Ageing International (2023) 48:918–941
https://doi.org/10.1007/s12126-022-09510-9

Factors Associated with Food Insecurity among Older Adults in India: Impacts of Functional Impairments and Chronic Diseases

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Accepted: 9 October 2022 / Published online: 29 October 2022

Abstract

Food security is an important agenda in MDG goals for people of all age groups irrespective of socio-economic strata in all developing and developed countries. For India, with increasing hunger index, provision of food security among older adults comes out to be a rising concern and matter of discussion under hunger eradication programmes and policies. The study concentrated on prevalence of food insecurity among population aged 60 and above in India and their associated health factors controlling the level of food insecurity. The data used for the research is taken from a nationally representative survey, Longitudinal Ageing Study in India (LASI), Wave I (2019–2020) with a sample of 31,464 people aged 60 and above all over India. The outcome variable of food insecurity is made with composite scores from 5 sets of questions and made a binary variable of whether the respondent is food secure or insecure. Descriptive and bivariate analysis are performed to understand the correlation between the food insecurity and associated explanatory variables, with special focus on various types of functional impairments and chronic diseases. Through binary logistic regression models, the likelihood of food insecurity under different vulnerable conditions are analysed. The result describes 10.6% of older population aged 60 years and above of India experience food insecurity especially in rural areas (12.6%). Older adults living alone, in rural areas, with poor household income, with multimorbidity and functional impairments are more susceptible to be food insecure in India. With increasing number of functional limitations, the likelihood of being food insecure increases around 1.6 times. While presence of multimorbidity increases food insecurity; individual diseases like diabetes and hypertension negatively affects food insecurity among older adults.

Keywords Food Insecurity · Functional Impairment · Multimorbidity · Older adults

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Introduction

As India's population grows, its expanding share of older adults is particularly notable. Currently, the growth rate of the number of older individuals (aged 60 and above) is three times higher than that of the population as a whole (Giridhar et al., 2014). As older population increases in size, accurate assessments of the extension of food insecurity become more essential for public health (Wolfe et al., 2003). Food insecurity is a complex phenomenon defined as "the limited or uncertain availability of nutritionally adequate and safe foods, or the limited or uncertain ability to get appropriate foods in socially acceptable ways" (Anderson, 1990). While over-nutrition is becoming a major public health concern in many industrialised nations (Seidell & Halberstadt, 2015), the majority of low- and middle-income countries continue to struggle with hunger and malnutrition (FAO, 2017). Hunger today affects about 11% of the world's population, and by 2050, the world will need to feed an additional 2.3 billion people (FAO, 2017).

Ensuring food security was one of the Millennium Development Goals (MDGs) of the United Nations, which sought to cut the rate of extreme food insecurity in half by the year 2015 (UNDP, 2000). The 2015 report on progress towards the MDGs target 1 to halve the proportion of people who suffer from hunger between 1990 and 2015 (UNDP, 2015) indicated that in the developing world, food insecurity dropped from 23.3 percent in 1990–91 to 12.9 percent (projected) in 2014–16. (UNDP, 2015). Though the degree of food insecurity has been dropping in most countries, it has stayed at a relatively high level in South Asia (UNDP, 2015). Furthermore, the pace of eradication of food insecurity was slow, and as a result, it failed to achieve the international target by the end of 2015 (FAO, 2015). Despite the high economic growth and significant improvements in agricultural production, India had the "second-highest estimated number of undernourished individuals in the world" from 2003–04 to 2012–13. (FAO, 2015, p. 15; Government of India, 2015, 2016). According to the State of Food Insecurity in the World (2012), India has around 217 million people who are undernourished (McGuire, 2013). In 2010, India's Global Hunger Index (GHI) was 24.1, putting it in the "alarming" category (ranking 67, significantly below neighbouring nations such as China and Pakistan) (Grebmer et al., 2010).

Food insecurity in older persons is a multifaceted phenomenon that is linked to a number of negative nutrition- and non-nutrition-related outcomes that may have an impact on the older population's health and well-being (Lee et al., 2010). It has been found to have a negative influence on an individual's health and quality of life, both directly and indirectly (Stuff et al., 2004). Food insecurity among older adults comprises not only limited food availability, and accessibility but also altered food use (Sengupta, 2016). Given the four essential characteristics of food security: availability, accessibility, usage, and stability, older persons are one of the most susceptible demographic groups, since their unique vulnerability across the four dimensions of food security may limit their ability to use food (Hall & Brown, 2005). Their individual vulnerabilities imply that they confront a variety of issues, ranging from difficulties in finding food that meet their needs,

to acquiring access to food, to their capacity to participate in the preparation, eating, and maintaining an acceptable diet (Quandt et al., 1997, 1998).

Food insecurity among older adults is caused by more than just a lack of financial resources. Functional impairment, homelessness, loneliness, gender, and poor health have statistically significant associations with food insecurity. These links suggest that differences in food consumption between older and younger people should be taken into account. These important risk factors for food insecurity are more likely to occur together in older populations, resulting in a much-increased risk of food insecurity (Bishop & Wang, 2018; Dean et al., 2020; Fernandes et al., 2018; Jih et al., 2018; Laraia, 2013; Lee & Frongillo, 2001; Lee et al., 2011; Quine & Morrell, 2006; Vilar-Compte et al., 2016). The health characteristics of older adults differ from other age groups. Approximately 23% of the global burden of disease is attributed to ailments that affect the older adults; chronic diseases are the main contributors to this excessive load (WHO, 2002). Age and chronic conditions increase the risk of developing a functional limitation which could impact an individual's ability to leave the house and get support for food (Dunlop et al., 2002). The term "functional limitation" refers to a person's capacity to do actions or activities that are essential to daily living. Physical limits (PL), basic activities of daily living (BADL), and instrumental activities of daily living (IADL) are the three primary categories of tasks and skills. Functional limits are regarded to be a forerunner to disability in the disablement process, as moderate limitations indicate future severe restrictions and, eventually, disability (Boult et al., 1994; Dunlop et al., 2002; Jette et al., 1997). Older adults who are food insecure exhibit restrictions in daily activities that are comparable to those of food-secure seniors fourteen years older (Gundersen & Ziliak, 2015). Similarly, Individuals who are food insecure have a 46 percent higher chance of becoming high-cost health care users in the future than those who are food secure (Fitzpatrick et al., 2015). Many low-income older persons with various chronic diseases and limited financial means may be forced to choose between basic food and healthcare needs, putting their food, medical care, and prescription needs at risk (Bengle et al., 2010; Sullivan et al., 2010).

Though various studies have been conducted to assess food insecurity at the global level, the literature is limited as far as India is concerned (Gopichandran et al., 2010; Nord, 2004; Oluwole & Adeola, 2012; Ray et al., 1997; Willows et al., 2009). For Indian scenario, little is known about the characteristics of food insecurity in older adults, whose numbers and proportions are expected to increase dramatically in near future. Taking all this into consideration, the present study is conducted with the objective of documenting the factors determining the food insecurity among older adults in India, with special emphasis on functional impairment and presence of chronic diseases.

Methods

Data Source

The data for the study, has been taken from Longitudinal Ageing Study in India, (LASI wave I) as a cross-sectional analysis. It is a nationally representative data

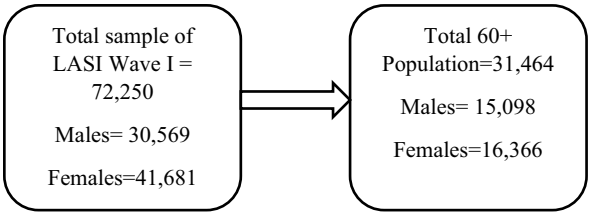

Fig. 1 Flow Chart of Sample Selection

for adults aged 45 and above, conducted by International Institute for Population Sciences in collaboration with Harvard T.H Chan School for Public Health and University of Southern California in the 2017–2018. LASI is India's first comprehensive survey, which includes demographics, household economic status, chronic health conditions, functional health, mental health (cognition and depression), retirement for people aged 45 years and above (IIPS et al., 2020). The survey contains well-developed measures for evaluating the impact of policy changes on health outcomes among India's older citizens. The respondents selected for the survey is above 45 years of age and information about their spouse is also collected irrespective of the spouse's age. The total number of households covered under the survey is 42,949 to interview 72,250 individuals among which 31,464 people are of age 60 and above (Fig. 1). In this present study, only the respondents, aged above 60, are taken into consideration. The survey covered 30 states and 6 union territories according to 2011 census of India except the state, Sikkim.

Explanatory and Outcome Variables

In the study, the outcome variable is binary in nature; whether the respondent is food secure or not. The survey has included a set of questions to understand individual's food availability within a household; according to Food and Nutrition Technical Assistance (FANTA) guideline (IIPS et al., 2020). The respondents were asked these following questions; if they had reduced or skipped their meals, did not eat enough food of their choice, whether they were hungry and did not eat a whole day, lost weight due to lack of food availability for a year prior to the survey. Those respondents who responded positive; "yes" for any of these questions, are termed as food insecure as they were devoid of food to some extent. All others are kept as food secure group.

Other associated background factors and health expenditure of the household were also collected from the same data source for the same time being. The major exposure variables; the physical impairment and limitations in instrumental activities or presence of chronic illness are categorical variable in nature whereas the proportion of monthly health care expenditure is taken as continuous variable. Daily life impairment was further divided into three separate components; *mobility restrictions*- whether the respondent has any difficulty in moving, walking or sitting at a stretch or any other mobile activities; *limitations in daily life activities* or ADL- in bathing, eating, dressing or using toilet and *limitation in instrumental activities of daily living* or IADL- i.e., cooking, taking medicines or shopping groceries etc. All the

three components are classified into 3 separate sections; respondents do not have any issue; respondents suffering from only one limitation and respondents having more than one limitations. The variable representing morbidity condition of the respondents is categorised as null, presence of any single chronic disease or multimorbid condition; and a set of chronic diseases (such as, diabetes, hypertension, cholesterol, cardio-vascular diseases, bone diseases etc.) was further analysed with the food insecurity outcome separately. Another most important exposure variable taken into study is the financial dependency of the respondents irrespective of household wealth; those respondents who were engaged in any economic activities whether they are covered with pension or not; if they are getting any financial assistance from other household members, their current working status; all the variables related to financial dependency is categorised into binary variables. The health expenditure is calculated as the proportion of total household expenditure and thus that is continuous in nature. Information related to food security scheme (Annapurna Scheme) coverage are also controlled in the analysis.

To explain the confounding factors in potential relationship between food insecurity and health and financial dependency, socio-economic and demographic characteristics of the respondents aged 60 and above are taken into consideration (Fig. 2). The variables are- Age group [60–69,70–79 & 80+], whether the respondent lives in rural or in urban area, education in completed years, gender [male, female], religion [Hindu, Muslim, others]; caste [SC, ST, OBC, Others] marital status [currently married, widowed, others], living arrangement- whether the respondent is living alone, with spouse and children or with others; number of children alive etc. Monthly per capita expenditure quintile and total number of household member are taken as household level variables. To understand the social connectedness the frequency of visit and talking to friends are compiled together into a binary variable; social isolation. Annapurna scheme is one of the important food security related schemes which is included in the analysis. Tobacco and alcohol consumption are considered as risk factors of the health behaviour and thus it is also controlled in the study.

Statistical Analysis

This research includes both descriptive and regression analysis. Prevalence of Food insecurity (Fi) was calculated according the background characteristics of the respondents. To justify whether the correlation between the covariates and food insecurity is significant or not, chi-square test has been done for the categorial variables and Kruskal–Wallis test is performed for continuous variables.

Model Used to Analyze the Data

Binary logistic regression was carried out between the background characteristics and the outcome variable. The equation of the logistic regression is as follows,

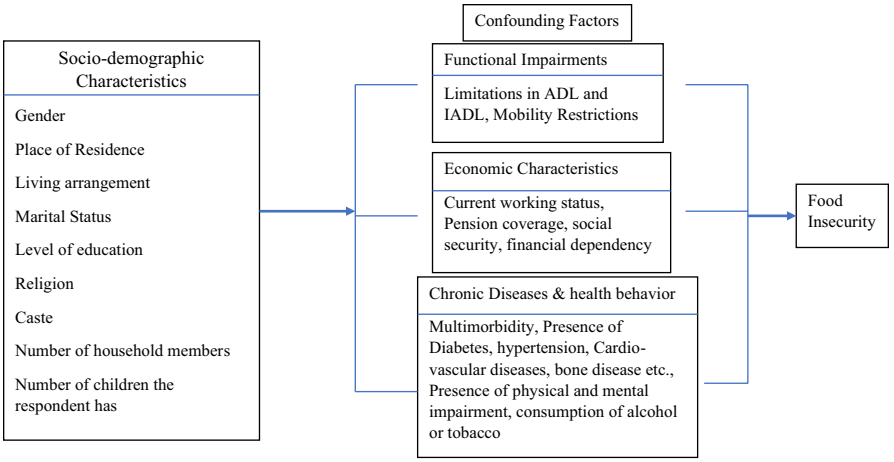

Fig. 2 Conceptual Framework

$$\text{Logit (Y)} = \ln\left({}^{p}/_{1-p}\right) = \text{a} + b_1X_1 + b_2X_2 \ldots \ldots \cdots + b_kX_k$$

where p is the probability of the event and a is the intercept, b is regression coefficients, is the set of predictors. All the statistical analysis is done using Stata-15 software.

Results

Demographic, Socio-economic and Health Profile of the Study Population

The demographic and socio-economic characteristics of the study population are shown in Table 1. The majority of the study participants, 58.9%, were in the 60–69 years age group, followed by 28.9% in the 70–79 years age group. Males (48.2%) and females (51.8%) are sharing almost equal share in the participants. 65.4% of the total sample population lives in rural areas. Out of the total participants, 53.7% are not educated, 61.6% are currently married and most of the respondents (73.2.2%) are Hindu by faith and OBC (Other Backward Classes) stands highest (37.1%) in the caste composition. The majority of older adults live with their spouses and children (86%). Most of the older adults were found to be not working (68.8%) but only 10.9% of them receive a pension, and 17% depends on financial assistance from other sources. 12% of the older persons suffers any kind of physical or mental impairment. 25% of older adults had multiple medical illnesses, and 29.8% had at least one chronic ailment, according to the study. Hypertension (35.8%), diabetes (23.1%) and bone disease (19.8%) are found three most prevalent ailments of older adults. This study revealed that more than 70% of the older adults have functional limitations especially walking limitations. It is

Table 1 Socioeconomic, Demographic and Health Profile of the Sample Population, India, 2017–18

Category	N = 31464	Percentage
Age Group		
60–69	18528	58.9
70–79	9111	28.9
80+	3825	12.2
Place of Residence		
Rural	20592	65.4
Urban	10872	34.6
Gender		
Male	15164	48.2
Female	16300	51.8
Education Level		
No Education	16887	53.7
Less Than 5 Years	3782	12.0
5–9 years	6019	19.1
10 or more years	4776	15.2
Marital Status		
Currently married	19399	61.6
Widowed	10622	33.8
Others	1443	4.6
Religion		
Hindu	23037	73.2
Muslims	3732	11.9
Others	4695	14.9
Caste		
SC	5393	17.1
ST	5329	16.9
OBC	11663	37.1
None of them	9081	28.9
Living Arrangement		
Alone	2171	6.9
With spouse & children	27070	86.0
With others	2223	7.1
MPCE Quintile		
Poorest	6373	20.3
Poorer	6513	20.7
Middle	6462	20.5
Richer	6221	19.8
Richest	5895	18.7
Covered with Pension		
Yes	3414	10.9
No	28050	89.1
Working Status		
Not Working	21635	68.8

Table 1 (continued)

Category	N = 31464	Percentage
Working	9829	31.2
Financial Help		
Receiving	5347	17.0
Not Receiving	26117	83.0
Physical/Mental Impairment		
Yes	3762	12.0
No	27702	88.0
Chronic disease		
No	14221	45.2
Single	9368	29.8
Multi-morbidity	7875	25.0
Hypertension		
No	20205	64.2
Yes	11259	35.8
Diabetes		
No	24205	76.9
Yes	7259	23.1
Cancer		
No	30224	96.1
Yes	1240	3.9
Chronic Lung Disease		
No	28241	89.8
Yes	3223	10.2
CVD		
No	28296	89.9
Yes	3168	10.1
Bone Disease		
No	25246	80.2
Yes	6218	19.8
Neurological Disorder		
No	29664	94.3
Yes	1800	5.7
Cholesterol		
No	29382	93.4
Yes	2082	6.6
Functional Limitation		
No	7613	24.2
Yes	23851	75.8
Limitations in Walking		
No	8741	27.8
Yes	22723	72.2
Limitation in ADL		
No	23863	75.8

Table 1 (continued)

Category	N = 31464	Percentage
One Limitation	3249	10.4
2 or more Limitations	4352	13.8
Limitation in IADL		
No	17080	54.3
One Limitation	3905	12.4
2 or more Limitations	10479	33.3
Physical Activities		
No	18557	59.0
Yes	12907	41.0
Social Isolation		
Isolated	21670	68.9
Not Isolated	9794	31.1
Annapurna Scheme		
No	26985	85.8
Yes	4479	4.2
Smoking		
No	19107	60.7
Yes	12357	39.3
Alcohol Consumption		
No	27718	88.1
Yes	3746	11.9

Source: Longitudinal Ageing study in India, Wave 1, 2017–18

SC Scheduled Caste, *ST* Scheduled Tribe, *OBC* Other Backward Caste, *CVD* Cardio-vascular Disease, *ADL* Activities in daily living, *IADL* Instrumental activities in daily living

observed that 13.8% have 2 or more limitation of activities of daily living (ADL) and one third (33.3%) of the older adults have of 2 or more instrumental activities of daily living (IADL). The study revealed that less than half (41%) of the older adults engage themselves in any kind of physical activities. Majority of the older adults (68.9%) are socially isolated. 39.3% older adults reported smoking and 11.9% have consumed alcohol.

Prevalence of Food Insecurity according to Background Characteristics of the Older Adults

The index of food insecurity is made up of four questions from the available dataset as discussed earlier; rural–urban difference in the prevalence is identified in all the questions (Fig. 3), where most of the persons has reduced their meal size; around 8% in urban and 3% in rural areas. 7% among the urban respondents reported to be

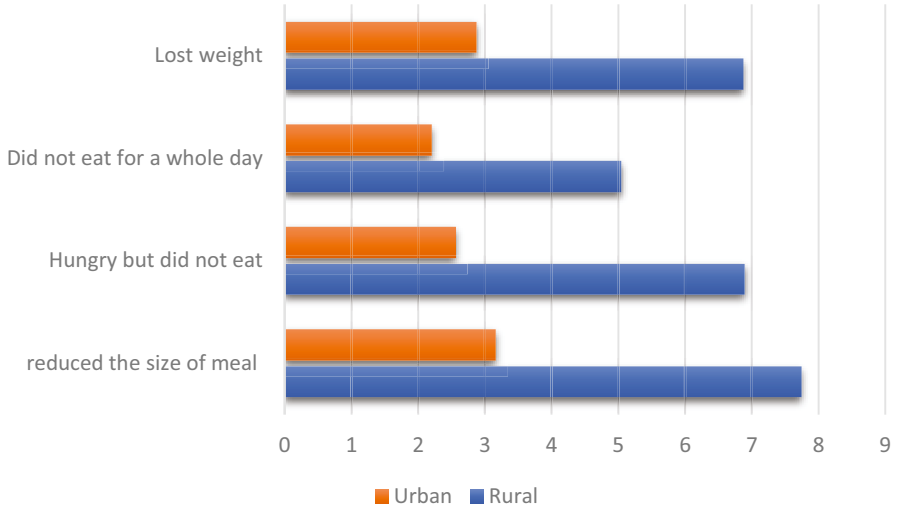

Fig. 3 Categories Comprises Food Insecurity among Older Adults in India, 2017–18

hungry but did not eat and 5% did not eat a whole day. Thus around 10% of the older adults aged 60 and above in India are identified to be food insecure. If we look into the state wise distribution of food insecurity (Fig. 4), Madhya Pradesh reports highest food insecurity (22%) which is much higher than the national average.

The prevalence of food insecurity by selected characteristics is outlined in Table 2. The overall prevalence of food insecurity among older adults (≥ 60 years) in India is 10.6% in 2017–18. Food insecurity is most prevalent among women (11.1%), those who are never married/divorced/separated (14.1%), and those who are living alone (21.7%). Rural–Urban differentials in prevalence of food insecurity are almost double. In rural areas the food insecurity is surprisingly very high (12.6%), higher than the national average. Food insecurity is more common among older persons who belongs to the poorest strata of monthly per capita expenditure quintile (MPCE) and who does not have a pension coverage (11.4%). The findings also reveal that older persons' physical/mental impairments are linked to a higher prevalence of food insecurity (18.6%). The prevalence of food insecurity follows a clear trend with respect to level of education, as highest levels of food insecurity is found to occur among non-educated (13.2%) older adults. Among the religious groups, Muslims reports a higher prevalence (14.1%) of food insecurity. On the other hand, no significant relationships were found between age, physical activities, alcohol consumption, and food insecurity status in this study. Food insecurity is found to be more common among older persons with functional limitations (11.9%). Socially isolated older adults also had a higher prevalence of food insecurity (11.3%). The study also found that older persons who did not participate in the Annapurna food supply scheme were more likely to be food insecure (11.9%).

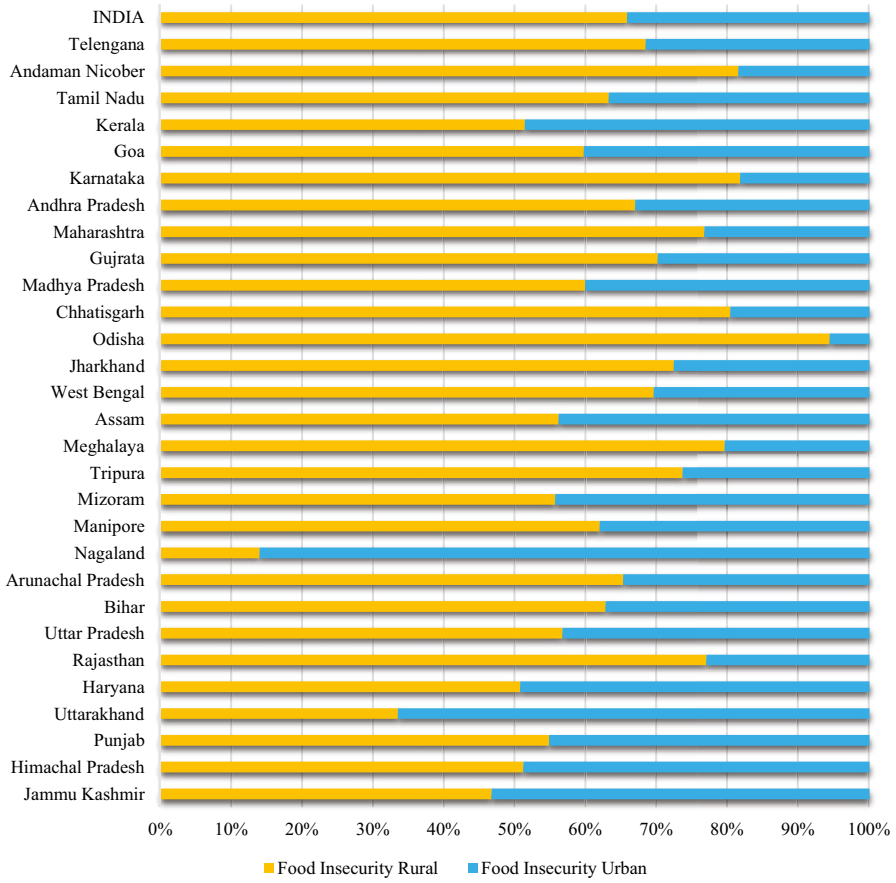

Fig. 4 State-Wise Prevalence of Food Insecurity among Older Adults in India, 2017–18

Association of Socio-economic, Demographic and Health-related Factors in Controlling the Food Insecurity among the Older Adults

Table 3 depicts the binary logistic regression of the factors associated with the food insecurity of older individuals in India. The analysis revealed that odds of reporting food insecurity is lower with increasing age (AOR: 0.851; 95% CI: 0.735, 0.984 for the age group 70–79 years). When compared to older individuals in rural areas, respondents in urban areas are (AOR: 0.687; 95% CI: 0.619, 0.762) 30% less likely to be food insecure. Females are 11% (AOR: 0.891; 95% CI: 0.802, 0.991) less likely to be food insecure than their male counterparts. There is a clear trend of decreasing food insecurity with increasing level of education. The older adults having 10 or more years of schooling are 46% (AOR: 0.542; 95% CI: 0.449, 0.653) less likely to be food insecure than respondents having no formal education. Older respondents who lived with their spouse and children are 40% (AOR: 0.590; 95% CI: 0.495, 0.702) less food insecure than those who lived alone. Being in the richest category, cuts down the risk

Table 2 Prevalence of Food Insecurity among Older Adults in India, 2017–18

Background characteristics	Prevalence of food insecurity	P value
Age group		
60–69	10.9	
70–79	11.2	0.720
80+	10.0	
Place of Residence		
Rural	12.6	
Urban	6.4	0.000
Gender		
Male	10.8	
Female	11.1	0.004
Education Level		
No Education	13.2	
Less Than 5 years	12.1	
5–9 years	8.1	0.000
10 or more years	4.1	
Marital Status		
Currently Married	9.9	
Widowed	12.4	0.000
Others	14.1	
Religion		
Hindu	10.6	
Muslims	14.1	0.000
Others	10.2	
Caste		
SC	14.6	
ST	13.2	
OBC	10.5	0.000
None of them	8.3	
Living Arrangement		
Alone	21.7	
With spouse	9.9	0.000
With others	15.3	
MPCE Quintile		
Poorest	13.9	
Poorer	11.4	
Middle	9.4	0.000
Richer	10.1	
Richest	9.1	
Covered with Pension		
Yes	4.0	0.000
No	11.4	

Table 2 (continued)

Background characteristics	Prevalence of food insecurity	P value
Working status		
Not Working	10.2	0.001
Working	12.4	
Financial Help		
Receiving	11.7	0.000
Not Receiving	10.8	
Physical/Mental impairment		
Yes	18.6	0.000
No	10.0	
Chronic disease		
No	11.1	0.133
Single	10.9	
Multimorbidity	10.5	
Hypertension		
No	11.5	0.000
Yes	9.8	
Diabetes		
No	11.5	0.000
Yes	7.4	
Cancer		
No	10.9	0.491
Yes	9.9	
Chronic Lung Disease		
No	10.7	0.040
Yes	13.1	
CVD		
No	10.9	0.394
Yes	11.0	
Bone Disease		
No	10.5	0.000
Yes	12.9	
Neurological Disorder		
No	10.8	0.000
Yes	15.1	
Cholesterol		
No	11.0	0.000
Yes	6.3	
Functional Limitation		
No	6.9	0.000
Yes	11.9	
Limitation in Walking		
No	7.7	0.000

Table 2 (continued)

Background characteristics	Prevalence of food insecurity		P value
Yes	11.9		
Limitation in ADL			
No	9.4		0.000
One Limitation	15.6		
2 or more Limitations	16.2		
Limitation in IADL			
No	8.1		0.000
One Limitation	10.9		
2 or more Limitations	14.2		
Physical Activities			
No	10.9		0.216
Yes	10.8		
Social Isolation			
Isolated	11.3		0.000
Not Isolated	9.9		
Annapurna Scheme			
No	11.9		0.029
Yes	9.3		
Smoking			
No	10.3		0.000
Yes	11.9		
Alcohol			
No	10.8		0.172
Yes	12.4		
	Mean	**SD**	
No of Children	4.1	2.4	0.023
No of Household Members	4.5	2.9	0.000
Proportion of Health Expenditure (in %)	1.5	5.9	0.039
Total		**10.6 (31464)**	

SC Scheduled Caste, *ST* Scheduled Tribe, *OBC* Other Backward Caste, *CVD* Cardio-vascular Disease, *ADL* Activities in daily living, *IADL* Instrumental activities in daily living

of food insecurity to half (AOR: 0.501; 95% CI: 0.434, 0.580). The analysis reveals that older adults with higher number of household members are 10% less (AOR: 0.930: 95% CI: 0.913, 0.946) likely to be food insecure. Older adults, who did not received pension are 1.5 times (AOR: 1.529: 95% CI: 1.210, 1.933) more likely to be food insecure than those who receives pension. Whereas, having any form of physical or mental impairment increases the likelihood of being food insecure 1.7 times (AOR: 1.718; 95% CI: 1.529, 1.931), presence of functional impairment increases the likelihood around 1.6 times (AOR: 1.588; 95% CI: 1.411, 1.788).

Table 3 Binary Logistic Regression of the Factors Associated with the Food Insecurity of the Older Adults in India, 2017–18

Background variables	Adjusted odds ratio	95% Confidence interval
Age group		
60-69[a]		
70–79	0.933	[0.848,1.028]
80+	0.851*	[0.735,0.984]
Place of Residence		
Rural[a]		
Urban	0.687***	[0.619,0.762]
Gender		
Male[a]		
Female	0.891*	[0.802,0.991]
Education Level		
No Education[a]		
Less than 5 years	0.904	[0.794,1.031]
5–9 years	0.711***	[0.627,0.807]
10 or more years	0.542***	[0.449,0.653]
Marital Status		
Currently Married[a]		
Widowed	1.015	[0.913,1.129]
Others	1.076	[0.825,1.402]
Religion		
Hindu[a]		
Muslim	1.384***	[1.216,1.574]
Others	0.907	[0.789,1.043]
Caste		
None[a]		
SC	1.406***	[1.234,1.603]
ST	1.046	[0.902,1.214]
OBC	1.155*	[1.034,1.290]
Living Arrangement		
Living Alone[a]		
Living with spouse & children	0.590***	[0.495,0.702]
Living with others	0.666***	[0.533,0.833]
MPCE Quintile		
Poorest[a]		
Poorer	0.738***	[0.657,0.831]
Middle	0.642***	[0.567,0.726]
Richer	0.560***	[0.491,0.638]
Richest	0.501***	[0.434,0.580]
No of Children	1.001	[0.982,1.021]
No of Household Members	0.930***	[0.913,0.946]
Covered with Pension		
Yes[a]		

Table 3 (continued)

Background variables	Adjusted odds ratio	95% Confidence interval
No	1.529***	[1.210,1.933]
Working Status		
Not Working[a]		
Working	1.090	[0.983,1.208]
Financial Help		
Not Receiving[a]		
Receiving	0.881*	[0.789,0.983]
Physical/Mental Impairment		
No[a]		
Yes	1.718***	[1.529,1.931]
Chronic Disease		
No[a]		
Single	1.055	[0.957,1.163]
Multi-morbidity	1.114*	[0.997,1.245]
Functional Impairments		
No[a]		
Yes	1.588***	[1.411,1.788]
Physical Activities		
No[a]		
Yes	1.039	[0.948,1.140]
Social Isolation		
Not Isolated[a]		
Isolated	1.110*	[1.007,1.224]
Annapurna Scheme		
Yes[a]		
No	0.984	[0.708,1.368]
Smoking		
No[a]		
Yes	1.088	[0.993,1.191]
Alcohol		
No[a]		
Yes	1.011	[0.874,1,169]
Proportion of Health Expenditure	0.996	[0.989,1.003]
Observations	31464	

SC scheduled Caste, *ST* Scheduled Tribe, *OBC* Other backward caste

Significance level @ p-value < 0.1 *; p < 0.05 **; p < 0.01 ***

[a]Reference category

To justify the association of physical limitation in controlling food insecurity the inference of adjusted odd's ratio after controlling other background characteristics has been depicted in Table 4. The older adults who have mobility restrictions are 1.2 times (AOR: 1.199: 95% CI: 1.072, 1.341) more likely to be food insecure than

Table 4 Adjusted Odds Ratio of Food Insecurity among Older Adults for Each of the 3 domains of Physical/Functional Limitations Compared to those without Physical/Function Limitations, 2017–18

Functional limitation	Adjusted odds ratio	95% Confidence interval
Limitations in Walking		
No[a]		
Yes	1.199***	[1.072,1.341]
Limitation in ADL		
No[a]		
One Limitation	1.348***	[1.178,1.542]
2 or more Limitations	1.520***	[1.351,1.711]
Limitation in IADL		
No[a]		
One Limitation	1.063	[0.921,1.226]
2 or more Limitations	1.423***	[1.285,1.576]
Observations	31,464	

ADL Activities in daily living, *IADL* Instrumental Activities of daily living

Significance level @ p-value < 0.1 *; p < 0.05 **; p < 0.01 ***; values are adjusted for other background characteristics

[a]Reference category

the older adults with no limitations. The respondents Having limitation in ADL and IADL increases food insecurity significantly; where having only one ADL limitation increases food insecurity 1.3 time (AOR: 1.348; 95% CI: 1.178, 1.542) and having two or more limitations increases the likelihood of food insecurity 1.5 times (AOR: 1.520, 95% CI: 1.351, 1.711), only one IADL limitation does not increases food insecurity that much but having two or more number of IADL limitations increases the risk of food insecurity 1.4 times (AOR: 1.423, 95% CI: 1.285, 1.576).

Table 5 depicts the background characteristics adjusted odds of food security for older individuals in India based on chronic health condition. Older persons with chronic bone/joint disease are 1.4 times (AOR: 1.369, 95% CI: 1.239, 1.512) more likely to feel food sinecure. Similarly, older persons with neurological disorders are 1.5 times (AOR: 1.478; 95% CI: 1.190, 1.836) more food insecure than their counterparts without the ailment. On the other hand, older adults with hypertension, diabetes and high cholesterol are less likely to be food insecure than their counterparts without these ailments.

Discussion

The present study attempts to understand the factors associated with the food insecurity and the impacts of functional impairments and chronic disease on food insecurity among the older population in India during 2017–18. The study identified that 10.6% older adults in India experiences food insecurity and place of residence, gender, living arrangement, household economic condition and respondent's economic dependency, physical-mental and functional impairment, chronic health condition

Table 5 Adjusted Odds Ratio for Food Insecurity of Older Adults by Chronic Disease Condition Categories in India, 2017–18

Chronic diseases	Adjusted odds ratio	95% Confidence interval
Hypertension		
No[a]		
Yes	0.907*	[0.827,0.995]
Diabetes		
No[a]		
Yes	0.772***	[0.675,0.883]
Cancer		
No[a]		
Yes	1.257	[0.812,1.945]
Chronic Lung Disease		
No[a]		
Yes	1.138	[0.984,1.316]
Cardio-Vascular Disease		
No[a]		
Yes	1.066	[0.906,1.255]
Chronic Bone/Joint Disease		
No[a]		
Yes	1.369***	[1.239,1.512]
Neurological/Psychiatric Problem		
No[a]		
Yes	1.478***	[1.190,1.836]
High Cholesterol		
No[a]		
Yes	0.654**	[0.495,0.865]
Observations	31,464	

Significance level @ p-value < 0.1 *; p < 0.05 **; p < 0.01 ***; values are adjusted for other background characteristics

[a]Reference category

are identified to be controlling factors for food insecurity. Older adults living alone, in rural areas, with poor household income, with multimorbidity and functional impairments are more susceptible to be food insecure in India. Food security or say, availability of food possesses a bi-directional relationship with health outcome (Johnson et al., 2021). In a way, unavailability of nutritious food has adverse effect on physical and mental health irrespective of age-group but in other way, presence of chronic disease, multi-morbidity and physical impairment controls the food availability or say in long term food security; where age has to play an important role (Lee & Frongillo, 2001; Laraia, 2013; Fernandes et al., 2018; Jih et al., 2018). Presence of any physical impairment can be a hindrance to food security; which is significantly positively proved in the analysis. Presence of any kind of physical or mental impairment increases the possibility of food insecurity 1.7 times among older adults; while

functional impairments increase the risk of food insecurity by 1.6 times but having multimorbidity raises the chance of being food insecure by 1.1 times. Thus, being immobile makes the older adults more vulnerable to access to food. With increasing number of limitations in daily life activities, the risk of being food insecure also increases. Urbanicity ensures less food insecurity among older adults and the rural urban difference in food insecurity is highly significant; in urban areas around 6.4% of the older adults are reported to have food insecurity whereas the prevalence is double in rural area (12.6%). Prevalence of high chronic diseases and inadequate health care access is one of major causes that creates food insecurity among the rural people along with lack of education and job opportunities aggravate the situation of food insecurity in rural areas (Upadhyay & Palanivel, 2011; Zhang et al., 2017). A qualitative study, conducted in Indiana, by Valliant et al. (2021) also supports that food insecurity among older adults is more prevalent in rural communities compared to urban and suburban (8.4% compared to 7.1% non-rural) even in a developed country like USA, though the difference is much lower. If physical impairments are to be taken into consideration, then physical limitation put bars on mobility and in rural areas door to door services for cooked food or raw material supply is not a common provision but for urban areas these facilities may act as a positive point for the older adults to limit food insecurity (Dunlop et al., 2002). Thus, living alone and isolated contributes positively to the risk of being food insecure (Burris et al., 2021). Though the present research has identified, having multimorbidity ensures food insecurity among older adults in India; separately having a single chronic disease like diabetes, hypertension and increased cholesterol etc. does not ensure food insecurity, on the contrary, having only diabetes indicates less likelihood of food insecurity. But some chronic diseases like bone disease or neurological or psychiatric disease increases the likelihood of food insecurity around 1.5 times and the relationship is highly significant. In support of this statement, an argument can be put here that, diabetes and hypertension or high cholesterol are mostly diagnosed in sedentary lifestyle which is highly prevalent in urban areas, but bone diseases are related to limitation of functional activities which limits the food access to increase food insecurity. Gupta and Bansal (2020) in their study also revealed the same that sedentary lifestyle among the urban areas make the urban population more susceptible to overweight and obesity, which significantly increases the risk of diabetes and high blood pressure (Wei, 2017). Other than health condition, this study establishes that economic dependency in older ages also play an important role in controlling food security among older adult population. At comparatively young ages, by any means, a respondent is capable of earn their daily food requirements which becomes very much tough with increasing age, fragile health and economic insecurity. In this research also older adults who are working even after age 60 years and above shows higher risk to be food insecure; those who does not have any work-related pension scheme shows higher likelihood of food insecurity. Respondents receiving financial help from informal sources; like children etc. shows reduced risk of food insecurity to some extent; 12% less likely to be food insecure. Financial dependency can have an added effect on health and health care access which leads to further health deterioration and more food insecurity. This is further supported by the study of Arranhado (2021) that the suspension of medication use due to financial difficulties was found

to be an independent predictor of food insecurity across all levels. Similarly, with increasing health care cost, expenditure on food is also affected and that leads to food alteration and prolonged health issues (Berkowitz et al., 2013; Dean et al., 2020; Tarasuk et al., 2015). Thus, health condition, health care cost and food insecurity are highly inter-dependent and are nesting a vicious cycle of increased health care cost and food insecurity for older adults in India.

Conclusion

The study only focuses on prevalence and associated factors of food insecurity among older adults which are distinct from those of other age groups, and the phenomenon of food insecurity is also peculiar in this group. Though the study pointed out clearly how different health condition changes the likelihood of food insecurity, there are some unexplained parts; i.e., reverse causality analysis; how far food insecurity causes occurrence of chronic disease especially like diabetes. The research finally concludes that better age friendly living conditions for the older adults with functional limitations, better provision of economic and social security is the crying need to reduce the food insecurity for this age group. Clearly, prevailing system of public distribution of food (PDS) and government social pension schemes are not enough to establish a food secure environment for future ageing society of India.

Author's Contribution RC and JK conceptualised the study; RC and AJ analysed the data; RC and JK interpreted and drafted the manuscript; RC, JK and AJ approved the manuscript.

Funding Authors declare that they have not received any funding for this work.

Data Availability The data used here "Longitudinal Ageing Study in India, 2017–18 – Wave 1" is publicly available and can be obtained from https://g2aging.org/.

Declarations

Conflict of Interest The authors declare no conflict of interest.

Informed Consent Not Applicable.

Ethical Treatment of Experimental Subjects (Animal and Human) Not Applicable.

References

Anderson, S. A. (1990). Core indicators of nutritional state for difficult-to-sample populations. *The Journal of Nutrition, 120*(suppl_11), 1555–1600. https://doi.org/10.1093/jn/120.suppl_11.1555

Arranhado, S. G. (2021). Food insecurity in older adults: much more than food - understanding it before taking action. *MOJ Gerontology & Geriatrics, 6*(1), 32–36. https://doi.org/10.15406/mojgg.2021.06.0026

Bengle, R., Sinnett, S., Johnson, T., Johnson, M. A., Brown, A., & Lee, J. S. (2010). Food insecurity is associated with cost-related medication non-adherence in community-dwelling, low-income older adults in Georgia. *Journal of Nutrition for the Elderly, 29*(2), 170–191. https://doi.org/10.1080/01639361003772400

Berkowitz, S. A., Baggett, T. P., Wexler, D. J., Huskey, K. W., & Wee, C. C. (2013). Food insecurity and metabolic control among US adults with diabetes. *Diabetes Care, 36*(10), 3093–3099. https://doi.org/10.1111/1475-6773.12730

Bishop, N. J., & Wang, K. (2018). Food insecurity, comorbidity, and mobility limitations among older US adults: Findings from the Health and Retirement Study and Health Care and Nutrition Study. *Preventive Medicine, 114*, 180–187. https://doi.org/10.1016/j.ypmed.2018.07.001

Boult, C., Kane, R. L., Louis, T. A., Boult, L., & McCaffrey, D. (1994). Chronic conditions that lead to functional limitation in the elderly. *Journal of Gerontology, 49*(1), M28–M36. https://doi.org/10.1093/geronj/49.1.M28

Burris, M., Kihlstrom, L., Arce, K. S., Prendergast, K., Dobbins, J., McGrath, E., Renda, A., Shannon, E., Cordier, T., Song, Y., & Himmelgreen, D. (2021). Food insecurity, loneliness, and social support among older adults. *Journal of Hunger & Environmental Nutrition, 16*(1), 29–44. https://doi.org/10.1080/19320248.2019.1595253

Dean, E. B., French, M. T., & Mortensen, K. (2020). Food insecurity, health care utilization, and health care expenditures. *Health Services Research, 55*, 883–893. https://doi.org/10.1111/1475-6773.13283

Dunlop, D. D., Manheim, L. M., Sohn, M. W., Liu, X., & Chang, R. W. (2002). Incidence of functional limitation in older adults: The impact of gender, race, and chronic conditions. *Archives of Physical Medicine and Rehabilitation, 83*(7), 964–971. https://doi.org/10.1053/apmr.2002.32817Get

FAO, Ifad, & WFP. (2015). The State of Food Insecurity in the World 2015. Meeting the 2015 international hunger targets: taking stock of uneven progress. FAO, Rome.

Fernandes, S. G., Rodrigues, A. M., Nunes, C., Santos, O., Gregório, M. J., de Sousa, R. D., Dias, S., & Canhão, H. (2018). Food insecurity in older adults: Results from the epidemiology of chronic diseases cohort study 3. *Frontiers in Medicine, 5*, 203. https://doi.org/10.3389/fmed.2018.00203

Fitzpatrick, T., Rosella, L. C., Calzavara, A., Petch, J., Pinto, A. D., Manson, H., Goel, V., & Wodchis, W. P. (2015). Looking beyond income and education: Socioeconomic status gradients among future high-cost users of health care. *American Journal of Preventive Medicine, 49*(2), 161–171. https://doi.org/10.1016/j.amepre.2015.02.018

Food and Agriculture Organization of the United Nations. (2017). *The future of food and agriculture: Trends and challenges*. Rome. http://www.fao.org/3/a-i6583e.pdf

Giridhar, G., Sathyanarayana, K. M., Kumar, S., James, K. S., & Alam, M. (2014). *Population ageing in India*. Cambridge University Press.

Gopichandran, V., Claudius, P., Baby, L. S., Felinda, A., & Mohan, V. R. (2010). Household food security in urban Tamil Nadu: A survey in Vellore. *The National Medical Journal of India, 23*(5), 278–280.

Government of India. (2015). Economic survey 2014-15. Retrieved December 6, 2021, from https://www.finmin.nic.in. at 12.40 p.m.

Government of India. (2016). Economic survey 2015-16. Retrieved December 6, 2021, from https://www.finmin.nic.in. at 12.40 p.m.

Grebmer, K. V., Ruel, M. T., Menon, P., Nestorova, B., Olofinbiyi, T., Fritschel, H., Yohannes, Y., Oppeln, C. V., Towey, O., Golden, K., & Thompson, J. (2010). *Global Hunger Index 2010. The challenge of hunger, focus on the crisis of child undernutrition* (ISBN: 978-0-89629-926-9). Welt Hunger Hilfe, International Food Policy Research Institute (IFPRI) & Concern Worldwide. Retrieved October 9, 2021, from https://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/4764/filename/4765.pdf

Gundersen, C., & Ziliak, J. P. (2015). Food insecurity and health outcomes. *Health Affairs, 34*(11), 1830–1839.

Gupta, S., & Bansal, S. (2020). Effect of Urbanization, Sedentary Lifestyle and Consumption Pattern on Obesity: An Evidence From India. *Sedentary Lifestyle and Consumption Pattern on Obesity: An Evidence From India* [Unpublished manuscript]. Centre for International Trade and Development, Jawaharlal Nehru University. Retrieved from https://www.doi.org/10.2139/SSRN.3741382

Hall, B., & Brown, J. L. (2005). Food security among older adults in the United States. *Topics in Clinical Nutrition, 20*(4), 329–338.

International Institute for Population Sciences, MoHFW, HSPH, & USC. (2020). *Longitudinal Ageing Study in India (LASI), Wave 1, 2017–18*. Mumbai: IIPS. India report.

Jette, A. M., Hamilton, B. B., Liang, M. H., & Whiteneck, G. G. (1997). Disablement outcomes in geriatric rehabilitation. *Medical care, 35*, JS28–JS47.

Jih, J., Stijacic-Cenzer, I., Seligman, H. K., Boscardin, W. J., Nguyen, T. T., & Ritchie, C. S. (2018). Chronic disease burden predicts food insecurity among older adults. *Public Health Nutrition, 21*(9), 1737–1742. https://doi.org/10.1017/S1368980017004062

Johnson, K. T., Palakshappa, D., Basu, S., Seligman, H., & Berkowitz, S. A. (2021). Examining the bidirectional relationship between food insecurity and healthcare spending. *Health Services Research, 56*(5), 864–873. https://doi.org/10.1111/1475-6773.13641

Laraia, B. A. (2013). Food insecurity and chronic disease. *Advances in Nutrition, 4*(2), 203–212. https://doi.org/10.3945/an.112.003277

Lee, J. S., & Frongillo, E. A., Jr. (2001). Nutritional and health consequences are associated with food insecurity among US elderly persons. *The Journal of Nutrition, 131*(5), 1503–1509. https://doi.org/10.1093/geronb/56.2.S94

Lee, J. S., Fischer, J. G., & Johnson, M. A. (2010). Food insecurity, food and nutrition programs, and aging: Experiences from Georgia. *Journal of Nutrition for the Elderly, 29*(2), 116–149. https://doi.org/10.1080/01639366.2010.480895

Lee, J. S., Johnson, M. A., Brown, A., & Nord, M. (2011). Food security of older adults requesting Older Americans Act Nutrition Program in Georgia can be validly measured using a short form of the US Household Food Security Survey Module. *The Journal of Nutrition, 141*(7), 1362–1368. https://doi.org/10.3945/jn.111.139378

McGuire, S. (2013). WHO, World Food Programme, and International Fund for Agricultural Development. 2012. The State of Food Insecurity in the World 2012. Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition. *Advances in Nutrition* (Bethesda, Md.), *4*(1), 126–127. https://doi.org/10.3945/an.112.003343

Nord, M. (2004). *Household food security in the United States, 2003 (No. 42)*. US Department of Agriculture, Economic Research Service.

Oluwole, S. I., & Adeola, O. O. (2012). Prevalence of food insecurity among rural communities and its effects on nutritional status of children (8–15 years) in Ondo state, Nigeria. *Journal of Medicine and Medical Sciences, 3*(1), 005–015.

Quandt, S. A., Arcury, T. A., & Bell, R. A. (1998). Self-management of nutritional risk among older adults: A conceptual model and case studies from rural communities. *Journal of Aging Studies, 12*(4), 351–368. https://doi.org/10.1016/S0890-4065(98)90024-X

Quandt, S. A., Vitolins, M. Z., DeWalt, K. M., & Roos, G. M. (1997). Meal patterns of older adults in rural communities: Life course analysis and implications for undernutrition. *Journal of Applied Gerontology, 16*(2), 152–171. https://doi.org/10.1177/073346489701600202

Quine, S., & Morrell, S. (2006). Food insecurity in community-dwelling older Australians. *Public Health Nutrition, 9*(2), 219–224.

Ray, S. K., Biswas, A. B., & Kumar, S. (1997). A comparative study of household food security and nutritional profile of underfive children in a rural and an urban community of West Bengal. *Indian Journal of Public Health, 41*(4), 136–147.

Seidell, J. C., & Halberstadt, J. (2015). The global burden of obesity and the challenges of prevention. *Annals of Nutrition and Metabolism, 66*(Suppl. 2), 7–12.

Sengupta, P. (2016). Food security among the elderly: an area of concern. *Journal of Gerontology & Geriatric Research*, *5*(4). https://doi.org/10.4172/2167-7182.1000320

Stuff, J. E., Casey, P. H., Szeto, K. L., Gossett, J. M., Robbins, J. M., Simpson, P. M., Connell, C., & Bogle, M. L. (2004). Household food insecurity is associated with adult health status. *The Journal of Nutrition, 134*(9), 2330–2335. https://doi.org/10.1093/jn/134.9.2330

Sullivan, A. F., Clark, S., Pallin, D. J., & Camargo, C. A., Jr. (2010). Food security, health, and medication expenditures of emergency department patients. *The Journal of Emergency Medicine, 38*(4), 524–528.

Tarasuk, V., Cheng, J., De Oliveira, C., Dachner, N., Gundersen, C., & Kurdyak, P. (2015). Association between household food insecurity and annual health care costs. *CMAJ, 187*(14), E429–E436. https://doi.org/10.1503/cmaj.150234

United Nations. (2000). *United Nations millennium declaration. a/Res/55/2, 9*. Retrieved December 12, 2021, from https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_55_2.pdf at 09.35 a.m.

United Nations. Department of Public Information. (2005). *The millennium development goals report 2005*. United Nations Publications. Retrived from https://mdgs.un.org/unsd/mdg/resources/static/products/goals2005/english.pdf

Upadhyay, R. P., & Palanivel, C. (2011). Challenges in achieving food security in India. *Iranian Journal of Public Health, 40*(4), 31.

Valliant, J. C., Burris, M. E., Czebotar, K., Stafford, P. B., Giroux, S. A., Babb, A., Waldman, K., & Knudsen, D. C. (2021). Navigating Food Insecurity as a Rural Older Adult: The Importance of Congregate Meal Sites, Social Networks and Transportation Services. *Journal of Hunger & Environmental Nutrition, 17*(5), 593–614. https://doi.org/10.1080/19320248.2021.1977208

Vilar-Compte, M., Martínez-Martínez, O., Orta-Alemán, D., & Perez-Escamilla, R. (2016). Functional limitations, depression, and cash assistance are associated with food insecurity among older urban adults in Mexico City. *Journal of Health Care for the Poor and Underserved, 27*(3), 1537–1554.

Willows, N. D., Veugelers, P., Raine, K., & Kuhle, S. (2009). Prevalence and sociodemographic risk factors related to household food security in Aboriginal peoples in Canada. *Public Health Nutrition, 12*(8), 1150–1156.

Wolfe, W. S., Frongillo, E. A., & Valois, P. (2003). Understanding the experience of food insecurity by elders suggests ways to improve its measurement. *The Journal of Nutrition, 133*(9), 2762–2769.

World Health Organization. (2002). Active ageing: A policy framework (No. WHO/NMH/NPH/02.8). World Health Organization.

Wei, O. Y. (2017). *The relationship between obesity, diabetes and the heart*. Retrieved January 17, 2022, from https://www.mountelizabeth.com.sg/healthplus/article/the-relationship-between-obesity-diabetes-and-the-heart

Zhang, X., Dupre, M. E., Qiu, L., Zhou, W., Zhao, Y., & Gu, D. (2017). Urban-rural differences in the association between access to healthcare and health outcomes among older adults in China. *BMC Geriatrics, 17*(1), 1–11. https://doi.org/10.1186/s12877-017-0538-9

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