

The Hidden Role of Undernutrition in Geriatric Syndromes Among Prefrail Older Adults

✉ Zehra Sarıkaya Demirbaş, ✉ Mehmet Ilkin Naharcı

University of Health Sciences Türkiye, Gülhane Training and Research Hospital-Gülhane Faculty of Medicine, Clinic of Geriatrics, Ankara, Türkiye

ABSTRACT

Introduction: Undernutrition frequently coexists with geriatric syndromes in older adults and may share common pathophysiological mechanisms, particularly among prefrail individuals. However, evidence regarding these associations in prefrail older adults remains limited. This study aimed to investigate the relationship between undernutrition and specific geriatric syndromes in this population.

Methods: This cross-sectional study included 624 community-dwelling prefrail adults aged ≥ 65 years evaluated at University of Health Sciences Türkiye, Gülhane Training and Research Hospital, Clinic of Geriatrics between 2018 and 2025. Prefrailty was defined according to Fried's physical frailty phenotype. Nutritional status was assessed using the Mini Nutritional Assessment-Short Form (MNA-SF), with scores ≤ 11 indicating undernutrition. Geriatric syndromes, including polypharmacy, depression, insomnia, urinary incontinence, falls, cognitive impairment, and functional decline, were evaluated. Binary logistic regression analyses were performed to examine associations between geriatric syndromes and undernutrition, with sensitivity analyses restricted to participants with severe undernutrition (MNA-SF ≤ 7).

Results: The mean age was 77.6 ± 4.9 years, and 61.5% were women. Undernutrition was present in 8.5% of participants. Although depression, falls, cognitive impairment, and functional decline were more common among undernourished individuals, only insomnia remained independently associated with undernutrition after adjustment for age, sex, and education [odds ratio (OR): 2.27, 95% confidence interval (CI): 1.23-4.17, $p=0.008$]. This association persisted in sensitivity analyses of severe undernutrition (OR: 2.48, 95% CI: 1.39-4.44, $p=0.002$).

Conclusion: Insomnia was independently associated with undernutrition among prefrail older adults. These findings highlight the importance of incorporating sleep assessment into the comprehensive geriatric evaluation and suggest that targeting insomnia may represent a clinically relevant strategy to improve nutritional status and to prevent the progression to frailty.

Keywords: Undernutrition, prefrailty, geriatric syndromes, insomnia, comprehensive geriatric assessment

Introduction

The global increase in the proportion of older adults represents a major demographic transformation (1). A longer life expectancy is frequently accompanied by a gradual decline in overall health status and physical functioning, which contributes to the development of conditions such as cognitive impairment and frailty (2). Frailty is widely defined in clinical practice as a complex, multidimensional condition marked by diminished physiological reserves and an increased susceptibility to external stressors. This state of vulnerability is associated with a higher incidence of adverse health outcomes and a substantial increase in healthcare utilization, particularly in geriatric populations (3). Current clinical perspectives widely acknowledge frailty as a strong predictor of reduced survival (4).

The concept of prefrailty, defined as an intermediate stage between robust health and established frailty, has gained recognition as an important component of comprehensive geriatric assessment (5). Prefrailty is defined by the presence of one or two of the five components of the Fried frailty phenotype: weakness, self-reported exhaustion, low physical activity, slow gait speed, and unintentional weight loss (6). Identifying individuals at this transitional stage is crucial, as prefrailty represents a potentially reversible condition and offers an opportunity for early preventive interventions.

Over the past two decades, there has been a marked increase in research examining the link between nutritional status and frailty in older adults. Nutritional interventions are increasingly recognized as a promising strategy for improving the management of frailty and potentially reversing its course (7). Moreover, the impact of nutritional



Address for Correspondence: Zehra Sarıkaya Demirbaş, MD, University of Health Sciences Türkiye, Gülhane Training and Research Hospital-Gülhane Faculty of Medicine, Clinic of Geriatrics, Ankara, Türkiye
E-mail: drsarikayademirbas@gmail.com **ORCID ID:** orcid.org/0000-0003-2663-4119

Cite this article as: Sarıkaya Demirbaş Z, Naharcı Mİ. The hidden role of undernutrition in geriatric syndromes among prefrail older adults. İstanbul Med J. 2026; 27(4): 313-319

Received: 03.06.2026

Accepted: 10.08.2026

Publication Date: 30.10.2026



©Copyright 2026 by the University of Health Sciences Türkiye, İstanbul Training and Research Hospital/İstanbul Medical Journal published by Galenos Publishing House.
Licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 (CC BY-NC-ND) International License

interventions on prefrail older adults remains unclear (8). Current systematic reviews highlight the limited evidence regarding the effects of nutritional interventions on a range of outcomes in frail and prefrail older adults (9). Consequently, this limitation hinders the ability to draw definitive conclusions about their effectiveness. Considering the potential of targeted interventions to prevent, delay, or even reverse frailty, the heterogeneity of study outcomes and intervention strategies poses significant challenges for clinicians and policymakers seeking to implement evidence-based practices (10).

Undernutrition in older adults is strongly linked to the onset and progression of geriatric syndromes (11). Conditions such as functional impairment, falls, urinary incontinence, depression, and polypharmacy share common underlying mechanisms with undernutrition, including sarcopenia, chronic inflammation, and a diminished physiological reserve (12,13). Undernutrition may accelerate the onset and severity of these syndromes by impairing muscle strength, immune response, and overall functional capacity. Conversely, the presence of geriatric syndromes may further deteriorate nutritional status through reduced mobility, loss of appetite, cognitive decline, and increased dependency (14). This bidirectional relationship underscores the clinical importance of evaluating undernutrition within the broader context of geriatric syndromes, particularly in vulnerable populations such as prefrail older adults.

Despite the growing body of evidence linking nutritional status to frailty and geriatric syndromes, data specifically focusing on prefrail older adults are scarce. Since prefrailty is considered a transitional and potentially reversible condition, identifying factors linked to unfavorable outcomes in this population carries significant clinical relevance. Within this context, the present study aimed to investigate, using a comprehensive geriatric assessment approach, the relationship between undernutrition and geriatric syndromes in prefrail older adults. By elucidating these associations, this study seeks to contribute to the early identification of high-risk individuals and to inform targeted multidisciplinary interventions that may help prevent the progression to frailty and the associated negative health outcomes.

Methods

Study Design and Sample

Participants were community-dwelling individuals aged ≥ 65 years who were consecutively assessed at a specialized geriatric outpatient center from 2018 to 2025. During the initial screening process, individuals with conditions that could introduce substantial clinical heterogeneity and potentially affect the validity of the analyses were excluded. These exclusion criteria included a documented diagnosis of dementia; total functional dependence; advanced-stage malignancy; advanced chronic obstructive pulmonary disease (COPD); severe heart failure; terminal conditions; or anticipated survival of less than three months. All eligible participants were subsequently assessed using a standardized protocol based on a comprehensive review of medical records and patient documentation. As shown in Figure 1, 857 prefrail older adults were initially evaluated. Among these, 171 individuals aged >85 years and 23 individuals with incomplete assessments were excluded. The

remaining 663 participants were evaluated for eligibility. Subsequently, 39 individuals were excluded due to missing key outcome or covariate data. The final study cohort comprised 624 prefrail older adults who were included in the analysis.

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki and was approved by the University of Health Sciences Türkiye, Gülhane Training and Research Hospital Ethics Committee (decision number: 2026/107, date: 07.05.2026). Due to the retrospective design of the study and the use of anonymized medical records, the requirement for written informed consent was waived by the ethics committee. The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology guidelines.

Data were derived from Comprehensive Geriatric Assessments conducted by a multidisciplinary team under the supervision of a geriatrician. Each assessment included a structured clinical evaluation encompassing vital signs, comorbidities, and current medication use, along with standardized measures of cognitive function, psychological status, and functional capacity. These assessments provided the basis for evaluating the nutritional status and geriatric syndromes within the study population.

Frailty Screening

Frailty status was determined according to the physical frailty phenotype described by Fried et al. (15), which consists of five domains. Unintentional weight loss was defined as a decrease of at least 5% in body weight within the previous year. Muscle strength was assessed by measuring handgrip strength in the dominant hand using a Jamar hydraulic dynamometer (Patterson Medical Ltd.), and the results were interpreted according to sex- and body mass index (BMI)-specific thresholds. Exhaustion was evaluated using two items from the 20-item Center for Epidemiologic Studies-Depression scale ("I felt that everything I did was an effort" and "I could not get going"), with responses of "moderate" or "most of the time" considered indicative of exhaustion (16). Slowness was assessed by measuring gait speed over a 15-foot distance, using threshold values adjusted for gender and height. Physical activity level was determined using the International Physical Activity Questionnaire, and participants in the lowest tertile were classified as having low physical activity levels (17). Individuals meeting one or two of these criteria were categorized as prefrail and constituted the study population.

Undernutrition

Nutritional status was assessed using the Mini Nutritional Assessment-Short Form (MNA-SF; score range, 0-14). In accordance with established cut-off values, participants with a score of ≤ 11 were classified as having undernutrition (12).

Geriatric Syndromes

The geriatric syndromes examined in this study included polypharmacy, depression, insomnia, urinary incontinence, falls, cognitive impairment, and functional decline. Polypharmacy was defined as the concurrent use of five or more medications (18). Depressive symptoms were assessed using the Patient Health Questionnaire-2, which evaluates

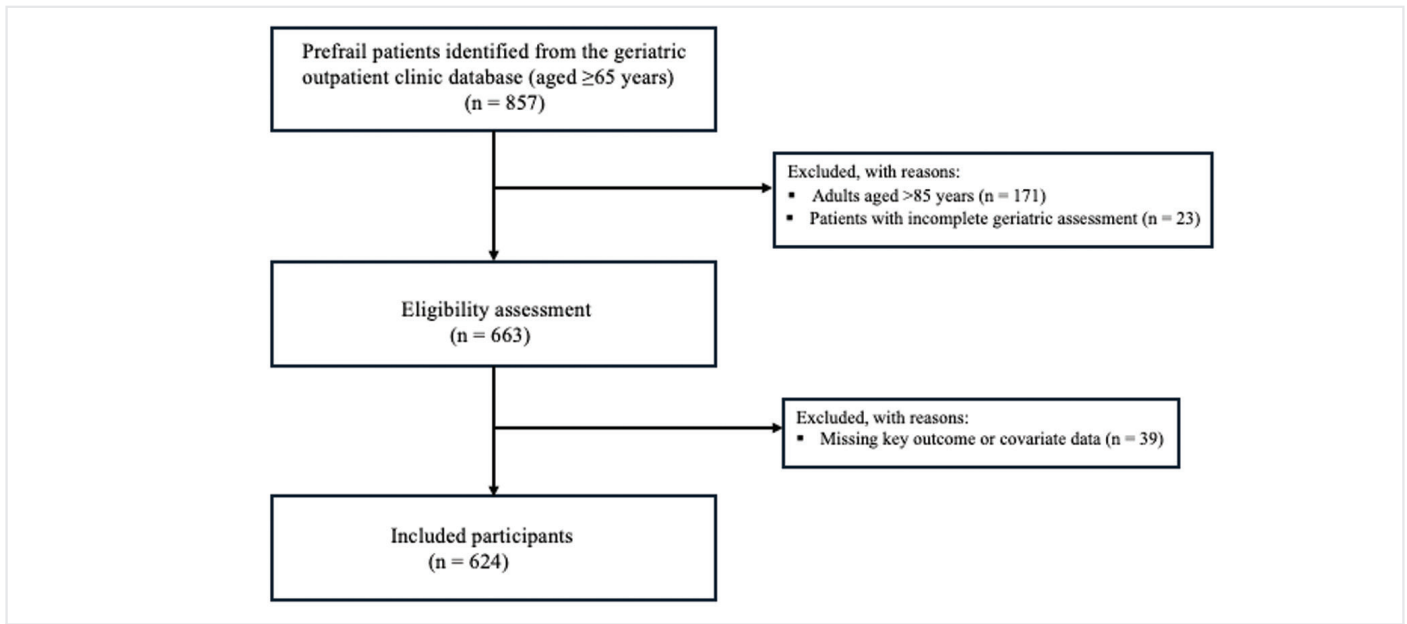


Figure 1. Flow diagram of sample selection process

mood-related symptoms over the preceding two weeks. A score of ≥ 3 (range 0-6) or current use of antidepressant therapy was considered indicative of depression (19). Sleep disturbances were evaluated through four items addressing difficulty initiating sleep, difficulty resuming sleep after nocturnal awakenings, early morning awakenings, and the need for daytime napping. Participants reporting at least one of these symptoms were classified as having insomnia (20). Urinary incontinence was determined from dichotomous (yes/no) questionnaire items regarding involuntary urine leakage. Information on falls was obtained from the participants' relatives or extracted from medical records, and individuals reporting at least one fall within the previous year were categorized as having a history of falls (21). Cognitive impairment was defined as a Mini-Mental State Examination score <24 and recorded as a binary variable (present/absent) (22). Functional status was assessed using the Barthel Index (range 0-100), with scores <90 indicating functional impairment (23). Additionally, for each participant, the total burden of geriatric syndromes was quantified by summing the individual conditions. Participants were further categorized based on the presence of at least two geriatric syndromes.

Other Variables

Baseline characteristics (age, gender, BMI, marital and educational status, smoking status, alcohol consumption, and comorbid conditions) were obtained from patient self-report and electronic health records. Participants' height and weight were recorded during outpatient visits, and BMI was calculated as weight divided by height squared. Routine blood analyses were conducted to measure laboratory parameters such as glucose, hemoglobin, and the levels of vitamins B12 and D.

Statistical analysis

Statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS), version 29.0 (IBM Corp., Armonk, NY, USA). Categorical variables were presented as frequencies and percentages,

whereas continuous variables were expressed as mean $\pm$ standard deviation or as median values according to their distribution. The distribution of continuous variables was assessed using the Kolmogorov-Smirnov test. Comparisons between groups were conducted using the chi-square (χ^2) test for categorical variables and the Mann-Whitney U test for continuous variables when the assumption of normality was not met.

The relationship between undernutrition and geriatric syndromes was first assessed using chi-square analysis. Subsequently, binary logistic regression analyses were performed to further examine the relationship between undernutrition and the presence of geriatric syndromes. Unadjusted models were constructed for each variable. Variables that were found to be statistically significant in the univariate analyses ($p < 0.05$) were included in the multivariable models. Adjusted analyses were performed, controlling for age, gender, and level of education.

The results were presented as odds ratios (ORs) with 95% confidence intervals (CIs). A two-sided p value < 0.05 was considered statistically significant. To evaluate the stability of the results, sensitivity analyses were conducted by re-running all regression models in a subgroup limited to participants with more pronounced undernutrition, defined as an MNA-SF score ≤ 7 . Model calibration was assessed with the Hosmer-Lemeshow goodness-of-fit test, while overall model performance was evaluated using the omnibus test of model coefficients.

Results

Sample Characteristics

Baseline demographic and clinical characteristics of the study population are summarized in Table 1. A total of 624 older adults were included in the analysis, with a mean age of 77.6 ± 4.9 years, and 61.5% were women. The mean BMI was 28.0 ± 4.2 kg/m², and 65.1% of participants were married. Most individuals had a low educational level (≤ 5 years) (60.6%), and smoking and alcohol use were relatively uncommon

(6.7% and 2.1%, respectively). Hypertension was the most common chronic condition (74.4%), followed by diabetes mellitus (35.6%) and cardiovascular diseases (26.3%). Other comorbidities, including COPD (7.5%), cerebrovascular disease (4.6%), chronic kidney disease (3.8%), and Parkinson's disease (1.6%), were less frequent. With respect to geriatric syndromes, polypharmacy was the most prevalent condition (47.4%), followed by depression (32.4%), insomnia (27.2%), and urinary incontinence (26.1%). Falls were reported in 18.3% of individuals, while cognitive impairment and functional decline were present in 9.0% and 4.2% of the sample, respectively. Undernutrition was identified in 8.5% of the participants. The median number of geriatric syndromes was 2 (range, 0-6), and more than half of the participants (51.1%) had two

or more geriatric syndromes. In laboratory assessments, the median glucose level was 97.5 mg/dL, hemoglobin was 13.6 g/dL, vitamin B12 was 331 pg/mL, and vitamin D was 24.0 ng/mL.

Association Between Undernutrition and Geriatric Syndromes

The prevalence of geriatric syndromes stratified by undernutrition status is summarized in Table 2. Depression and insomnia were significantly more common among individuals with undernutrition than among those without (47.2% vs. 31.0%, $p=0.01$; 45.3% vs. 25.6%, $p=0.002$, respectively). Similarly, falls, cognitive impairment, and functional decline were more frequent in participants with undernutrition (28.3% vs. 17.3%, $p=0.04$; 17.0% vs. 8.2%, $p=0.03$; and 11.3% vs. 3.5%, $p=0.01$, respectively). In contrast, no significant differences were observed for polypharmacy and urinary incontinence between the groups. Binary logistic regression analyses evaluating the association between geriatric syndromes and undernutrition are presented in Table 3. In the unadjusted analyses, insomnia was significantly associated with higher odds of undernutrition (OR: 2.17; 95% CI: 1.19-3.96; $p=0.01$). This association remained significant after adjustment for age, gender, and education level (OR: 2.27; 95% CI: 1.23-4.17; $p=0.008$). Although falls, cognitive impairment, and functional decline showed higher ORs in both unadjusted and adjusted models, these associations did not reach statistical significance. Depression was not significantly associated with undernutrition in either model. The adjusted associations are summarized in Figure 2, which demonstrates that insomnia was the only geriatric syndrome independently associated with undernutrition among prefrail older adults.

Sensitivity Analyses

The main findings remained consistent in sensitivity analyses restricted to participants with MNA-SF scores ≤ 7 , supporting the robustness of the results. In this analysis, insomnia remained independently associated with a higher likelihood of undernutrition (OR: 2.48; 95% CI: 1.39-4.44; $p=0.002$).

Model diagnostics indicated good calibration and satisfactory overall performance. The Hosmer-Lemeshow test was non-significant (χ^2 : 5.733; $p=0.677$), supporting an adequate model fit. Furthermore, the Omnibus test confirmed that the model was statistically significant ($-2LL$: 346.186; $\chi^2(2)$: 16.561; $p=0.002$).

Discussion

This study examined the association between undernutrition and geriatric syndromes in a sizable cohort of prefrail older adults, employing a comprehensive geriatric assessment framework. The principal finding was that insomnia was independently associated with undernutrition, even after adjustment for key sociodemographic variables and in sensitivity analyses restricted to individuals with more severe nutritional impairment. Although several geriatric syndromes, including falls, cognitive impairment, and functional decline, were more prevalent among undernourished individuals, these associations did not remain statistically significant in multivariable models. These findings highlight insomnia not merely as a coexisting geriatric syndrome but as a potentially central determinant of nutritional

Table 1. Demographic and clinical characteristics of the study sample

Variables	Total (n=624)
Age (years), mean $\pm$ SD	77.6 $\pm$ 4.9
Gender (female), n (%)	384 (61.5)
BMI (kg/m ²), mean $\pm$ SD	28.0 $\pm$ 4.2
Marital status, married, n (%)	406 (65.1)
Education, ≤ 5 y, n (%)	378 (60.6)
Smoking, n (%)	42 (6.7)
Alcohol, n (%)	13 (2.1)
Chronic diseases	
Hypertension, n (%)	464 (74.4)
Diabetes mellitus, n (%)	222 (35.6)
Cardiovascular disease, n (%)	164 (26.3)
COPD, n (%)	47 (7.5)
Cerebrovascular disease, n (%)	29 (4.6)
Chronic kidney disease, n (%)	24 (3.8)
Parkinson's disease, n (%)	10 (1.6)
Geriatric syndromes	
Polypharmacy, n (%)	296 (47.4)
Depression, n (%)	202 (32.4)
Sleep disorder, n (%)	170 (27.2)
Urinary incontinence, n (%)	163 (26.1)
Fall, n (%)	114 (18.3)
Cognitive impairment, n (%)	56 (9.0)
Malnutrition risk, n (%)	53 (8.5)
Functional decline, n (%)	26 (4.2)
Geriatric syndrome count, median (min-max)	2 (0-6)
Geriatric syndrome burden, n (%)	
<2	305 (48.9)
≥ 2	319 (51.1)
Laboratory assessments	
Glucose (mg/dL), median	97.5
Complete blood count (CBC), median	13.60
Vitamin B12 level, median	331.0
Serum 25-hydroxyvitamin D levels, median	24.0
Results are mean $\pm$ SD, median (minimum-maximum), or percentage. Missing data: Vitamin B12 level (49), serum 25-hydroxyvitamin D levels (58). SD: Standard deviation, BMI: Body mass index, COPD: Chronic obstructive pulmonary disease	

Table 2. Association between undernutrition and geriatric syndromes in prefrail older adults (n=624)

Geriatric syndromes	Undernutrition		p
	No	Yes	
Polypharmacy, n (%)	271 (47.5)	25 (47.2)	0.96
Depression, n (%)	177 (31.0)	25 (47.2)	0.01
Insomnia, n (%)	146 (25.6)	24 (45.3)	0.002
Urinary incontinence, n (%)	147 (25.7)	17 (32.1)	0.31
Fall, n (%)	99 (17.3)	15 (28.3)	0.04
Cognitive impairment, n (%)	47 (8.2)	9 (17.0)	0.03
Functional decline, n (%)	20 (3.5)	6 (11.3)	0.01

Table 3. Binary logistic regression analysis of geriatric syndromes associated with undernutrition

Variables	Unadjusted		Adjusted	
	OR (95% CI)	p	OR (95% CI)	p
Depression	1.44 (0.78-2.65)	0.23	1.45 (0.79-2.69)	0.22
Insomnia	2.17 (1.19-3.96)	0.01	2.27 (1.23-4.17)	0.008
Fall	1.75 (0.91-3.36)	0.09	1.74 (0.90-3.35)	0.09
Cognitive impairment	1.85 (0.78-4.34)	0.15	1.63 (0.69-3.87)	0.26
Functional decline	2.37 (0.82-6.81)	0.11	2.12 (0.73-6.12)	0.16

Note: Adjusted for age, gender and education. OR: Odds ratio, CI: Confidence interval

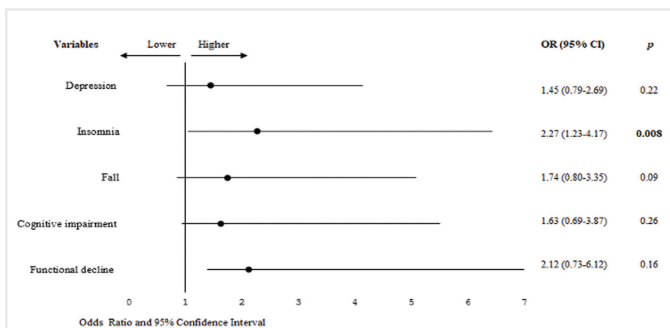


Figure 2. Forest plot of adjusted odds ratios for geriatric syndromes associated with malnutrition risk. The model was adjusted for age, sex, and educational level, OR: Odds ratio, CI: Confidence interval

vulnerability in the prefrail state. These findings suggest that insomnia represents a particularly important and potentially modifiable factor in this vulnerable population.

The relationship identified between insomnia and undernutrition aligns with prior evidence highlighting a strong interaction between sleep disturbances and nutritional status among older adults. Sleep problems have been associated with diminished appetite, disrupted eating behaviors, and insufficient energy intake, which may collectively contribute to nutritional decline (24,14). In addition, earlier studies have linked poor sleep quality to frailty and unfavorable health outcomes, indicating that sleep disturbances may serve as an early indicator of physiological vulnerability (25). However, most existing literature has focused on frail individuals or the broader older adult population, with relatively limited data on prefrail individuals. The present findings extend current knowledge by demonstrating that this association is already detectable during the prefrail stage, an intermediate and potentially reversible phase within the frailty continuum.

Inflammatory processes also play a pivotal role in the link between sleep disturbances and malnutrition. Chronic sleep disorders have been associated with elevated levels of systemic inflammatory markers, particularly interleukin-6 and C-reactive protein, whereas findings regarding tumor necrosis factor-alpha remain less consistent. These inflammatory pathways may contribute to muscle catabolism and appetite suppression (26). In prefrail older adults, who already exhibit reduced physiological reserves, this state of chronic low-grade inflammation may further exacerbate nutritional vulnerability and accelerate the progression to frailty (27).

Beyond biological mechanisms, behavioral and functional factors may also contribute to this association. Insomnia is frequently accompanied by daytime fatigue, reduced physical activity, and diminished motivation, which may adversely affect an individual's ability to maintain an adequate nutritional intake. Furthermore, sleep disturbances are often associated with depressive symptoms and cognitive decline, both of which have been linked to irregular eating patterns and reduced food consumption. In prefrail individuals, the interaction of these factors may exert a cumulative effect, contributing to deterioration in nutritional status, as reflected by the lower MNA-SF scores observed in our study.

In our study, falls, cognitive impairment, and functional decline were more common among participants with undernutrition; however, these associations did not persist after further analysis. This suggests that the link between undernutrition and these geriatric syndromes may not represent a direct, independent relationship but may rather operate through complex, multifactorial pathways. For example, Yu et al. (28) demonstrated a significant association between undernutrition and an increased risk of cognitive impairment; the difference compared with our findings may be explained by the prefrail characteristics of our cohort, in which cognitive decline is likely to be at an earlier

stage. In contrast, a narrative review has suggested that malnutrition contributes to a higher risk of falls and loss of functional independence through mechanisms such as decreased muscle mass and strength, impaired balance, and reduced physical performance (29). However, these associations are often mediated by intermediate factors, including frailty, sarcopenia, comorbidity burden, and physical inactivity (30). This may explain why the observed relationships in our study did not retain statistical significance after adjustment. Overall, these results suggest that the effects of undernutrition on geriatric syndromes may become more evident in advanced stages of frailty or in older populations with greater heterogeneity.

Study Limitations

Several limitations should be considered when interpreting these findings. The cross-sectional design of the study limits the ability to determine the directionality of the association between insomnia and undernutrition. However, the inclusion of comprehensive geriatric assessment data, along with adjustment for important confounding factors, strengthens the credibility of the findings. Although the study was conducted in a single tertiary care center, which may restrict generalizability, the inclusion of a well-defined and relatively large prefrail cohort supports the clinical relevance of our results. Moreover, evaluating insomnia based on self-reported symptoms rather than objective measures may have introduced reporting bias. However, the use of a standardized evaluation approach and consistent application of the assessment method across all participants likely mitigated this effect. Furthermore, the consistency of findings across the sensitivity analyses strengthens the robustness of the observed association and reinforces the internal validity of the study.

Conclusion

Insomnia emerged as an independent correlate of undernutrition among prefrail older adults. This finding underscores the importance of incorporating sleep assessments into comprehensive geriatric evaluations. These findings support the integration of sleep assessment into routine comprehensive geriatric evaluation and suggest that targeting insomnia may represent a novel and clinically relevant strategy for mitigating undernutrition and preventing progression to frailty. Future longitudinal studies are warranted to further elucidate the underlying causal mechanisms and evaluate the impact of sleep-focused interventions on nutritional and functional outcomes.

Ethics

Ethics Committee Approval: This study was approved by the University of Health Sciences Türkiye, Gülhane Training and Research Hospital Ethics Committee (decision number: 2026/107, date: 07.05.2026).

Informed Consent: Due to the retrospective design of the study and the use of anonymized medical records, the requirement for written informed consent was waived by the ethics committee.

Footnotes

Authorship Contributions: Surgical and Medical Practices - Z.S.D., M.I.N.; Concept - Z.S.D., M.I.N.; Design - Z.S.D., M.I.N.; Data Collection

or Processing - Z.S.D., M.I.N.; Analysis or Interpretation - Z.S.D., M.I.N.; Literature Search - Z.S.D., M.I.N.; Writing - Z.S.D., M.I.N.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

References

1. Partridge L, Deelen J, Slagboom PE. Facing up to the global challenges of ageing. *Nature*. 2018; 561: 45-56.
2. O'Connor D, Molloy AM, Laird E, Kenny RA, O'Halloran AM. Sustaining an ageing population: the role of micronutrients in frailty and cognitive impairment. *Proc Nutr Soc*. 2023; 82: 315-28.
3. Kim DH, Rockwood K. Frailty in older adults. *N Engl J Med*. 2024; 391: 538-48.
4. Yu L, Tang X, Gong D, Man C, Fan Y. Prefrailty prevalence and all-cause mortality risk in older adults from the general population: a meta-analysis of prospective cohort studies. *Geriatr Gerontol Int*. 2025; 25: 1167-77.
5. Sezgin D, Liew A, O'Donovan MR, O'Caoimh R. Pre-frailty as a multi-dimensional construct: a systematic review of definitions in the scientific literature. *Geriatr Nurs*. 2020; 41: 139-46.
6. Won CW. Diagnosis and management of frailty in primary health care. *Korean J Fam Med*. 2020; 41: 207-13.
7. Shi L, Tian X, Bongsook Y, Chen J. Predicting the unseen: nutritional interventions as a key to combat frailty. *Front Nutr*. 2025; 12: 1575922.
8. Ueshima J, Nagano F, Wakabayashi H, Maeda K, Arai H. Effectiveness of non-pharmacological therapies for preventing frailty in older people: an umbrella review. *Arch Gerontol Geriatr*. 2025; 128: 105628.
9. Li W, Wu Z, Liao X, Geng D, Yang J, Dai M, et al. Nutritional management interventions and multi-dimensional outcomes in frail and pre-frail older adults: a systematic review and meta-analysis. *Arch Gerontol Geriatr*. 2024; 125: 105480.
10. Dent E, Morley JE, Cruz-Jentoft AJ, Woodhouse L, Rodríguez-Mañas L, Fried LP, et al. Physical frailty: ICFSR International Clinical Practice Guidelines for identification and management. *J Nutr Health Aging*. 2019; 23: 771-87.
11. Tasci I, Safer U, Naharci MI. Multiple antihyperglycemic drug use is associated with undernutrition among older adults with type 2 diabetes mellitus: a cross-sectional study. *Diabetes Ther*. 2019; 10: 1005-18.
12. Naharci MI, Katipoglu B, Tasci I. Association of anticholinergic burden with undernutrition in older adults: a cross-sectional study. *Nutr Clin Pract*. 2022; 37: 1215-24.
13. Akpinar B, Karadavut M, İnci C, Avci O, Sasmaz ME, Utlu M, et al. Malnutrition and associated geriatric syndromes in older outpatients: a comprehensive analysis. *Asia Pac J Clin Nutr*. 2026; 35: 360-8.
14. Saka B, Kaya O, Ozturk GB, Erten N, Karan MA. Malnutrition in the elderly and its relationship with other geriatric syndromes. *Clin Nutr*. 2010; 29: 745-8.
15. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Frailty in older adults: evidence for a phenotype. *J Gerontol A Biol Sci Med Sci*. 2001; 56: M146-56.
16. Radloff LS. The CES-D scale: a self-report depression scale for research in the general population. *Appl Psychol Meas*. 1977; 1: 385-401.
17. Tomioka K, Iwamoto J, Saeki K, Okamoto N. Reliability and validity of the International Physical Activity Questionnaire (IPAQ) in elderly adults: the Fujiwara-kyo Study. *J Epidemiol*. 2011; 21: 459-65.
18. Masnoon N, Shakib S, Kalisch-Ellett L, Caughey GE. What is polypharmacy? A systematic review of definitions. *BMC Geriatr*. 2017; 17: 230.

19. Manea L, Gilbody S, Hewitt C, North A, Plummer F, Richardson R, et al. Identifying depression with the PHQ-2: a diagnostic meta-analysis. *J Affect Disord.* 2016; 203: 382-95.
20. Naharcı Mİ, Bozoğlu E, Koçak N, Doruk H. Analysis of the effects of galantamine and donepezil on sleep disturbances in patients with dementia. *Psychiatry Clin Psychopharmacol.* 2011; 21: 139-44.
21. Hauer K, Lamb SE, Jorstad EC, Todd C, Becker C; PROFANE-Group. Systematic review of definitions and methods of measuring falls in randomised controlled fall prevention trials. *Age Ageing.* 2006; 35: 5-10.
22. Kochhann R, Varela JS, Lisboa CSM, Chaves MLF. The Mini mental state examination: review of cutoff points adjusted for schooling in a large Southern Brazilian sample. *Dement Neuropsychol.* 2010; 4: 35-41.
23. Mahoney FI, Barthel DW. Functional evaluation: the Barthel Index. *Md State Med J.* 1965; 14:61-5.
24. Soysal P, Smith L, Dokuzlar O, Isik AT. Relationship between nutritional status and insomnia severity in older adults. *J Am Med Dir Assoc.* 2019; 20: 1593-8.
25. Nemoto Y, Sato S, Kitabatake Y, Nakamura M, Takeda N, Maruo K, et al. Bidirectional relationship between insomnia and frailty in older adults: a 2-year longitudinal study. *Arch Gerontol Geriatr.* 2021; 97: 104519.
26. Irwin MR, Olmstead R, Carroll JE. Sleep disturbance, sleep duration, and inflammation: a systematic review and meta-analysis of cohort studies and experimental sleep deprivation. *Biol Psychiatry.* 2016; 80: 40-52.
27. Soysal P, Stubbs B, Lucato P, Luchini C, Solmi M, Peluso R, et al. Inflammation and frailty in the elderly: a systematic review and meta-analysis. *Ageing Res Rev.* 2016; 31: 1-8. Erratum in: *Ageing Res Rev.* 2017; 35: 364-5.
28. Yu W, Yu W, Liu X, Wan T, Chen C, Xiong L, et al. Associations between malnutrition and cognitive impairment in an elderly Chinese population: an analysis based on a 7-year database. *Psychogeriatrics.* 2021; 21: 80-8.
29. Kupisz-Urbanska M, Marcinowska-Suchowierska E. Malnutrition in older adults-effect on falls and fractures: a narrative review. *Nutrients.* 2022; 14: 3123.
30. Naharcı Mİ, Tascı I. Frailty status and increased risk for falls: the role of anticholinergic burden. *Arch Gerontol Geriatr.* 2020; 90: 104136.