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Food insecurity and associated depression among older adults in India: Evidence from a population-based study

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Abstract

Objective: The present study aimed to examine the associations of several indicators of food insecurity with depression among older adults in India.

Design: A cross-sectional study was conducted using a country-representative survey data.

Setting and participants: The present study uses data of the Longitudinal Aging Study in India (LASI) baseline wave (Wave 1) conducted during 2017-18. The effective sample size for the present study was 31,464 older adults aged 60 years in above.

Primary and secondary outcome measures: The outcome variable was severe depression among older adults. Descriptive statistics along with bivariate analysis was presented. Additionally, binary logistic regression analysis was used to establish the association between the depression and food security factors along with other covariates.

Results: It was found that 6.3% of the older adults reduced the size of meals, 40% reported that they did not eat enough food of their choice, 5.6% mentioned that they were hungry but did not eat, 4.2% reported that they did not eat for a whole day and 5.6% think that they have lost weight due to lack of enough food in the household. It was revealed that older adults who reported to have reduced the size of meals due to lack of enough food were 65% significantly more likely to suffer from severe depression in reference to their counterpart [AOR: 1.65, CI: 1.35-2.02]. The older adults who reported that they were hungry but did not eat [AOR: 1.28, CI: 1.01-1.64], did not eat food for the whole day [AOR:1.32; CI: 1.02-1.70], lost weight due to lack of food were [AOR: 1.58, CI: 1.31-1.90] were significantly more likely to suffer from severe depression.

Conclusion: The present paper suggests that the national food security programs should be promoted as an effort to improve mental health status and quality of life among older population.

Keywords: Major depression; food security; older adults; India.

Strengths and limitations:

- The study utilizes a large nationally representative sample of the older population.
- Cross-sectional design is a limitation of the study as it is impossible to establish the observed directions of the relationships.
- The food security indicators were self-reported which may result in recall and reporting biases

Introduction

Food insecurity is defined as all people who do not have physical, social and economic access to sufficient safe and nutritious food that satisfies their dietary needs and food choices for a productive and healthy life [1, 2]. About 815 million people live in this situation globally [3]. To support this population, Sustainable Development Goals, targets 2.1 and 2.2 emphasize ending hunger and all forms of malnutrition [4]. Food insecurity incorporates more than just the current nutritional state, capturing as well vulnerability to anticipated disturbances in access to adequate and appropriate food [5–7]. After the economic liberalizations, developing countries struggle to meet global nutritional standards and ensure food security [8]. Food security has been a policy priority in India for a long time, mainly focusing on its vulnerable populations like children and older adults [9–11].

In adult populations, food insecurity is associated with insufficient dietary consumption, nutritional status, and poor physical and mental well-being [12]. A group of studies found food insecurity related to poor social and functional health, hypertension, diabetes, and anxiety [12–16]. Empirical evidence points out that the prevalence of food insecurity is exceptionally high among older adults [17–19] due to physical limitations, poor heart conditions, social isolation, and lack of transportation [20–23]. Food insecure older adults have been reported to spend less on healthcare [24] and to show higher proportions of non-adherence to medical treatments due to financial limitations [25]. Among older adults, food insecurity has been linked with lower, poorer overall health status [26], lower cognitive performance [27] and, notably, higher risk of depression [28].

WHO defines depression as characterized by sadness, lack of interest or pleasure, guilt or low self-worth, disordered sleep or appetite, feelings of tiredness, and reduced concentration [29]. Researches have shown a relationship between depression and various socio-economic variables such as old age, low level of education, hunger and physical labour [30, 31]. Depressive disorders are the most common psychiatric condition among older people [32, 33]. Recent research has recognized several factors for depression in older adults, including co-morbid physical disease, pain, and disability, Cognitive impairment, neuroticism, education level, loneliness and lack of social support [34–37]. Also, many studies have stated that food insecurity is connected with poor mental health, especially depressive symptoms among older adults [38–40].

For older adults, food insecurity is a vital psychosocial stressor that adds to variations in major depression across socio-economic strata [41]. A majority of research approaches food insecurity as a static experience; still, both life transitions and cumulative experiences can influence depression in old age [42, 43]. Older adults may be significantly exposed to the consequence of food insecurity. For instance, some evidence indicates that food insecurity is more prone to poor diet condition among older adults than younger age groups [41, 44]. In turn, poor diet quality is associated with depression, potentially a source of chronic systemic inflammation [45]. Food insecurity also intensifies the medical conditions common in older age, like diabetes, poor health status, and medical morbidity are recognized risk factors for older age depression[46–48]. Seeking alternative food sources through food support plans, food banks, or social networks is challenging for older adults due to social isolation, loss of independence, and weakness, increasing with age [49]. Therefore, older adults may feel particularly incapable when faced with food insecurity, probably raising the likelihood of depression [50].

The majority of the research articulates that food insecurity directly impacts depressive symptoms in older adults. This study aimed to examine the associations of several indicators of food insecurity with depression among older adults in India. Further, we analysed the association of food insecurity after adjusting for socio-economic and health attributes of older Indian adults with their depressive symptoms. Based on past researches, this study hypothesized that those who became food insecure and those who remained food insecure or lost weight due to food shortage would be more likely to be depressed compared to those who did not experience food insecurity.

Data, Variables, and Methods

Data Source

This study utilizes data from India's first nationally representative longitudinal Ageing survey (LASI-2017-18) which investigates into the health, economics and social determinants and consequences of population ageing in India [51]. The present study was cross-section in nature. The representative sample included 72,250 older adults aged 45 and above and their spouses across all states and union territories of India except Sikkim. The LASI adopts a multistage stratified area probability cluster sampling design to select the eventual units of observation. Households with at least one member aged 45 and above were taken as the eventual unit of observation. This study provides scientific evidence on demographics,

household economic status, chronic health conditions, symptom based health condition, functional and mental health, biomarkers, health care utilization, work and employment etc. It enables the cross state analyses and the cross national analyses of ageing, health, economic status and social behaviours and has been designed to evaluate the effect of changing policies and behavioural outcomes in India. Detailed information on the sampling frame is available on the LASI WAVE-1 Report. The effective sample size for the present study was 31,464 older adults aged 60 years and above [51].

Variable description

Outcome variable

The outcome variable for the study was depression which was coded as 0 for "not diagnosed with depression" and 1 for "diagnosed with depression" [51]. 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. The lowest 10th percentile is used as a proxy measure of severe depression among older adults [51].

Explanatory variables

The explanatory variables were divided into three sections namely, food security factors, individual factors and household factor.

Food security indicators

i. 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".
ii. 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 enough food of once choice" and it was coded as 0 "no" and 1 "yes".
iii. 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".

iv. 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".

v. 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".

Individual factors

i. Age was categorized as young old (60-69 years), old-old (70-79 years) and oldest old (80+ years).

ii. Sex was categorized as male and female.

iii. Educational status was categorized as no education/primary not completed, primary, secondary and higher.

iv. Working status was categorized as currently working, retired and not working.

v. Social participation was categorized as no and yes. Social participation was measured though the question "Are you a member of any of the organizations, religious groups, clubs, or societies"? The response was categorized as no and yes [52].

vi. Life satisfaction among older adults was assessed using the questions a. In most ways my life is close to ideal; b. The conditions of my life are excellent; c. I am satisfied with my life d. So far, I have got the important things I want in life; e. If I could live my life again, I would change almost nothing. The responses were categorized as strongly disagree, somewhat disagree, slightly disagree, neither agree nor disagree, slightly agree, somewhat agree and strongly agree. Using the responses to the five statements regarding life satisfaction, a scale was constructed. The categories of the scale are 'low satisfaction' (score of 5–20), 'medium satisfaction' (score of 21–25), and 'high satisfaction' (score of 26–35) [51].

vii. Self-rated health was coded as good which includes excellent, very good and good where as poor includes fair and poor [53].

viii. 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 older adults [54, 55].

ix. Difficulty in IADL (Instrumental Activities of Daily Living) was coded as no and yes. Activities of daily living that are not necessary related to fundamental functioning of a person, but they let an individual live independently in a community. The set ask were 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 [54, 55].

x. Morbidity status was categorized as 0 "no morbidity", 1 "any one morbid condition" and 2+ "co-morbidity" [56].

Household factors

i. 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. The variable was then divided into five quintiles i.e., from poorest to richest [51].

ii. Religion was coded as Hindu, Muslim, Christian, and Others.

iii. Caste was recoded as Scheduled Tribe, Scheduled Caste, Other Backward Class, and others. 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 Castes (SCs) and Scheduled Tribes (STs) are among the most disadvantaged socio-economic groups in India. 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 [57].

iv. Place of residence was categorized as rural and urban.

v. The region was coded as North, Central, East, Northeast, West, and South [58].

Statistical analysis

In this study, descriptive statistics and bivariate analysis has been performed to determine the prevalence of severe depression by food security factors along individual and household factors. Chi-square test was used to check for intergroup differences in the prevalence of depression among older adults [59, 60]. Further, binary logistic regression analysis [61] was used to fulfil the aims and objective of the study. The results are presented in the form of odds ratio (OR) with a 95% confidence interval (CI).

The equation for logistic regression is as follows:

$$\ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \beta_1 x_1 + \ldots + \beta_M x_{m-1},$$

Where,β_0,.....,β_M, are regression coefficients indicating the relative effect of a particular explanatory variable on the outcome variable. Variance inflation factor [62–64] was used to check multicollinearity among the variables used and it was found that there was no evidence of multicollinearity. Svyset command was used in STATA 14 [65] to account for complex survey design. Further, individual weights were used to make the estimates nationally representative.

Patient and Public Involvement

No patient involved

Results

Socio-demographic profile of the older adults in India

Table 1 depicts the socio-economic profile of the older adults in India. It was found that 6.3% of the older adults reduced the size of meals due to lack of enough food in the household. About 40% of the older adults reported that they did not eat enough food of their choice. Nearly 5.6% of the older adults mentioned that they were hungry but didn't eat because there was not enough food at their household. About 4.2% of the older adults reported that they did not eat for a whole day because there was not enough food at their household. Nearly 5.6% of the older adults think that they have lost weight due to lack of food at their household. Around 11% of the older adults belonged to oldest old age group. About 68% of the older

adults had no education or their primary education was incomplete. Around 5.7% of the older adults reported to have living arrangement as "alone". About 26.4% of the older adults reported to have working status as "not working". The share of older adults who had any social participation was about 4.5%. About 32.2% of the older adults had low level of satisfaction in life. Nearly 48.6% of the older adults reported to have self-rated health as "poor". About 24.4% and 48.7% of the older adults had difficulty in ADL and IADL respectively. Around 23.9% of older adults had two or more chronic diseases.

Percentage of older adults suffering from severe depression in India

Table 2 represents the share of older adults suffering from severe depression in India. Higher percentage of older adults who reduced their size of meal suffered from severe depression (24.1%). The older adults who were hungry but did not eat had higher prevalence of severe depression (25.8%). Higher percentage of older adults who did not eat for a whole day suffered from severe depression (25.2%). The older adults who lost their weight due to lack of food had higher prevalence of severe depression (24.7%).

Logistic regression estimates for older adults suffering through severe depression in India

Table 3 represents the logistic regression analysis of the older adults suffering from severe depression. Mode-1 represents the unadjusted estimates whereas model-2 represents the adjusted estimates. In model-1 it was revealed that the older adults who reported to have reduced the size of meals due to lack of enough food were 95% significantly more likely to suffer from severe depression in reference to the older adults who did not reduced the size of meals due to lack of enough food [UOR: 1.95, CI: 1.61-2.37]. The choice of food did not had any significant impact on severe depression among older adults in India. The older adults who reported that they were hungry but did not eat because there was not enough food at their household were 46% significantly more likely to suffer from severe depression in reference to their counter parts [UOR: 1.46, CI: 1.16-1.85]. The older adults who reported that they have lost weight due to lack of food were two times significantly more likely to suffer from severe depression in reference to their counterparts [UOR: 2.17, CI: 1.80-2.6].

Model-2 reveals that older adults who reported to have reduced the size of meals due to lack of enough food were 65% significantly more likely to suffer from severe depression in reference to the older adults who did not reduced the size of meals due to lack of enough food [AOR: 1.65, CI: 1.35-2.02]. The choice of food did not have any significant impact on severe depression among older adults in India. The older adults who reported that they were hungry

but did not eat because there was not enough food at their household were 28% significantly more likely to suffer from severe depression in reference to their counter parts [AOR: 1.28, CI: 1.01-1.64]. The older adults who did not eat food for the whole day had higher odds to suffer from severe depression in reference to their counterparts [AOR:1.32; CI: 1.02-1.70]. The older adults who reported that they have lost weight due to lack of food were 1.58 times significantly more likely to suffer from severe depression in reference to their counterparts [AOR: 1.58, CI: 1.31-1.90].

The odds of major depression were significantly higher among the older females in comparison of the older males [AOR: 1.16, CI: 1.03-1.29]. The odds of major depression were lower among the older adults who were living with children in comparison of the older adults who were living with others [AOR: 0.76, CI: 0.63-0.92]. The older adults who had low satisfaction in life were two times significantly more likely to suffer from severe depression in comparison of the older adults who had high satisfaction in life [AOR: 2.01, CI: 1.80-2.24]. The older adults who had poor self-rated health were two times significantly more likely to suffer from severe depression in comparison of the older adults who had good self-rated health [AOR: 2.10, CI: 1.90-2.34]. The odds of severe depression were significantly higher among the older adults who had difficulty in ADL and IADL in reference to the older adults who did not had difficulty in ADL and IADL respectively [AOR: 1.61, CI: 1.45-1.80] [AOR: 1.54, CI: 1.39-1.72]. The older adults who were from poorest MPCE quintile had significantly lower odds to suffer from severe depression in reference to older adults from richest wealth quintile [AOR: 0.73; CI: 0.63-0.85]. Older adults from urban place of residence had significantly high odds to suffer from severe depression in reference to older adults who were from rural areas [AOR: 1.20; CI: 1.07-1.34].

Discussion

The current study explored the prevalence of food insecurity and associated depression in late life through descriptive and regression analyses of a large country-representative survey data. With the increasing age, because of the development of more physical disabilities, there is a higher probability of increased food insecurity [66]. Consistently, the results have shown a substantial proportion of older population not eating enough food, reducing the size of their meals, and losing their body weight.

In line with the recent literature, we observed strong positive associations between food insecurity indicators and depression even after adjusting for several socio-demographic and

health variables [67–69]. However, since food insecurity and depression are multifactorial in nature, the mechanisms through which food insecurity affects depression are not adequately understood. There is a growing body of literature suggesting that food insecurity may act as an environmental stressor that can lead to late-life depressive disorders [70, 71]. Food insecurity is considered as a major source of anxiety and life stress in the psychological pathways, leading to the shame or concern about one's position in the society [68]. Similarly, financial constraints may enhance feelings of worry and anxiety about the food situation and asking for food that is considered to be socially unacceptable creates feelings of stress [28]. On the other hand, the link between nutritional deficiencies and depressive symptoms is well-documented [72]. A couple of studies have shown poor nutrition and dietary imbalances leading to depression [73, 74]. Also, burgeoning studies on nutritional psychiatry attempt to address the pathway of availability and accessibility of food and the onset and the severity of depressive disorders [72, 75]. The findings suggest that addressing food at the population level that is often an overlooked issue in the context of mental health, especially among the older population, may contribute to better mental health and psychological well-being in an aging population.

Reduced intake of food and weight loss being indicators of food insecurity was found to be significantly associated with the risk of depression among the older sample in this study and the associations were stronger than other indicators. This was consistent with several previous studies that had identified less nutrient intakes and to be associated with poor mental health and depressive symptoms [76–78]. The mechanism of this contribution can be explained by the relationship between stressors emerging as a result of reduced body weight and morbidities and negative mental health outcomes [79]. The inverse causation also has been discussed in past studies suggesting that weight changes in both direction increased or decreased intake maybe caused by the appetite changes due to depression [80]. Our findings also suggest that promoting food security should be regarded as an important aspect of preventing psychological morbidity among the older population who are food-insecure. Besides, the findings imply that food security interventions can have both nutritional and non-nutritional impacts.

Other important findings include age and sex differences in the prevalence of depression. The odds of suffering from depression were higher among young and female older adults compared with their male and oldest counterparts. The previous studies have also reported a higher prevalence of depression among women, as the global depression ratio stands in

favour of men [81]. Several studies elaborate that the gender disparity may stem primarily from behavioural as well as socioeconomic differences such as diet, tobacco and alcohol use, and education [82]. Others explained that the higher prevalence of depression among women can also be related to biological conditions such as menstrual disorders, postpartum depression and postmenopausal depression and anxiety [81]. Furthermore, older people by increasing age tend to accept ill health as an impact of aging and are less likely to be worried about their poor mental status [83]. On the other side, younger people tend to be more aware of their psychological problems and are more sensitive towards any decline in their mental well-being. The declining trend in depression in older ages was also reported in multiple previous studies [84, 85].

However, the findings of the present study need to be interpreted in light of several limitations. Firstly, the data were cross-sectional, hence no causality can be inferred between the outcome that is depression and predictor variables. Also, the food security indicators were self-reported which may result in recall and reporting biases. However, due to the use of a large country representative dataset, results can be generalizable to the broader population. In addition, depression was assessed with a globally accepted scale of CIDI-SF that adds to the validity and reliability of the present study.

Conclusion

The results showed that self-reported food insecurity indicators are strongly associated with major depression among older Indian adults. The findings can be of especial significance to health-decision makers and researchers involved in the areas of mental health of aging population in India and other low- and middle income countries with similar demographic and economic transitional stages. They suggest that the national food security programs should be promoted as an effort to improve mental health status and quality of life among older population.

Contributor statement

Conceived and designed the research paper: SS and MT; analysed the data: SS; Contributed agents/materials/analysis tools: SS; Wrote the manuscript: SKM, MT and DD; Refined the manuscript: SS and MT.

Competing interest

The authors declare that there is no competing interest

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Data sharing statement

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

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

Background characteristics	Sample	Percentage
Food security factors		
Reduced the size of meals		
No	29,471	93.7
Yes	1,993	6.3
Did not eat enough food of one's choice		
No	18,922	60.1
Yes	12,542	39.9
Hungry but did not eat		
No	29,711	94.4
Yes	1,753	5.6
Did not eat for a whole day		
No	30,152	95.8
Yes	1,312	4.2
Lost weight due to lack of food		
No	29,695	94.4
Yes	1,769	5.6
Individual factors		
Age		
Young-old	18,410	58.5
Old-old	9,501	30.2
Oldest-old	3,553	11.3
Sex		
Male	14,931	47.5
Female	16,533	52.6
Education		
No education/primary not completed	21,381	68.0
Primary completed	3,520	11.2
Secondary completed	4,371	13.9
Higher and above	2,191	7.0
Living arrangements		
Alone	1,787	5.7
With spouse	6,397	20.3
With children	21,475	68.3
Others	1,805	5.7
Working status		
Working	9,680	30.8
Retired	13,470	42.8
Not working	8,314	26.4
Social participation		
No	30,053	95.5
Yes	1,411	4.5
Life satisfaction*		
Low	9,773	32.2
Medium	6,796	22.4
High	13,822	45.5
Self-rated health*		
Good	15,850	51.4
Poor	14,961	48.6

Difficulty in ADL*			
	No	23,802	75.7
	Yes	7,662	24.4
Difficulty in IADL*			
	No	16,130	51.3
	Yes	15,334	48.7
Morbidity status			
	0	14,773	47.0
	1	9,171	29.2
	2+	7,520	23.9
Household factors			
MPCE quintile			
	Poorest	6,829	21.7
	Poorer	6,831	21.7
	Middle	6,590	21.0
	Richer	6,038	19.2
	Richest	5,175	16.5
Religion			
	Hindu	25,871	82.2
	Muslim	3,548	11.3
	Christian	900	2.9
	Others	1,145	3.6
Caste			
	Scheduled Caste	5,949	18.9
	Scheduled Tribe	2,556	8.1
	Other Backward Class	14,231	45.2
	Others	8,729	27.7
Place of residence			
	Rural	22,196	70.6
	Urban	9,268	29.5
Region			
	North	3,960	12.6
	Central	6,593	21.0
	East	7,439	23.6
	Northeast	935	3.0
	West	5,401	17.2
	South	7,136	22.7
Total		31,464	100.0

MPCE: Monthly per capita expenditure; *ADL: Activities of daily living; IADL: Instrumental activities of daily living; *The sample is low due to missing cases and non-response.*

Table-2. Percentage of older adults suffering from severe depression in India, 2017-18

Background characteristics	Percentage	p-value
Food security factors		
Reduced the size of meals		0.001
No	7.6	
Yes	24.1	
Did not eat enough food of one's choice		0.984
No	8.2	
Yes	9.3	
Hungry but did not eat		0.001
No	7.6	
Yes	25.8	
Did not eat for a whole day		0.001
No	7.9	
Yes	25.2	
Lost weight due to lack of food		0.001
No	7.7	
Yes	24.7	
Individual factors		
Age		0.207
Young-old	8.4	
Old-old	8.4	
Oldest-old	10.8	
Sex		0.001
Male	7.5	
Female	9.7	
Education		0.001
No education/primary not completed	9.6	
Primary completed	8.0	
Secondary completed	6.1	
Higher and above	5.9	
Living arrangements		0.001
Alone	13.5	
With spouse	8.6	
With children	8.1	
Others	11.7	
Working status		0.001
Working	7.8	
Retired	10.0	
Not working	7.6	
Social participation		0.001
No	8.8	
Yes	6.7	
Life satisfaction		0.001
Low	13.1	
Medium	7.7	
High	6.0	
Self-rated health		0.001
Good	4.7	
Poor	12.9	

Difficulty in ADL			0.001
	No	6.7	
	Yes	15.3	
Difficulty in IADL			0.001
	No	5.6	
	Yes	12.1	
Morbidity status			0.001
	0	7.1	
	1	8.6	
	2+	11.8	
Household factors			
MPCE quintile			0.001
	Poorest	8.9	
	Poorer	7.9	
	Middle	8.2	
	Richer	8.7	
	Richest	9.9	
Religion			0.001
	Hindu	8.6	
	Muslim	9.6	
	Christian	7.2	
	Others	8.5	
Caste			0.001
	Scheduled Caste	10.0	
	Scheduled Tribe	4.9	
	Other Backward Class	9.3	
	Others	7.9	
Place of residence			0.001
	Rural	9.6	
	Urban	6.3	
Region			0.001
	North	6.8	
	Central	14.5	
	East	8.3	
	Northeast	5.6	
	West	7.7	
	South	5.8	
Total		8.7	

MPCE: Monthly per capita expenditure; *ADL: Activities of daily living; IADL: Instrumental activities of daily living*

Table-3. Logistic regression estimates for older adults suffering through severe depression in India, 2017-18

Background characteristics	Model-1	Mode-2
	UOR (95% CI)	AOR (95% CI)
Food security factors		
Reduced the size of meals		
No	Ref.	Ref.
Yes	1.95*(1.61,2.37)	1.65*(1.35,2.02)
Did not eat enough food of one's choice		
No	Ref.	Ref.
Yes	1.01(0.92,1.10)	0.98(0.89,1.08)
Hungry but did not eat		
No	Ref.	Ref.
Yes	1.46*(1.16,1.85)	1.28*(1.01,1.64)
Did not eat for a whole day		
No	Ref.	Ref.
Yes	1.15(0.90,1.47)	1.32*(1.02,1.70)
Lost weight due to lack of food		
No	Ref.	Ref.
Yes	2.17*(1.80,2.6)	1.58*(1.31,1.90)
Individual factors		
Age		
Young-old		Ref.
Old-old		0.82*(0.74,0.91)
Oldest-old		0.78*(0.66,0.91)
Sex		
Male		Ref.
Female		1.16*(1.03,1.29)
Education		
No education/primary not completed		0.93(0.75,1.16)
Primary completed		1.01(0.8,1.28)
Secondary completed		0.95(0.76,1.20)
Higher and above		Ref.
Living arrangements		
Alone		0.93(0.73,1.19)
With spouse		0.70*(0.56,0.86)
With children		0.76*(0.63,0.92)
Others		Ref.
Working status		
Working		Ref.
Retired		0.99(0.88,1.11)
Not working		0.81*(0.70,0.94)
Social participation		
No		0.93(0.75,1.15)
Yes		Ref.
Life satisfaction		
Low		2.01*(1.80,2.24)
Medium		1.28*(1.13,1.46)
High		Ref.
Self-rated health		

	Good	Ref.
	Poor	2.10*(1.90,2.34)
Difficulty in ADL		
	No	Ref.
	Yes	1.61*(1.45,1.80)
Difficulty in IADL		
	No	Ref.
	Yes	1.54*(1.39,1.72)
Morbidity status		
	0	Ref.
	1	1.23*(1.10,1.39)
	2+	1.57*(1.39,1.78)
Household factors		
MPCE quintile		
	Poorest	0.73*(0.63,0.85)
	Poorer	0.75*(0.64,0.87)
	Middle	0.68*(0.59,0.8)
	Richer	0.87(0.75,1.01)
	Richest	Ref.
Religion		
	Hindu	Ref.
	Muslim	1.03(0.89,1.19)
	Christian	0.96(0.76,1.21)
	Others	1.14(0.91,1.42)
Caste		
	Scheduled Caste	Ref.
	Scheduled Tribe	0.57*(0.46,0.69)
	Other Backward Class	1.13(0.99,1.28)
	Others	0.94(0.81,1.09)
Place of residence		
	Rural	Ref.
	Urban	1.20*(1.07,1.34)
Region		
	North	Ref.
	Central	1.96*(1.68,2.29)
	East	0.94(0.80,1.10)
	Northeast	0.64*(0.50,0.82)
	West	1.20*(1.01,1.43)
	South	0.62*(0.53,0.74)

**if p<0.05; Ref: Reference; UOR: Unadjusted odds ratio; AOR: Adjusted odds ratio; CI: Confidence interval; ADL: Activities of daily living; IADL: Instrumental activities of daily living; MPCE: Monthly per capita expenditure*

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

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Food insecurity and associated depression among older adults in India: Evidence from a population-based study

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Food insecurity and associated depression among older adults in India: Evidence from a population-based study

Abstract

Objective: The present study aimed to examine the associations of several indicators of food insecurity with depression among older adults in India.

Design: A cross-sectional study was conducted using a country-representative survey data.

Setting and participants: The present study uses data of the Longitudinal Aging Study in India (LASI) conducted during 2017-18. The effective sample size for the present study was 31,464 older adults aged 60 years and above.

Primary and secondary outcome measures: The outcome variable was severe depression among older adults. Descriptive statistics along with bivariate analysis was presented. Additionally, binary logistic regression analysis was used to establish the association between the depression and food security factors along with other covariates.

Results: It was found that 6.3% of the older adults reduced the size of meals, 40% reported that they did not eat enough food of their choice, 5.6% mentioned that they were hungry but did not eat, 4.2% reported that they did not eat for a whole day and 5.6% think that they have lost weight due to lack of enough food in the household. It was revealed that older adults who reported to have reduced the size of meals due to lack of enough food [AOR: 1.65, CI: 1.35-2.02], were hungry but did not eat [AOR: 1.28, CI: 1.01-1.64], did not eat food for a whole day [AOR:1.32; CI: 1.02-1.70], lost weight due to lack of food [AOR: 1.58, CI: 1.31-1.90] were at higher odds of being severely depressed in reference to their respective counterparts.

Conclusion: The results showed that self-reported food insecurity indicators including the reduction in the size of meals, not eating food of one's choice, not eating enough food, remaining hungry for a whole day and losing the body weight are strongly associated with major depression among older Indian adults.

Keywords: Major depression; food security; older adults; India.

Strengths and limitations:

- The study utilizes a large nationally representative sample of the older population.
- Cross-sectional design is a limitation of the study as it is impossible to establish the observed directions of the relationships.
- The food security indicators were self-reported which may result in recall and reporting biases

Introduction

Food insecurity is defined as all people who do not have physical, social and economic access to sufficient, safe and nutritious food that satisfies their dietary needs and food choices for a productive and healthy life [1, 2]. About 815 million people live in this situation globally [3]. To support this population, Sustainable Development Goals, targets 2.1 and 2.2 emphasize ending hunger and all forms of malnutrition [4]. Food insecurity incorporates more than just the current nutritional state, capturing as well vulnerability to anticipated disturbances in access to adequate and appropriate food [5–7]. After the economic liberalizations, developing countries struggle to meet global nutritional standards and ensure food security [8]. Food security has been a policy priority in India for a long time, mainly focusing on its vulnerable populations like children and older adults [9–11].

In adult populations, food insecurity is associated with insufficient dietary consumption, nutritional status, and poor physical and mental well-being [12]. A couple of studies found that food insecurity is related to poor social and functional health, hypertension, diabetes, and anxiety [12–16]. Empirical evidence pointed out that the prevalence of food insecurity is exceptionally high among older adults [17–19] due to physical limitations, poor heart conditions, social isolation, and lack of transportation [20–23]. Similarly, food insecure older adults have been reported to spend less on healthcare [24] and to show higher levels of non-adherence to medical treatments due to financial limitations [25]. Therefore, among older adults, food insecurity has been linked with poor health status [26], lower cognitive performance [27] and, notably, higher risk of depression [28].

WHO defines depression as characterized by sadness, lack of interest or pleasure, guilt or low self-worth, disordered sleep or appetite, feelings of tiredness, and reduced concentration [29]. Research has shown a relationship between depression and various socio-economic variables such as old age, low level of education, hunger and physical labour [30, 31]. Depressive disorders are the most common psychiatric condition among older people [32, 33]. Recent evidence recognized several factors associated with depression in older adults, including co-morbid physical disease, pain, and disability, Cognitive impairment, neuroticism, education level, loneliness and lack of social support [34–37]. Also, multiple studies have suggested that food insecurity is connected with poor mental health, especially depressive symptoms among older adults [38–40].

The majority of the research articulates that food insecurity positively associates with depressive symptoms in older adults and there is a dearth of studies in low and middle income countries. This study aimed to examine the associations of specific indicators of food insecurity including reduction in meal size, not eating food of one's choice, not eating enough food, remaining hungry for a whole day and body weight loss with depression among older adults in India. Further, we analysed the association of food insecurity indicators after adjusting for socio-economic and health attributes of older Indian adults with their depressive symptoms. Based on the conceptual framework provided (Figure 1) and the past research, this study hypothesized that those who reduced meal size due to food shortage, did not have food of own choice, remained hungry for a whole day or lost weight due to food shortage would be more likely to be depressed compared to those who did not experience these.

[Insert Figure-1]

Data, Variables, and Methods

Data Source

This study utilizes data from India's first nationally representative longitudinal Ageing survey (LASI-2017-18) which investigates into the health, economics and social determinants and consequences of population ageing in India [41]. The present study was cross-sectional in nature. The representative sample included 72,250 older adults aged 45 and above and their spouses across all states and union territories of India except Sikkim. The LASI adopts a multistage stratified area probability cluster sampling design to select the eventual units of observation. Households with at least one member aged 45 and above were taken as the eventual unit of observation. This study provides scientific evidence on demographics, household economic status, chronic health conditions, symptom based health condition, functional and mental health, biomarkers, health care utilization, work and employment etc. It enables the cross state analyses and the cross national analyses of ageing, health, economic status and social behaviours and has been designed to evaluate the effect of changing policies and behavioural outcomes in India. The LASI was interviewer (face to face) administered survey during household visits using computer-assisted personal interview (CAPI) technology. The interview was conducted in the local language of the area administered [41]. The total response rate was at individual level was 95.6%. Detailed information on the sampling frame is available on the LASI WAVE-1 Report [41]. The effective sample size for the present study was 31,464 older adults aged 60 years and above [41]. The Indian Council

of Medical Research (ICMR) extended the necessary guidance and ethical approval for conducting the LASI [41]. Informed consent was taken before the interview [41].

Variable description

Outcome variable

The outcome variable for the study was depression which was coded as 0 for "not diagnosed with depression" and 1 for "diagnosed with depression" [41]. 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 (Cronabach alpha: 0.70). 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 [42]. The lowest 10th percentile is used as a proxy measure of severe depression among older adults [41].

Explanatory variables

The explanatory variables were divided into three sections namely, food security factors, individual factors and household factor.

Food security indicators

i. 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".
ii. 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 enough food of once choice" and it was coded as 0 "no" and 1 "yes".
iii. 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".
iv. 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".

v. 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".

Individual factors

i. Age was categorized as young old (60-69 years), old-old (70-79 years) and oldest old (80+ years).
ii. Sex was categorized as male and female.
iii. Educational status was categorized as no education/primary not completed, primary, secondary and higher.
iv. Working status was categorized as currently working, retired and not working.
v. Social participation was categorized as no and yes. Social participation was measured though the question "Are you a member of any of the organizations, religious groups, clubs, or societies"? The response was categorized as no and yes [43].
vi. Life satisfaction among older adults was assessed using the questions a. In most ways my life is close to ideal; b. The conditions of my life are excellent; c. I am satisfied with my life d. So far, I have got the important things I want in life; e. If I could live my life again, I would change almost nothing. The responses were categorized as strongly disagree, somewhat disagree, slightly disagree, neither agree nor disagree, slightly agree, somewhat agree and strongly agree. Using the responses to the five statements regarding life satisfaction, a scale was constructed. The categories of the scale are 'low satisfaction' (score of 5–20), 'medium satisfaction' (score of 21–25), and 'high satisfaction' (score of 26–35) [41].
vii. Self-rated health was coded as good which includes excellent, very good and good where as poor includes fair and poor [44].
viii. 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 older adults [45, 46].
ix. Difficulty in IADL (Instrumental Activities of Daily Living) was coded as no and yes. Activities of daily living that are not necessary related to fundamental functioning of a person, but they let an individual live independently in a community. The set ask were

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 [45, 46].

x. Morbidity status was categorized as 0 "no morbidity", 1 "any one morbid condition" and 2+ "co-morbidity" [47].

Household factors

i. The monthly per capita consumption 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 MPCE is computed and used as the summary measure of consumption. The variable was then divided into five quintiles i.e., from poorest to richest [41].

ii. Religion was coded as Hindu, Muslim, Christian, and Others.

iii. Caste was recoded as Scheduled Tribe, Scheduled Caste, Other Backward Class, and others. 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 Castes (SCs) and Scheduled Tribes (STs) are among the most disadvantaged socio-economic groups in India. The OBC is the group of people who were identified as "educationally, economically and socially backward". The OBCs are considered low in the traditional caste hierarchy but are not considered untouchables. The "other" caste category is identified as having higher social status [48].

iv. Place of residence was categorized as rural and urban.

v. The region was coded as North, Central, East, Northeast, West, and South [49].

Statistical analysis

In this study, descriptive statistics and bivariate analysis has been performed to determine the prevalence of severe depression by food security factors along individual and household factors. Chi-square test was used to check for intergroup differences in the prevalence of

depression among older adults [50, 51]. Further, binary logistic regression analysis [52] was used to fulfil the aims and objective of the study. The results are presented in the form of odds ratio (OR) with a 95% confidence interval (CI).

The equation for logistic regression is as follows:

$$\ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \beta_1 x_1 + \ldots + \beta_M x_{m-1},$$

Where,β_0,.....,β_M, are regression coefficients indicating the relative effect of a particular explanatory variable on the outcome variable. Variance inflation factor [53–55] was used to check multicollinearity among the variables used and it was found that there was no evidence of multicollinearity. Svyset command was used in STATA 14 [56] to account for complex survey design. Further, individual weights were used to make the estimates nationally representative.

Patient and Public Involvement

No patient involved

Results

Socio-demographic profile of the older adults in India

Table 1 depicts the socio-economic profile of the older adults in India. It was found that 6.3% of the older adults reduced the size of meals due to lack of enough food in the household. About 40% of the older adults reported that they did not eat enough food of their choice. 5.6% of the older adults mentioned that they were hungry but didn't eat because there was not enough food at their household. 4.2% of the older adults reported that they did not eat for a whole day because there was not enough food at their household. 5.6% of the older adults think that they have lost weight due to lack of food at their household. Around 11% of the older adults belonged to oldest old age group. 68% of the older adults had no education or their primary education was incomplete. 5.7% of the older adults reported to have living arrangement as "alone". 26.4% of the older adults reported to be "not working". The share of older adults who had any social participation was 4.5%. 32.2% of the older adults had low level of satisfaction in life. Nearly 48.6% of the older adults reported to have self-rated health as "poor". About 24.4% and 48.7% of the older adults had difficulty in ADL and IADL respectively. Around 23.9% of older adults had two or more chronic diseases.

[Insert Table-1]

Percentage of older adults suffering from severe depression in India

Table 2 represents the share of older adults suffering from severe depression in India. The overall prevalence of severe depression was 8.4% among older adults in India. Higher percentage of older adults who reduced their size of meal suffered from severe depression (23.6%) in reference to their counterparts (7.4%). The older adults who were hungry but did not eat had higher prevalence of severe depression (25.3%) in reference to their counterparts (7.4%). Higher percentage of older adults who did not eat for a whole day suffered from severe depression (24.8%) in reference to their counterparts (7.7%). The older adults who lost their weight due to lack of food had higher prevalence of severe depression (24.1%) in reference to their counterparts (7.5%).

[Insert Table-2]

Logistic regression estimates for older adults suffering through severe depression in India

Table 3 represents the logistic regression analysis of the older adults suffering from severe depression. Mode-1 represents the unadjusted estimates whereas model-2 represents the adjusted estimates. In model-1 it was revealed that the older adults who reported to have reduced the size of meals due to lack of enough food were at higher odds of being severely depressed in reference to the older adults who did not reduced the size of meals due to lack of enough food [UOR: 1.95, CI: 1.61-2.37]. The choice of food did not have any significant impact on severe depression among older adults in India. The older adults who reported that they were hungry but did not eat because there was not enough food at their household were at higher odds of being severely depressed in reference to their counterparts [UOR: 1.46, CI: 1.16-1.85]. The older adults who reported that they have lost weight due to lack of food were at higher odds of being severely depressed in reference to their counterparts [UOR: 2.17, CI: 1.80-2.6].

Model-2 reveals that older adults who reported to have reduced the size of meals due to lack of enough food were at higher odds of being severely depressed in reference to the older adults who did not reduced the size of meals due to lack of enough food [AOR: 1.65, CI: 1.35-2.02]. The choice of food did not have any significant impact on severe depression among older adults in India. The older adults who reported that they were hungry but did not eat because there was not enough food at their household w were at higher odds of being

severely depressed in reference to their counter parts [AOR: 1.28, CI: 1.01-1.64]. The older adults who did not eat food for the whole day had higher odds to suffer from severe depression in reference to their counterparts [AOR:1.32; CI: 1.02-1.70]. The older adults who reported that they have lost weight due to lack of food were at higher odds of being severely depressed in reference to their counterparts [AOR: 1.58, CI: 1.31-1.90].

The odds of major depression were significantly higher among the older females in comparison of the older males [AOR: 1.16, CI: 1.03-1.29]. The odds of major depression were lower among the older adults who were living with children in comparison of the older adults who were living with others [AOR: 0.76, CI: 0.63-0.92]. The older adults who had low satisfaction in life were two times significantly more likely to suffer from severe depression in comparison of the older adults who had high satisfaction in life [AOR: 2.01, CI: 1.80-2.24]. The older adults who had poor self-rated health were two times significantly more likely to suffer from severe depression in comparison of the older adults who had good self-rated health [AOR: 2.10, CI: 1.90-2.34]. The odds of severe depression were significantly higher among the older adults who had difficulty in ADL and IADL in reference to the older adults who did not had difficulty in ADL and IADL respectively [AOR: 1.61, CI: 1.45-1.80] [AOR: 1.54, CI: 1.39-1.72]. The older adults who were from poorest MPCE quintile had significantly lower odds to suffer from severe depression in reference to older adults from richest wealth quintile [AOR: 0.73; CI: 0.63-0.85]. Older adults from urban place of residence had significantly high odds to suffer from severe depression in reference to older adults who were from rural areas [AOR: 1.20; CI: 1.07-1.34]. Table S1 (supplementary file) represents the regression estimates for older adults suffering through severe depression in India. It was found that older adults with food insecurity had significantly higher odds for depression in reference to their counter parts in model-1 [UOR: 1.39; CI: 1.27-1.51]. Whereas in model-2 which was adjusted for individual and household factors it was found that older adults with food insecurity had significantly higher odds for depression in reference to their counter parts in model-1 [AOR: 1.35; CI: 1.23-1.48].

[Insert Table-3]

Discussion

The current study aimed to explore the prevalence of specific indicators of food insecurity and associated depression in late life through descriptive and regression analyses of a large country-representative survey data. With the increasing age, because of the development of

more physical disabilities, there is a higher probability of increased food insecurity [57]. Consistently, the results have shown a substantial proportion of older population reducing the size of their meals due to food shortage, not eating food of own choice, not eating enough food, remaining hungry for a whole day and losing their body weight. In line with the recent literature, we also observed strong positive associations between food insecurity indicators and depression even after adjusting for several socio-demographic and health variables [58–60].

However, since food insecurity and depression are multifactorial in nature, the mechanisms through which food insecurity affects depression are not adequately understood. There is a growing body of literature suggesting that food insecurity may act as an environmental stressor that can lead to late-life depressive disorders [61, 62]. Food insecurity is considered as a major source of anxiety and life stress in the psychological pathways, leading to the shame or concern about one's position in the society [59]. Similarly, financial constraints may enhance feelings of worry and anxiety about the food situation and asking for food that is considered to be socially unacceptable creates feelings of stress [28]. On the other hand, the link between nutritional deficiencies and depressive symptoms is well-documented [63]. A couple of studies have shown poor nutrition and dietary imbalances leading to depression [64, 65]. Also, burgeoning studies on nutritional psychiatry attempt to address the pathway of availability and accessibility of food and the onset and the severity of depressive disorders [63, 66]. The findings suggest that addressing food at the population level that is often an overlooked issue in the context of mental health, especially among the older population, may contribute to better mental health and psychological well-being in an aging population. Reduced intake of food and weight loss being indicators of food insecurity was found to be significantly associated with the risk of depression among the older sample in this study and the associations were stronger than other indicators. This was consistent with several previous studies that had identified less nutrient intakes and to be associated with poor mental health and depressive symptoms [67–69]. The mechanism of this contribution can be explained by the relationship between stressors emerging as a result of reduced body weight and morbidities and negative mental health outcomes [70]. The inverse causation also has been discussed in past studies suggesting that weight changes in both direction increased or decreased intake maybe caused by the appetite changes due to depression [71]. Seeking alternative food sources through food support plans, food banks, or social networks is challenging for older adults due to social isolation, loss of independence, and weakness,

increasing with age [72], in turn, they may feel particularly incapable when faced with food insecurity, probably raising the likelihood of depression [73], suggesting the bidirectional association of food insecurity and depressive symptoms in old age. Our findings also suggest that promoting food security should be regarded as an important aspect of preventing psychological morbidity among the older population who are food-insecure. Besides, the findings imply that food security interventions can have both nutritional and non-nutritional impacts including an improved mental health status.

Other important findings include age and sex differences in the prevalence of depression. The odds of suffering from depression were higher among young and female older adults compared with their male and oldest counterparts. The previous studies have also reported a higher prevalence of depression among women, as the global depression ratio stands in favour of men [74]. Several studies elaborate that the gender disparity may stem primarily from behavioural as well as socioeconomic differences such as diet, tobacco and alcohol use, and education [75]. Others explained that the higher prevalence of depression among women can also be related to biological conditions such as menstrual disorders, postpartum depression and postmenopausal depression and anxiety [74]. Furthermore, older people by increasing age tend to accept ill health as an impact of aging and are less likely to be worried about their poor mental status [76]. On the other side, younger people tend to be more aware of their psychological problems and are more sensitive towards any decline in their mental well-being. The declining trend in depression in older ages was also reported in multiple previous studies [77, 78].

However, the findings of the present study need to be interpreted in light of several limitations. Firstly, the data were cross-sectional, hence no causality can be inferred between the outcome that is depression and predictor variables. Also, the food security indicators were self-reported which may result in recall and reporting biases. Similarly, the huge variations in the prevalence of food insecurity measured through several indicators that varies from 4.2% for the question regarding "did not eat for a whole day due to food shortage" to 39.9% for the question regarding "did not have food of own choice" may result in misclassification effects, for example, people who are food secure might be marked as food insecure in specific indicator which suggests the need for further investigation of appropriate measures of food security in Indian setting. However, due to the use of a large country representative dataset with detailed measures of food insecurity, results can be generalizable to the broader population. In addition, depression was assessed with a globally accepted scale of CIDI-SF that adds to the

validity and reliability of the present study. For older adults, food insecurity is a vital psychosocial stressor that adds to variations in major depression across socio-economic strata [79]. A majority of research considered food insecurity as a static experience; however, both life transitions and cumulative experiences could also influence depression in old age [80, 81]. Importantly, older adults may be significantly exposed to the consequence of food insecurity. For instance, some evidence indicates that food insecurity is more prone to poor diet condition among older adults than younger age groups [79, 82]. In turn, poor diet quality is associated with depression, potentially a source of chronic systemic inflammation [83]. Food insecurity also intensifies the medical conditions common in older age, like diabetes, poor health status, and medical morbidity that are recognized as risk factors for older age depression [84–86]. These aspects suggest future investigation of several pathways of food insecurity including adverse childhood and adulthood exposures leading to mental stressors and late-life depression.

Conclusion

The results showed that self-reported food insecurity indicators including the reduction in the size of meals, not eating food of one's choice, not eating enough food, remaining hungry for a whole day and losing the body weight are strongly associated with major depression among older Indian adults. The findings can be of special interest to health-decision makers and researchers involved in the areas of mental health of aging population in India and other low- and middle income countries with similar demographic and economic transitional stages. The study suggests that the national food security programs should be promoted as an effort to improve mental health status and quality of life among older population.

Contributor statement

Conceived and designed the research paper: TM and SS; analysed the data: SS; Contributed agents/materials/analysis tools: TM; Wrote the manuscript: SKM, TM and DD; Refined the manuscript: TM and SS.

Ethics Statement

The Indian Council of Medical Research (ICMR) extended the necessary guidance and

ethical approval for conducting the LASI.

Competing interest

The authors declare that there is no competing interest

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Data sharing statement

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

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

Background characteristics	Total		Not depressed		Depressed	
	Sample	Percentage	Sample	Percentage	Sample	Percentage
Food security factors						
Reduced the size of meals						
No	29,471	93.7	27,746	94.7	1784	82.2
Yes	1,993	6.3	1,548	5.3	386	17.8
Did not eat enough food of one's choice						
No	18,922	60.1	17,712	60.5	1229	56.6
Yes	12,542	39.9	11,582	39.5	941	43.4
Hungry but did not eat						
No	29,711	94.4	27,963	95.5	1806	83.2
Yes	1,753	5.6	1,331	4.5	364	16.8
Did not eat for a whole day						
No	30,152	95.8	28,291	96.6	1903	87.7
Yes	1,312	4.2	1,003	3.4	267	12.3
Lost weight due to lack of food						
No	29,695	94.4	27,928	95.3	1820	83.9
Yes	1,769	5.6	1,366	4.7	350	16.1
Individual factors						
Age						
Young-old	18,410	58.5	17,165	58.6	1250	57.6
Old-old	9,501	30.2	8,878	30.3	630	29.0
Oldest-old	3,553	11.3	3,251	11.1	290	13.4
Sex						
Male	14,931	47.5	14,079	48.1	886	40.8
Female	16,533	52.6	15,215	51.9	1284	59.2
Education						
No education/primary not completed	21,381	68.0	19,710	67.3	1633	75.2
Primary completed	3,520	11.2	3,299	11.3	225	10.4
Secondary completed	4,371	13.9	4,186	14.3	208	9.6
Higher and above	2,191	7.0	2,098	7.2	105	4.8
Living arrangements						
Alone	1,787	5.7	1,576	5.4	194	8.9
With spouse	6,397	20.3	5,977	20.4	424	19.5
With children	21,475	68.3	20,102	68.6	1394	64.2
Others	1,805	5.7	1,639	5.6	158	7.3
Working status						
Working	9,680	30.8	9,079	31.0	613	28.3
Retired	13,470	42.8	12,386	42.3	1054	48.6
Not working	8,314	26.4	7,829	26.7	502	23.2
Social participation						
No	30,053	95.5	27,955	95.4	2093	96.5
Yes	1,411	4.5	1,339	4.6	77	3.5
Life satisfaction*						
Low	9,773	32.2	9,829	33.6	1070	49.3
Medium	6,796	22.4	6,334	21.6	429	19.8

High	13,822	45.5	13,131	44.8	672	31.0
Self-rated health*						
Good	15,850	51.4	16,108	55.0	603	27.8
Poor	14,961	48.6	13,186	45.0	1567	72.2
Difficulty in ADL*						
No	23,802	75.7	22,594	77.1	1291	59.5
Yes	7,662	24.4	6,700	22.9	879	40.5
Difficulty in IADL*						
No	16,130	51.3	15,489	52.9	732	33.7
Yes	15,334	48.7	13,805	47.1	1438	66.3
Morbidity status						
0	14,773	47.0	13,981	47.7	835	38.5
1	9,171	29.2	8,540	29.2	632	29.1
2+	7,520	23.9	6,773	23.1	703	32.4
Household factors						
MPCE quintile						
Poorest	6,829	21.7	6,343	21.7	483	22.3
Poorer	6,831	21.7	6,411	21.9	430	19.8
Middle	6,590	21.0	6,174	21.1	424	19.5
Richer	6,038	19.2	5,613	19.2	424	19.5
Richest	5,175	16.5	4,753	16.2	409	18.9
Religion						
Hindu	25,871	82.2	24,091	82.2	1780	82.0
Muslim	3,548	11.3	3,286	11.2	259	12.0
Christian	900	2.9	850	2.9	52	2.4
Others	1,145	3.6	1,067	3.6	78	3.6
Caste						
Scheduled Caste	5,949	18.9	5,458	18.6	475	21.9
Scheduled Tribe	2,556	8.1	2,475	8.5	99	4.6
Other Backward Class	14,231	45.2	13,168	45.0	1048	48.3
Others	8,729	27.7	8,193	28.0	548	25.3
Place of residence						
Rural	22,196	70.6	20,446	69.8	1708	78.7
Urban	9,268	29.5	8,848	30.2	462	21.3
Region						
North	3,960	12.6	3,755	12.8	218	10.0
Central	6,593	21.0	5,759	19.7	761	35.1
East	7,439	23.6	6,951	23.7	492	22.7
Northeast	935	3.0	898	3.1	42	1.9
West	5,401	17.2	5,080	17.3	331	15.3
South	7,136	22.7	6,851	23.4	325	15.0
Total	31,464	100.0	29,294	100.0	2170	100.0

MPCE: Monthly per capita *consumption* expenditure; *ADL: Activities of daily living; IADL: Instrumental activities of daily living; *The sample is low due to missing cases and non-response.*

Table-2. Percentage of older adults suffering from severe depression in India, 2017-18

Background characteristics	Not depressed	Depressed	p-value
Food security factors	**Percentage (n)**	**Percentage (n)**	
Reduced the size of meals			0.001
No	92.6 (27297)	7.4 (2174)	
Yes	76.4 (1523)	23.6 (470)	
Did not eat enough food of one's choice			0.984
No	92.1 (17425)	7.9 (1497)	
Yes	90.9 (11395)	9.1 (1147)	
Hungry but did not eat			0.001
No	92.6 (27511)	7.4 (2200)	
Yes	74.7 (1309)	25.3 (444)	
Did not eat for a whole day			0.001
No	92.3 (27833)	7.7 (2319)	
Yes	75.2 (987)	24.8 (325)	
Lost weight due to lack of food			0.001
No	92.5 (27477)	7.5 (2218)	
Yes	75.9 (1343)	24.1 (426)	
Individual factors			
Age			0.207
Young-old	91.7 (16887)	8.3 (1523)	
Old-old	91.9 (8734)	8.1 (767)	
Oldest-old	90 (3199)	10 (354)	
Sex			0.001
Male	92.8 (13851)	7.2 (1080)	
Female	90.5 (14969)	9.5 (1564)	
Education			0.001
No education/primary not completed	90.7 (19392)	9.3 (1989)	
Primary completed	92.2 (3246)	7.8 (274)	
Secondary completed	94.2 (4119)	5.8 (253)	
Higher and above	94.2 (2064)	5.8 (127)	
Living arrangements			0.001
Alone	86.8 (1551)	13.2 (236)	
With spouse	91.9 (5880)	8.1 (516)	
With children	92.1 (19777)	7.9 (1698)	
Others	89.3 (1612)	10.7 (193)	
Working status			0.001
Working	92.3 (8933)	7.7 (747)	
Retired	90.5 (12185)	9.5 (1284)	
Not working	92.6 (7702)	7.4 (612)	
Social participation			0.001
No	91.5 (27503)	8.5 (2550)	
Yes	93.4 (1317)	6.6 (94)	
Life satisfaction			0.001
Low	88.1 (9670)	11.9 (1304)	
Medium	92.3 (6232)	7.7 (522)	
High	94 (12918)	6 (818)	
Self-rated health			0.001

Good	95.6 (15848)	4.4 (734)	
Poor	87.2 (12973)	12.8 (1910)	
Difficulty in ADL			0.001
No	93.4 (22229)	6.6 (1573)	
Yes	86 (6591)	14 (1071)	
Difficulty in IADL			0.001
No	94.5 (15238)	5.5 (892)	
Yes	88.6 (13582)	11.4 (1752)	
Morbidity status			0.001
0	93.1 (13755)	6.9 (1017)	
1	91.6 (8402)	8.4 (770)	
2+	88.6 (6663)	11.4 (857)	
Household factors			
MPCE quintile			0.001
Poorest	91.4 (6240)	8.6 (589)	
Poorer	92.3 (6308)	7.7 (524)	
Middle	92.2 (6074)	7.8 (516)	
Richer	91.5 (5522)	8.6 (516)	
Richest	90.4 (4676)	9.6 (499)	
Religion			0.001
Hindu	91.6 (23702)	8.4 (2169)	
Muslim	91.1 (3232)	8.9 (316)	
Christian	92.9 (837)	7.1 (64)	
Others	91.7 (1049)	8.3 (96)	
Caste			0.001
Scheduled Caste	90.3 (5370)	9.7 (579)	
Scheduled Tribe	95.3 (2435)	4.7 (121)	
Other Backward Class	91 (12955)	9 (1276)	
Others	92.4 (8061)	7.7 (668)	
Place of residence			0.001
Rural	90.6 (20116)	9.4 (2081)	
Urban	93.9 (8705)	6.1 (563)	
Region			0.001
North	93.3 (3695)	6.7 (265)	
Central	85.9 (5666)	14.1 (927)	
East	91.9 (6839)	8.1 (600)	
Northeast	94.5 (884)	5.5 (51)	
West	92.5 (4997)	7.5 (404)	
South	94.4 (6740)	5.6 (397)	
Total	91.6 (28,820)	8.4 (2644)	

MPCE: Monthly per capita consumption expenditure; *ADL: Activities of daily living; IADL: Instrumental activities of daily living; the estimates are weighted.*

Table-3. Logistic regression estimates for older adults suffering through severe depression in India, 2017-18

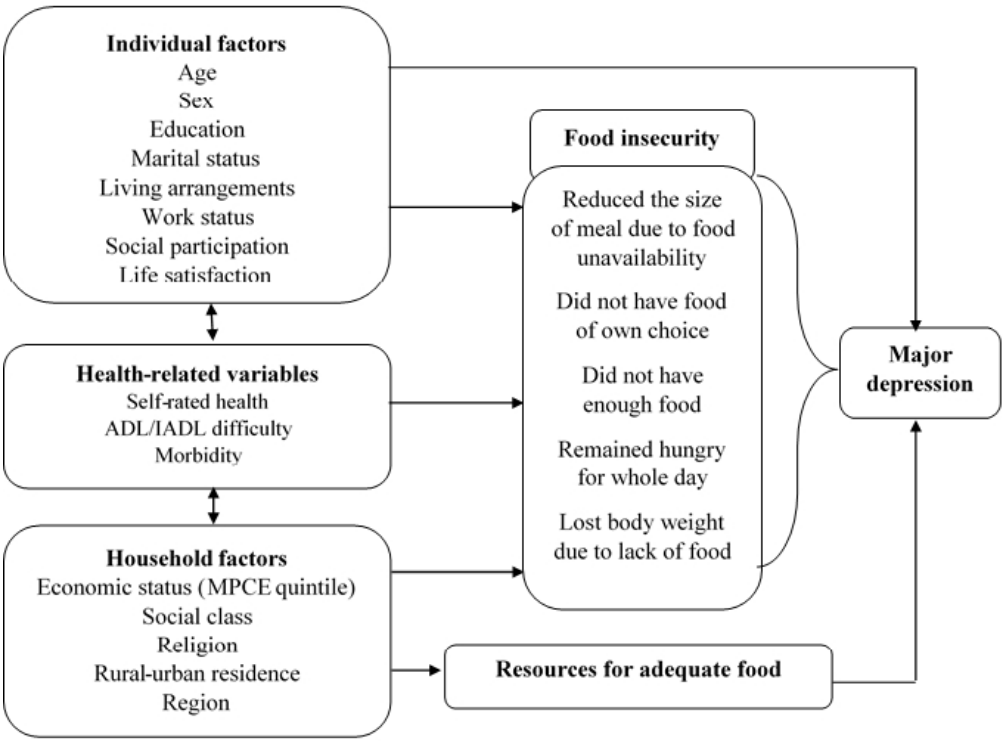
Background characteristics	Model-1 UOR (95% CI)	Model-2 AOR (95% CI)
Food security factors		
Reduced the size of meals		
No	Ref.	Ref.
Yes	1.95*(1.61,2.37)	1.65*(1.35,2.02)
Did not eat enough food of one's choice		
No	Ref.	Ref.
Yes	1.01(0.92,1.10)	0.98(0.89,1.08)
Hungry but did not eat		
No	Ref.	Ref.
Yes	1.46*(1.16,1.85)	1.28*(1.01,1.64)
Did not eat for a whole day		
No	Ref.	Ref.
Yes	1.15(0.90,1.47)	1.32*(1.02,1.70)
Lost weight due to lack of food		
No	Ref.	Ref.
Yes	2.17*(1.80,2.6)	1.58*(1.31,1.90)
Individual factors		
Age		
Young-old		Ref.
Old-old		0.82*(0.74,0.91)
Oldest-old		0.78*(0.66,0.91)
Sex		
Male		Ref.
Female		1.16*(1.03,1.29)
Education		
No education/primary not completed		0.93(0.75,1.16)
Primary completed		1.01(0.8,1.28)
Secondary completed		0.95(0.76,1.20)
Higher and above		Ref.
Living arrangements		
Alone		0.93(0.73,1.19)
With spouse		0.70*(0.56,0.86)
With children		0.76*(0.63,0.92)
Others		Ref.
Working status		
Working		Ref.
Retired		0.99(0.88,1.11)
Not working		0.81*(0.70,0.94)
Social participation		
No		0.93(0.75,1.15)
Yes		Ref.
Life satisfaction		
Low		2.01*(1.80,2.24)
Medium		1.28*(1.13,1.46)
High		Ref.
Self-rated health		

Good	Ref.
Poor	2.10*(1.90,2.34)
Difficulty in ADL	
No	Ref.
Yes	1.61*(1.45,1.80)
Difficulty in IADL	
No	Ref.
Yes	1.54*(1.39,1.72)
Morbidity status	
0	Ref.
1	1.23*(1.10,1.39)
2+	1.57*(1.39,1.78)
Household factors	
MPCE quintile	
Poorest	0.73*(0.63,0.85)
Poorer	0.75*(0.64,0.87)
Middle	0.68*(0.59,0.8)
Richer	0.87(0.75,1.01)
Richest	Ref.
Religion	
Hindu	Ref.
Muslim	1.03(0.89,1.19)
Christian	0.96(0.76,1.21)
Others	1.14(0.91,1.42)
Caste	
Scheduled Caste	Ref.
Scheduled Tribe	0.57*(0.46,0.69)
Other Backward Class	1.13(0.99,1.28)
Others	0.94(0.81,1.09)
Place of residence	
Rural	Ref.
Urban	1.20*(1.07,1.34)
Region	
North	Ref.
Central	1.96*(1.68,2.29)
East	0.94(0.80,1.10)
Northeast	0.64*(0.50,0.82)
West	1.20*(1.01,1.43)
South	0.62*(0.53,0.74)

**if p<0.05; Ref: Reference; UOR: Unadjusted odds ratio; AOR: Adjusted odds ratio; CI: Confidence interval; ADL: Activities of daily living; IADL: Instrumental activities of daily living; MPCE: Monthly per capita consumption expenditure; Model-2 was adjusted for all the individual and household factors whereas model-1 represents the unadjusted estimates.*

Figure legends

Figure 1: Conceptual framework of major depression



Conceptual framework of major depression

179x132mm (96 x 96 DPI)

Table-S1. Logistic regression estimates for older adults suffering through severe depression in India, 2017-18

Background characteristic	Model-1	Model-2
	UOR (95% CI)	AOR (95% CI)
Food insecurity		
No	Ref.	Ref.
Yes	1.39* (1.27, 1.51)	1.35* (1.23, 1.48)

**if p<0.05; Ref: Reference; UOR: Unadjusted odds ratio; AOR: Adjusted odds ratio; CI: Confidence interval. Model-2 was controlled for individual and household factors; Food insecurity variable was generated using the following five questions: -*

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?
2. In the last 12 months, did you eat enough food of your choice?
3. In the last 12 months, were you hungry but didn't eat because there was not enough food at your household?
4. In the past 12 months did you ever not eat for a whole day because there was not enough food at your household?
5. Do you think that you have lost weight in the last 12 months because there was not enough food at your household?

All the variables were coded as 0 "no" and 1 "yes". Then a summation score of 0-5 was generated using a egen command in STATA. Lastly, the variable was coded as 0 if the summation score was 0 and 1 if the summation score ranges from 1-5. The variable was hence categorized as food insecurity (no and yes).

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation
Title and abstract	1	Page1-2
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*Give information separately for exposed and unexposed groups.

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Food insecurity and associated depression among older adults in India: Evidence from a population-based study

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Food insecurity and associated depression among older adults in India: Evidence from a population-based study

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Food insecurity and associated depression among older adults in India: Evidence from a population-based study

Abstract

Objective: The present study aimed to examine the associations of several indicators of food insecurity with depression among older adults in India.

Design: A cross-sectional study was conducted using country-representative survey data.

Setting and participants: The present study uses data of the Longitudinal Aging Study in India (LASI) conducted during 2017-18. The effective sample size for the present study was 31,464 older adults aged 60 years and above.

Primary and secondary outcome measures: The outcome variable was major depression among older adults. Descriptive statistics along with bivariate analysis was presented. Additionally, binary logistic regression analysis was used to establish the association between the depression and food security factors along with other covariates.

Results: The overall prevalence of major depression was 8.4% among older adults in India. A proportion of 6.3% of the older adults reduced the size of meals, 40% reported that they did not eat enough food of their choice, 5.6% mentioned that they were hungry but did not eat, 4.2% reported that they did not eat for a whole day and 5.6% think that they have lost weight due to lack of enough food in the household. Older adults who reported to have reduced the size of meals due to lack of enough food [AOR: 1.76, CI: 1.44, 2.15], were hungry but did not eat [AOR: 1.35, CI: 1.06, 1.72], did not eat food for a whole day [AOR: 1.33; CI: 1.03,1.71], lost weight due to lack of food [AOR: 1.57; CI: 1.30,1.89] had higher odds of being depressed in reference to their respective counterparts.

Conclusion: The findings suggest that self-reported food insecurity indicators were strongly associated with major depression among older Indian adults. The national food security programs should be enhanced as an effort to improve mental health status and quality of life among older population.

Keywords: Major depression; food security; older adults; India.

Strengths and limitations:

- The study utilizes a large nationally representative sample of older population.
- Cross-sectional design is a limitation of the study as it is impossible to establish the observed directions of the relationships.
- The food security indicators were self-reported which may result in recall and reporting biases

Introduction

Food insecurity is defined as not having physical, social and economic access to sufficient, safe and nutritious food that satisfies their dietary needs and food choices for a productive and healthy life [1, 2]. About 815 million people live in this situation globally [3]. To support this population, Sustainable Development Goals, targets 2.1 and 2.2 emphasize ending hunger and all forms of malnutrition [4]. Food insecurity incorporates more than just the current nutritional state, capturing as well vulnerability to anticipated disturbances in access to adequate and appropriate food [5–7]. After the economic liberalizations, developing countries struggle to meet global nutritional standards and ensure food security [8]. Food security has been a policy priority in India for a long time, mainly focusing on its vulnerable populations like children and older adults [9–11].

In adult populations, food insecurity is associated with insufficient dietary consumption, nutritional status, and poor physical and mental well-being [12]. A couple of studies found that food insecurity is related to poor social and functional health, hypertension, diabetes, and anxiety [12–16]. Empirical evidence pointed out that the prevalence of food insecurity is exceptionally high among older adults [17–19] due to physical limitations, poor heart conditions, social isolation, and lack of transportation [20–23]. Similarly, food insecure older adults have been reported to spend less on healthcare [24] and to show higher levels of non-adherence to medical treatments due to financial limitations [25]. Therefore, among older adults, food insecurity has been linked with poor health status [26], lower cognitive performance [27] and, notably, higher risk of depression [28].

The world health organization (WHO) defines depression as a mental disorder characterized by sadness, lack of interest or pleasure, guilt or low self-worth, disordered sleep or appetite, feelings of tiredness, and reduced concentration [29]. Research has shown a relationship between depression and various socio-economic variables such as old age, low level of education, hunger and physical labour [30, 31]. Depressive disorders are the most common psychiatric condition among older people [32, 33]. Recent evidence recognized several factors associated with depression in older adults, including co-morbid physical disease, pain, and disability, Cognitive impairment, neuroticism, education level, loneliness and lack of social support [34–37]. Also, multiple studies have suggested that food insecurity is connected with poor mental health, especially depressive symptoms among older adults [38–40].

The majority of the research articulates that food insecurity positively associates with depressive symptoms in older adults and there is a dearth of studies in low- and middle-income countries. This study aimed to examine the associations of specific indicators of food insecurity including reduction in meal size, not eating food of one's choice, not eating enough food, remaining hungry for a whole day and body weight loss with depression among older adults in India. Further, we analysed the association of food insecurity indicators after adjusting for socio-economic and health attributes of older Indian adults with their depressive symptoms. Based on the conceptual framework provided (Figure 1) and the past research, this study hypothesized that those who reduced meal size due to food shortage, did not have food of own choice, remained hungry for a whole day or lost weight due to food shortage would be more likely to be depressed compared to those who did not experience these.

[Insert Figure-1]

Data, Variables, and Methods

Data Source

This study utilizes data from India's first nationally representative longitudinal Ageing survey (LASI, 2017-18) which investigates into the health, economics and social determinants and consequences of population ageing in India [41]. The present study was cross-sectional in nature. The representative sample included 72,250 individuals aged 45 and above and their spouses across all states and union territories of India except Sikkim. The LASI adopts a multistage stratified area probability cluster sampling design to select the eventual units of observation. Households with at least one member aged 45 and above were taken as the eventual unit of observation. This study provides scientific evidence on demographics, household economic status, chronic health conditions, symptom based health condition, functional and mental health, biomarkers, health care utilization, work and employment etc. It enables the cross state analyses and the cross national analyses of ageing, health, economic status and social behaviours and has been designed to evaluate the effect of changing policies and behavioural outcomes in India. The LASI was interviewer (face to face) administered survey during household visits using computer-assisted personal interview (CAPI) technology. The interview was conducted in the local language of the area administered [41]. The total response rate was at individual level was 95.6%. Detailed information on the sampling frame is available on the LASI wave-1 Report [41]. The effective sample size for the present study was 31,464 older adults aged 60 years and above

[41]. The Indian Council of Medical Research (ICMR) extended the necessary guidance and ethical approval for conducting the LASI [41]. Prior informed consent from the respondents was taken before conducting the interviews [41].

Variable description

Outcome variable

The outcome variable for the study was major depression which was coded as 0 for "not diagnosed with depression" and 1 for "diagnosed with depression" [41]. Major depression among older adults with symptoms of dysphoria was calculated using the Short Form Composite International Diagnostic Interview (CIDI-SF) (Cronabach alpha: 0.70). Persons with a score of 3 or more were considered being depressed. This scale is used for probable psychiatric diagnosis of major depression and has been validated in field settings and widely used in population-based health surveys [42, 43].

Explanatory variables

The explanatory variables were divided into three sections namely, food security indicators, individual factors and household/community factors.

Food security indicators

The food security indicators in the current study were adapted from similar items established in food security questionnaires of the U.S. Household Food Security Survey Module (HFSSM) adult scale [22], and the items are validated in Indian settings [44]. The items are:

i. 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".
ii. 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 enough food of once choice" and it was coded as 0 "no" and 1 "yes".
iii. 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".

iv. 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".

v. 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".

Individual factors

i. Age was categorized as young old (60-69 years), old-old (70-79 years) and oldest old (80+ years).

ii. Sex was categorized as male and female.

iii. Educational status was categorized as no education/primary not completed, primary, secondary and higher.

iv. Working status was categorized as currently working, not working/retired and never worked.

v. Social participation was categorized as no and yes. Social participation was measured though the question "Are you a member of any of the organizations, religious groups, clubs, or societies"? The response was categorized as no and yes [45].

vi. Self-rated health was coded as good which includes excellent, very good and good where as poor includes fair and poor [46].

vii. 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 older adults [47, 48].

viii. Difficulty in IADL (Instrumental Activities of Daily Living) was coded as no and yes. Activities of daily living that are not necessarily related to fundamental functioning of a person, but they let an individual live independently in a community. The set ask were 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 [47, 48].

ix. Morbidity status was categorized as 0 "no morbidity", 1 "any one morbid condition" and 2+ "co-morbidity" [49].

Household/community factors

i. The monthly per capita consumption 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 MPCE is computed and used as the summary measure of consumption. The variable was then divided into five quintiles i.e., from poorest to richest [41].

ii. Religion was coded as Hindu, Muslim, Christian, and Others.

iii. Caste was recoded as Scheduled Tribe, Scheduled Caste, Other Backward Class, and others. 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 Castes (SCs) and Scheduled Tribes (STs) are among the most disadvantaged socio-economic groups in India. The OBC is the group of people who were identified as "educationally, economically and socially backward". The OBCs are considered low in the traditional caste hierarchy but are not considered untouchables. The "other" caste category is identified as having higher social status [50].

iv. Place of residence was categorized as rural and urban.

v. The region was coded as North, Central, East, Northeast, West, and South [51].

Statistical analysis

In this study, descriptive statistics and bivariate analysis has been performed to determine the prevalence of major depression by food security factors along individual and household factors. Chi-square test was used to check for intergroup differences in the prevalence of depression among older adults [52, 53]. Further, binary logistic regression analysis [54] was used to fulfil the aims and objective of the study. The results are presented in the form of odds ratio (OR) with a 95% confidence interval (CI). There were two models in the present analysis. Model-1 represents the unadjusted odds ratio. Model-2 represents the adjusted odds

ratio i.e., adjusted for individual (age, sex, education, living arrangements, work status, social participation, self-rated health, ADL/IADL difficulty and chronic morbidity) and household/community factors (wealth quintiles, religion, caste, place of residence and regions).

The equation for logistic regression is as follows:

$$\ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \beta_1 x_1 + \ldots + \beta_M x_{m-1},$$

Where,β_0,.....,β_M, are regression coefficients indicating the relative effect of a particular explanatory variable on the outcome variable. Variance inflation factor [55–57] was used to check multicollinearity among the variables used and it was found that there was no evidence of multicollinearity. Svyset command was used in STATA 14 [58] to account for complex survey design. Further, individual weights were used to make the estimates nationally representative.

Patient and Public Involvement

No patient involved

Results

Socio-demographic and health profile of older adults

Table 1 depicts the socio-economic profile of older adults in India. A proportion of 6.3% of the older adults reduced the size of meals due to lack of enough food in the household. About 40% of the older adults reported that they did not eat enough food of their choice. 5.6% of the older adults reported that they were hungry but did not eat because there was not enough food at their household. 4.2% of the older adults reported that they did not eat for a whole day because there was not enough food at their household. 5.6% of the older adults think that they have lost weight due to lack of food at their household. Around 11% of the older adults belonged to oldest old age group; 68% of older adults had no education or their primary education was incomplete; 5.7% of older adults lived alone; and 26.4% of older adults never worked in their lifetime. The share of older adults who had any social participation was 4.5%. Nearly 48.6% of older adults had poor self-rated health; 24.4% and 48.7% of older adults had difficulty in ADL and IADL respectively; and 23.9% of older adults had two or more chronic diseases.

[Insert Table-1]

Percentage of older adults suffering from major *depression*

Table 2 presents the share of older adults suffering from major depression in India. The overall prevalence of major depression was 8.4% among older adults in India. Higher percentage of older adults who reduced their size of meal suffered from major depression (23.6%) compared to those who did not reduce their meal (7.4%). Older adults who were hungry but did not eat had higher prevalence of major depression (25.3%) than those who had enough food (7.4%). Higher percentage of older adults who did not eat for a whole day suffered from major depression (24.8%) in compared to those who had food daily (7.7%). Older adults who lost their weight due to lack of food had higher prevalence of major depression (24.1%) in reference to their counterparts with no weight loss (7.5%).

[Insert Table-2]

Logistic regression estimates of older adults suffering from major depression

Table 3 presents the results from logistic regression analysis of older adults suffering from major depression. Model-1 represents the unadjusted estimates whereas model-2 represents the adjusted estimates. In model-1, older adults who reported to have reduced the size of meals due to lack of enough food had higher odds of being depressed in comparison to those who did not reduce the size of meals due to lack of enough food [UOR: 1.95, CI: 1.61-2.37]. Older adults who reported that they were hungry but did not eat because there was not enough food in their household had higher odds of being depressed in comparison to their counterparts with adequate food availability [UOR: 1.46, CI: 1.16-1.85]. Older adults who reported that they have lost weight due to lack of food had higher odds of being depressed compared to their counterparts with no weight loss [UOR: 2.17, CI: 1.80-2.6].

Model-2 reveals that older adults who reported to have reduced the size of meals due to lack of enough food had higher odds of being depressed in comparison to those who did not reduce the size of meals due to lack of enough food [AOR: 1.76, CI: 1.44, 2.15]. The choice of food did not have any significant association with major depression among older adults. Older adults who reported that they were hungry but did not eat because there was not enough food in their household had higher odds of being depressed compared to their counterparts with adequate food availability [AOR: 1.35, CI: 1.06, 1.72]. Older adults who did not eat food for the whole day had higher odds of suffering from major depression in

comparison to their counterparts who had food [AOR: 1.33; CI: 1.03, 1.71]. Older adults who reported that they have lost weight due to lack of food had higher odds of being depressed compared to their counterparts with no weight loss [AOR: 1.57; CI: 1.30, 1.89].

The odds of major depression were higher among older women than men [AOR: 1.15; CI: 1.02, 1.28]. The odds of major depression were lower among older adults who were living with children in comparison to those who were living with others [AOR: 0.80, CI: 0.66,0.96]. Older adults who had poor self-rated health had 2.38 times higher odds of suffering from major depression in comparison to older adults who had good self-rated health [AOR: 2.38, CI: 2.15,2.64]. The odds of major depression were significantly higher among the older adults who had difficulty in ADL and IADL in reference to the older adults who did not had difficulty in ADL and IADL respectively [AOR: 1.56, CI: 1.4,1.74] [AOR: 1.54, CI: 1.38,1.72]. Older adults who belonged to the poorest MPCE quintile had lower odds of suffering from major depression in comparison to older adults from richest wealth quintile [AOR: 0.75; CI: 0.65,0.88]. Older adults from urban areas had significantly lower odds of suffering from major depression compared to older adults who were from rural areas [AOR: 0.82; CI: 0.73, 0.92]. Table S1 (supplementary file) presents the regression estimates of older adults with food insecurity suffering from major depression. In model-1 (unadjusted), older adults with food insecurity had higher odds of major depression in comparison to their food secure counterparts [UOR: 1.39; CI: 1.27, 1.51]. Similarly, in the adjusted model (model 2), older adults with food insecurity had higher odds of major depression compared to their food secure counterparts [AOR: 2.56; CI: 2.28, 2.88].

[Insert Table-3]

Discussion

The current study aimed to explore the prevalence of specific indicators of food insecurity and associated depression in late life through descriptive and regression analyses of a large country-representative survey data. With the increasing age, because of the development of more physical disabilities, there is a higher probability of increased food insecurity [59]. Consistently, the results have shown a substantial proportion of older population reducing the size of their meals due to food shortage, not eating food of own choice, not eating enough food, remaining hungry for a whole day and losing their body weight. In line with the recent literature, we also observed strong positive associations between food insecurity indicators

and depression even after adjusting for several socio-demographic and health variables [60–62].

However, since food insecurity and depression are multifactorial in nature, the mechanisms through which food insecurity affects depression are not adequately understood. There is a growing body of literature suggesting that food insecurity may act as an environmental stressor that can lead to late-life depressive disorders [63, 64]. Food insecurity is considered as a major source of anxiety and life stress in the psychological pathways, leading to the shame or concern about one's position in the society [61]. Similarly, financial constraints may enhance feelings of worry and anxiety about the food situation and asking for food that is considered to be socially unacceptable creates feelings of stress [28]. On the other hand, the link between nutritional deficiencies and depressive symptoms is well-documented [65]. A couple of studies have shown poor nutrition and dietary imbalances leading to depression [66, 67]. Also, burgeoning studies on nutritional psychiatry attempt to address the pathway of availability and accessibility of food and the onset and the severity of depressive disorders [65, 68]. The findings suggest that addressing food at the population level that is often an overlooked issue in the context of mental health, especially among the older population, may contribute to better mental health and psychological well-being in an aging population.

Reduced intake of food and weight loss being indicators of food insecurity was found to be significantly associated with the risk of depression among the older sample in this study and the associations were stronger than other indicators. This was consistent with several previous studies that had identified less nutrient intakes and to be associated with poor mental health and depressive symptoms [69–71]. The mechanism of this contribution can be explained by the relationship between stressors emerging as a result of reduced body weight and morbidities and negative mental health outcomes [72]. The inverse causation also has been discussed in past studies suggesting that weight changes in both direction increased or decreased intake maybe caused by the appetite changes due to depression [73]. Seeking alternative food sources through food support plans, food banks, or social networks is challenging for older adults due to social isolation, loss of independence, and weakness, increasing with age [74], in turn, they may feel particularly incapable when faced with food insecurity, probably raising the likelihood of depression [75], suggesting the bidirectional association of food insecurity and depressive symptoms in old age. Our findings also suggest that promoting food security should be regarded as an important aspect of preventing psychological morbidity among the older population who are food-insecure. Besides, the

findings imply that food security interventions can have both nutritional and non-nutritional impacts including an improved mental health status.

Other important findings of the current study include significant age and sex differences in the prevalence of major depressive disorder. The odds of suffering from depression were higher among young and female older adults compared with their male and oldest counterparts. The previous studies have also reported that depression is more prevalent among women, as the global depression ratio stands in favour of men [76]. Several studies elaborate that the gender disparity may stem primarily from behavioural as well as socioeconomic differences such as diet, tobacco and alcohol use, and education [77]. Some studies reported that the higher prevalence of depression among women can be related to their biological conditions such as menstrual disorders, post-menopausal depression and anxiety and postpartum depression [76]. Furthermore, older people by increasing age tend to accept ill health as an impact of aging and are less likely to be worried about their poor mental status [78]. On the other side, younger population becomes more aware of their psychological problems and is more sensitive towards any deficit in their mental well-being. The declining trend in depression in older ages was also reported in multiple previous studies [79, 80].

However, the findings of the current study need to be interpreted in light of major limitations. Firstly, the study was conducted with a cross-sectional design hence causality cannot be inferred between outcome variable that is depression and predictor variables. Also, the food security indicators were self-reported by older adults, which may result in their recall or reporting biases. Similarly, the huge variations in the prevalence of food insecurity measured through several indicators that varies from 4.2% for the question regarding “did not eat for a whole day due to food shortage” to 39.9% for the question regarding “did not have food of own choice” may result in misclassification effects, for example, people who are food secure might be marked as food insecure in specific indicator which suggests the need for further investigation of appropriate measures of food security in Indian setting. However, due to the use of a large country representative dataset with detailed measures of food insecurity, results can be generalizable to the broader population. In addition, depression was assessed with a globally accepted scale of CIDI-SF that adds to the validity and reliability of the present study. For older adults, food insecurity is a vital psychosocial stressor that adds to variations in major depression across socio-economic strata [81].

A majority of research considered food insecurity as a static experience; however, both life transitions and cumulative experiences could also influence depression in old age [82, 83]. Importantly, older adults may be significantly exposed to the consequence of food insecurity. For instance, some evidence indicates that food insecurity is more prone to poor diet condition among older adults than younger age groups [81, 84]. In turn, poor diet quality is associated with depression, potentially a source of chronic systemic inflammation [85]. Food insecurity also intensifies the medical conditions common in older age, like diabetes, poor health status, and medical morbidity that are recognized as risk factors for older age depression [86–88]. These aspects suggest future investigation of several pathways of food insecurity including adverse childhood and adulthood exposures leading to mental stressors and late-life depression.

Conclusion

The results showed that self-reported food insecurity indicators including the reduction in the size of meals, not eating food of one's choice, not eating enough food, remaining hungry for a whole day and losing the body weight are strongly associated with major depression among older Indian adults. The findings can be of special interest to health-decision makers and researchers involved in the areas of mental health of aging population in India and other low- and middle-income countries with similar demographic and economic transitional stages. The findings suggest that the national food security programs should be enhanced as an effort to improve mental health status and quality of life among older population.

Contributor statement

Conceived and designed the research paper: TM and SS; analysed the data: SS; Contributed agents/materials/analysis tools: TM; Wrote the manuscript: SKM, TM and DD; Refined the manuscript: TM and SS.

Ethics Statement

The Indian Council of Medical Research (ICMR) extended the necessary guidance and ethical approval for conducting the LASI.

Competing interest

The authors declare that there is no competing interest

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Data sharing statement

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

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

Background characteristics	Total		Not depressed		Depressed	
	Sample	Percentage	Sample	Percentage	Sample	Percentage
Food security factors						
Reduced the size of meals						
No	29,471	93.7	27,746	94.7	1784	82.2
Yes	1,993	6.3	1,548	5.3	386	17.8
Did not eat enough food of one's choice						
No	18,922	60.1	17,712	60.5	1229	56.6
Yes	12,542	39.9	11,582	39.5	941	43.4
Hungry but did not eat						
No	29,711	94.4	27,963	95.5	1806	83.2
Yes	1,753	5.6	1,331	4.5	364	16.8
Did not eat for a whole day						
No	30,152	95.8	28,291	96.6	1903	87.7
Yes	1,312	4.2	1,003	3.4	267	12.3
Lost weight due to lack of food						
No	29,695	94.4	27,928	95.3	1820	83.9
Yes	1,769	5.6	1,366	4.7	350	16.1
Individual factors						
Age						
Young-old	18,410	58.5	17,165	58.6	1250	57.6
Old-old	9,501	30.2	8,878	30.3	630	29.0
Oldest-old	3,553	11.3	3,251	11.1	290	13.4
Sex						
Male	14,931	47.5	14,079	48.1	886	40.8
Female	16,533	52.6	15,215	51.9	1284	59.2
Education						
No education/primary not completed	21,381	68.0	19,710	67.3	1633	75.2
Primary completed	3,520	11.2	3,299	11.3	225	10.4
Secondary completed	4,371	13.9	4,186	14.3	208	9.6
Higher and above	2,191	7.0	2,098	7.2	105	4.8
Living arrangements						
Alone	1,787	5.7	1,576	5.4	194	8.9
With spouse	6,397	20.3	5,977	20.4	424	19.5
With children	21,475	68.3	20,102	68.6	1394	64.2
Others	1,805	5.7	1,639	5.6	158	7.3
Working status						
Working	9,680	30.8	9,079	31.0	613	28.3
Not working/retired	13,470	42.8	12,386	42.3	1054	48.6
Never worked	8,314	26.4	7,829	26.7	502	23.2
Social participation						
No	30,053	95.5	27,955	95.4	2093	96.5
Yes	1,411	4.5	1,339	4.6	77	3.5
Self-rated health*						
Good	15,850	51.4	16,108	55.0	603	27.8
Poor	14,961	48.6	13,186	45.0	1567	72.2

Difficulty in ADL*						
No	23,802	75.7	22,594	77.1	1291	59.5
Yes	7,662	24.4	6,700	22.9	879	40.5
Difficulty in IADL*						
No	16,130	51.3	15,489	52.9	732	33.7
Yes	15,334	48.7	13,805	47.1	1438	66.3
Morbidity status						
0	14,773	47.0	13,981	47.7	835	38.5
1	9,171	29.2	8,540	29.2	632	29.1
2+	7,520	23.9	6,773	23.1	703	32.4
Household/community factors						
MPCE quintile						
Poorest	6,829	21.7	6,343	21.7	483	22.3
Poorer	6,831	21.7	6,411	21.9	430	19.8
Middle	6,590	21.0	6,174	21.1	424	19.5
Richer	6,038	19.2	5,613	19.2	424	19.5
Richest	5,175	16.5	4,753	16.2	409	18.9
Religion						
Hindu	25,871	82.2	24,091	82.2	1780	82.0
Muslim	3,548	11.3	3,286	11.2	259	12.0
Christian	900	2.9	850	2.9	52	2.4
Others	1,145	3.6	1,067	3.6	78	3.6
Caste						
Scheduled Caste	5,949	18.9	5,458	18.6	475	21.9
Scheduled Tribe	2,556	8.1	2,475	8.5	99	4.6
Other Backward Class	14,231	45.2	13,168	45.0	1048	48.3
Others	8,729	27.7	8,193	28.0	548	25.3
Place of residence						
Rural	22,196	70.6	20,446	69.8	1708	78.7
Urban	9,268	29.5	8,848	30.2	462	21.3
Region						
North	3,960	12.6	3,755	12.8	218	10.0
Central	6,593	21.0	5,759	19.7	761	35.1
East	7,439	23.6	6,951	23.7	492	22.7
Northeast	935	3.0	898	3.1	42	1.9
West	5,401	17.2	5,080	17.3	331	15.3
South	7,136	22.7	6,851	23.4	325	15.0
Total	31,464	100.0	29,294	100.0	2170	100.0

MPCE: Monthly per capita *consumption* expenditure; *ADL: Activities of daily living; IADL: Instrumental activities of daily living; *The sample is low due to missing cases and non-response.*

Table-2. Percentage of older adults suffering from major depression in India, 2017-18

Background characteristics	Not depressed	Depressed	p-value
Food security factors	**Percentage (n)**	**Percentage (n)**	
Reduced the size of meals			<0.001
No	92.6 (27297)	7.4 (2174)	
Yes	76.4 (1523)	23.6 (470)	
Did not eat enough food of one's choice			0.984
No	92.1 (17425)	7.9 (1497)	
Yes	90.9 (11395)	9.1 (1147)	
Hungry but did not eat			<0.001
No	92.6 (27511)	7.4 (2200)	
Yes	74.7 (1309)	25.3 (444)	
Did not eat for a whole day			<0.001
No	92.3 (27833)	7.7 (2319)	
Yes	75.2 (987)	24.8 (325)	
Lost weight due to lack of food			<0.001
No	92.5 (27477)	7.5 (2218)	
Yes	75.9 (1343)	24.1 (426)	
Individual factors			
Age			0.207
Young-old	91.7 (16887)	8.3 (1523)	
Old-old	91.9 (8734)	8.1 (767)	
Oldest-old	90 (3199)	10 (354)	
Sex			<0.001
Male	92.8 (13851)	7.2 (1080)	
Female	90.5 (14969)	9.5 (1564)	
Education			<0.001
No education/primary not completed	90.7 (19392)	9.3 (1989)	
Primary completed	92.2 (3246)	7.8 (274)	
Secondary completed	94.2 (4119)	5.8 (253)	
Higher and above	94.2 (2064)	5.8 (127)	
Living arrangements			<0.001
Alone	86.8 (1551)	13.2 (236)	
With spouse	91.9 (5880)	8.1 (516)	
With children	92.1 (19777)	7.9 (1698)	
Others	89.3 (1612)	10.7 (193)	
Working status			<0.001
Working	92.3 (8933)	7.7 (747)	
Not working/retired	90.5 (12185)	9.5 (1284)	
Never worked	92.6 (7702)	7.4 (612)	
Social participation			<0.001
No	91.5 (27503)	8.5 (2550)	
Yes	93.4 (1317)	6.6 (94)	
Self-rated health			<0.001
Good	95.6 (15848)	4.4 (734)	
Poor	87.2 (12973)	12.8 (1910)	
Difficulty in ADL			<0.001
No	93.4 (22229)	6.6 (1573)	

Yes	86 (6591)	14 (1071)	
Difficulty in IADL			<0.001
No	94.5 (15238)	5.5 (892)	
Yes	88.6 (13582)	11.4 (1752)	
Morbidity status			<0.001
0	93.1 (13755)	6.9 (1017)	
1	91.6 (8402)	8.4 (770)	
2+	88.6 (6663)	11.4 (857)	
Household/community factors			
MPCE quintile			<0.001
Poorest	91.4 (6240)	8.6 (589)	
Poorer	92.3 (6308)	7.7 (524)	
Middle	92.2 (6074)	7.8 (516)	
Richer	91.5 (5522)	8.6 (516)	
Richest	90.4 (4676)	9.6 (499)	
Religion			<0.001
Hindu	91.6 (23702)	8.4 (2169)	
Muslim	91.1 (3232)	8.9 (316)	
Christian	92.9 (837)	7.1 (64)	
Others	91.7 (1049)	8.3 (96)	
Caste			<0.001
Scheduled Caste	90.3 (5370)	9.7 (579)	
Scheduled Tribe	95.3 (2435)	4.7 (121)	
Other Backward Class	91 (12955)	9 (1276)	
Others	92.4 (8061)	7.7 (668)	
Place of residence			<0.001
Rural	90.6 (20116)	9.4 (2081)	
Urban	93.9 (8705)	6.1 (563)	
Region			<0.001
North	93.3 (3695)	6.7 (265)	
Central	85.9 (5666)	14.1 (927)	
East	91.9 (6839)	8.1 (600)	
Northeast	94.5 (884)	5.5 (51)	
West	92.5 (4997)	7.5 (404)	
South	94.4 (6740)	5.6 (397)	
Total	91.6 (28,820)	8.4 (2644)	

MPCE: Monthly per capita consumption expenditure; *ADL: Activities of daily living; IADL: Instrumental activities of daily living; the estimates are weighted.*

Table-3. Logistic regression estimates for older adults suffering from major depression in India, 2017-18

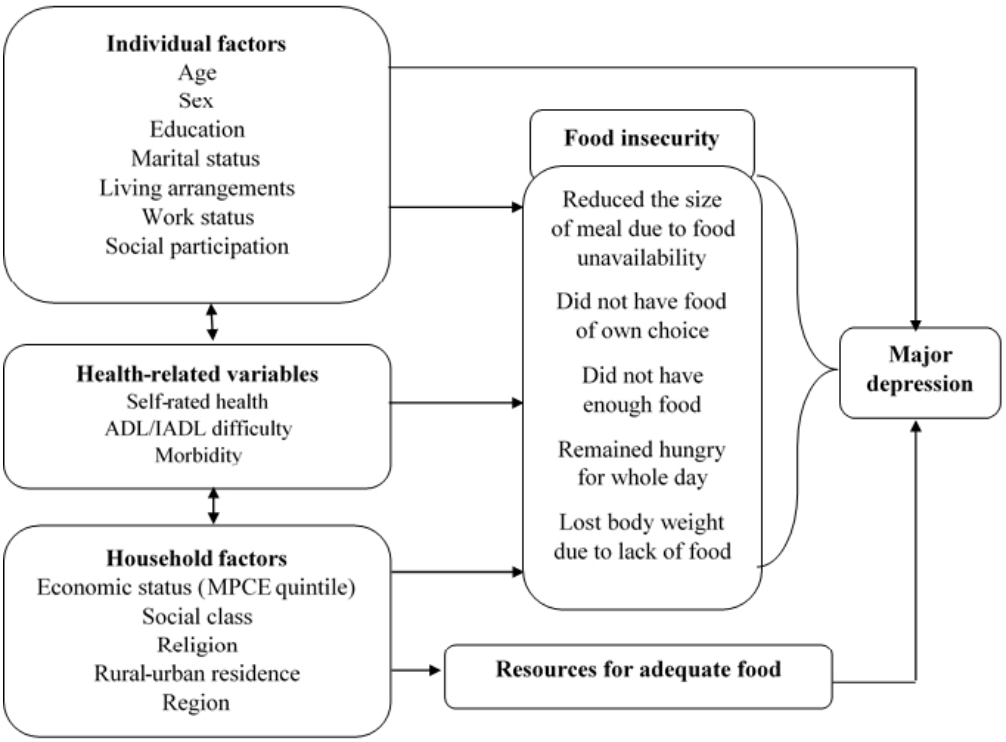
Background characteristics	Model-1	Model-2
	UOR (95% CI)	AOR (95% CI)
Food security factors		
Reduced the size of meals		
No	Ref.	Ref.
Yes	1.95*(1.61,2.37)	1.76*(1.44,2.15)
Did not eat enough food of one's choice		
No	Ref.	Ref.
Yes	1.01(0.92,1.10)	0.92(0.84,1.02)
Hungry but did not eat		
No	Ref.	Ref.
Yes	1.46*(1.16,1.85)	1.35*(1.06,1.72)
Did not eat for a whole day		
No	Ref.	Ref.
Yes	1.15(0.90,1.47)	1.33*(1.03,1.71)
Lost weight due to lack of food		
No	Ref.	Ref.
Yes	2.17*(1.80,2.6)	1.57*(1.3,1.89)
Individual factors		
Age		
Young-old		Ref.
Old-old		0.81*(0.73,0.91)
Oldest-old		0.74*(0.63,0.86)
Sex		
Male		Ref.
Female		1.15*(1.02,1.28)
Education		
No education/primary not completed		1.03(0.83,1.28)
Primary completed		1.08(0.85,1.37)
Secondary completed		0.99(0.78,1.24)
Higher and above		Ref.
Living arrangements		
Alone		1.05(0.82,1.33)
With spouse		0.72*(0.59,0.89)
With children		0.8*(0.66,0.96)
Others		Ref.
Working status		
Working		Ref.
Not working/retired		0.99(0.88,1.11)
Never worked		0.80*(0.69,0.93)
Social participation		
No		0.92(0.74,1.14)
Yes		Ref.
Self-rated health		
Good		Ref.
Poor		2.38*(2.15,2.64)

Difficulty in ADL	
No	Ref.
Yes	1.56*(1.4,1.74)
Difficulty in IADL	
No	Ref.
Yes	1.54*(1.38,1.72)
Morbidity status	
0	Ref.
1	1.23*(1.09,1.37)
2+	1.56*(1.38,1.76)
Household/community factors	
MPCE quintile	
Poorest	0.75*(0.65,0.88)
Poorer	0.77*(0.67,0.89)
Middle	0.70*(0.6,0.81)
Richer	0.88(0.76,1.01)
Richest	Ref.
Religion	
Hindu	Ref.
Muslim	1.06(0.92,1.22)
Christian	0.93(0.74,1.18)
Others	1.09(0.88,1.36)
Caste	
Scheduled Caste	Ref.
Scheduled Tribe	0.58*(0.47,0.7)
Other Backward Class	1.11(0.98,1.26)
Others	0.92(0.8,1.06)
Place of residence	
Rural	Ref.
Urban	0.82*(0.73,0.92)
Region	
North	Ref.
Central	1.96*(1.67,2.29)
East	0.97(0.83,1.14)
Northeast	0.62*(0.49,0.79)
West	1.09(0.92,1.29)
South	0.65*(0.55,0.77)

**if p<0.05; Ref: Reference; UOR: Unadjusted odds ratio; AOR: Adjusted odds ratio; CI: Confidence interval; ADL: Activities of daily living; IADL: Instrumental activities of daily living; MPCE: Monthly per capita consumption expenditure; Model-2 was adjusted for all the individual and household factors whereas model-1 represents the unadjusted estimates.*

Figure legends

Figure 1: Conceptual framework of major depression



Conceptual framework of major depression

119x88mm (144 x 144 DPI)

Table-S1. Logistic regression estimates for older adults suffering from major depression in India, 2017-18

Background characteristic	Model-1	Model-2
	UOR (95% CI)	AOR (95% CI)
Food insecurity		
No	Ref.	Ref.
Yes	1.39* (1.27, 1.51)	2.56* (2.28, 2.88)

**if p<0.05; Ref: Reference; UOR: Unadjusted odds ratio; AOR: Adjusted odds ratio; CI: Confidence interval. Model-2 was controlled for individual and household factors; Food insecurity variable was generated using the following five questions: -*

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?
2. In the last 12 months, did you eat enough food of your choice?
3. In the last 12 months, were you hungry but didn't eat because there was not enough food at your household?
4. In the past 12 months did you ever not eat for a whole day because there was not enough food at your household?
5. Do you think that you have lost weight in the last 12 months because there was not enough food at your household?

All the variables were coded as 0 "no" and 1 "yes". Then a summation score of 0-5 was generated using a egen command in STATA. Lastly, the variable was coded as 0 if the summation score was 0 and 1 if the summation score ranges from 1-5. The variable was hence categorized as food insecurity (no and yes).

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation
Title and abstract	1	Page1-2
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*Give information separately for exposed and unexposed groups.