in central Tanzania: Preliminary report from a questionnaire interview in Majeleko village, Dodoma. *Journal of the Faculty of International Studies, Utsunomiya University, 39*, 133–150. Retrieved from http://hdl.handle.net/10241/9613

Sakamoto, K. (2015b). Situation of women and children in southeast Tanzania: Preliminary report from a questionnaire interview in Mchinga II village, Lindi. *Journal of the Faculty of International Studies, Utsunomiya University, 39*, 151–170. Retrieved from http://hdl.handle.net/10241/9614

Sakamoto, K. (2017). Does mutual assistance contribute to child survival? Comparative analysis of influencing factors on child mortality in 3 areas of Tanzania. *Journal of African Studies, 92*, 1–17.

Sakamoto, K. (2020). *Factors influencing child survival in Tanzania: Comparative analysis of diverse deprived rural villages*. Springer.

Sakamoto, K., Ohmori, R., & Tsuda, K. (2020). Health, livelihoods, and food intake of children and adults in central Tanzania: From questionnaire interviews in Chinangali I village, Chamwino district, Dodoma region. *Regional Design Utsunomiya University, 7*, 43–63. Retrieved from http://hdl.handle.net/10241/00012127

Sakamoto, K., Ohmori, R., & Tsuda, K. (2021). Correlation between intake of wild food and health in 4 areas of Tanzania: Analysis from semi-arid central and inland/coastal southeast. *International Development, 30*(2), 93–112.

Sakamoto, K., Kaale, L., & Ohmori, R. (2022). Nutrient content of seven African wild leafy vegetables in semi-arid Tanzania. *Journal of International Development Studies, 54*, 17–28.

Schönfeldt, H. C., & Pretorius, B. (2011). The nutrient content of five traditional South African dark green leafy vegetables: A preliminary study. *Journal of Food Composition and Analysis, 24*(8), 1141–1146. https://doi.org/10.1016/j.jfca.2011.04.004

Stuetz, W., Gowele, V., Kinabo, J., Bundala, N., Mbwana, H., Rybak, C., Eleraky, L., Lambert, C., & Biesalski, H. K. (2019). Consumption of dark green leafy vegetables predicts vitamin A and iron intake and status among female small-scale farmers in Tanzania. *Nutrients, 11*, 1025. https://doi.org/10.3390/nu11051025

Sugiyama, Y. (2007). The path of money', 'the path of food', and 'the path of respect. In K. Naoki (Ed.), *Money and resources*. Kobundo.

Tanzania, the United Republic of. (2015). *Mortality and health*. National Bureau of Statistics, Ministry of Finance and Office of Chief Government Statistician, Ministry of State, President Office, State House and Good Governance 33. Retrieved March 27, 2016, from https://www.nbs.go.tz/nbs/takwimu/census2012/Mortality_and_Health_Monograph.pdf

Tanzania, Government of the United Republic of, University of Dodoma, development partners & UNICEF. (2018). *Tanzania national nutrition survey using SMART methodology (TNNS) 2018*. MoHCDGEC, MoH, TFNC, NBS, OCGS, UNICEF. Retrieved September 17, 2016, from https://www.unicef.org/tanzania/reports/tanzania-national-nutrition-survey-2018

TFNC (Tanzania Food and Nutrition Center). (2014). *Tanzania national nutrition survey 2014*. The United Republic of Tanzania, Ministry of Health and Social Welfare. Retrieved October 1, 2016, from https://www.lishe.org/tanzania-national-nutrition-survey-2014-final-report/

Tsunoda, N., Inayama, T., Hata, K., & Oka, J. (2015). Vegetable dishes, dairy products and fruits are key items mediating adequate dietary intake for Japanese adults with spinal cord injury. *Spinal Cord, 53*, 78–790.

Tsuruta, T., & Sugiyama, Y. (2018). Coping with *njaa* (food shortage): Food insecurity and household strategies among agro-pastoralists in central Tanzania. *Memoirs of the Faculty Agriculture of Kindai University, 51*, 11–12.

Uusiku, N. P., Oelofse, A., Duodu, K. G., Bester, M. J., & Faber, M. (2010). Nutritional value of leafy vegetables of Sub-Saharan Africa and their potential contribution to human health: A review. *Journal of Food Composition and Analysis, 23*(6), 499–509.

van Jaasveld, P., Faber, M., Heerden, L. V., Wenhold, F., Rensburg, W. J. B., & Averbekee, W. V. (2014). Nutrient content of eight African leafy vegetables and their potential contribution to dietary reference intakes. *Journal of Food Composition and Analysis, 33*(1), 77–84. https://doi.org/10.1016/j.jfca.2013.11.003

Wyss, K., Wagner, A. K., Whiting, D., Mtasiwa, D. M., Tanner, M., Gandek, B., & Kilima, P. M. (1999). Validation of the Kiswahili version of the SF-36 health survey in a representative sample of an urban population in Tanzania. *Quality of Life Research, 8*(1–2), 111–120. https://doi.org/10.1023/A:1026431727374

Yamane, Y., Kularatne, J., & Ito, K. (2018). Agricultural production and food consumption of mountain farmers in Tanzania: A case study of Kiboguwa village in Uluguru mountains. *Agric & Food Security, 7*, 54. https://doi.org/10.1186/s40066-018-0207-z

Yatsuka, H. (2012). *Changes in natural resource use and social relationships among the Sandawe in Tanzania: Implications with regard to the modernization of hunter-gatherer societies*. Kyoto University African Study Series 011

Chapter 13
Nutrition Potential of African Wild Leafy Vegetables: Evidence from Semiarid Central Tanzania

Lilian Daniel Kaale, Kumiko Sakamoto, and Reiko Ohmori

Abstract African wild leafy vegetables (AWLVs) are receiving more attention concerning the potential health advantages of consuming vegetables. The proximate composition, mineral, and vitamin contents of seven AWLVs consumed locally by rural populations of the semiarid Dodoma region in Tanzania were determined. AWLVs showed significant amounts of iron, calcium, and protein as well as a moderate amount of β-carotene and vitamin C. Raw *Cleome hirta* had higher iron and calcium levels (26.7 and 1153.6 vs. 44.8 mg/100 g and 2104.1 mg/100 g, respectively) than raw *Cleome gynandra* (Cg-RL). High calcium contents were also revealed in both raw *Ceratotheca sesamoides* (Cs-RL, 1059.5 mg/100 g) and dried with *Cucumis dipsaceus* (Cs&Cd-DL, 2794.5 mg/100 g). Raw *Ipomoea obscura* had a high iron concentration (55.2 mg/100 g), which was 100 times greater than that in cultivated sweet potato leaves. Iron was also present in significant amounts in the raw *Ipomoea sinensis* subsp. *blepharosepala* (Isb-RL) and Cs-RL (41.5 mg/100 g and 39.9 mg/100 g, respectively). The protein content in Cg-RL was 12.3 g/100 g. Cs&Cd-DL and Cg-RL exhibited the highest β-carotene and vitamin C contents (17,489.1 μg and 13.5 g/100 g, respectively). AWLVs are recommended for managing protein, mineral, and vitamin deficiencies, which are endemic to inhabitants of the Dodoma region and other African countries.

Keywords Leafy · Tanzania · Semiarid · Proximate composition · Micronutrients

L. D. Kaale (✉)
Department of Food Science and Technology, University of Dar es Salaam, Dar es Salaam, Tanzania
e-mail: elykaale@gmail.com; dlilian@udsm.ac.tz

K. Sakamoto
School of International Studies, Utsunomiya University, Utsunomiya, Japan
e-mail: ksaka@cc.utsunomiya-u.ac.jp

R. Ohmori
School of Regional Design, Utsunomiya University, Utsunomiya, Japan
e-mail: rohmori@cc.utsunomiya-u.ac.jp

K. Sakamoto et al. (eds.), *Changing Dietary Patterns, Indigenous Foods, and Wild Foods*, https://doi.org/10.1007/978-981-99-3370-9_13

13.1 Introduction

The previous chapters (Chaps. 6, 10, and 12) provided evidence that frequent consumption of wild foods during the rainy season in the semiarid area, especially by the "poor," can be a contributing factor to their health. This is in line with the overall objective of the book to understand the changing dietary patterns, indigenous foods, and wild foods. The analysis in this chapter focuses on wild leafy vegetables, which can be seen as contributing wild foods during the rainy season.

Some studies have researched the nutritional value of African wild leafy vegetables (AWLVs) from other nations or areas. Nutrients from the same species may differ depending on the geographical and meteorological circumstances of a certain place (Maseko et al., 2018). For example, the study by Msuya et al. (2009) asserts that several species of bitter lettuce (*Launaea cornuta*) and cat's whiskers (*Cleome gynandra*, Cg) in Kongwa district, Dodoma area, have higher iron and β-carotene levels than those in Tanga and Arusha regions. Furthermore, it is thought that the use of AWLVs is declining on a global scale. This chapter has therefore focused on the significance of consuming AWLVs and examined their nutritional qualities. The collective of leafy vegetables that typically grow wild will be referred to as AWLV in this chapter. These vegetables are grown more organically, with little or no use of pesticides, and are low in calories, nutrient-rich, and fiber-rich to support health and well-being. Seven AWLVs consumed locally by rural inhabitants in the semiarid Dodoma region of Tanzania were examined for their proximate composition and mineral and vitamin levels.

13.2 African Wild Leafy Vegetables Use and Knowledge in Africa

AWLVs are naturally growing plants that can be consumed as food. Traditional vegetables have traditionally been used as dietary supplements and medicine by African ethnic groups (Ntuli, 2019). AWLVs have the potential to significantly contribute to both food security and human health given that they provide sufficient levels of nutrients, vitamins, and minerals. In addition, AWLVs diversify diets, making them more enticing and healthier. It is therefore a methodological shortcoming that diet surveys frequently overlook wild species in favor of cultivated ones. In many ethnic groups' knowledge systems, wild vegetables form a distinctive cultural realm (Powell et al., 2014).

Although other African nations have acknowledged the role of wild leafy vegetables in ensuring food security, Tanzanians seldom use them, especially in cities. The main reasons are poverty and lack of knowledge of adequate feeding practices. However, it is interesting to note that rural areas (e.g., the semiarid Dodoma region of Tanzania) continue to retain their traditional knowledge of wild crops. By replacing edible native species, modern agricultural methods have exacerbated "hidden hunger" (micronutrient deficiency), even though they have been successful in supplying calories (Modi et al., 2006). The World Health Organization (WHO) has suggested a daily intake of more than 400 g of vegetables and fruit per person to regulate or lessen the hidden hunger challenge. However, due to the high cost of vegetables and fruits, it has been particularly difficult, especially for low-income urban residents, to afford the recommended amount. On the other hand, these AWLVs are readily available to people in rural areas at no cost; they can be picked up from private gardens, abandoned lots, or the wild (Faber et al., 2010). African wild vegetables also allow for a more varied diet, serve as a source of appropriate macro- and micronutrients, and lower disease vulnerability (Kissanga et al., 2021). In terms of sustainability and viability, these plants can be particularly resilient to environmental changes and provide residents with an alternative during periods of drought or food scarcity.

13.3 Current Status of Consuming Wild Leafy Vegetables in Africa

The population of Africa was 1.38 billion in 2021, and by 2030, it is anticipated that it will reach 1.71 billion (Mohajan, 2022). In addition, food insecurity and malnutrition are the leading causes of death and morbidity in Africa. In Africa, 9.3 million children under the age of 5 were overweight in 2019 (Mohajan, 2022). Worldwide, being overweight affects more than seven out of ten children. On the other hand, one of the main problems in developing nations continues to be undernutrition. For example, in Tanzania, the prevalence of undernourishment, severe food insecurity, and stunted growth of children under the age of 5 years was 25.0%, 23.8%, and 31.8%, respectively, in 2019. In the meantime, Sustainable Development Goals (SDGs) 2 and 3 state that by 2030, the world hopes to eradicate hunger, achieve food security, improve nutrition, ensure healthy lives, and advance well-being for people of all ages. Therefore, the production of food must be expanded to address these challenges. Insufficient intake of fruits and vegetables, according to research, affects 44% of children worldwide (UNICEF, 2019), which results in nutrient deficiencies. Furthermore, this deficiency with maternal undernutrition is included as one of the top ten risk factors contributing to mortality (Ezzati et al., 2002). This circumstance emphasizes the significance of utilizing free or inexpensive local resources to acquire a healthy diet. Attention to AWLVs (Smith & Eyzaguirre, 2007) and studies on their nutritious content have raised their significance in this setting (Uusiku et al., 2010). AWLVs can help close dietary gaps by providing wholesome, inexpensive, nutrient-dense alternatives. Some AWLVs are rich in elements that are necessary for maintaining health and fighting off infections, including vitamins, minerals, antioxidants, and even anticancer agents (Maseko et al., 2018).

It is interesting to note that Tanzanians have begun to pay attention to local uses of edible plants, and some nutrients in locally grown wild vegetables have also been investigated. The Dodoma region is part of a semiarid area of central Tanzania where frequent food insufficiencies occur in rural areas. However, because of the consumption of AWLVs, this region has malnutrition rates that are comparable to those of the entire country. For example, stunted growth of children under the age of 5 years is observed in 37.2% of children compared with the national average of 31.8%, and 17.8% of children are underweight compared with the national average of 14.6%. Furthermore, only 24.0% of women in Dodoma have anemia compared with the national average of 28.8% (Tanzania, 2019). Other studies have also reported that women in Dodoma have relatively low anemia due to their intake of green leafy vegetables (Keding et al., 2011; Stuetz et al., 2019). In the Chinangali I village of Chamwino district, Dodoma region, food sufficiency occurs during the rainy seasons, in which the frequency of wild food consumption increases and the main wild foods consumed are leafy vegetables.

Understanding the nutritional impacts of these alternative food items could partly influence achieving the SDG goals, such as reducing poverty, hunger, and diseases. The chance of attaining these goals can be magnified when the nutritional qualities of locally available edible vegetables are expressed. Therefore, in this chapter, the proximate minerals (iron, sodium, calcium) and vitamins (ascorbic and β-carotene) of seven AWLVs in semiarid Tanzania are presented.

13.4 Materials and Methods

13.4.1 Sample Description and Selection

This study used samples of seven AWLVs grown in the farms of Chinangali I village. The vegetables found on the farms have different names and potentials for society. Among the vegetables, raw Cg (Cg-RL) called ***mgagani*** in Swahili and **mzimwe** in the native language (Gogo), raw *Ceratotheca sesamoides* (Cs-RL) called **ilende/mgulu** (Gogo), and *Cucumis dipsaceus* (Cd-RL) called **ilumbu/hulihuli** (Gogo) were widely distributed.[1] They are either jointly or separately processed when fresh or dried to form a sticky relish known as *mlenda* (Swahili). Raw *Cleome hirta* (Ch-RL), called **muhilile** (Gogo), has similar uses as Cg-RL; however, it has received little attention in previous research (Msuya et al., 2009).

There were three types of wild sweet potato leaves (***matembele pori*** in Swahili). Raw *Ipomoea obscura* or *Ipomoea mombassana* (Io-RL) called **chapali** (Gogo) when crushed and then dried together (Io-CD), or **sagula sagula** when dried separately (Io-DL). Raw *Ipomoea sinensis* subsp. *blepharosepala* (Isb-RL) called **maweza** (Gogo) was characterized by round leaves forming a moon shape. Baobab

[1] Plant names in the local language are in bold and Swahili plant names are in bold italics.

(*Adansonia digitata*, Ad) offers edible young leaves called **ikuwi** (Gogo) (Bamalli et al., 2014; Chadare, 2010; Msuya et al., 2009). The edible young leaves of these vegetables were selected for the study.

13.4.2 Sample Collection and Processing

Samples of Cg-RL, Ch-RL, Isb-RL, Cs-RL, Ad-RYL, and Ad-RML were harvested on March 3, 2020, from farms in Chinangali I village, Dodoma region, Tanzania. Approximately 2 kg of fresh young green leaves were harvested, and 1 kg of dry leaves per species Io-CD, Io-DL, and Cs & Cd-DL was collected. Leaves of Io were processed in two different methods that are practiced traditionally. The first method was sorted to remove damaged leaves, crushed, and molded into a pancake-shaped disc that was dried in sunlight for 2 days to form the traditional Gogo vegetable called **chapali** (Io-CD). The second method was sorted to remove damaged leaves and dried directly in sunlight for 2 days to form the traditional vegetable named **sagula sagula** (Io-DL). *C. sesamoides* and *C. dipsaceus* leaves were sorted to remove damaged leaves, mixed, and dried in sunlight for 2 days (Cs & Cd-DL). The dried leaves are then pounded in a wooden mortar to produce a powdered vegetable traditionally called **ilende** to cook a sticky relish *mlenda*.

Samples were precisely packed in polyethylene bags, labeled, placed in cool boxes embedded with iced thermal gels, and finally transported from Dodoma to the Dar es Salaam region using an air-conditioned vehicle for experimental studies. Most of the samples were delivered to the International Institute of Tropical Agriculture (IITA) and the others to the Tanzania Bureau of Standards (TBS).

13.4.3 Sample Analyses

Sample analyses for proximate composition and minerals were performed at IITA and for vitamin C and β-carotene at TBC.

13.4.3.1 Moisture Content Determination

Approximately 2 g of each sample was weighed in preconditioned Petri plates that were preheated in an oven set at 105 °C for 2 h and cooled in a desiccator for 2 h. The samples were dried in a hot air oven at 105 °C overnight until constant weight (AOAC, 2005).

13.4.3.2 Ash Content Determination

Approximately 2 g of each sample was weighed into preconditioned porcelain crucibles that were preheated in an oven set at 105 ± 2 °C for 2 h and cooled in a desiccator for 2 h. The samples were placed in a temperature-controlled muffle furnace (Nabertherm GmbH, Lilienthal, Germany) and incinerated at 550 °C for 5 h. The crucibles were transferred to a desiccator, cooled to 29 ± 2 °C, and reweighed (AOAC, 2005).

13.4.3.3 Crude Fat Determination

The fat contents of the samples were determined using the Soxhlet system (Foss SoxtecTM 2043, Hilleroed, Denmark). Aluminum cups were preheated in an oven set at 105 ± 2 °C for 2 h and thereafter cooled in a desiccator for 30 min. Each aluminum cup was filled with 30 mL of petroleum ether and placed under an adapter holding thimble loaded with 2 g of the sample. Each thimble was submerged in boiled petroleum ether for 20 min to extract fat. Fat remaining in the samples was rinsed out by reflux using boiling petroleum ether for 45 min. Excess petroleum ether was recovered by evaporation from each cup into the condenser unit of the Soxhlet system for 10 min. The fat extract was dried in a hot air oven set at 105 °C for 30 min.

13.4.3.4 Crude Fiber Determination

The fiber content was determined by the Foss Fibertec system instructions. Fiber crucibles were first preheated in an oven set at 105 °C for 2 h and then filled with 2 g of sample and weighed. The fiber crucibles containing the samples were then fixed underneath glassier columns (Foss Fibertec™ 1020). Then, 100 mL of hot H_2SO_4 (1.25%) was added to the glassier columns to hydrolyze organic substances (e.g., protein, carbohydrate) with occasional auto-heating for 30 min. Resultant residues were washed with hot deionized water followed by adding hot NaOH (1.25%) to affect the saponification of fat in the sample over 30 min. The sample residues were further washed with hot water and then dried for 2 h in a hot air oven at 130 °C. The crucibles containing the dried sample residues were ignited in a muffle furnace at 550 °C for 5 h and weighed again after cooling following incineration.

13.4.3.5 Crude Protein Level Determination

An aliquot of 2 g of each sample was placed into a labeled Kjeldahl tube followed by adding Kjeltec catalyst [3 selenium oxide (2 g) tablets] and 20 mL of concentrated sulfuric acid (98%). The tubes and the contents were inserted into the digestion unit

(Foss Tecator™ Digester) and digested completely (until white fumes and blackish mass were absent) for 2 h at 400 °C. The digests were cooled to 29 ± 2 °C and then distilled for 5 min using an auto-distillation unit (Foss Kjeltec™ 8200) that had been rinsed and calibrated using the following setup: 80 mL of dilution volume (deionized water); 90 mL of sodium hydroxide (alkali solution 40%); and 3 mL of mixed indicator (70 mL of 0.1 g methyl red and 100 mL of 0.1 g bromocresol green dissolved in 100 mL methanol). The distillate was collected in the flasks. In addition, it was titrated with 0.104 M hydrochloric acid solution.

13.4.3.6 Mineral Determination

The samples were prepared for determining ash according to the methods described in the AOAC manual (AOAC, 2005). Approximately 5 g of each sample was weighed into preconditioned porcelain crucibles that were preheated in an oven set at 105 ± 2 °C for 2 h and cooled in a desiccator for 2 h. The samples were placed in a temperature-controlled muffle furnace (Nabertherm GmbH, Lilienthal, Germany) and incinerated at 550 °C for 5 h. The crucibles were transferred to a desiccator and cooled to 29 ± 2 °C. After obtaining the ash, HCl (6 M) was added at a ratio of 1:1 (approximately 20 mL). The sample was placed on a hot plate to evaporate the HCl, ensuring that the residue did not crack. To avoid evaporating the acid into a hard cake, evaporation was stopped when the sample was half wet and half caked. The extracts were dissolved in 10 mL of hot distilled water in crucibles and filtered into 50-mL volumetric flasks through filter paper. Ten milliliters (10 mL) of hot distilled water was further added, and a glass rod was used to remove any residue that remained in the crucibles. The extract was then passed through the same filter paper into 50-mL volumetric flasks and filled up to the mark. The flasks were well shaken, and the samples were transferred to sample bottles ready for analysis. An atomic absorption spectroscopy instrument (Buck Scientific 210 VGP, East Norwalk, CT, USA) was used to record the mineral content in the dilute filtrate solutions.

13.4.3.7 Determination of β-Carotene

Evaluation of β-carotene in the samples involved a procedure with three parts: sample preparation, standard preparation, and HPLC quantification.

Sample Preparation for β-Carotene

Samples were prepared through extraction, concentration, partitioning, saponification, and drying. Extraction of β-carotene was performed according to the method described by Kimura et al. (2007), with minor modifications to the number of solvents used (acetone and petroleum ether). During the extraction, approximately 1 g of sample was weighed (Mettler Toledo Excellent plus XP 205, Greifensee, Switzerland) into glass tubes, and 5 mL of cold acetone (refrigerated at 4 °C for approximately 2 h) was added. The mixture was then homogenized using a homogenizer (T 25 digital Ultra-Turrax, IKA, Staufen, Germany) for 1 min at 3600 rpm. Extractions (with acetone) were performed five times until a colorless residue was obtained; the final total volume of the extract was 25 mL. The supernatant (acetone extract) was pipetted into a 250-mL separating funnel (containing 10 mL of petroleum ether) for partitioning. The mixture was allowed to separate for approximately 3 min, and the lower aqueous phase was discarded. The petroleum ether phase was washed 3–4 times with 20 mL of distilled water. This procedure (partitioning) was repeated to extract all β-carotene in the sample to obtain a total volume of 20 mL. To prevent emulsion, washing was performed slowly along the walls of the funnel without shaking; when emulsion occurred, saturated sodium chloride (NaCl) solution was added to break the emulsion. Residual water was removed by passing the extract through a small funnel with glass wool containing approximately 15 g of anhydrous sodium sulfate.

Standard solution preparation for β-carotene

For standard preparation, 1 g/L of the β-carotene reference standard (99.9%, Sigma Aldrich, St. Louis, MO, USA) was prepared in a 10 mL amber-colored volumetric flask. This solution was further diluted to 100 mg/L in a volumetric flask to obtain working solutions with concentrations of 1 mg/L, 5 mg/L, 10 mg/L, 20 mg/L, 25 mg/L, and 30 mg/L. The concentrations were used to obtain the standard calibration curve.

HPLC quantification for β-carotene

Quantification conditions were adapted from (Zeb, 2017) using HPLC (Shimadzu Nexera X2, Kyoto, Japan) equipped with an LC-30Ad pump, degasser (DGU-20A3R) membrane, 105-capacity autosampler (SIL-30 AC), diode array detector (SPD-M30A), and column oven (CTO-20 AC). The mobile phase solvent A was methanol: deionized water (92:8 , v/v) buffered with 10 mm ammonium acetate; solvent B was deionized water with 0.01 mm ammonium acetate, and solvent C was methyl tertiary butyl ether (100%) run isocratically at 80:18 :2%. A Zorbax Eclipse Plus C18 reversed-phase 5 μm 4.0 × 150 mm column was used, the oven temperature was set to 30 °C, the detection wavelength was 450 nm, the run time was 12 min, the peak detection time was 9.8 min, the flow rate was 1.5 mL/min, and the injection volume was set to 10 μL.

13.4.3.8 Determination of Vitamin C

Sample Preparation for Vitamin C

Vitamin C determination used slightly modified procedures of (Rizzolo, 1984). To approximately 5 g of each sample in 50-mL Teflon tubes weighed by a digital balance (Excellent plus XP 205), 30 mL of 6% metaphosphoric acid was added. The mixture was homogenized by a polytron homogenizer (T 25 digital Ultra-Turrax) set at 3600 rpm for 5 min. Then, 50 mL of double-distilled water was added to a homogenate, and the resultant vortexed for 1 min (Talboys Troemner LLC, Thorofare, NJ, USA). The heterogeneous formed was centrifuged at 2415 g for 5 min (300R-Hettich, Tuttlingen, Germany). The resulting upper supernatant was filtered through a 0.45 μm micro filter (Whatman, Maidstone, UK) into 1.5 mL HPLC vials ready for injection.

Standard Preparation for Vitamin C

A stock solution of 1000 mg/L ascorbic acid standard (99.9%, Carlo Erba Reagent, Barcelona, Spain) in 0.02% metaphosphoric acid was prepared. This solution was further diluted to different concentrations (1 mg/L, 3 mg/L, 5 mg/L, 8 mg/L, 10 mg/L, 15 mg/L, and 20 mg/L), which were later used to generate the calibration curve.

HPLC Determination for Vitamin C

HPLC conditions for the analysis of ascorbic acid adhered to (Mazurek & Jamroz, 2015). A Shimadzu Nexera X2 HPLC pump (LC-30 AD), membrane degasser (DGU-20A3R), 105-capacity auto-sampler (SIL-30 AC), diode array detector (SPD-M30A), and column oven (CTO-20 AC) were used. A mobile phase of 0.02% metaphosphoric acid (pH 2.4): methanol = 95:5 with a low-pressure gradient was used (Table 13.1). A Zorbax Eclipse Plus C18 reversed-phase 5 μm 4.0 × 150 mm column was used. The detection wavelength was 245 nm, with a run time of 9 min, a peak detection time of 1.9 min, a flow rate of 1.0 mL/min, and an injection volume of 10 μL.

Table 13.1 HPLC gradient conditions for determining ascorbic acid content

Time (min)	0.02% phosphoric acid	HPLC methanol
2.5	95	5
5	20	80
6	20	80
7	95	5

13.5 Statistical Analysis

The statistical analysis was performed using IBM SPSS Statistics 21.0 (Armonk, NY, USA). Data are expressed as the means ± standard deviations of duplicate experiments. A one-way analysis of variance was performed to compare the means. Tukey's HSD test was used to verify the variance homogeneity and identify significant differences ($p < 0.05$).

13.6 Results and Discussion

13.6.1 Proximate Composition of Leafy Vegetables

The results of the proximate composition of the seven AWLVs are summarized in Table 13.2. The moisture content of raw leaves of vegetables ranged from 48.3 g/100 g to 73.3 g/100 g, whereby the highest moisture content was observed in Cd-RL (73.3 g/100 g) followed by that in Cg-RL (71.5 g/100 g), and the lowest value was observed in the matured raw baobab leaves (Ad-RML, 48.3 g/100 g) followed by that of Ad-RYL (65.4 g/100 g). The moisture contents of Ch-RL, the young raw baobab leaves (Ad-RYL), and Cs-RL ($p = 0.06$) and those of Io-CD and Io-DL ($p = 0.597$) were not significantly different. However, the remaining samples were significantly different ($p < 0.001$). The dried leaves (sun-dried) had moisture content ranging from 12.4 g/100 g to 14.1 g/100 g. The mixture of dried leaves (Cs & Cd-DL) had lower ($p < 0.001$) moisture content compared with that of Io-DL or Io-CD.

The moisture content of the studied vegetables was approximately 10% less than previously reported values of 77–93% (Jansen van Rensburg et al., 2004; Odhav et al., 2007; Schönfeldt & Pretorius, 2011; Uusiku et al., 2010; van Jaarsveld et al., 2014). The difference may have resulted from the difference in morphological and physiological characteristics of AWLVs. Differences in the contents of water-soluble vitamins such as vitamin C and folic acid may have also contributed to the observed variations.

The highest protein content was observed in Cs-RL (13.3 g/100 g), and the lowest was observed in Cd-RL (1.6 g/100 g). The protein contents obtained in the mixture of Cs & Cd-DL and Ad-RYL ($p = 1.00$) and that of Ch-RL and Ad-RML ($p = 0.407$) were not significantly different; however, those in the remaining samples differed significantly ($p < 0.001$). Cg-RL, Ch-RL, and Isb-RL contained protein contents that were higher than previously reported 5.68% in *C. gynandra* (Schönfeldt & Pretorius, 2011), 4.84% in *C. hirta* (Agea et al., 2014), and 6.37% in *I. batata* (Awol, 2014). Cs-RL and Cd-RL had lower protein contents than previously reported 29.85% (Fasakin, 2004) and *C. sativus* 5.71% (Attar & Ghane, 2017) by similar studies. For the young raw baobab leaves, the protein content was below the range (5–17%), while for the mature baobab leaves, the

Table 13.2 Proximate composition of selected raw and dried leafy vegetables (per 100 g edible portion) (Sakamoto et al., 2022)

Scientific name	Gogo name	Condition	Abbrev.	Moisture (g/100 g)	Protein	Fat	Fiber	Ash
Cleome gynandra	Mgagadi, Mzimwe	Raw	Cg-RL	71.5 ± 0.2^{b}	12.3 ± 0.1^{b}	3.2 ± 0.2^{a}	8.6 ± 0.1^{e}	11.6 ± 0.7^{e}
Cleome hirta	Muhilile	Raw	Ch-RL	65.5 ± 0.8^{de}	9.1 ± 0.2^{d}	1.5 ± 0.1^{c}	7.4 ± 0.2^{f}	19.0 ± 0.2^{a}
Ipomoea obscura or *ipomoea mombassana*	Chapali	Raw	Io-RL	66.9 ± 0.3^{cd}	10.1 ± 0.2^{c}	1.5 ± 0.1^{c}	9.4 ± 0.3^{de}	14.3 ± 0.2^{cd}
	(pl. Mapali)	Crushed & dried	Io-CD	13.3 ± 0.6^{gh}	4.1 ± 0.1^{g}	1.5 ± 0.0^{c}	8.9 ± 0.2^{de}	15.3 ± 0.3^{c}
	Sagula sagula	Dried	Io-DL	14.1 ± 0.1^{g}	5.2 ± 0.0^{f}	1.3 ± 0.0^{cd}	9.2 ± 0.4^{de}	13.4 ± 0.3^{d}
Ipomoea sinensis subsp. *Blepharosepala*	Maweza	Raw	Isb-RL	68.1 ± 0.1^{c}	8.2 ± 0.1^{e}	0.8 ± 0.1^{e}	9.7 ± 0.1^{d}	14.2 ± 0.2^{de}
Ceratotheca sesamoides	Ilende, Mgulu	Raw	Cs-RL	65.5 ± 0.8^{de}	13.3 ± 0.1^{a}	1.2 ± 0.2^{cde}	8.8 ± 0.2^{e}	16.9 ± 0.2^{b}
Ceratotheca sesamoides & *Cucumis dipsaceus*	Ilende	Dried	Cs & cd-DL	12.4 ± 0.2^{h}	3.7 ± 0.0^{h}	3.0 ± 0.1^{a}	7.7 ± 0.3^{f}	12.2 ± 0.3^{e}
Cucumis dipsaceus	Ilumbu, Hulihuli	Raw	Cd-RL	73.3 ± 0.2^{a}	1.6 ± 0.0^{i}	2.2 ± 0.2^{b}	12.0 ± 0.4^{b}	10.1 ± 0.7^{f}
Adansonia digitata	Ikuwi	Raw young	Ad-RYL	65.4 ± 0.4^{e}	3.6 ± 0.1^{h}	1.0 ± 0.2^{de}	10.7 ± 0.4^{c}	6.0 ± 0.2^{h}
		Raw mature	Ad-RML	48.3 ± 0.8^{f}	9.4 ± 0.4^{d}	2.3 ± 0.2^{b}	14.9 ± 0.1^{a}	7.3 ± 0.1^{g}

The results are expressed as the mean ± SD, $n = 3$. Samples with different superscript letters across the column indicate significant differences according to Tukey's HSD test protein was within the range reported in the corresponding study by Heuzé et al. (2016). During the processing of Io-RL, the protein contents were significantly decreased from 10.1% to 5.2% when dried (Io-DL) ($p < 0.001$) and from 5.2% to 4.1% when crushed (Io-CD) ($p < 0.001$). Awol reported less protein in *I. batata* than in *I. obscura* (Awol, 2014).

The reasonable amounts of protein observed in the samples suggest the use of AWLVs in promoting the formation of hormones that control coordination systems, growth, body repair, and maintenance. In addition, AWLVs can be used in the management of protein deficiencies, as stipulated in the (TFNC, 2014).

The findings of this study showed that Cg-RL (3.2 g/100 g) and Cs & Cd-DL (3.0 g/100 g) contained the highest fat content, while the lowest content was observed in Isb-RL (0.8 g/100 g), followed by Ad-RYL (1.0 g/100 g). These results agree with the general observation that leafy vegetables are a poor source of plant fat, and they are low lipid-containing foods, thus providing advantages for health use in avoiding obesity (Awol, 2014). The fat contents in Cd-RL, Ad-RML, Cs & Cd-DL, and Cg-RL were significantly ($p < 0.001$) different from those in the rest of the samples. However, those of Isb-RL and Ad-RYL ($p = 0.063$; Io-DL, Cs-RL, and Io-RL ($p = 0.376$; Cs-RL, Io-RL, Io-CD, and Ch-RL ($p = 0.11$), respectively, were not significantly different.

The fat contents observed in leaves of Cg-RL and Ch-RL were higher compared to 0.4–0.9% of *C. gynandra* (Chweya & Mnzava, 1997) and 0.64% of *C. hirta* (Agea et al., 2014), and Cd-RL was lower (2.2%) to 3.00% of *Cucumis sativus* (Attar & Ghane, 2017) reported in related studies. On the other hand, the fat contents of Io (−RL, -CD, and -DL), Cs-RL, and Isb-RL were low compared with 4.6% in Cs-RL (Fasakin, 2004). Deviation of the findings of this study relative to the results of previous reports might have been attributed to the difference in the geographical location and the agronomical factors.

In this study, crude fiber was analyzed for the sake of dietary fiber due to equipment challenges. The results showed that Ad-RML (14.9 g/100 g) had the highest fiber content, followed by Cd-RL (12.0 g/100 g) and Ad-RYL (10.7 g/100 g), at $p < 0.001$. The fiber contents in Cg-RL, Cs-RL, Io-CD, Io-DL, and Io-RL were not significantly different ($p > 0.005$). The lowest fiber content was observed in Ch-RL (7.4 g/100 g), followed by Cs & Cd-DL (7.7 g/100 g), at $p = 0.965$.

The results revealed that many samples were observed with comparably high values of crude fiber, while fewer samples deviated. This is supported by the observation that AWLVs have been traditionally recognized as great potential sources of fiber (Schönfeldt & Pretorius, 2011). The observed crude fiber contents in the mature and young raw baobab leaves (Ad-RML and Ad-RYL) were lower than those of the same matured plant leaves (10–19%) reported in the literature (Heuzé et al., 2016). The fiber content observed in Cd-RL (12%) in this study was higher than the 10.12% previously reported for *Cucumis sativus* (Attar & Ghane, 2017). Similarly, the fiber contents observed in the raw leaves of *C. gynandra* (8.6%) and *C. hirta* (7.4%) were higher than those previously reported (1.3–1.4%) (Chweya & Mnzava, 1997) and (2.27%) (Agea et al., 2014), respectively, and were slightly higher than those observed in *C. sesamoides* (7.91–8.16%) (Fasakin, 2004). The variation in fibers in AWLVs may be due to the difference in the geographical region, the mode of processing employed by the Gogo people in this study, the agroclimatic conditions, stages of maturity, and the type and rate of fertilizer application.

Ash contents ranged from 6.0% to 19.0%, and the highest amount was observed in Ch-RL (19.0%), while the lowest amount was in the baobab (Ad-RYL 6.0% and Ad-RML 7.3%). This indicated that AWLVs consumed in Chinangali I village of Chamwino district in the Dodoma region are rich in mineral elements, and upon consumption, they greatly supplement deficiencies related to minerals. There were significant differences ($p < 0.001$) between the ash contents in all the plant leaves studied.

The values of ash contents observed in Cg-RL (11.6%), Ch-RL (19.0%), and Cs-RL (16.9%) were higher than those previously reported: 2.1–3.0% in *C. gynandra* (Chweya & Mnzava, 1997), 2.93% in *C. hirta* (Agea et al., 2014) and 9.38–11.13% in *C. sesamoides* (Fasakin, 2004). Values in Io-RL (14.3%) and Io-CD (15.3%) were higher than those previously reported, 13.74% in *I. batatas* (Awol, 2014). On the other hand, the ash content detected in Cd-RL (10.1%) was lower than that previously reported (20.5%) in *Cucumis sativus* (Attar & Ghane, 2017). The ash contents in the baobab (Ad-RYL and Ad-RML) were lower than the values reported, 7.8–16.3% (Heuzé et al., 2016). Likewise, the variation in mineral contents might be due to the agro-climatic conditions, the stages of plant maturity, and the type and rate of fertilizer application.

13.6.2 Minerals, β-Carotene, and Vitamin C Levels of Leafy Vegetables

Leafy vegetables are chief sources of vitamins and minerals compared with staple food grains. They contain high levels of β-carotenes, vitamin C, iron, calcium, and sodium (Natesh et al., 2017). Table 13.3 summarizes the minerals (iron, calcium, and sodium), β-carotene, and vitamin C of the selected AWLVs.

The iron content in raw leaves ranged from 1.2 mg/100 g (Ad-RYL) to 55.2 mg/100 g (Io-RL), and in dried samples, it ranged from 43.5 mg/100 g (Cs & Cd-DL) to 68.8 mg/100 g (Io-CD). The highest iron content was found in Io-CD (68.8 mg/100 g), followed by Io-RL (55.2 mg/100 g) and Io-DL (51.1 mg/100 g, $p < 0.005$). The lowest iron content was observed in Ad-RYL (1.2 mg/100 g), followed by Ad-RML (7.0 mg/100 g, $p < 0.005$).

On the other hand, there was no significant difference ($p = 0.052$) between Isb-RL (41.5 mg/100 g), Cs & Cd-DL (43.5 mg/100 g), and Ch-RL (44.8 mg/100 g). Similarly, there was no significant difference ($p = 0.671$) between Cs-RL (39.9 mg/100 g) and Isb-RL (41.5 mg/100 g).

The iron content detected in Ad-RYL (1.2 mg/100 g) was significantly lower ($p < 0.005$) than the iron content detected in Ad-RML (7.0 mg/100 g). The difference

Table 13.3 Minerals and vitamins of the selected raw and dried leafy vegetables (per 100 g edible portion) (Sakamoto et al., 2022)

Vegetables	Iron (mg)	Calcium (mg)	Sodium (mg)	β-Carotene (μg)	Vitamin C (mg)
Cg-RL	26.7 ± 0.7 [f]	1153.6 ± 16.7 [e]	153.9 ± 1.6 [c]	3175.5 ± 188.0 [b]	13.5 ± 0.2 [a]
Ch-RL	44.8 ± 0.0 [d]	2104.1 ± 44.6 [b]	138.3 ± 0.9 [cde]	1449.2 ± 101.7 [c]	0.8 ± 0.0 [e]
Io-RL	55.2 ± 1.1 [b]	943.8 ± 12.2 [f]	224.4 ± 5.2 [a]	218.1 ± 20.7 [e]	0.6 ± 0.0 [ef]
Io-CD	68.8 ± 0.3 [a]	1486.2 ± 3.0 [c]	195.9 ± 3.0 [b]	2907.3 ± 103.1 [b]	6.1 ± 0.1 [b]
Io-DL	51.1 ± 1.3 [c]	1353.3 ± 29.5 [d]	232.5 ± 13.7 [a]	367.3 ± 46.5 [de]	2.1 ± 0.1 [d]
Isb-RL	41.5 ± 1.0 [de]	495.6 ± 5.4 [h]	144.9 ± 0.1 [cd]	193.1 ± 10.9 [e]	0.8 ± 0.0 [e]
Cs-RL	39.9 ± 0.0 [e]	1059.5 ± 11.7 [e]	125.7 ± 0.2 [e]	735.0 ± 48.7 [d]	0.8 ± 0.0 [e]
Cs & cd-DL	43.5 ± 1.7 [d]	2794.5 ± 42.6 [a]	151.7 ± 0.1 [c]	17,489.1 ± 406.6 [a]	4.9 ± 0.1 [c]
Cd-RL	7.2 ± 0.2 [g]	804.7 ± 9.2 [g]	129.0 ± 1.4 [de]	466.6 ± 44.3 [de]	6.4 ± 0.1 [b]
Ad-RYL	1.2 ± 0.1 [h]	372.3 ± 34.8 [i]	130.9 ± 1.4 [de]	304.5 ± 12.1 [de]	0.4 ± 0.0 [f]
Ad-RML	7.0 ± 0.6 [g]	1556.6 ± 7.2 [c]	136.4 ± 2.4 [cde]	N.D.	0.6 ± 0.0 [ef]

The results are expressed as the mean ± SD, $n = 3$. Samples with different superscript letters across the column indicate significant differences according to Tukey's HSD test

Cg-RL raw leaves of *Cleome gynandra*, *Ch-RL* raw leaves of *Cleome hirta*, *Io* raw leaves of *Ipomoea obscura* or *Ipomoea mombassana*, *Io-CD* crush-dried leaves of *Ipomoea obscura*, *Io-DL* dried leaves of *Ipomoea obscura*, *Isb-RL* raw leaves of *Ipomoea sinensis* subsp. *blepharosepala*, *Cs-RL* raw leaves of *Ceratotheca sesamoides*, *Cs & Cd-DL* dried leaves of *Ceratotheca sesamoides* and *Cucumis dipsaceus*, *Cd-RL* raw leaves of *Cucumis dipsaceus*, *Ad-RYL* raw young leaves of *Adansonia digitata*, *Ad-RML* raw mature leaves of *A. digitata*, *N.D.* not detected

contradicts the previously reported results from Mali, where young leaves had higher iron contents (19.31–27.22 mg/100 g) than mature leaves (9.77–10.32 mg/100 g) (Hyacinthe et al., 2015). The iron contents in Cd-RL and Ad-RYL observed in this study were lower to 2400 mg/100 g in *C. dipsaceus* of India (Chandran et al., 2013) and 9.77–27.22 mg/100 g in baobab leaves of Burkina Faso (Hyacinthe et al., 2015), respectively.

Similarly, the iron contents in leaves of Cg-RL (39.0 mg/100 g) and Ch-RL (56.4 mg/100 g) reported in a previous study carried out in Chinoje and Mzula villages, Chamwino district of the Dodoma region, Tanzania, were higher in comparison to results observed in this study carried out in Chinagali I village in the same district (Gowele et al., 2019). On the other hand, the iron content of Cg-RL observed in this study was higher compared with 2.1–14.3 mg/100 g in *C. gynandra* grown in South Africa (Schönfeldt & Pretorius, 2011; van Jaarsveld et al., 2014). The observed differences could be ascribed to the difference in the maturity of the leaves, the agroecological factors, and the farming systems used by the farmers. Iron is required for hemoglobin formation, and iron deficiency leads to anemia. Previous research indicates that anemia in women of Dodoma was lower despite concurrent food deficiency and malnutrition (Keding et al., 2011; Stuetz et al., 2019; Tanzania, 2019). This denotes the role played by the utilization of AWLVs, and thus, they constitute a contributing factor to decreasing anemia.

Calcium is essential for a healthy diet and a mineral necessary for life. It plays an important role in building strong and dense bones and teeth. The calcium content observed in this study ranged from 372.3 mg/100 g to 2794.5 mg/100 g. The richest sources of calcium were found to be Cs & Cd-DL, Ch-RL, Ad-RML, Io-CD, Io-DL, Cg-RL, and Cs-RL, with calcium contents ranging from 2794.5 mg/100 g to 1059.5 mg/100 g, and the moderate sources were Io-RL, Cd-RL, Isb-RL, and Ad-RYL, with calcium contents ranging from 943.8 mg/100 g to 372.3 mg/100 g. The results showed that there was no significant difference ($p = 0.243$) between Io-CD and Ad-RML and between Cs-RL and Cg-RL at $p = 0.600$. On the other hand, all the remaining samples were observed to have a significant difference in calcium content ($p < 0.005$).

Previous studies observed lower calcium contents in raw leaves of *C. gynandra* (260.1 mg/100 g), *C. hirta* (310.5 mg/100 g), *I. obscura* (320.125 mg/100 g), *C. sesamoides* (248.8 mg/100 g), and *C. dipsaceus* (270 mg/100 g) compared with the findings of this study (Chandran et al., 2013; Stuetz et al., 2019). In contrast, the previously reported value of 1961 mg/100 g in Ad-RML was higher than the value observed in this study. Likewise, the observed differences could be due to differences in the maturity of the leaves, agroecological factors, and farming systems used by the farmers.

The highest sodium content was observed in Io-DL (232.5 mg/100 g), followed by Io-RL (224.4 mg/100 g), Io-CD (195.9 mg/100 g), Cg-RL (153.9 mg/100 g), Cs & Cd-DL (151.7 mg/100 g) and then Isb-RL (144.9 mg/100 g), while the lowest content was observed in Cs-RL (125.7 mg/100 g), followed by Cd-RL (129.0 mg/100 g), Ad-RYL (130.9 mg/100 g), Ad-RML (136.4 mg/100 g), and Ch-RL (138.3 mg/100 g). The results showed there was no significant difference between Cs-RL (125.7 mg/100 g), Cd-RL (129.0 mg/100 g), Ad-RYL (130.9 mg/100 g), Ad-RML (136.4 mg/100 g), and Ch-RL (138.3 mg/100 g, $p = 0.296$). Similarly, there was also no significant difference observed between Ad-RML (136.4 mg/100 g), Ch-RL (138.3 mg/100 g), Isb-RL (144.9 mg/100 g), Cs & Cd-DL (151.7 mg/100 g), and Cg-RL (153.9 mg/100 g, $p = 0.67$). Likewise, there was no significant difference ($p = 0.787$) between Io-RL (224.4 mg/100 g) and Io-DL (232.5 mg/100 g). On the other hand, Io-CD (195.9 mg/100 g) showed a significant difference ($p < 0.005$) in all samples.

Sodium levels in Cg-RL, Io-RL, and Ad-RML detected in this study were higher compared with the findings previously reported (33.6 mg/100 g, 32.079 mg/100 g, 1.37 mg/100 g) in *C. gynandra* (Chweya & Mnzava, 1997), *I. batatas* (Awol, 2014), and baobab, respectively (Hyacinthe et al., 2015). This is probably due to the differences in the variety of the plant leaves used and the climate conditions. Indigenous processing techniques applied in handling the AWLVs may also influence the content of sodium in the vegetables.

The values in Cs-RL (125.7 mg/100 g) and Cd-RL (129.0 mg/100 g) were lower than those in the mixture Cs & Cd-DL (151.7 mg/100 g). The process of crushing may have affected the values of sodium in *I. obscura*. The sodium contents observed in the raw leaves (Io-RL) were significantly higher ($p = 0.012$) than the sodium contents in the crushed and then dried leaves (Io-CD); however, those of Io-DL and Io-RL were not significantly different ($p > 0.005$), meaning that drying may not affect the sodium content.

β-Carotene was detected in all samples of AWLVs used in this study except in Ad-RML, with the highest in Cg-RL at 3175.5 μg/100 g. The results showed that there were no significant differences ($p > 0.005$) between Io-DL (367.3 μg/100 g), Cd-RL (466.6 μg/100 g), and Ad-RYL (304.5 μg/100 g). Similarly, there was also no significant difference between Io-RL (218.1 μg/100 g) and Isb-RL (193.1 μg/100 g). The remaining samples showed significant differences ($p < 0.005$).

A previous study reported that indigenous AWLVs are good sources of antioxidants, including β-carotene and vitamin C (Gowele et al., 2019; Stuetz et al., 2019). The amount of β-carotene observed in Cg-RL (3175.5 μg/100 g) was higher than 291.04 μg/100 g or 670–1890 μg/100 g in *C. gynandra* (Chweya & Mnzava, 1997; Gowele et al., 2019). Similarly, the amount of β-carotene detected in Ch-RL (1449.2 μg/100 g) was higher than that previously reported (275.02 μg/100 g) in *C. hirta* (Gowele et al., 2019). On the other hand, the amount of β-carotene in Io-RL (218.1 μg/100 g) and Cs-RL (735.0 μg/100 g) was lower than the previously reported data of 1010 μg/100 g and 1960 μg/100 g, respectively (Gowele et al., 2019).

The range of vitamin C in the AWLVs was between 0.4 mg/100 g in Ad-RYL and 13.5 mg/100 g in Cg-RL. The results showed that there were no significant differences ($p = 0.109$) between Ad-RML (0.6 mg/100 g), Io-RL (0.6 mg/100 g), Cs-RL (0.8 mg/100 g), Isb-RL (0.8 mg/100 g), and Ch-RL (0.8 mg/100 g). Likewise, there were no significant differences ($p = 0.405$) between Io-RL (0.6 mg/100 g), Ad-RYL (0.4 mg/100 g), and Ad-RML (0.6 mg/100 g). The remaining samples showed significant differences ($p < 0.005$).

In previous studies, vitamin C contents of 2 mg/100 g or 15.44 mg/100 g in *C. gynandra* (Gowele et al., 2019; van Jaarsveld et al., 2014), 15.60 mg/100 g in *C. hirta* (Gowele et al., 2019), and 150–500 mg/100 g in baobab (Chadare, 2010) were observed. Several factors can influence the variations in vitamin C content in AWLVs, such as geographical location, plant variety or species, maturity stage, postharvest treatments, processing methods, storage conditions and time, packaging materials and technology, and cooking time.

13.7 Conclusion

This study shows that the seven evaluated AWLVs in semiarid Tanzania were rich in iron, calcium, and protein compared with the findings of previous research. Furthermore, their β-carotene and vitamin C contents were within the reported range. Our findings highlighted that *C. hirta*, which has not been as thoroughly studied as *C. gynandra*, exhibited higher calcium and iron contents. *I. obscura* also exhibited high iron content, up to 100 times that of cultivated sweet potato leaves. The protein content in *C. gynandra* was higher than that in previous reports. The high iron, calcium, and protein contents in the herbal species of this locality may be due to the environment, including the semiarid climate and soil. Together, the results indicate the high potential of these AWLVs to contribute to the improvement of the nutrition status of the local populace.

Acknowledgments We acknowledge Ms. Nobuko Tsubaki Nzullunge, Mr. Michael Chimosa, and the team in Chinangali I Village for sample collection and information regarding the utilization of the species; Mr. Frank Mbago for botanical assistance at the Herbarium of the University of Dar es Salaam; and Mr. Parinya Khemmarath for research assistance. Proximate composition and minerals were analyzed at the International Institute of Tropical Agriculture (IITA), and β-carotene and vitamin C were analyzed at the Tanzania Bureau of Standards (TBS).

The research was financially supported by the Japan Science and Technology Agency (JST) and Research Assistance System through Utsunomiya University Diversity Research Environment Promotion Headquarters, by the Japan Society for the Promotion of Science (JSPS) Grants-in-Aid for Scientific Research (KAKEHI) 18H03438 ("Possibilities of wild edible plants and traditional meals in East Africa") and 22H00032, and by Utsunomiya University. The funding sources do not have any role in the study design, the preparation of the article, or the decision to submit the article for publication.

Kaale is responsible for data analysis, drafting, editing, and revising the chapter. Sakamoto is responsible for conceptualization, information collection in Dodoma, editing, and revising the chapter. Ohmori has contributed to the conceptualization of the information collection. All the authors have gone through the final chapter and accepted.

References

Agea, J. G., Kimondo, J. M., Woiso, D. A., Okia, C. A., Obaa, B. B., Isubikalu, P., Okullo, J. B. L., Obua, J., & Teklehaimanot, Z. (2014). Proximate composition, vitamin C and beta-carotene contents of fifteen selected leafy wild and semi-wild food plants (WSWFPs) from Bunyoro-Kitara Kingdom, Uganda. *Journal of Natural Product and Plant Resources, 4*(3), 1–12.

AOAC. (2005). Official method of analysis. In *Association of officiating analytical chemists* (18th ed.). Retrieved November 10, 2022, from https://www.scirp.org/(S(351jmbntvnsjt1aadkposzje))/reference/ReferencesPapers.aspx?ReferenceID=2033299

Attar, U. A., & Ghane, S. G. (2017). Proximate composition, antioxidant activities and phenolic composition of Cucumis sativus forma hardwickii (Royle) WJ de Wilde & Duyfjes. *International Journal of Phytomedicine, 9*(1), 101–112.

Awol, A. (2014). Phytochemical screening, proximate and mineral composition of sweet potato leaves grown in Tepi Provision, south-west of Ethiopia. *Science, Technology and Arts Research Journal, 3*(3), 112. https://doi.org/10.4314/star.v3i3.19

Bamalli, Z., Mohammed, A. S., Ghazali, H. M., & Karim, R. (2014). Baobab tree (*Adansonia digitata* L) parts: Nutrition, applications in food and uses in ethno-medicine – A review. *Annals of Nutritional Disorders and Therapy, 1*(3), 1011.

Chadare, F. J. (2010). *Baobab (Adansonia digitata L.) foods from Benin: Composition, processing and quality*. Wageningen University. Retrieved December 31, 2022, from https://library.wur.nl/WebQuery/wurpubs/fulltext/146791

Chandran, R., Nivedhini, V., & Parimelazhagan, T. (2013). Nutritional composition and antioxidant properties of Cucumis dipsaceus Ehrenb. Ex Spach leaf. *The Scientific World Journal, 2013*, 890451. https://doi.org/10.1155/2013/890451

Chweya, J. A., & Mnzava, N. A. (1997). *Promoting the conservation and use of underutilized and neglected crops. 11. Cat's whiskers*. International Plant Genetic Resources Institute.

Ezzati, M., Lopez, A. D., Rodgers, A., Hoorn, S. V., & Murray, C. J. L. (2002). Comparative risk assessment collaborating group: Selected major risk factors and global and regional burden of disease. *Lancet, 360*(9343), 1347–1360. Retrieved November 11, 2022, from https://ci.nii.ac.jp/naid/10026123875/

Faber, M., Oelofse, A., van Jaarsveld, P., Wenhold, F., & Jansen van Rensburg, W. (2010). African leafy vegetables consumed by households in the Limpopo and KwaZulu-Natal provinces in South Africa. *South African Journal of Clinical Nutrition, 23*(1), 30–38. https://doi.org/10.1080/16070658.2010.11734255

Fasakin, K. (2004). Proximate composition of bungu (Ceratotheca sesamoides Endl.) leaves and seeds. *Nigerian Society for Experimental Biology, 16*(2), 88–92. https://doi.org/10.4314/biokem.v16i2.32575

Gowele, V. F., Kinabo, J., Jumbe, T., Kirschmann, C., Frank, J., & Stuetz, W. (2019). Provitamin a carotenoids, tocopherols, ascorbic acid and minerals in indigenous leafy vegetables from Tanzania. *Foods (Basel, Switzerland), 8*(1), 35. https://doi.org/10.3390/foods8010035

Heuzé V, Tran G, Archimède H, & Bastianelli D. (2016). African baobab (*Adansonia digitata*)| Feedipedia, a programme by INRA, CIRAD, AFZ and FAO. Retrieved November 11, 2022, from http://www.feedipedia.org/node/525. Last updated on March 14, 2016, 17: 39.

Hyacinthe, T., Charles, P., Adama, K., Diarra, C.-S., Dicko, M. H., Svejgaard, J. J., & Diawara, B. (2015). Variability of vitamins B1, B2 and minerals content in baobab (*Adansonia digitata*) leaves in East and West Africa. *Food Science & Nutrition, 3*(1), 17–24. https://doi.org/10.1002/fsn3.184

Jansen van Rensburg, W. S., Venter, S. L., Netshiluvhi, T. R., van den Heever, E., Vorster, H. J., de Ronde, J. A., & Bornman, C. H. (2004). Role of indigenous leafy vegetables in combating hunger and malnutrition. *South African Journal of Botany, 70*(1), 52–59. https://doi.org/10.1016/s0254-6299(15)30268-4

Keding, G. B., Msuya, J. M., Maass, B. L., & Krawinkel, M. B. (2011). Dietary patterns and nutritional health of women: The nutrition transition in rural Tanzania. *Food and Nutrition Bulletin, 32*(3), 218–226. https://doi.org/10.1177/156482651103200306

Kimura, M., Kobori, C. N., Rodriguez-Amaya, D. B., & Nestel, P. (2007). Screening and HPLC methods for carotenoids in sweetpotato, cassava and maize for plant breeding trials. *Food Chemistry, 100*(4). Retrieved November 11, 2022, from https://www.sciencedirect.com/science/article/pii/S0308814605009180

Kissanga, R., Sales, J., Moldão, M., Alves, V., Mendes, H., Romeiras, M. M., et al. (2021). Nutritional and functional properties of wild leafy vegetables for improving food security in southern Angola. *Frontiers in Sustainable Food Systems, 5*. https://doi.org/10.3389/fsufs.2021.791705

Maseko, I., Mabhaudhi, T., Tesfay, S., Araya, H., Fezzehazion, M., & Plooy, C. (2018). African leafy vegetables: A review of status, production and utilization in South Africa. *Sustainability, 10*(2), 16. https://doi.org/10.3390/su10010016

Mazurek, A., & Jamroz, J. (2015). Precision of dehydroascorbic acid quantitation with the use of the subtraction method: Validation of HPLC–DAD method for determination of total vitamin C in food. *Food Chemistry, 173*, 543–550. https://doi.org/10.1016/j.foodchem.2014.10.065

Modi, A., Modi, M., & Hendriks, S. (2006). Potential role for wild vegetables in household food security: A preliminary case study in Kwazulu-Natal, South Africa. *African Journal of Food, Agriculture, Nutrition and Development, 6*(1). https://doi.org/10.4314/ajfand.v6i1.19167

Mohajan, H. K. (2022). Food insecurity and malnutrition of Africa: A combined attempt can reduce them. *Journal of Economic Development, Environment and People, 11*(1), 24–34. https://doi.org/10.26458/jedep.v1i1.716

Msuya, J. M., Mamiro, P., & Weinberger, K. (2009). Iron, zinc and β-carotene nutrients potential of non-cultivated indigenous vegetables in Tanzania. *Acta Horticulturae, 806*, 217–222. https://doi.org/10.17660/ACTAHORTIC.2009.806.26

Natesh, N. H., SK, A., & Abbey, L. (2017). An overview of nutritional and anti nutritional factors in green leafy vegetables. *Horticulture International Journal, 1*(2), 58–65. https://doi.org/10.15406/hij.2017.01.00011

Ntuli, N. R. (2019). Nutrient content of scarcely known wild leafy vegetables from northern KwaZulu-Natal, South Africa. *South African Journal of Botany, 127*, 19–24. https://doi.org/10.1016/j.sajb.2019.08.033

Odhav, B., Beekrum, S., Akula, U., & Baijnath, H. (2007). Preliminary assessment of nutritional value of traditional leafy vegetables in KwaZulu-Natal, South Africa. *Journal of Food Composition and Analysis, 20*(5), 430–435. https://doi.org/10.1016/j.jfca.2006.04.015

Powell, B., Ouarghidi, A., Johns, T., Ibn Tattou, M., & Eyzaguirre, P. (2014). Wild leafy vegetable use and knowledge across multiple sites in Morocco: A case study for transmission of local knowledge? *Journal of Ethnobiology and Ethnomedicine, 10*, 34. https://doi.org/10.1186/1746-4269-10-34

Rizzolo, A. (1984). HPLC assay of ascorbic acid in fresh and processed fruit and vegetables. *Food Chemistry, 14*(3), 189–199. https://doi.org/10.1016/0308-8146(84)90058-x

Sakamoto, K., Kaale, L., & Ohmori, R. (2022). Nutrient content of seven African wild leafy vegetables in semi-arid Tanzania. *Journal of the Faculty of International Studies, Utsunomiya University, 54*, 17–28.

Schönfeldt, H. C., & Pretorius, B. (2011). The nutrient content of five traditional South African dark green leafy vegetables: A preliminary study. *Journal of Food Composition and Analysis, 24*(8), 1141–1146. https://doi.org/10.1016/j.jfca.2011.04.004

Smith, F. I., & Eyzaguirre, P. (2007). African leafy vegetables: Their role in the World Health Organization's global fruit and vegetables initiative. *African Journal of Food, Agriculture, Nutrition and Development, 7*(14), 1–17. https://doi.org/10.18697/ajfand.14.ipgri1-1

Stuetz, W., Gowele, V., Kinabo, J., Bundala, N., Mbwana, H., Rybak, C., Eleraky, L., Lambert, C., & Biesalski, H. K. (2019). Consumption of dark green leafy vegetables predicts vitamin A and iron intake and status among female small-scale farmers in Tanzania. *Nutrients, 11*(5), 1025. https://doi.org/10.3390/nu11051025

Tanzania, United Republic. (2019). *Tanzania national nutrition survey using SMART methodology (TNNS) 2018.* Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC) [Tanzania Mainland], Ministry of Health (MoH) [Zanzibar], Tanzania Food and Nutrition Centre (TFNC), National Bureau of Statistics (NBS), Office of the Chief Government Sta. Retrieved from https://www.unicef.org/tanzania/media/2141/file/Tanzania National Nutrition Survey 2018.pdf

TFNC. (2014). *Tanzania national nutrition survey 2014*. Retrieved November 10, 2022, from https://www.tfnc.go.tz/uploads/publications/sw1514893882-Tanzania%20National%20Nutrition%20Survey%202014_Final_Report.pdf

UNICEF. (2019). *The state of the world children 2019: Children, food and nutrition: Growing well in a changing world*. Retrieved from https://www.unicef.org/media/60806/file/SOWC-2019.pdf

Uusiku, N. P., Oelofse, A., Duodu, K. G., Bester, M. J., & Faber, M. (2010). Nutritional value of leafy vegetables of sub-Saharan Africa and their potential contribution to human health: A review. *Journal of Food Composition and Analysis, 23*(6), 499–509. https://doi.org/10.1016/j.jfca.2010.05.002

van Jaarsveld, P., Faber, M., van Heerden, I., Wenhold, F., Jansen van Rensburg, W., & van Averbeke, W. (2014). Nutrient content of eight African leafy vegetables and their potential contribution to dietary reference intakes. *Journal of Food Composition and Analysis, 33*(1), 77–84. https://doi.org/10.1016/j.jfca.2013.11.003

Zeb, A. (2017). A simple, sensitive HPLC-DAD method for simultaneous determination of carotenoids, chlorophylls and α-tocopherol in leafy vegetables. *Journal of Food Measurement and Characterization, 11*(3), 979–986. https://doi.org/10.1007/s11694-017-9472-y

Chapter 14
Conclusions

What Is the Secret to Good Health, and How Are Wealth and Mutual Assistance Related?

Kumiko Sakamoto, Lilian Daniel Kaale, Reiko Ohmori, and Tamahi Kato

Abstract This chapter draws conclusions from previous chapters, focusing on Dodoma, Lindi, Iringa, and Dar es Salaam, to understand the shifting dietary patterns and uses of indigenous foods and wild foods in relation to wealth, mutual relations, and health in Tanzania. First, the analysis indicated that animal and fish protein intake was associated with health and quality of life. Second, vegetable intake was associated with good health, but changing dietary patterns to patterns of purchased food decreased vegetable intake. Third, good health was associated with mutual assistance in food but not in monetary assistance. Finally, there was evidence in semiarid rural Dodoma that "poor" households maintained good health based on the traditional diet with green vegetables supplemented by the rich iron, calcium, and protein contained in leafy wild vegetables. Recommendations are as follows: (1) Promotion of vegetable intake through encouraging the consumption of leafy wild vegetables and vegetable cultivation. (2) Diverse strategies to obtain animal and fish protein based on location and situation. (3) Further research and dissemination of findings on the benefits of local wild foods, health implications of pulses, and healthy and unhealthy foods. (4) A holistic (methodological) strategy and the implementation of sound legislation and policies to address the double burden of malnutrition.

K. Sakamoto (✉)
School of International Studies, Utsunomiya University, Utsunomiya, Japan
e-mail: ksaka@cc.utsunomiya-u.ac.jp

L. D. Kaale
Department of Food Science and Technology, University of Dar es Salaam, Dar es Salaam, Tanzania
e-mail: elykaale@gmail.com; dlilian@udsm.ac.tz

R. Ohmori
School of Regional Design, Utsunomiya University, Utsunomiya, Japan
e-mail: rohmori@cc.utsunomiya-u.ac.jp

T. Kato
Center for African Area Studies, Kyoto University, Kyoto, Japan

K. Sakamoto et al. (eds.), *Changing Dietary Patterns, Indigenous Foods, and Wild Foods*, https://doi.org/10.1007/978-981-99-3370-9_14

Keywords Double burden of malnutrition (DBM) · Tanzania · Tea · Vegetable · Protein · Wild foods

14.1 Summary of the Chapters

This book has analyzed the case of Tanzania to understand the situation of changing dietary patterns and the use of indigenous and wild foods. The analysis has been related to wealth and mutual relations, and its implications for and associations with health, specifically quality of life (QOL), have been analyzed. The main findings of the book are illustrated in Fig. 14.1.

14.1.1 Part I Dietary Patterns in Tanzania: Obtaining Foods and Combining Them in the Varied Environment

Part I reviewed the diverse environment and different dietary patterns and analyzed food diaries from 15 households in the semiarid Dodoma region (Mbelezungu village), coastal bushland Lindi region (Rutamba and Miche villages), and the city of Dar es Salaam, providing the following implications. In Chap. 1, households with a high intake of tea, biased in Dar es Salaam and Lindi, also had a high intake of

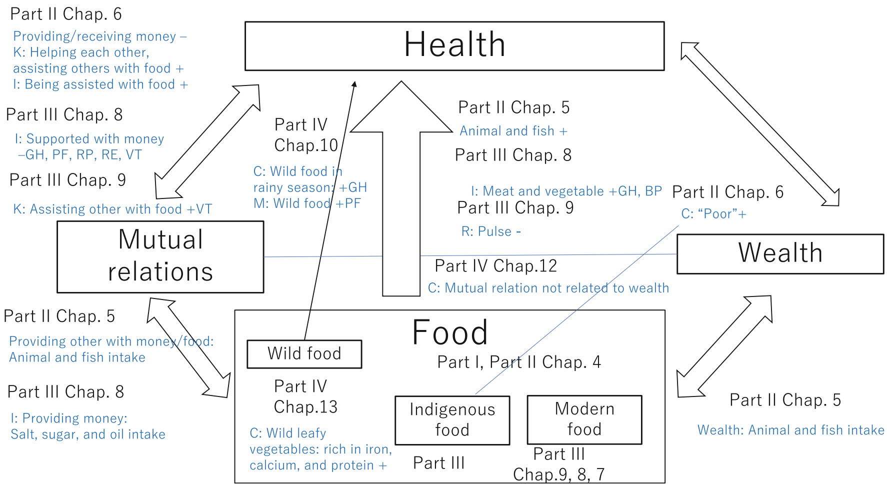


Fig. 14.1 Main findings of the book. *K* Kijiweni village, Lindi region; *I* Ifunda and Bandabichi village, Iringa region; *C* Chinangali I village, Dodoma region; *R* Rahaleo Elementary school, Lindi town, Lindi region. *PF* Physical Functioning; *RP* Role Physical; *BP* Body Pain; *GH* General Health; *VT* Vitality; *RE* Role Emotional
− = negative relationship with health
+ = positive relationship with health

staple foods but a low intake of green vegetables. Chapter 2 analyzed how food ingredients are obtained, confirming that sugar, oil, and salt were purchased. Vegetables were purchased and cultivated, but the analysis indicated that those who cultivate vegetables have a higher intake of vegetables.

14.1.2 Part II Food Patterns, Health, Wealth and Mutual Relations

Part II analyzed data from 424 adults from four villages in the southern highland Iringa region (Ifunda and Baidabichi villages), Lindi region (coastal Kijiweni and inland Malolo villages), and Dodoma region (Chinangali I village). The analysis of food group intake frequency in Chap. 4 indicated that meat was infrequently consumed in all the villages. Fish were frequently consumed in the coastal Lindi region and milk in Iringa region but not in the other three villages, confirming the inadequate intake of animal protein. Except for Iringa region in the highlands, all the three lowland villages had food deficits but more variety in the rainy season.

Chapter 5 indicated that those with dietary patterns emphasizing animal and fish intake had high QOL and wealth and provided others with food and monetary assistance. The results of Chap. 6 showed that those who regarded themselves as “poor” had good physical health in the semiarid Dodoma region. Mutual relations had varied results, but (1) in the Muslim coastal village in Lindi region, those who considered villagers as helping each other had high physical health, and those who provided food assistance had positive mental health; however, (2) those receiving food assistance had low physical health in the Iringa highland village, and (3) providing and receiving final support had a negative effect on physical and mental health in various villages.

14.1.3 Part III Case Studies: Changing Food Patterns and Implications for Health

Part III provides case studies of changing dietary patterns. Chapter 7 provides a vivid description of Dar es Salaam, with high population growth, significant disparities, diverse eating patterns, and worsening malnutrition problems.

Chapter 8, presenting the case of Iringa region with high production, indicated that (1) eating meat and vegetables had a positive effect on physical health; (2) wealthier women who assisted others with money consumed oil, salt, and sugar frequently; and (3) women who received assistance in the form of food had low health evaluations.

Chapter 9 confirmed that in coastal Kijiweni village in the Lindi region, people consumed seafoods as well as wild fruits, tubers, and vegetables. Frequent intake of pulses may have a negative effect on children's health. Assisting others with food was associated with vitality.

14.1.4 Part IV Wild Food Intake and Its Association with Health

Part IV focuses on wild foods and health. Chapter 10 provided evidence that a higher intake of wild foods in the rainy season was associated with a high evaluation of General Health (GH) in semiarid Chinangali I village in the Dodoma region. In the inland Malolo village in the Lindi region, higher wild food intake was associated with Physical Functioning (PF).

Chapter 11 further introduced the situation of Malolo village analyzed in Chap. 10 and elaborated on the rich and diverse wild foods available and utilized by the villagers. Chapter 12 analyzed the situation in Chinangali I village in which residents coped with food shortages with available resources, especially by utilizing leafy vegetables. However, mutual assistance was not necessarily related to wealth, and the wealthy did not necessarily assist the "poor". Chapter 13 analyzed the nutrient value of African wild leafy vegetables from Chinangali I village, and significant amounts of iron, calcium, and protein were proven.

14.2 Discussion

The above findings of the book are discussed here in reference to previous research.

14.2.1 Protein Intake Associated With Health and Wealth

As mentioned in previous research in Tanzania (Cochrane & D'Souza, 2015), inadequate intake of animal and fish protein remains an issue, especially in rural villages in Tanzania (Chap. 4). Animal and fish protein intake is understood as essential for physical health, but the analyses in Chaps. 5 and 8 further confirmed that it is also associated with QOL.

The association of animal meat intake and wealth that was implied in previous research (Keding et al., 2011) was also confirmed in Chap. 5. The chapter also indicated a new finding that the wealthy assist others with food and money (Fig. 14.1).

On the other hand, there was evidence that pulse intake may have a negative effect on health (Chap. 9). Previous research also indicated that pulses may have anti-nutritional factors (ANFs), negatively affecting nutrient digestibility and bioaccessibility when they are not thoroughly cooked or well processed (Alphonce et al., 2020; Kaale et al., 2022). While pulses are an important source of protein for the poor, further research is necessary to avoid the negative effects of these foods on health.

Among the research villages, fish in the coastal villages and milk in the highland (Chap. 4) were consumed at relatively high levels. A variety of wild animals and insects were also eaten in Malolo village, located in the inland Lindi region. Although bush meat needs to be cooked thoroughly and caution is needed in its preparation to avoid health hazards, it can also be a source of protein.

14.2.2 Changing Dietary Patterns: Intake of Vegetables Associated With Good Health But Decreased by Purchasing Foods

Regarding changing dietary patterns, the modernization of dietary patters was especially seen in Dar es Salaam and to some extent in the coastal area (Lindi region) in this book, in agreement with previous research (Keding, 2016; Keding et al., 2011). Excessive intake of oil, sugar, and salt was seen in those who help others with money in Iringa. The consumption pattern of a frequent intake of tea, which is a typical purchase commodity in the research area, was coupled with a high intake of staple foods but a low intake of green vegetables (Chap. 1). This pattern implies that purchasing power ensures the quantity of food but can be detrimental to a balanced diet, decreasing green vegetable intake.

The results of Chap. 4 also provided evidence that rural people tended to have a better balance of foods during the lean times in the rainy season, rather than when staple food was abundant. The analysis in Iringa further confirmed that frequent intake of vegetables was associated with positive physical health (Chap. 8). This finding takes us back to the traditional dietary pattern with an emphasis on green vegetables.

14.2.3 Mutual Assistance in Food Associated With Good Health But Not Money

In previous research in Zambia, perceptions of food and money transactions were clearly differentiated (Sugiyama, 2007). Further research in Tanzania on child mortality in Dodoma, Lindi, and Zanzibar provided evidence that children who were able to receive shared food in times of shortage had higher possibilities of survival, but such an association was not seen in assistance through money (Sakamoto, 2020). This book further provided cases in which trust and providing food were related to good health in a Muslim village in Lindi (Chaps. 6 and 9).

However, mutual assistance in money is related to poor physical and mental health in various villages (Chap. 6). Food assistance in a relatively food-ample village in Iringa was also associated with low physical health (Chap. 6). The findings confirmed the differences in mutual food and monetary assistance as implied in previous research but also revealed varied implications in a food-ample village. Mutual food assistance in relatively traditional and low-production villages may have a positive impact on the people. However, relying on and being relied on for money or relying on others for food when others have ample food may be a sign of destitution associated with a negative health evaluation.

14.2.4 African Leafy Vegetables as the Reason for the "Poor" to Be in Good Health in a Semiarid Agro-Pastoral Village

The association of wealth and mutual relations with health indicated interesting results (Chap. 6). The fact that the "poor" reported better physical health can be related to the indigenous dietary pattern classified as the healthy "traditional-inland" dietary pattern by Keding et al. (2011). In semiarid agro-pastoral societies, the relatively "poor" families have dietary patterns with an emphasis on staple foods and green leafy vegetables, also confirmed in Chaps. 2 and 3, although not as evident in Chap. 12.

Our findings indicated that people who had a frequent intake of wild foods in the rainy season had good health (Chap. 10). Moreover, a nutrition analysis of African leafy wild vegetables that were the main wild foods of the season was performed (Chap. 13). *C. hirta*, which has not been as thoroughly studied as *C. gynandra* (Agea et al., 2014), exhibited higher calcium and iron contents. *I. obscura* also exhibited a high iron content, up to 100 times that of cultivated sweet potato leaves (Awol, 2014).

14.3 Implications and Recommendations From the Findings

Based on the findings of the book, the following implications and recommendations can be put forward.

1. Promotion of vegetable intake

   Vegetable intake in general was also highly associated with health; therefore, its intake should be promoted.

(a) Promotion of wild vegetable intake

Where available, especially in semiarid areas where high iron, calcium, and protein are expected, wild vegetable intake should be promoted. Information on nutritional value should be widely shared to promote knowledge of nutritional value, which can prevent anemia in pregnant women, among other health benefits.

(b) Cultivation of green vegetables

Since green vegetable intake was associated with the cultivation of vegetables (Chap. 3), cultivation of green vegetables can be promoted where possible to promote vegetable intake.

2. Diverse strategies to increase animal and fish protein intake

   Intake of animal and fish proteins was associated with QOL, and this intake was reliant on the endowment in each area: fish on the coast, milk in the highlands, and wild animals in the inland southeast. Strategies to increase animal and fish populations should be diverse, depending on each environment. Livelihood strategies to increase income would also contribute to increased animal and fish protein intake but should go hand in hand with Recommendation 3(c) to prevent the transition to an unhealthy diet.
3. Further research and dissemination of the results

(a) Further research on wild foods and the dissemination of the results

The potential of the variety of wild foods has been indicated as one of the findings. Further research on the variety of wild foods utilized in various locations along with their health implications should be performed, and the results should be disseminated for utilization if healthy and environmentally sound.

(b) Further research on pulses and the dissemination of the results

Pulses are a common and valuable protein when animal or fish protein is unavailable. While the pilot research indicated the negative effects of pulses on school children's health, further research on their health implications should be pursued. Furthermore, knowledge on the appropriate preparation of pulses should be disseminated to avoid health hazards.

(c) Dissemination of information on healthy foods and unhealthy foods and the enabling environment

In response to changing dietary patterns, precise information on healthy foods and unhealthy foods should be disseminated to promote health for both urban and rural populations. Excessive intake of sugar, oil, and salt should be prevented. For the urban population, reasonable urbanization policies by the government should ease the movement of people to allow them to spend more time on the preparation of healthy foods.

4. Recognizing community mutual food and monetary assistance and its diversity and limits

Mutual food assistance in some villages was positively associated with good health, but not in all villages. On the other hand, financial assistance was negatively associated with health. While mutual assistance should be respected and promoted where functioning, policies and external interventions should also recognize its diversity and limitations in the respective contexts.

The above are based on the findings of the book but are not exhaustive measures to improve the situation. However, the realization of even some of the recommendations would be a great step in improving the nutrition and health situation of the people of Tanzania.

14.4 Conclusions and Recommendations

This book provides vital information on malnutrition, wealth, indigenous and traditional foods, wild foods, social and mutual relationships, and health. Every year, millions of people, including children under 5, lose their lives due to malnutrition; as a result, more attention should be placed on developing effective solutions to combat the problem. With a high prevalence of undernutrition and rising obesity, the situation of malnutrition in developing countries, especially in sub-Saharan Africa, is an excellent example of the double burden of the disease. Diet-related noncommunicable diseases (NCDs) are exacerbated by both situations. The term double burden of malnutrition (DBM) needs to be promoted as a "new paradigm," acknowledging that treating or preventing nutritional excesses separately from deficiencies is no longer practical given that most countries have been addressing both issues at the same time (Shrimpton & Rokx, 2012). However, currently, both the local and global communities struggle to treat and/or prevent the DBM because it is closely linked to many other diseases, particularly NCDs, which are major causes of mortality. To attain universal health coverage and achieve the Sustainable Development Goals (SDGs), there must be a strong mechanism to bring attention to the DBM as a key contributor to the "double burden of disease."

To solve the problem of the DBM, it is strongly recommended that policies be adapted to support the treatment and prevention of nutritional deficiencies and the DBM. Tanzania, where malnutrition is widespread and NCDs are on the rise, has decentralized many of its food and health policies, but little is known about how the country views the DBM. The country should establish both short-term and long-term plans and policies to encourage better diets and, more broadly, the sustainable growth of food and agricultural systems from farm to table.

A better understanding of nutritional transition and DBM problems in rural areas is important for planning rural food and nutrition policies. This is especially true in Africa, where many poor and undernourished people still reside in rural areas. Therefore, supporting food and agriculture through these policies has the potential to lead to changes in the accessibility of various foods, such as indigenous and wild foods, and the affordability of healthy diets, which in turn can impact dietary patterns.

The prevention of obesity/diet-related NCDs, integrated nutrition interventions for social welfare, agriculture and supply chains for healthy foods, food environment policies, and innovation should all be prioritized in efforts to improve DBM-related policy (Thow et al., 2020).

Despite the high prevalence of malnutrition, the issue has not spurred enough political action and has not been given sufficient attention in Tanzania's development plans, such as the 5 Year Development Plan 2012–2017 and the Tanzania Development Vision 2025 (United Republic of Tanzania, 2012).

There is an excellent paper developed by United Republic of Tanzania (2012) on the nutrition policy mapping effort to assess relevant policies and legislative instruments, including institutional arrangements pertinent to policy implementation in addressing nutrition concerns in Tanzania. In this work, 33 policy documents and 12 strategies were reviewed. Most of the policies and strategies reviewed (approximately 24%) had some policy commitments that were action oriented and regularly addressed nutrition-related concerns. The work discovered that the nutrition issues that were most frequently discussed in the reviewed policies were related to diseases and food insecurity. Additionally, the majority of men, youth, and the elderly were mostly ignored in favor of children and women. The observed weaknesses were the absence of monitoring and assessment, the lack of key stakeholders' comprehension of the impact of various sectors on nutrition, and the lack of cross-sectoral cooperation during policy formation and implementation (United Republic of Tanzania, 2012). There are also gaps in the reviewed policies that relate to the current nutrition situation because they were developed approximately 20 years ago. These gaps include issues with overweight, noncommunicable diseases, and nutrition problems related to climate change and HIV/AIDS (United Republic of Tanzania, 2012).

Effective DBM treatment/prevention regulations and policies can encourage stakeholders to undertake appropriate measures. In fact, the lack of suitable legislation, regulations, and policies in most communities in developing countries contributes to the existing low level of understanding of the causes and effects of nutritional transition and the DBM in those nations. The issue of nutritional transition and DBM treatment and preservation has drawn the attention of several development agencies, academic institutions, governments, nongovernmental organizations, and other entities in poor nations, particularly in Africa. As a result, there is an expanding body of information and literature on the nutritional transition in relation to the DBM. From this literature, it is clear that efforts to manage and prevent the issue do not use integrative or holistic approaches. As a result, the current efforts are having a negligible influence; it has not been demonstrated that utilizing or administering an individual treatment can effectively treat and prevent the DBM. Therefore, this book recommends bringing all stakeholders together and emphasizing the application of holistic approaches in solving the challenge. Strong policies and opinions from politicians seem to be very important in the treatment and prevention of the challenge of the DBM.

References

Agea, J. G., Kimondo, J. M., Woiso, D. A., Okia, C. A., Obaa, B. B., Isubikalu, P., Okullo, J. B. L., Obua, J., & Teklehaimanot, Z. (2014). Proximate composition, vitamin C and beta-carotene contents of fifteen selected leafy wild and semiwild food plants (WSWFPs) from Bunyoro-Kitara Kingdom, Uganda. *Journal of Natural Product and Plant Resources, 4*(3), 1–12.

Alphonce, S., Kaale, L. D., Millinga, F., & Rweyemamu, L. M. P. (2020). Enrichment of fermented cassava meal 'mchuchume' with micronutrient ingredients from soya bean flour and *Moringa oleifera* leaves powder. *Journal of the Science of Food and Agriculture, 101*, 3575–3581.

Awol, A. (2014). Phytochemical screening, proximate and mineral composition of sweet potato leaves grown in Tepi Provision, south–west of Ethiopia. *Science, Technology and Arts Research Journal, 3*(3), 112. https://doi.org/10.4314/star.v3i3.19

Cochrane, N., & D'Souza, A. (2015). *Measuring access to food in Tanzania*. USDA Economic Research Service. Retrieved October 23, 2022, from https://www.ers.usda.gov/webdocs/publications/43932/51864_eib135.pdf?v=2057

Kaale, L. D., Siddiq, M., & Hooper, S. (2022). Lentil (*Lens culinaris* Medik) as nutrient-rich and versatile food legume: A review. *Legume Science, 3*(2), 1–11. https://doi.org/10.1002/leg3.169

Keding, G. (2016). Nutrition transition in rural Tanzania and Kenya. In H. K. Biesalski and R. E. black (Eds.), *Hidden hunger. Malnutrition and the first 1,000 days of life: Causes, consequences, and solutions. Nutrition transition and nutritional deficiencies in low-income countries*, Basel, Karger, World Rev Nutr Diet. 115, 61–74. https://doi.org/10.1159/000442073

Keding, G. B., Msuya, J. M., Mass, B. L., & Krawinkel, M. B. (2011). Dietary patterns and nutritional health of women. *Food and Nutrition Bulletin, 32*(3), 218–226. https://doi.org/10.1177/156482651103200306

Sakamoto, K. (2020). *Factors influencing child survival in Tanzania: Comparative analysis of diverse deprived rural villages*. Springer.

Shrimpton, R., & Rokx, C. (2012). *The double burden of malnutrition: A review of global evidence*. Health, Nutrition and Population (HNP) Discussion Paper. The International Bank for Reconstruction and Development/The World Bank. Retrieved June 4, 2023, from http://documents.worldbank.org/curated/en/905651468339879888/The-double-burden-of-malnutrition-a-review-of-global-evidence

Sugiyama, Y. (2007). 'Path for money', 'path for food', and 'path for respect' [in Japanese]. In N. Haruka (Ed.), *Money and resources* (pp. 147–187). Kobundo.

Thow, A. M., Farrell, P., Helble, M., & Rachmi, C. N. (2020). *Eating in developing Asia: Trends, consequences, and policies*. Background paper for Asian Development Outlook Update 2020, Asian Development Bank. Retrieved February 1, 2023, from https://www.adb.org/sites/default/files/institutional-document/633886/adou2020bp-eating-developing-asia-trends.pdf

United Republic of Tanzania. (2012). *Nutrition policy mapping for Tanzania*. Retrieved March 1, 2023, from https://tanzania.savethechildren.net/sites/tanzania.savethechildren.net/files/library/Policy%20Mapping%20Consultancy%20%20Report%20%20final.pdf

Index

K. Sakamoto et al. (eds.), *Changing Dietary Patterns, Indigenous Foods, and Wild Foods*, https://doi.org/10.1007/978-981-99-3370-9

E

F

Q

R