

Rural-Urban Differences in Food Insecurity and Associated Cognitive Impairment Among Older Adults: Findings from a Nationally Representative Survey

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Research Article

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Abstract

Introduction

Due to rapid urbanization, Covid-19 pandemic, and increasing food prices, a higher rate of food insecurity has been observed in recent years in India. Thus, we aim to study the prevalence of food insecurity among older Indian adults and the association of food insecurity as a modifiable risk factor with late-life cognitive impairment.

Method

Data for this study was utilized from the recent release of Longitudinal Ageing Study in India which was conducted 2017-18. The total sample size for the present study is 31,464 older adults aged 60 years and above. Descriptive statistics along with cross-tabulation were presented in the present study. Additionally, binary logistic regression analysis was used to fulfil the objective of the present study.

Results

It was found that 7.7% of older adults in rural areas reduced their size of meals due to unavailability (urban, 3.2%), 41.2% of them did not eat enough food of their choice (urban, 38.3%), 6.9% were hungry but did not eat food (urban, 2.6%), 5.0% did not eat for whole day (urban, 2.2%), and 6.9% lost weight due to lack of food in their household (urban, 2.9%). It was found that older adults who did not have enough food of their choice had significantly higher odds of suffering from cognitive impairment in reference to their counterparts. Similarly, the older adults who were hungry but did not eat were 33% more likely to suffer from cognitive impairment in reference to their counterparts. Interaction model revealed that older adults who had food insecurity in rural areas had higher odds of cognitive impairment than older adults who had food insecurity in urban areas.

Conclusion

The results of the study highlight that the food security status in older adults may bring about greater challenges due to their limited economic resources. Interventions focusing on food security may have unintended positive impacts on late-life mental wellbeing as the older age is associated with higher cognitive deficits.

Introduction

Food insecurity refers to the unavailability of nutritionally adequate and safe foods or inability to acquire foods in socially acceptable ways [1]. Recent projections show that despite some progress, the world is not on track to achieve Sustainable Development Goal 2, Zero Hunger by 2030 [2, 3]. More than one in 9 of the world population do not get enough to eat and the prevalence of undernourishment is considerably high in developing countries [4]. Evidence also suggests that the food security status of the most vulnerable population groups is likely to deteriorate further [5, 6].

The linkage between food security and health conditions has been well-documented among different populations [7, 8], including older adults [9]. Current research suggests that household food insecurity is associated with adverse mental health outcomes across the lifespan [10, 11]. Also, there is increasing evidence that food insecurity is associated with decline in cognitive abilities among aging populations [12–15].

A growing body of literature suggests that food insecurity may magnify the existing socioeconomic disparities within populations which in turn may increase the risk of those who are vulnerable and influence their mental wellbeing [16]. The inability to intake food due to functional limitations and health problems may also result in higher risk of food insecurity among older population consequently leading to a decreased mental health status [17, 18]. However, the exact mechanisms linking food insecurity and cognitive impairment are not yet clear. A couple of studies suggest that the stress resulting from food insecurity may increase the risk of declining cognitive abilities. For example, elevated cortisol can lead to changes in the functions of brain and subsequent decline in cognitive abilities [19]. It has also been hypothesized that the increasing age being a risk factor, food insecurity may increase the risk of cognitive decline via stress, depression, or poor nutritional intake [20]. Poor diet on the other hand, has been associated with increased risk of cognitive decline and several vitamins have been shown to have a protective effect against dementia [21].

However, despite the fact that food insecurity is more common in poor resource settings, there are only few studies specifically on the association between food insecurity and cognitive impairment in low- and middle-income countries [13]. Also, due to rapid urbanization, Covid-19 pandemic, and increasing food prices, a higher rate of food insecurity has been observed in recent years in India [22–24]. Thus, we aim to study the prevalence of food insecurity among older Indian adults and the association of food insecurity as a modifiable risk factor with late-life cognitive impairment.

Methods

Data

Data for this study was utilized from the recent release of Longitudinal Ageing Study in India (LASI) wave 1 [25]. LASI is a full-scale national survey of scientific investigation of the health, economic, and social determinants and consequences of population aging in India, conducted in 2017-18. The LASI is a nationally representative survey of over 72000 older adults aged 45 and above across all states and union territories of India [25]. The main objective of the survey is to study the health status and the social and economic well-being of older adults in India. LASI adopted a multistage stratified area probability cluster sampling design to arrive at the eventual units of observation: older adults age 45 and above and their spouses irrespective of age. The survey adopted a three-stage sampling design in rural areas and a four-stage sampling design in urban areas. In each state/UT, the first stage involved the selection of Primary Sampling Units (PSUs), that is, sub-districts (Tehsils/Talukas), and the second stage involved the selection of villages in rural areas and wards in urban areas in the selected PSUs [25]. In rural areas,

households were selected from selected villages in the third stage. However, sampling in urban areas involved an additional stage. Specifically, in the third stage, one Census Enumeration Block (CEB) was randomly selected in each urban area [25]. In the fourth stage, households were selected from this CEB. The detailed methodology, with the complete information on the survey design and data collection, was published in the survey report [25]. The present study is conducted on eligible respondents aged 60 years and above. The total sample size for the present study is 31,464 older adults aged 60 years and above. The sample from rural areas was 20,725 and from urban areas it was 10,739.

Variable description

Outcome variable

Cognitive impairment was measured through five broad domains (memory, orientation, arithmetic function, executive function, and object naming). The description of these tests is given in the *supplementary material*. The cognitive impairment in our study is based on the different cognitive measures including: immediate (0–10 points) and delayed word recall (0–10 points), orientation related to time (0-4 points), and place (0-4 points), arithmetic ability based on serial 7s (0–5 points), computation (0-2) and backward counting from 20 (0–2 points), executive functioning based on paper folding (0-3) and pentagon drawing (0-1), and object naming (0-2). The overall score ranges between 0 and 43, and a higher score indicate better cognitive functioning. In our study, the respondents who received assistance during the cognition module were excluded from the analysis. The lowest 10th percentile is used as a proxy measure of poor cognitive functioning [25].

Explanatory variable

The main explanatory variables were derived from food security section of the LASI dataset. The five questions which were related to food security among older adults were:

1. In the last 12 months, did you ever reduce the size of your meals or skip meals because there was not enough food at your household? The variable generated using this question was “reduced the size of meals” and it was coded as 0 “no” and 1 “yes”.
2. In the last 12 months, did you eat enough food of your choice? Please exclude fasting/food related restrictions due to religious or health related reason. The variable generated using this question was “did not eat food of once choice” and it was coded as 0 “no” and 1 “yes”.
3. In the last 12 months, were you hungry but didn’t eat because there was not enough food at your household? Please exclude fasting/food related restrictions due to religious or health related reasons. The variable generated using this question was “hungry but did not eat” and it was coded as 0 “no” and 1 “yes”.
4. In the past 12 months did you ever not eat for a whole day because there was not enough food at your household? Please exclude fasting/food related restrictions due to religious or health related

reasons. The variable generated using this question was “did not eat for a whole day” and it was coded as 0 “no” and 1 “yes”.

5. Do you think that you have lost weight in the last 12 months because there was not enough food at your household? The variable generated using this question was “lost weight due to lack of food” as it was coded as 0 “no” and 1 “yes”.

The main stratifying variable for the present study was place of residence which was coded as rural and urban.

Individual factors

Age was coded as young old (60-69 years), old-old (70-79 years), and oldest-old (80+ years). Sex was coded as male and female. Educational status was coded as no education/primary not completed, primary, secondary and higher. Working status was coded as currently working, retired, and not working [26]. Marital status was coded as currently married, widowed and others. Others included divorced/separated/never married. Living arrangement was coded as living alone, living with spouse, living with spouse and children and living with others [27]. Social participation was coded as no and yes. Social participation was measured through the question “Are you a member of any of the organizations, religious groups, clubs, or societies? The response was coded as no and yes. Physical activity status was coded as frequent (every day), rare (more than once a week, once a week, one to three times in a month), and never. The question through which physical activity was assessed was “How often do you take part in sports or vigorous activities, such as running or jogging, swimming, going to a health centre or gym, cycling, or digging with a spade or shovel, heavy lifting, chopping, farm work, fast bicycling, cycling with loads”? [25].

Health factors

The probable major depression among the older adults with symptoms of dysphoria, calculated using the CIDI-SF (Short Form Composite International Diagnostic Interview) score of 3 or more. This scale estimates a probable psychiatric diagnosis of major depression and has been validated in field settings and widely used in population-based health surveys [25]. The lowest 10th percentile is used as a proxy measure for major depression among older adults. Self-rated health was coded as good which includes excellent, very good, and good whereas poor includes fair and poor [28]. Difficulty in ADL (Activities of Daily Living) was coded as no and yes. Activities of Daily Living (ADL) is a term used to refer to normal daily self-care activities (such as movement in bed, changing position from sitting to standing, feeding, bathing, dressing, grooming, personal hygiene, etc.) The ability or inability to perform ADLs is used to measure a person’s functional status, especially in the case of people with disabilities and the ones in their older ages [26]. Difficulty in IADL (Instrumental Activities of Daily Living) was coded as no and yes. Activities of daily living that are not necessarily related to the fundamental functioning of a person, but they let an individual live independently in a community. These tasks are necessary for independent functioning in the community. Respondents were asked if they were having any difficulties that were

expected to last more than three months, such as preparing a hot meal, shopping for groceries, making a telephone call, taking medications, doing work around the house or garden, managing money (such as paying bills and keeping track of expenses), and getting around or finding an address in unfamiliar places [29]. Morbidity was coded as no morbidity, 1 and 2+ [29].

Household factors

The monthly per capita expenditure (MPCE) quintile was assessed using household consumption data. Sets of 11 and 29 questions on the expenditures on food and non-food items, respectively, were used to canvas the sample households. Food expenditure was collected based on a reference period of seven days, and non-food expenditure was collected based on reference periods of 30 days and 365 days. Food and non-food expenditures have been standardized to the 30-day reference period. The monthly per capita consumption expenditure (MPCE) is computed and used as the summary measure of consumption [25]. The variable was then divided into five quintiles i.e., from poorest to richest. The variable objective socio-economic status was coded as low which includes poorest and poorer, middle which includes middle and high which includes richer and richest [30]. Religion was coded as Hindu, Muslim, Christian, and Others [31]. Caste was recoded as Scheduled Tribe, Scheduled Caste, Other Backward Class, and others [31]. The Scheduled Caste include “untouchables”, a group of the population that is socially segregated and financially/economically by their low status as per Hindu caste hierarchy. The Scheduled Tribes (STs) and Scheduled Castes (SCs) are among the most disadvantaged and discriminated socio-economic groups in India [32]. The OBC is the group of people who were identified as “educationally, economically and socially backward”. The OBC’s are considered low in the traditional caste hierarchy but are not considered untouchables. The “other” caste category is identified as having higher social status [33]. The regions of India were coded as North, Central, East, Northeast, West, and South [27].

Statistical analysis

Descriptive statistics along with cross-tabulation were presented in the present study. Proportion test was used to evaluate the significance level of differences in cognitive impairment among older adults from rural and urban place of residence [34]. Additionally, binary logistic regression analysis [35] was used to establish the association between the outcome variable (cognitive impairment) and food security among older adults in India.

The binary logistic regression model is usually put into a more compact form as follows:

$$\text{Logit [P(Y = 1)]} = \beta_0 + \beta * X + \epsilon$$

The parameter β_0 estimates the log odds of cognitive impairment for the reference group, while β estimates the maximum likelihood, the differential log odds of cognitive impairment associated with a set of predictors X, as compared to the reference group, and ϵ represents the residual in the model.

Variance inflation factor (VIF) was generated in STATA 14 [36] to check the multicollinearity and it was found that there was no evidence of multicollinearity in the variables used [37, 38].

Moreover, interaction effects [29, 39–42] were observed for food security variables and place of residence with cognitive impairment among older adults in India. Model-3 to model-7 in figure 3b provides adjusted estimates for interaction effects.

Results

Table-1 represents the socio-economic profile of older adults in India. It was found that about 77% of older adults were not educated in rural areas whereas in urban areas the percentage was 46.0%. There is higher percentage of older adults not working in urban areas (36.4%) than in rural areas (22.2%). Higher percentage of older adults in rural areas were living alone (6.3%) than in urban areas (4.1%). About 65.8% of older adult in rural areas were not involve in physical activity whereas the estimates were 77.4% in urban areas. Higher percentage of older adults in rural areas (9.6%) suffers from depression than in urban areas (6.3%). Higher percentage of older adult in rural areas (50.9%) report poor SRH in reference to older adults in urban areas (42.9%). About 51.7% of older adults in rural areas had difficulty in IADL in reference to 41.7% in urban areas. Higher percentage of older adult from urban areas suffers from two or more morbidities (35.4%) in comparison to older adults in rural areas (19.1%).

Figure-1 reveals that higher percentage of older adults in rural areas (7.7%) reduced their size of meals because there was not enough food at your household (urban, 3.2%). Higher percentage of older adults in rural areas (41.2%) did not eat enough food of their choice because there was not enough food at your household (urban, 38.3%). Similarly, higher percentage of older adults in rural areas (6.9%) were hungry but did not eat food because there was not enough food at your household (urban, 2.6%). Higher percentage of older adults in rural areas (5.0%) did not eat for whole day because there was not enough food at your household (urban, 2.2%). Higher percentage of older adults in rural areas (6.9%) lost weight due to lack of food at their household (urban, 2.9%).

Figure-2 represents the percentage of older adults suffering from cognitive impairment by place of residence in India. It was found that in all categories older adults from rural residence had significantly higher percentage of cognitive impairment.

Figure-3a represents plots for logistic regression estimates for cognitive impairment among older adults in India. Model-1 which reveals unadjusted estimates and it was found that older adults who reduced the size of the meal had 34% significantly higher likelihood to suffer from cognitive impairment than older adults who do not reduce their meal size. Older adults who do not had enough food of their choice had higher odds for cognitive impairment than older adults who had enough food of their choice. Older adults who reported that they did not eat when they were hungry had 54% significantly higher likelihood to suffer from cognitive impairment than their counterpart. Older adults who reported that they lost weight due to lack of food had higher odds for cognitive impairment in reference to their counterparts. Model-2 provide the adjusted estimates and it was found that older adults who did not had enough food of their choice

had significantly higher odds to suffer from cognitive impairment in reference to their counterparts. Similarly, the older adults who were hungry but did not eat food were 33% more likely to suffer from cognitive impairment in reference to their counterparts. The adjusted estimates along with other covariates can be found in Table-S1 (*supplementary file*).

Figure-3b presents the plots for interaction effects for cognitive impairment among older adults in India. Estimates for model-3 revealed that older adults who reduce their size of meal in rural areas were 61% significantly more likely to suffer from cognitive impairment in reference to the older adults who reduce their size of meal in urban areas. Similarly, the older adults who did not eat enough food of their choice in rural areas had significantly higher odds for cognitive impairment in comparison to older adults who did not eat enough food of their choice in urban areas. The older adults who were hungry or not eat for a whole day in rural areas had higher odds for cognitive impairment in reference to the older adults who were hungry or not eat for a whole day in urban areas respectively. However, the estimates were not significant. The older adults who lost their weight due to lack of food in rural areas were 76% significantly more likely to suffer from cognitive impairment in reference to the older adults who lost weight due to lack of food in urban areas.

Discussion

Due to increasing importance of food environment, there is a growing attention in the recent research towards the problems and challenges of hunger and the measures of food availability. Accordingly, a variety of methodologies including objective and self-perceived measures have been used to determine the availability and accessibility of food [43–45]. The current study using the respondent-based measures of food security found a substantially higher proportion of older population experiencing a reduced of lack of food availability and subsequent weight loss.

Further, in this sample of older population, most of the indicators of food insecurity were positively associated with cognitive impairment, independent of socio-demographic factors. This finding corroborates a previous study in which the authors found that food insecurity was associated with lower levels cognitive functioning among older adults, and that at more extreme levels of food insecurity, the magnitude of the association was greater [46]. Moreover, studies suggest that with lower intake of food, multiple processes in human bodies such as protein folding, degradation, and nutrient-sensing may get damaged [20, 47]. In the present analyses, the significant associations of multiple measures of food insecurity with cognitive impairment were observed even after adjusting for individual, health and household factors, suggesting food insecurity as an important social determinant that may contribute to cognitive decline in older ages. The results are also consistent with studies suggesting that food insecurity and hunger being biological and psychosocial stressors may potentially increase psycho-emotional problems particularly during older age [11].

Compared to older adults living in urban areas, those living in rural areas are found to be experiencing more health problems in multiple studies due to their inadequate access to health care services and

resources [48–50]. Again, several studies have reported that older population living in rural areas have limited access to food stores and wish away from their healthy food choices [51–53]. Rural living older individuals may also face physical immobility, lack of cooking skills, and lack of or limited supports for food and non-food products that can exacerbate the association between food insecurity and several mental disorders [54, 55]. Furthermore, randomized clinical trials have shown that supplementation of nutritious foods may improve cognitive function in older individuals [56, 57]. However, high intake of carbohydrate and macronutrients has been associated with higher risk of cognitive impairment [58]. Hence, further research is needed to explore the role of availability of particular food items that enhance the cognitive abilities in relation to food insecurity among residents in rural settings.

According to different rounds of National Sample Surveys, although food is accounted for the highest household expenditure, food expenditure on older adults has been decreasing over the time [59]. The urban poor are more likely to spend 60% more of their earnings on food than the rural poor [22]. In the present study, the results of interactive effects show that people aged ≥ 60 years not eating food of their choice and residing in urban areas had 2.26 times higher odds for cognitive impairment compared with those who had their choice of food and resided in urban areas. Long-term programs and multifaceted initiatives are needed to prevent food insecurity and address the poverty-related poor mental status among older population. The policies should also focus on connecting food insecure households especially those in rural areas to existing social services such as Public Distribution System in India.

The study had certain limitations. The data was cross-sectional in nature therefore how change in food insecurity lead to change in cognitive impairment in later lives could not be estimated. However, the study has its own strengths. Firstly, the cognitive impairment variable was measured using the standard scales. Secondly, the data is latest, therefore provides the current scenario among older adults in India. Additionally, the data is first of its type collected on pan India level.

Conclusion

The results of the study highlight that the food security status in older adults may bring about greater challenges due to their limited economic resources. Interventions focusing on food security may have unintended positive impacts on late-life mental wellbeing as the older age is associated with higher cognitive deficits.

Declarations

Competing interest

The authors declare that there is no competing interest

Funding

No funding was received for the study

Availability of data and material

The study uses a secondary data which is available on reasonable request through <https://www.iipsindia.ac.in/content/lasi-wave-i>

Consent for publication

Not applicable

Ethics approval and consent to participate

The survey agencies that conducted the field survey for the data collection have collected prior consent from the respondents. The Indian Council of Medical Research (ICMR) extended the necessary guidelines and ethics approval for undertaking the LASI survey.

Contributor statement

Conceived and designed the research paper: SS and MT, analysed the data: SS and MT, Wrote the manuscript: SS and MT, Refined the manuscript: SS and MT.

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Not applicable

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Tables

Table-1 Socio-economic profile of older adults in India, 2017-18

Background characteristics	Rural		Urban	
	Sample	Percentage	Sample	Percentage
Individual characteristics				
Age				
Young-old	12,139	58.6	6,268	58.4
Old-old	6,169	29.8	3,354	31.2
Oldest-old	2,417	11.7	1,117	10.4
Sex				
Male	10,045	48.5	4,835	45.0
Female	10,680	51.5	5,904	55.0
Education				
Not educated/primary not completed	15,986	77.1	4,937	46.0
Primary	2,069	10.0	1,511	14.1
Secondary	1,988	9.6	2,598	24.2
Higher	682	3.3	1,693	15.8
Working status				
Working	7,341	35.4	2,106	19.6
Retired	8,774	42.3	4,719	43.9
Not working	4,610	22.2	3,913	36.4
Marital status				
Currently married	13,017	62.8	6,315	58.8
Widowed	7,280	35.1	4,162	38.8
Others	427	2.1	262	2.4
Living arrangement				
Living alone	1,311	6.3	444	4.1
Living with spouse	4,455	21.5	1,883	17.5
Living with children and spouse	13,708	66.1	7,873	73.3
Living with others.	1,251	6.0	539	5.0
Social participation				

No	19,844	95.8	10,197	95.0
Yes	881	4.3	542	5.1
Physical activity				
Frequent	3,980	19.2	1,610	15.0
Rarely	3,101	15.0	813	7.6
Never	13,644	65.8	8,317	77.4
Health factors				
Depression				
No	18,271	90.4	9,774	93.7
Yes	1,945	9.6	662	6.3
Self-rated health				
Good	9,969	49.1	6,000	57.1
Poor	10,326	50.9	4,516	42.9
Difficulty in ADL				
No	15,625	75.4	8,190	76.3
Yes	5,100	24.6	2,549	23.7
Difficulty in IADL				
No	10,015	48.3	6,262	58.3
Yes	10,710	51.7	4,477	41.7
Morbidity				
No morbidity	10,926	52.7	3,558	33.1
1	5,840	28.2	3,380	31.5
2+	3,959	19.1	3,800	35.4
Household factors				
MPCE quintile				
Poorest	4,446	21.5	2,396	22.3
Poorer	4,608	22.2	2,197	20.5
Middle	4,375	21.1	2,207	20.6
Richer	3,932	19.0	2,117	19.7

Richest	3,364	16.2	1,822	17.0
Religion				
Hindu	17,309	83.5	8,497	79.1
Muslim	2,021	9.8	1,604	14.9
Christian	623	3.0	269	2.5
Others	772	3.7	369	3.4
Caste				
Scheduled Caste	4,572	22.1	1,220	11.4
Scheduled Tribe	2,125	10.3	325	3.0
Other Backward Class	9,213	44.5	5,056	47.1
Others	4,815	23.2	4,139	38.5
Region				
North	2,655	12.8	1,293	12.0
Central	4,920	23.7	1,533	14.3
East	5,678	27.4	1,573	14.7
Northeast	691	3.3	226	2.1
West	2,898	14.0	2,662	24.8
South	3,883	18.7	3,451	32.1
Total	20,725	100.0	10,739	100.0

Supplementary

Supplementary Material is not available with this version.

Figures

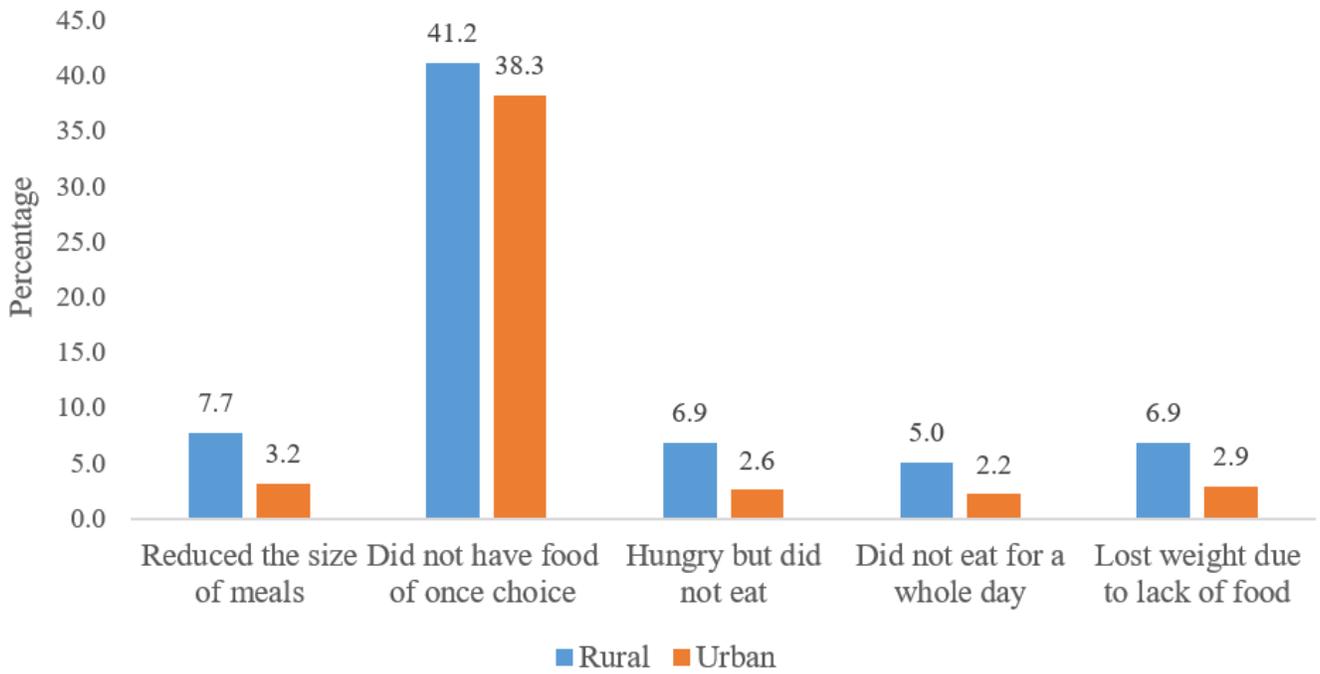
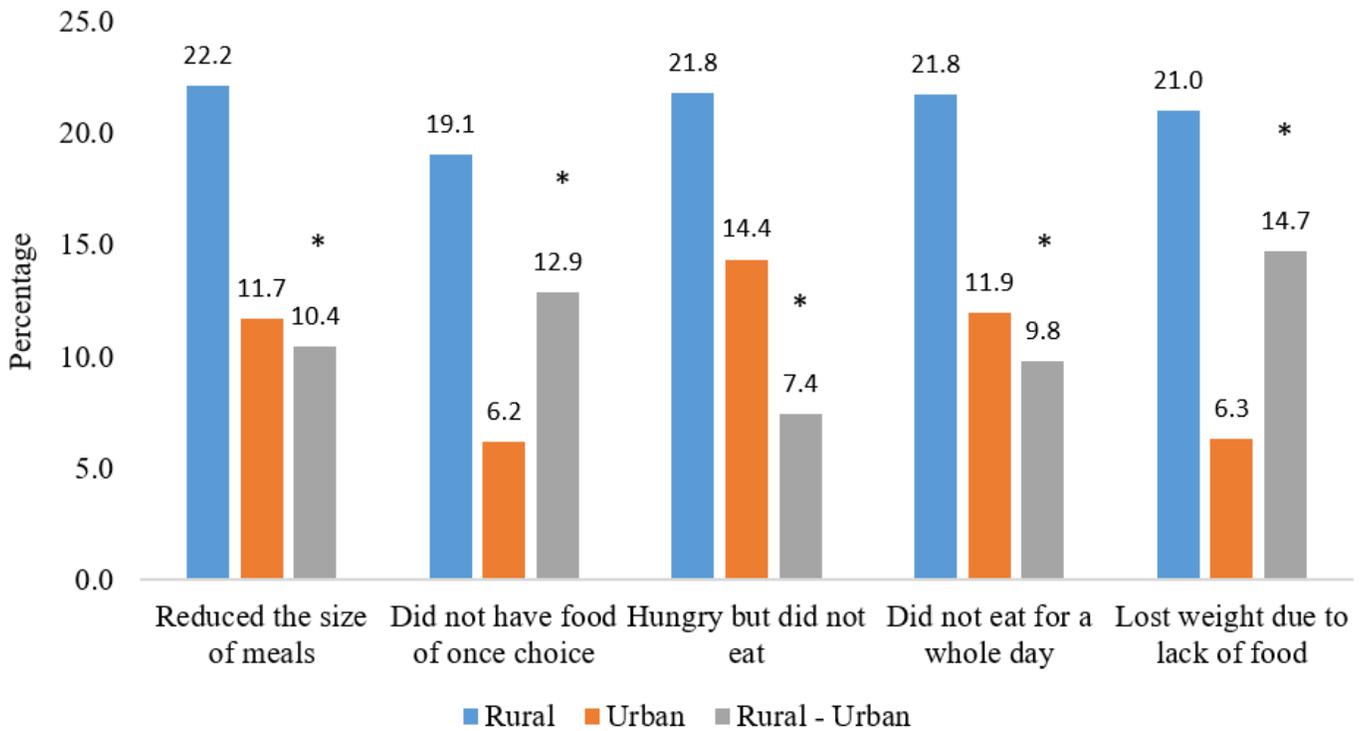


Figure 1

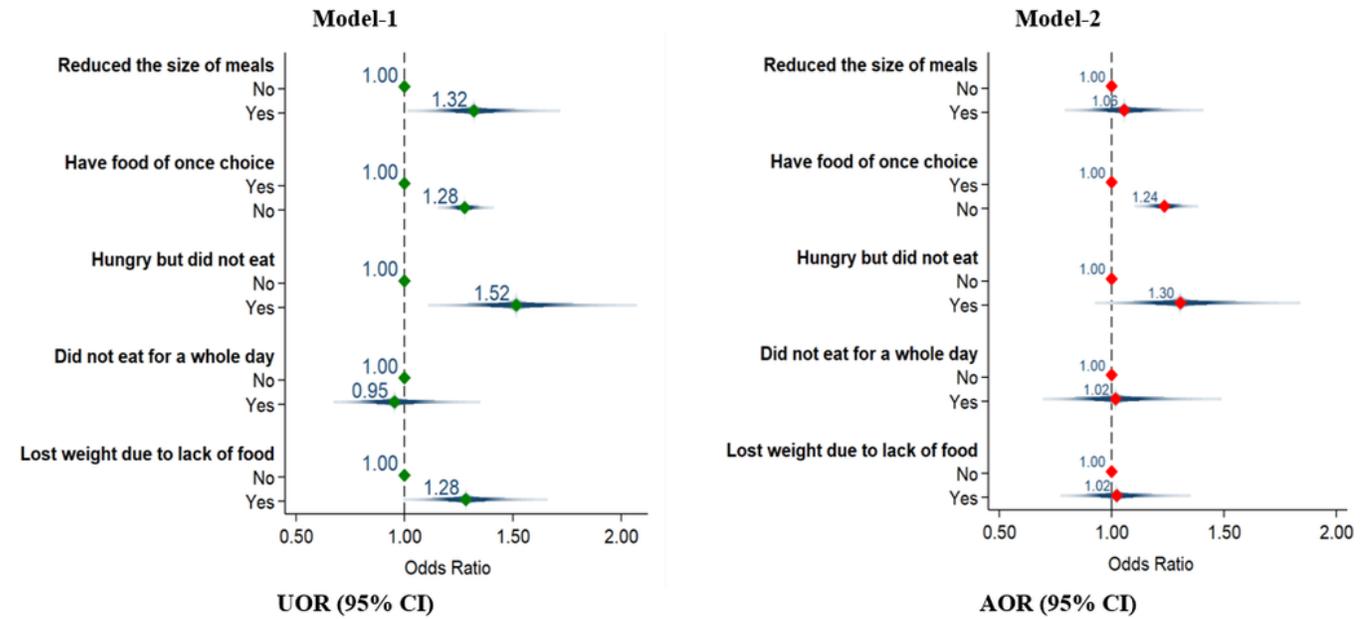
Percentage of older adults who had food security issues due to shortage of food at their household.



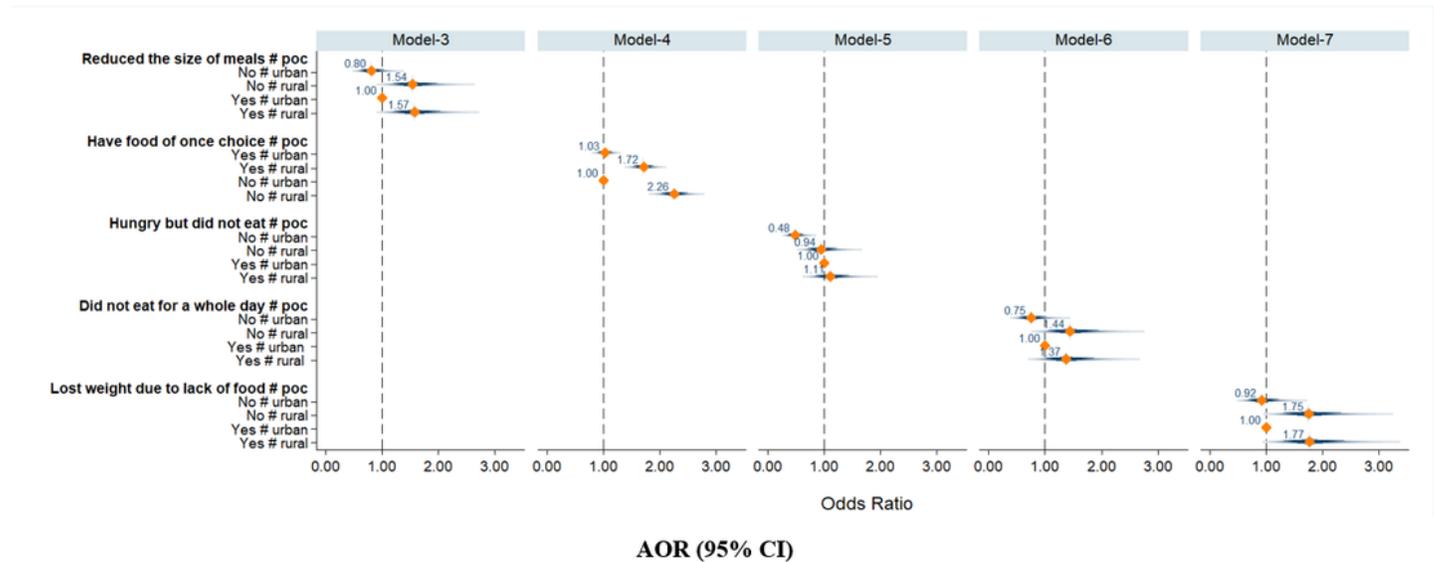
* $p < 0.001$

Figure 2

Percentage of older adults suffering from cognitive impairment by place of residence in India.



UOR: Unadjusted odds ratio, AOR: Adjusted odds ratio, CI: Confidence interval, Model-2 is adjusted for individual, health and household characteristics.



#: Interaction effects, AOR: Adjusted odds ratio, CI: Confidence interval, Model-3-7 is adjusted for individual, health and household characteristics.

Figure 3

a. Plots for logistic regression estimates for cognitive impairment among older adults in India b. Plots for interaction effects for cognitive impairment among older adults in India.