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# NUTRITIONAL STATUS AND PREDICTORS OF MUSCLE STRENGTH AMONG APPARENTLY HEALTHY URBAN ELDERLY IN DELHI: A COMMUNITY-BASED CROSS-SECTIONAL STUDY

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| **Heena Gupta** | Post Graduate Student, Discipline of Nutritional Sciences, Indira Gandhi National Open University, New Delhi |
| **Namrata Singh*** | Assistant Professor, Discipline of Nutritional Sciences, Indira Gandhi National Open University, New Delhi *Corresponding Author |
| **Ankita Gupta** | Assistant Professor, Discipline of Nutritional Sciences, Indira Gandhi National Open University, New Delhi |
| **Ashish Datt Upadhyay** | Scientist, Clinical Research Unit, All India Institute of Medical Sciences, New Delhi |

**ABSTRACT** Elderly face nutritional challenges due to age-related decline, chronic conditions and socio-economic constraints. To assess the nutritional status and predictors of muscle strength in elderly. Cross-sectional study was conducted on apparently healthy elderly in Brahmpuri, Delhi. Mini Nutritional Assessment-18 items, gait speed and a three-day 24-hour dietary recall were done. Out of 186 subjects (males =108, 67.1 ± 4.6 years), 52.2% were at risk of malnutrition, while none were malnourished. Energy and protein intake of males and females was 1781 ± 143 kcal and 51.5 ± 11.3 g, 1574 ± 172 kcal and 48.1 ± 9.8 g, respectively. Protein intake was less than 75% of RDA in 30% of the subjects. Females showed lower intake adequacy than men across all macronutrients. The gait speed was 0.98 ± 0.15 and 0.95 ± 0.17 m/s for males and females, respectively and 56% of subjects exhibited gait speed below 1.0 m/s (normal). In multivariate logistic regression analysis, age above 70 years has 12 times (OR- 12.23, 95% CI :3.54-42.15) more chance of poor gait speed. On the other hand, no dental issue has a 55% (OR-0.45, 95% CI: 0.23-0.91) less chance of having poor gait speed. These results suggest that half of the elderly were at risk of malnutrition with a low dietary protein intake and low muscle strength. Age and dental issues were the main predictors of muscle strength in the elderly.

**KEYWORDS :** Elderly, Nutritional Status, Gait Speed, Mini Nutritional Assessment.

## INTRODUCTION

Global and national demographic trends indicate a rapid increase in the elderly population, posing major public health challenges (Office of the Registrar General & Census Commissioner, India, 2011; Ministry of Statistics and Programme Implementation, 2016; United Nations, Department of Economic and Social Affairs, Population Division, 2022). Age-related physiological changes, chronic conditions and socio-economic factors predispose older adults to nutritional risk, which often remains under-recognized in community settings (World Health Organization, 2015; Dent et al., 2019; Cereda et al., 2016; Kaiser et al., 2010). Inadequate energy and protein intake contributes to sarcopenia, frailty and decline in physical performance (Agarwalla et al., 2015; Stratidaki et al., 2024; Chen et al., 2024; Cruz-Jentoft et al., 2019; Calcaterra et al., 2024). Gait speed is a simple and reliable marker of muscle strength and functional status in older adults (Coelho-Júnior et al., 2025; Studenski et al., 2011; Volkert et al., 2019). Oral health also plays a critical role in influencing dietary intake and physical function (Kiesswetter et al., 2020; Wu et al., 2024; Melebari et al., 2025). However, community-based evidence from urban India remains limited. This study aimed to assess nutritional status and predictors of muscle strength among apparently healthy elderly in an urban area of Delhi.

## Methodology

A community-based cross-sectional study was conducted among elderly individuals residing in Brahmpuri, an urban residential locality of Delhi, India, during the period from September 2024 to May 2025. The study area represents a typical urban settlement with mixed socio-economic characteristics and stable residential patterns. Community-dwelling elderly individuals aged 60–75 years who had been residing in the area for at least six months prior to data collection constituted the source population. Apparently healthy elderly who were ambulatory and available during the survey period were considered eligible for participation.

Participants were recruited using a purposive sampling technique. The sample size was determined based on the number of eligible elderly available in the study area during the study period, consistent with similar community based geriatric studies. All eligible individuals who met the inclusion criteria and provided written informed consent during the study period were enrolled. A total of 186 elderly participants were included in the final analysis. Individuals who were unable to complete the three-day dietary recall or had incomplete dietary data were excluded to ensure accuracy and reliability of dietary intake assessment.

Inclusion criteria comprised elderly men and women aged 60–75 years, residing in the community, ambulatory, apparently healthy and willing to participate. Individuals were excluded if they had acute illness at the time of data collection, diagnosed neurological disorders, severe musculoskeletal conditions, cognitive impairment affecting mobility, or conditions that markedly limited gait performance. Bedridden or institutionalized elderly were also excluded.

Data were collected using a pre-tested, structured questionnaire administered through face-to-face interviews. Information on sociodemographic characteristics, health status and lifestyle factors was obtained. Nutritional status was assessed using the Mini Nutritional Assessment (MNA®), an 18-item validated tool widely used for identifying malnutrition and nutritional risk among older adults in community settings (Cereda et al., 2016). The MNA categorizes individuals as having normal nutritional status, being at risk of malnutrition, or malnourished, enabling early detection of nutritional vulnerability.

Dietary intake was assessed using a three-day 24-hour dietary recall method to capture habitual intake. Potential recall bias was minimized by including a weekend day in the recall period. Standardized household measures and food models were used to improve portion size estimation. Macronutrient intake was calculated using DietCal software and values were compared with age- and sex-specific Recommended Dietary Allowances as per the Indian Council of Medical Research–National Institute of Nutrition guidelines (2020).

Muscle strength and physical performance were assessed using gait speed, a validated and widely accepted functional measure in geriatric research. Gait speed was measured over a standard walking distance at the participant's usual pace and the time taken was recorded using a stopwatch. Gait speed was calculated in meters per second (m/s), with a cut-off value of <1.0 m/s considered indicative of poor muscle strength and reduced physical performance, in accordance with established geriatric assessment criteria (Studenski et al., 2011; Volkert et al., 2019).

Written informed consent was obtained from all participants after explaining the objectives and procedures of the study in the local language. Confidentiality of participant information was strictly maintained and participation was entirely voluntary.

Data was entered and analyzed using appropriate statistical software. Descriptive statistics were used to summarize sociodemographic characteristics, nutritional status, dietary intake and gait speed. Continuous variables were expressed as mean and standard deviation, while categorical variables were presented as frequencies and percentages. Logistic regression analysis was performed to identify independent predictors of poor gait speed. Results were expressed as odds ratios with 95% confidence intervals and a P-value of less than 0.05 was considered statistically significant.

## RESULTS

A total of 186 eligible elderly participants were included in the final analysis. Participants who did not complete all three days of dietary recall were excluded prior to analysis. No eligible participant declined participation and no losses to follow-up occurred as the study was cross-sectional. Participants have a mean age of 67.1 ± 4.4 years. Males constituted 58.1% of the sample, while females accounted for 41.9%. Most participants were married (68.8%) and living in joint family settings (85.5%). Literacy levels were relatively high, with 84.9% of participants being literate; however, only 9.7% had attained education at the college level or above. Despite this, financial dependence was common, with nearly two-thirds of participants (63.4%) relying on others for financial support.

The majority resided in their own homes (72.6%), while 27.4% lived in rented accommodation. Physical activity levels were predominantly sedentary, reported by 74.7% of participants. Dental problems affecting chewing were present in 38.2% of the elderly. Chronic health conditions were common, particularly hypertension, arthritis and cardiovascular diseases and over half of the participants (53.8%) were on regular medication. Although most participants lived in joint family (85.48%), access to healthcare services was inconsistent, with only one-quarter reporting regular healthcare access.

Nutritional status of the participants was assessed using the Mini Nutritional Assessment (MNA) and gait speed was used as an indicator of muscular strength. The distribution of participants according to nutritional status and gait speed characteristics is presented in Table 1.

**Table 1. Distribution of Nutritional Status (Mini Nutritional Assessment) and Gait Speed Characteristics Among Community-Dwelling Elderly by Sex (N = 186)**

| Variable | Category / Measure | Total (N = 186) | Male (n = 108) | Female (n = 78) |
|---|---|---|---|---|
| Nutritional Status (MNA Score) | Malnourished (<17) | 0 (0.0) | 0 (0.0) | 0 (0.0) |
| | At risk of malnutrition (17–23.5) | 97 (52.2) | 52 (48.1) | 45 (57.7) |
| | Normal nutritional status (24–30) | 89 (47.8) | 56 (51.8) | 33 (42.3) |
| Gait Speed (m/s) | Mean ± SD (min–max) | 0.97 ± 0.15 (0.57–1.25) | 0.98 ± 0.15 (0.59–1.26) | 0.95 ± 0.17 (0.57–1.22) |
| Gait Speed Category | Poor gait speed, n (%) | 102 (54.8) | 55 (51.6) | 47 (60.3) |
| | Normal gait speed, n (%) | 84 (45.2) | 53 (48.4) | 31 (39.7) |

Note. MNA = Mini Nutritional Assessment. Nutritional status categories are defined as follows: MNA score <17 = malnourished; 17–23.5 = at risk of malnutrition; 24–30 = normal nutritional status. Gait speed values are expressed as mean ± standard deviation (minimum–maximum) or number (percentage). Gait speed was measured in meters per second (m/s) and poor gait speed is defined as <1.0 m/s.

Dietary intake analysis showed that males had a mean energy intake of 1781 ± 143 kcal and a mean protein intake of 51.5 ± 11.3 g. The distribution of participants according to percentage achievement of EAR for energy and RDA for protein is presented in Table 2. Approximately 12.7% of males consumed less than 75% of their energy EAR and 26.9% consumed less than 75% of the protein RDA.

Among females, the mean energy intake was 1574 ± 172 kcal and the mean protein intake was 48.1 ± 9.8 g. A higher proportion of females (18.8%) consumed less than 75% of their energy EAR and 32.1% consumed less than 75% of protein requirements. Compared to males, a lower proportion of females exceeded the recommended dietary allowance.

**Table 2. Distribution of Male and Female Participants by Percentage Achievement of Estimated Average Requirement (EAR) for Energy and Recommended Dietary Allowance (RDA) for Macronutrients**

| Nutrient (Reference Value) | Gender (n) | <50% | 50–75% | 75–100% | >100% |
|---|---|---|---|---|---|
| Energy (EAR: Male 1900 kcal; Female 1700 kcal) | Male (108) | 3.27 | 9.47 | 68.56 | 18.70 |
| | Female (78) | 4.08 | 14.72 | 61.28 | 19.92 |
| Protein (RDA: Male 60 g; Female 55 g) | Male (108) | 5.56 | 21.30 | 65.73 | 7.41 |
| | Female (78) | 7.69 | 24.36 | 66.67 | 1.28 |
| Fat (RDA) | Male (108) | 1.63 | 13.18 | 75.93 | 9.26 |
| | Female (78) | 2.41 | 13.46 | 73.07 | 11.06 |
| Carbohydrate (RDA) | Male (108) | 0.00 | 15.58 | 69.09 | 15.33 |
| | Female (78) | 0.00 | 18.00 | 58.72 | 23.28 |

Note. Values are percentages of participants within each category of requirement achievement. Energy requirements are based on the Estimated Average Requirement (EAR), whereas protein, fat and carbohydrate are based on the Recommended Dietary Allowance (RDA). Reference values are derived from ICMR–National Institute of Nutrition (2020) guidelines. Energy is expressed in kilocalories (kcal) and macronutrients are expressed in grams (g). Percentages may not total 100 due to rounding.

Predictors of poor gait speed were analyzed using bivariate analysis showed a statistically significant association between gait speed category and age group, use of assistive devices and presence of dental issues ($P < 0.001$ for all). Other sociodemographic, nutritional and lifestyle variables did not show a significant association with gait speed.

The final model was statistically significant (LR $\chi^2 = 39.17$, $P < 0.001$) with a pseudo $R^2$ of 0.153. Results of logistic regression are presented in table 3.

**Table 3. Factors Associated with Poor Gait Speed (<1.0 m/s) Among Elderly Participants: Results of Logistic Regression Analysis (n = 186)**

| Variable | Categories | Unadjusted OR (95% CI) | Adjusted OR (95% CI) |
|---|---|---|---|
| Age group (years) | 65–70(ref) | 1.00 | 1.00 |
| | 71–75 | 15.37 (4.53–52.11) | 12.23 (3.55–42.15) |
| Assistive device use | No(ref) | 1.00 | — |
| | Yes | 0.29 (0.15–0.56) | NS |
| Dental issues | Present(ref) | 1.00 | 1.00 |
| | Absent | 0.31 (0.17–0.59) | 0.46 (0.23–0.91) |

Note. OR: Odds ratio; CI: Confidence interval; Ref: Reference category; NS: Not significant.

Adjusted odds ratios derived from multivariable logistic regression model including age group, assistive device use and dental issues.

## DISCUSSION

This community-based cross-sectional study highlights important aspects of nutritional status and muscle strength among apparently healthy urban elderly in Delhi. Despite the absence of overt clinical illness, a considerable proportion of participants were at risk of malnutrition and exhibited reduced muscle strength, indicating early functional vulnerability in this population.

The high prevalence of nutritional risk is consistent with previous studies showing that malnutrition remains common among community-dwelling older adults (Cereda et al., 2016; Kaiser et al., 2010; Agarwalla et al., 2015; Stratidaki et al., 2024; Chen et al., 2024). The absence of overt malnutrition alongside a large at-risk group suggests a gradual and often subclinical progression of nutritional decline. This supports the role of the Mini Nutritional Assessment as an effective tool for early identification of nutritional vulnerability (Cereda et al., 2016; Kaiser et al., 2010).

Dietary assessment revealed inadequate macronutrient intake, particularly protein, among many participants. Insufficient protein intake is strongly associated with sarcopenia, frailty and functional decline in older adults (Cruz-Jentoft et al., 2019; Calcaterra et al., 2024; Coelho-Júnior et al., 2025). Females demonstrated lower intake adequacy compared to males, consistent with findings from similar settings, possibly reflecting socio-cultural and economic factors (Agarwalla et al., 2015; Stratidaki et al., 2024).

Gait speed assessment indicated a substantial burden of reduced physical performance. As a reliable and practical indicator of functional health, gait speed has strong predictive value in geriatric populations (Studenski et al., 2011; Volkert et al., 2019). The association between advancing age and poor gait speed reflects age-related physiological decline and reduced neuromuscular function (World Health Organization, 2015; Dent et al., 2019).

The study also identified a significant association between dental health and gait speed. Poor oral health may limit dietary intake and reduce consumption of nutrient-dense foods, thereby contributing to muscle weakness and reduced functional performance (Kiesswetter et al., 2020; Wu et al., 2024). This finding underscores the importance of integrating oral health into geriatric care.

Although assistive device use was associated with gait speed in unadjusted analysis, it was not an independent predictor, suggesting it reflects underlying functional limitation rather than causation (Melebari et al., 2025).

The study's strengths include its community-based design and use of validated tools. However, limitations such as cross-sectional design, potential recall bias and lack of direct muscle mass measurement should be considered.

Overall, the findings emphasize the need for early nutritional screening, promotion of adequate protein intake in line with national guidelines (Indian Council of Medical Research–National Institute of Nutrition, 2020) and incorporation of oral health assessment into primary care. Future longitudinal and interventional studies are needed to better understand causal relationships and improve functional outcomes in the ageing population.

## CONCLUSION

The present study demonstrates that a substantial proportion of apparently healthy urban elderly were at risk of malnutrition and exhibited reduced muscle strength, as assessed by gait speed. Suboptimal dietary protein intake was common, particularly among females, highlighting the presence of nutritional vulnerability even in the absence of overt malnutrition. Advancing age and poor dental health emerged as independent predictors of reduced muscle strength, underscoring the importance of early identification of functional decline. These findings emphasize the need for routine nutritional screening, promotion of adequate protein intake and integration of oral health assessment into community-based geriatric care to support healthy ageing and preserve functional independence.

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**Conflicts of Interest**

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