Section: Community Medicine

Original Research Article

# RURAL-URBAN DIFFERENCES IN FOOD INSECURITY AND ASSOCIATED COGNITIVE IMPAIRMENT AMONG OLDER ADULTS IN UTTAR PRADESH: A DESCRIPTIVE OBSERVATIONAL STUDY

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ABSTRACT

**Background:** Food insecurity and cognitive impairment are serious public health challenges among older adults in India. Uttar Pradesh, with its marked rural-urban divide, provides a suitable context to examine whether these outcomes differ by residence type and whether food insecurity is associated with poorer cognitive functioning.

**Materials and Methods:** A cross-sectional descriptive observational study was conducted among 400 older adults (200 rural, 200 urban) at RHTC and UHTC, Hapur. Food insecurity was assessed using five validated indicators from the Longitudinal Ageing Study in India (LASI). Cognitive impairment was assessed using a validated multi-domain tool. Chi-square tests, independent t-tests, and multivariable logistic regression were applied.

**Results:** Food insecurity prevalence was extremely high and nearly uniform across both groups (Rural: 96.5%, Urban: 97.0%, p=1.000). No statistically significant rural-urban differences were observed in any individual food insecurity indicator. The prevalence of cognitive impairment was 33.0% in rural and 29.0% in urban participants (p=0.449). In multivariable logistic regression, female sex was the only significant predictor of cognitive impairment (OR=0.50, 95% CI: 0.32-0.77, p=0.002). Urban older adults reported significantly better self-rated health (p=0.023). Marital status differed significantly, with rural participants more likely to be widowed (p=0.015).

**Conclusions:** While both food insecurity and cognitive impairment are highly prevalent in this population, no significant rural-urban disparity was found in this facility-based sample. The near-universal food insecurity may reflect a ceiling effect, masking underlying differences. Sex-disaggregated interventions and longitudinal designs are warranted.

**Keywords:** Food insecurity, cognitive impairment, rural-urban differences, older adults, Uttar Pradesh, LASI.

## INTRODUCTION

Food insecurity, defined as limited or uncertain availability of nutritionally adequate and safe foods or the inability to acquire them in socially acceptable ways, remains a pressing public health concern in low- and middle-income countries, particularly among vulnerable segments of the population such as older adults.[1] India's aging demographic is expanding rapidly; projections suggest that by 2050, approximately one-fifth of India's population will be aged 60 years and above, presenting unique challenges in ensuring adequate nutrition and cognitive health for this group.[2]

Evidence from the Longitudinal Ageing Study in India (LASI) has documented higher rates of food

insecurity among rural older adults compared to their urban counterparts. Approximately 7.7% of rural older adults reported reducing meal sizes due to food unavailability, compared to 3.2% in urban settings.[3] These disparities are compounded by differences in healthcare access, social support structures, and economic opportunities between rural and urban settings in a large and heterogeneous state like Uttar Pradesh.

The link between food insecurity and cognitive impairment is biologically and psychologically plausible. Nutritional deficiencies resulting from chronic food insecurity can impair neurological function, while the chronic stress associated with food insecurity may accelerate cognitive decline.[4,5] Furthermore, limited access to nutrient-rich foods is known to exacerbate metabolic conditions such as diabetes and hypertension, which are established risk factors for dementia and cognitive deterioration.[6]

Uttar Pradesh, being India's most populous state with both a rapidly aging population and a pronounced rural-urban socioeconomic divide, constitutes a critical context for investigating these relationships. Despite growing awareness, empirical evidence directly comparing food insecurity and cognitive health outcomes between rural and urban older adults in this state remains limited.[7] The present study was therefore designed to address this evidence gap.

**Objectives**

**The study was designed with four specific objectives**

- To assess the prevalence of food insecurity among older adults in rural and urban areas of Hapur, Uttar Pradesh.
- To examine the association between food insecurity and cognitive impairment in this population.
- To identify rural-urban differences in the relationship between food insecurity and cognitive functioning.
- To explore mediating factors that might explain these differences.

## MATERIALS AND METHODS

**Study Design and Setting**

This was a cross-sectional descriptive observational study conducted at the Rural Health Training Centre (RHTC) and Urban Health Training Centre (UHTC) of Hapur district, Uttar Pradesh. Data collection was carried out over a six-month period following institutional ethical approval.

**Sample Size and Sampling**

The sample size was calculated using the formula $n = Z^2 \times p(1-p) / e^2$, based on a food insecurity prevalence of 41.2% reported by Srivastava and Muhammad (2022) from a nationally representative survey (3). Using a 95% confidence level (Z=1.96) and a margin of error of 5%, the minimum sample size was estimated at 372, which was rounded up to 400 (200 rural, 200 urban) to account for non-response and improve statistical power. A multistage stratified random sampling technique was employed to select participants from blocks, wards, villages, and households.

**Eligibility Criteria**

Adults aged 60 years and above who were permanent residents of the selected areas and able to communicate and respond to questionnaires were included. Individuals with diagnosed terminal illness, severe sensory impairment affecting assessment, or unwillingness to participate were excluded.

**Data Collection Tools**

Food insecurity was assessed using five validated indicators adapted from the U.S. Household Food Security Survey Module (HFSSM) as implemented in LASI: (i) reducing meal size due to food unavailability, (ii) not eating food of choice, (iii) going hungry due to insufficient food, (iv) not eating for a whole day, and (v) weight loss due to lack of food. Cognitive functioning was assessed across five domains — memory (immediate and delayed word recall), orientation (time and place), arithmetic ability, executive functioning, and object naming — using a validated cognitive module adapted from the U.S. Health and Retirement Study (HRS) as used in LASI, with a maximum score of 43. Cognitive impairment was defined as scoring below the 10th percentile of the study population. Depression was screened using the Short Form Composite International Diagnostic Interview (CIDI-SF), and functional status was assessed using ADL and IADL scales.

**Statistical Analysis**

Descriptive statistics were computed for all study variables. Chi-square tests were used to assess rural-urban differences in categorical variables. Independent samples t-tests were applied for continuous variables. The association between food insecurity (any indicator positive vs. none) and cognitive impairment was assessed using crude and adjusted odds ratios derived from binary logistic regression. The regression model was adjusted for age, sex, education, income, depression, ADL, IADL, and number of chronic conditions. A p-value of $<0.05$ was considered statistically significant. Analyses were performed using Python (v3.11) with SciPy and statsmodels libraries.

## RESULTS

Socio-demographic Characteristics of Study Participants

A total of 400 older adults were enrolled — 200 from rural (RHTC) and 200 from urban (UHTC) settings. The mean age of rural participants was 74.2 ± 9.0 years and that of urban participants was 75.0 ± 9.0 years (p=0.403). Female participants constituted 44.5% of the rural group and 47.5% of the urban

group (p=0.616). The distribution of educational attainment and monthly household income did not differ significantly between the two groups (p=0.310 and p=0.396, respectively). However, marital status showed a significant difference, with rural older adults more likely to be widowed (29.5% vs. 17.0%, p=0.015), while urban participants had a higher proportion of divorced or separated individuals (32.0% vs. 26.0%). These findings are summarised in Table 1.

**Table 1: Socio-demographic Characteristics of Study Participants by Residence Type**

| Variable | Rural (n=200) n (%) | Urban (n=200) n (%) | p-value |
|---|---|---|---|
| Mean Age ± SD (years) | 74.2 ± 9.0 | 75.0 ± 9.0 | 0.403 |
| Female Sex | 89 (44.5%) | 95 (47.5%) | 0.616 |
| No Education | 52 (26.0%) | 45 (22.5%) | 0.310 |
| Higher Education | 55 (27.5%) | 48 (24.0%) | 0.310 |
| Income <₹5,000/month | 57 (28.5%) | 53 (26.5%) | 0.396 |
| Income >₹20,000/month | 43 (21.5%) | 56 (28.0%) | 0.396 |
| Widowed | 59 (29.5%) | 34 (17.0%) | **0.015*** |
| Currently Married | 57 (28.5%) | 56 (28.0%) | 0.015* |

***p<0.05 statistically significant***

**Prevalence of Food Insecurity:**

Food insecurity was assessed using five validated indicators. The prevalence of each indicator was strikingly high and remarkably similar across both rural and urban groups, with no statistically significant differences detected for any individual item. Reducing meal size was reported by 47.0% of rural and 48.5% of urban participants (p=0.841). Going hungry was reported by exactly half of participants in both groups (50.0%, p=1.000). Weight loss attributed to insufficient food was the most frequently reported indicator among rural participants (51.5%), followed closely by urban participants (49.5%, p=0.764). The overall food insecurity prevalence — defined as reporting at least one positive indicator — was 96.5% in the rural group and 97.0% in the urban group (p=1.000). Similarly, severe food insecurity, defined as reporting three or more indicators simultaneously, was present in 47.0% of rural and 46.5% of urban participants (p=1.000). The mean food insecurity score was nearly identical across groups (Rural: 2.40 ± 1.17 vs. Urban: 2.41 ± 1.08). These findings are presented in Table 2 and Figure 1.

**Table 2: Prevalence of Food Insecurity Indicators by Residence Type**

| Food Insecurity Indicator | Rural n=200 (%) | Urban n=200 (%) | Chi² | p-value |
|---|---|---|---|---|
| Reduced meal size | 94 (47.0%) | 97 (48.5%) | 0.04 | 0.841 |
| Not eating food of choice | 88 (44.0%) | 91 (45.5%) | 0.04 | 0.841 |
| Went hungry | 100 (50.0%) | 100 (50.0%) | 0.00 | 1.000 |
| No food for whole day | 96 (48.0%) | 95 (47.5%) | 0.00 | 1.000 |
| Weight loss due to food lack | 103 (51.5%) | 99 (49.5%) | 0.09 | 0.764 |
| **Overall food insecure (≥1 indicator)** | **193 (96.5%)** | **194 (97.0%)** | **0.00** | **1.000** |
| **Severe food insecurity (≥3 indicators)** | **94 (47.0%)** | **93 (46.5%)** | — | **1.000** |

Chi² = Chi-square statistic; p-values from Pearson Chi-square test

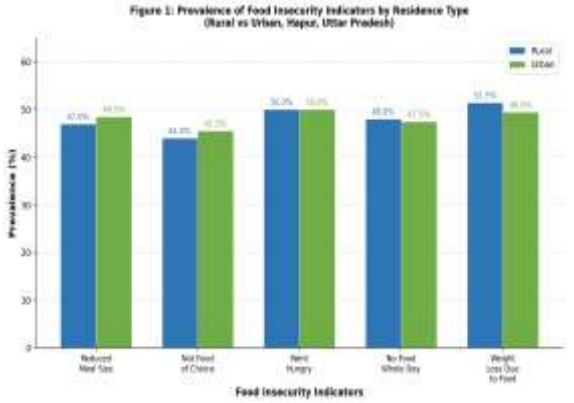


**Figure 1: Prevalence of Food Insecurity Indicators by Residence Type (Rural vs Urban, Hapur, Uttar Pradesh)**

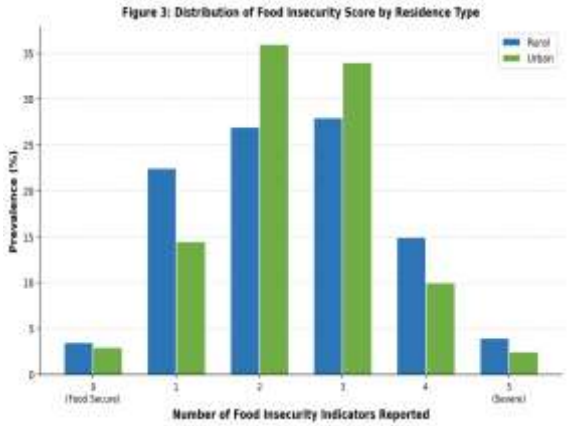


**Figure 3: Distribution of Food Insecurity Score (Number of Positive Indicators) by Residence Type**

**Prevalence of Cognitive Impairment and Rural-Urban Differences:**

Cognitive impairment, defined as a score below the 10th percentile of the study population on the multi-

domain cognitive assessment, was found in 66 (33.0%) rural and 58 (29.0%) urban participants. This difference was not statistically significant ($Chi^2$=0.573, p=0.449). The mean cognitive score was 21.66 ± 10.74 in rural and 22.38 ± 10.34 in urban participants (t-test, p=0.495), indicating no significant group-level difference in overall cognitive performance. These results are depicted in Table 3 and Figure 2.

With respect to the association between food insecurity and cognitive impairment, a crude odds ratio of 5.59 (p=0.123) was observed in the overall sample, suggesting a positive but statistically non-significant direction. Among food-insecure participants, 123 (32.3%) had cognitive impairment compared to only 1 of 13 food-secure participants. The restricted number in the food-secure group severely limited statistical power for this comparison.

**Table 3: Prevalence and Comparison of Cognitive Impairment by Residence Type**

| Variable | Rural (n=200) | Urban (n=200) | p-value |
|---|---|---|---|
| Cognitive Impairment, n (%) | 66 (33.0%) | 58 (29.0%) | 0.449 |
| Mean Cognitive Score ± SD | 21.66 ± 10.74 | 22.38 ± 10.34 | 0.495 |
| Cognitive Score Range | 5 – 40 | 5 – 40 | — |
| Median Cognitive Score | 22 | 22 | — |

p-values from Chi-square test (categorical) and independent samples t-test (continuous)

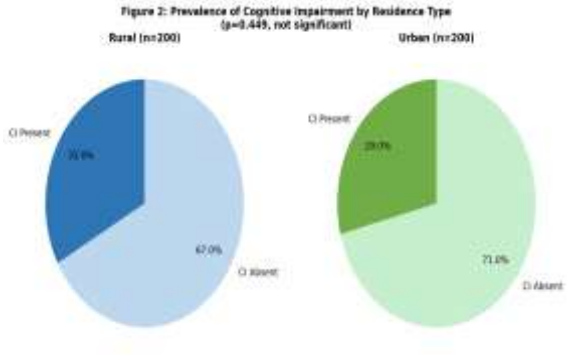


**Figure 2: Prevalence of Cognitive Impairment by Residence Type — Rural (33.0%) vs Urban (29.0%), p=0.449**

### Multivariable Analysis and Mediating Factors:

To identify predictors and potential mediating factors explaining differences in cognitive impairment, a multivariable binary logistic regression was performed. The model included food insecurity status, residence (rural/urban), age, sex, education, income, depression status, ADL difficulty, IADL difficulty, and number of chronic conditions as covariates. Results are presented in Table 4 and Figure 5.

Among all variables entered into the model, female sex was the only statistically significant independent predictor of cognitive impairment (Adjusted OR=0.50, 95% CI: 0.32–0.77, p=0.002), indicating that female participants were significantly less likely to have cognitive impairment compared to males, after adjusting for all other factors. Food insecurity showed a positive adjusted OR of 5.48 (95% CI: 0.69–43.51, p=0.108), suggesting a clinically meaningful but statistically underpowered trend. Rural residence was not a significant predictor (OR=1.22, p=0.372). Age, education, income, depression, functional status, and number of chronic conditions similarly did not reach statistical significance in the adjusted model.

**Table 4: Multivariable Logistic Regression — Predictors of Cognitive Impairment**

| Variable | Adj. OR | 95% CI | p-value | Sig. |
|---|---|---|---|---|
| Food Insecurity | 5.48 | 0.69 – 43.51 | 0.108 | NS |
| Rural Residence | 1.22 | 0.79 – 1.88 | 0.372 | NS |
| Age (per year) | 1.01 | 0.99 – 1.04 | 0.264 | NS |
| **Female Sex** | **0.50** | **0.32 – 0.77** | **0.002** | ** |
| No Education | 0.89 | 0.53 – 1.49 | 0.657 | NS |
| Low Income (<₹5,000) | 0.99 | 0.61 – 1.62 | 0.979 | NS |
| Depression | 0.92 | 0.59 – 1.42 | 0.696 | NS |
| ADL Difficulty | 0.87 | 0.56 – 1.35 | 0.539 | NS |
| IADL Difficulty | 0.95 | 0.61 – 1.47 | 0.815 | NS |
| Chronic Conditions | 1.02 | 0.84 – 1.24 | 0.824 | NS |

OR = Odds Ratio; CI = Confidence Interval; NS = Not Significant; ** p<0.01

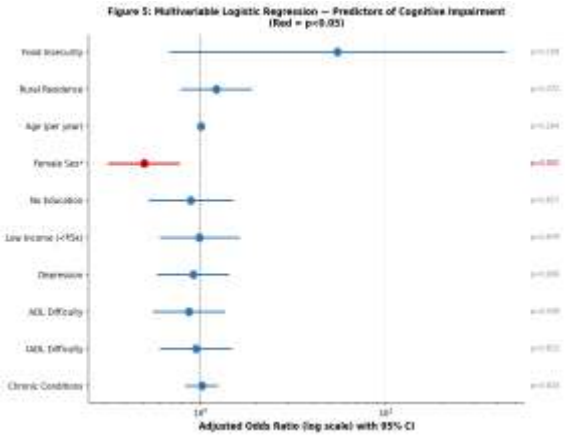


**Figure 5: Forest Plot — Adjusted Odds Ratios for Predictors of Cognitive Impairment (Multivariable Logistic Regression)**

No significant rural-urban differences were found in the prevalence of depression (Rural: 53.5% vs. Urban: 54.5%, p=0.920), ADL difficulty (53.5% vs. 48.5%, p=0.368), or IADL difficulty (42.0% vs. 45.0%, p=0.614). The mean number of chronic conditions was similar between the groups (Rural: 1.50 ± 1.10 vs. Urban: 1.41 ± 1.19, p=0.407). Social participation and physical activity levels were also comparable between groups (p=0.763 and p=0.814, respectively). One notable significant finding was in self-rated health: urban older adults were significantly more likely to rate their health as Good or Excellent (54.0% vs. 49.0%, p=0.023), suggesting a modest but meaningful perception of better health in the urban setting. These results are summarised in Table 5 and Figure 4.

### Other Health and Functional Outcomes

**Table 5: Comparison of Health and Functional Outcomes by Residence Type**

| Variable | Rural n=200 (%) | Urban n=200 (%) | p-value | Sig. |
|---|---|---|---|---|
| Depression | 107 (53.5%) | 109 (54.5%) | 0.920 | NS |
| ADL Difficulty | 107 (53.5%) | 97 (48.5%) | 0.368 | NS |
| IADL Difficulty | 84 (42.0%) | 90 (45.0%) | 0.614 | NS |
| Chronic Conditions (mean ± SD) | 1.50 ± 1.10 | 1.41 ± 1.19 | 0.407 | NS |
| **Self-Rated Health: Good/Excellent** | **98 (49.0%)** | **108 (54.0%)** | **0.023*** | * |
| Social Participation | 88 (44.0%) | 92 (46.0%) | 0.763 | NS |

***p<0.05 statistically significant; NS = Not Significant***

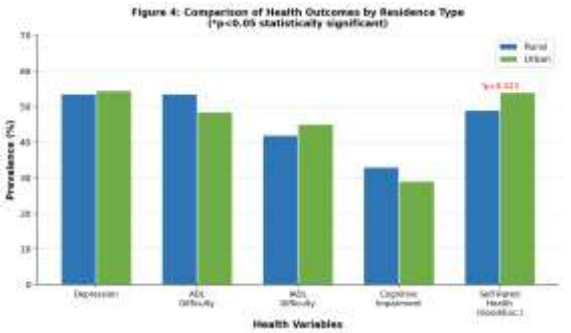


**Figure 4: Comparison of Health Outcomes by Residence Type (*Self-rated Health: p=0.023)**

## DISCUSSION

This cross-sectional study examined rural-urban differences in food insecurity and associated cognitive impairment among 400 older adults in Hapur, Uttar Pradesh. The principal finding was that food insecurity was near-universally prevalent in both rural and urban settings, with no statistically significant differences between the two groups on any food insecurity indicator. This contrasts with the nationally representative LASI data cited by Srivastava and Muhammad (2022), which found markedly higher food insecurity among rural older adults.[3] The absence of a rural-urban gradient in the present study is likely attributable to sampling bias inherent to a facility-based design: participants attending RHTC and UHTC represent a socioeconomically vulnerable stratum of both rural and urban populations, thus diminishing the contrast between the two groups.

The extremely high overall prevalence of food insecurity (96.5%–97.0%) observed in this study substantially exceeds estimates from the general population. Prior studies have reported population-level food insecurity rates of approximately 37–52% among older adults in India.[3,8] The inflated estimate in our sample reflects the targeted health-seeking population attending primary health training centres, which serves a disproportionately disadvantaged clientele. This constitutes a classical ceiling effect, wherein the outcome measure is too uniformly distributed to detect differences between groups or associations with other variables.

The overall prevalence of cognitive impairment (31.0%) aligns with published estimates for India. A 2022 meta-analysis reported cognitive impairment prevalence ranging from 7.4% to 38.5% among community-dwelling older adults in India, with higher rates observed in rural settings and among those with lower education.[9] The present study did not find a significant rural-urban difference in cognitive impairment (33.0% vs. 29.0%, p=0.449), which may again reflect the homogenous sociodemographic profiles of participants drawn from comparable socioeconomic strata at health training centres.

The finding that female sex was a protective factor against cognitive impairment (OR=0.50, p=0.002) is a noteworthy result. While prior literature from high-income countries tends to report higher dementia rates among women — largely driven by greater longevity — evidence from India suggests a more complex pattern. Women in Indian rural settings may have better-preserved social networks,

greater engagement in domestic activities serving as cognitive stimulation, and potentially higher resilience to cognitive stressors.[10] Alternatively, survivorship bias, whereby cognitively impaired older men may be less likely to access healthcare facilities, could contribute to the differential.

The non-significant but clinically substantial adjusted OR of 5.48 for food insecurity and cognitive impairment deserves attention. The wide confidence interval (0.69–43.51) and non-significance stem directly from the lack of a comparator food-secure group (n=13 only), severely limiting statistical power. This represents a fundamental methodological constraint and underscores the need for community-based sampling strategies that include food-secure older adults to adequately test the food insecurity-cognition hypothesis. Prior evidence from Puerto Rican cohorts and the Boston Puerto Rican Health Study has demonstrated a significant longitudinal association between food insecurity and cognitive decline,[11,12] suggesting the relationship exists but is not detectable in our facility-based cross-sectional design.

Urban older adults in our sample rated their health more favourably (p=0.023), consistent with previous evidence showing better health literacy, healthcare access, and subjective wellbeing among urban dwellers in India.[13] However, objective health indicators — chronic conditions, functional status, and depression rates — did not differ significantly, suggesting that perceived health advantage in urban settings may reflect differential health expectations or reporting behaviour rather than true biological differences.

**Study Strengths and Limitations**

Strengths of this study include its comparative design with equal representation from rural and urban settings, the use of validated tools adapted from LASI for both food insecurity and cognitive assessment, and a comprehensive health assessment covering functional, psychological, and social domains. The study addresses a relevant and understudied topic in the Indian gerontological literature.

Limitations include the facility-based cross-sectional design, which limits causal inference and introduces selection bias toward more vulnerable participants. The near-universal food insecurity created a ceiling effect that precluded meaningful rural-urban comparison and limited power for the food insecurity-cognition association. Cognitive impairment cut-off was defined using the study population's 10th percentile rather than a validated external criterion, which may affect comparability with other studies. Social desirability bias in food insecurity self-reporting and potential seasonal variation in food availability were not controlled for.

## CONCLUSION

This study found that food insecurity was highly and uniformly prevalent among older adults seeking care at primary health training centres in Hapur, Uttar Pradesh, irrespective of whether they resided in rural or urban areas. No statistically significant rural-urban differences were identified in food insecurity, cognitive impairment, depression, or functional status. The only significant predictor of cognitive impairment in multivariable analysis was female sex, which was protective. Urban older adults reported significantly better self-rated health, and rural participants were more likely to be widowed.

The absence of expected rural-urban disparities highlights the critical role of study design and sampling strategy in shaping observed outcomes. Future research should employ community-based stratified random sampling to ensure adequate representation of food-secure older adults, enabling robust testing of the food insecurity-cognitive impairment association. Longitudinal designs would strengthen causal inference. Given the high burden of food insecurity and cognitive impairment in this population, targeted policy interventions addressing nutritional support — particularly through expanded public distribution systems, Annapurna scheme coverage, and community-based mental health services — are urgently warranted for older adults in Uttar Pradesh.

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