Aging Clinical and Experimental Research (2022) 34:2023–2030
https://doi.org/10.1007/s40520-022-02143-7

ORIGINAL ARTICLE

The prevalence of undernutrition and associated factors in older obese patients

Pinar Soysal[1] · Saadet Koc Okudur[2] · Nazli Kilic[1] · Ozlem Ipar[1] · Lee Smith[3]

Received: 3 March 2022 / Accepted: 23 April 2022 / Published online: 16 May 2022

Abstract

Background Both obesity and malnutrition are common health problems in older adults.

Aim The aim of our study is to investigate the prevalence of undernutrition and related factors in older obese patients.

Methods 1911 older outpatients who underwent comprehensive geriatric assessment were included in this cross-sectional study. Body mass index (BMI) was categorized as follows: 'Underweight' = BMI < 18.5, 'Normal weight' = 18.5 ≤ BMI < 25, 'Overweight' 25 ≤ BMI < 30, and 'Obesity' ≥ BMI 30. Mini-Nutritional Assessment scores > 23.5, 17–23.5, or < 17 were categorized as well-nourished, malnutrition risk, and malnutrition, respectively. Those who were not well-nourished were considered undernutrition.

Results Of 1911 patients, with a mean age of 77.34 ± 8.0 years, 931 (48.7%) were obese. Of whom 6.0% were malnourished and 26.3% were at risk of malnutrition. Age, females, widowed and those living with their children, the number of drugs used, and the presence of heart failure, Parkinson's disease, and dementia, decreased calf circumference and muscle strength were higher in obese patients with undernutrition than obese well-nourished patients ($p < 0.05$). After adjustment for the aforementioned factors, basic and instrumental activities of daily livings, and Tinetti scores were lower, and falls and Geriatric Depression Scale-15 scores were higher in those with undernutrition compared to those with well-nourished among older obese patients ($p < 0.05$).

Conclusions Half of the older patients were obese and undernutrition was observed in one out of every three older obese patients. Undernutrition was associated with decreased functional capacity, impairment in balance and gait functions, falls, and depressed mood. Therefore, we recommend to screen older obese patients for nutritional status.

Keywords Obesity · Malnutrition · Malnutrition risk · Undernutrition · Older adults

Introduction

Malnutrition is a syndrome common in geriatric patients characterized by inadequate nutrient absorption and/or decreased nutrient intake, which, if left untreated or if treatment is delayed, may lead to adverse health conditions such as decreased physical and mental functions, deterioration in quality of life, frailty, sarcopenia, falls, and increased mortality [1–3]. Although malnutrition is often associated with low body mass index (BMI), it is also be observed in obese people [4]. Indeed, some reports emphasizes that obesity is actually often associated with poor quality nutrition [5, 6]. Obesity, which is associated with malnutrition of individuals despite excessive energy consumption, is defined as paradoxical malnutrition [5]. Deficiencies of essential micronutrients or insufficient protein consumption, consumption of foods with high calories but low nutritional value may adversely affect both physical health and emotional and intellectual status [7]. As a result, malnutrition and obesity can coexist in a patient.

Obesity, as well as malnutrition, is an important and common (36.6%) health problem in older adults [8]. Although a decrease in obesity-related cardiovascular mortality has been reported in recent years, malnutrition in obese individuals

✉ Pinar Soysal
dr.pinarsoysal@hotmail.com

[1] Department of Geriatric Medicine, Faculty of Medicine, Bezmialem Vakif University, Adnan Menderes Bulvarı (Vatan Street), Fatih, 34093 Istanbul, Turkey

[2] Department of Geriatric Medicine, Manisa State Hospital, Şehzadeler, 45040 Manisa, Turkey

[3] Centre for Health, Performance, and Wellbeing, Anglia Ruskin University, Cambridge, UK

has been associated with an increased burden of comorbidity, adverse cardiac remodeling, impaired cardiac relaxation function and hospitalization for heart failure, and increased all-cause mortality [9]. Moreover, there is an increase in obesity-related disability, which is even more notable for older adults, where functional disability is already common [10]. Although not studied to date, if malnutrition is observed in a geriatric obese patient, it may be hypothesized that obesity-related complications, such as disability, may increase. Therefore, current guidelines recommend routine screening of older adults for malnutrition and risk of malnutrition, even if they are overweight or obese [11]. Indeed, recommending weight loss without screening for malnutrition to reduce orthopedic problems, cardiovascular and metabolic risk in geriatric obese may predispose the patient to the occurrence of harmful effects such as sarcopenic obesity associated with weight loss [11].

Therefore, the frequency of malnutrition and malnutrition risk in the geriatric and obese as well as the factors causing nutritional deterioration in this population need to be identified. However, to the best of the authors' knowledge, there is no study on this so far. In only one study conducted in a geriatric outpatient clinic, but using the Mini-Nutritional Assessment-Short form, it was found that 33.7% of older patients were diagnosed with both obesity and malnutrition or were at risk of malnutrition [12]. However, associated factors were not investigated in this study. Thus, the aim of the present study is to investigate the prevalence of undernutrition (i.e., malnutrition and malnutrition risk) and related factors in older obese patients.

Methods

In this retrospective cross-sectional study, file records of older patients who were admitted to one geriatric clinic in Turkey as an outpatient and underwent detailed geriatric evaluation between November 2016 and January 2022 were reviewed. This study was approved by the Ethics in Research Committee of the local ethical review board.

Patients who had severe illness that may impair their general health status, such as acute cerebrovascular event, sepsis, acute renal failure, and acute respiratory failure, those with missing data in file records, with severe dementia or with severe vision and hearing impairment that prevent communication and understanding commands during the examination, and those with terminal disease or delirium were excluded. As a consequence, 1911 patients were available for the study analysis.

For each patient, age, gender, education, marital and living status, number of medications, and comorbid diseases (hypertension, diabetes mellitus, coronary heart disease, chronic obstructive pulmonary disease, cerebrovascular disease, congestive heart disease, peripheral vascular disease, Parkinson's disease, osteoarthritis, and dementia) were recorded. In addition, information on history of falling in the past year and scores of basic and instrumental Activities of Daily Living (BADL and IADL), Geriatric Depression Scale-15 (GDS-15), and Tinetti Performance Oriented Mobility Assessment indexes were also recorded. Grip strength of the dominant hand measured with a hand-grip dynamometer less than 16 kg in females and 27 kg in males was categorized as having dynapenia. A calf circumference (CC) below ≤ 31 cm was considered as low [13].

Evaluation of weight status

BMI was calculated for each patient using the standardized formula: weight (kg)/height $(m)^2$. BMI was categorized according to World Health Organization standards: 'Underweight' = BMI < 18.5, 'Normal weight' = 18.5 ≤ BMI < 25, 'Overweight' = 25 ≤ BMI < 30, 'Obesity' ≥ BMI 30 (obesity grade 1 (BMI, 30.0–34.9); obesity grade 2 (BMI, 35.0–39.9); and obesity grade 3 (BMI, ≥ 40.0) [14].

Evaluation of nutritional status

Mini-Nutritional Assessment (MNA) was performed on all patients to detect malnutrition risk, even if MNA-Short Form scores were ≥ 12. If the total score was > 23.5, 17–23.5, or < 17 it was accepted as well-nourished, risk of malnutrition, or malnutrition, respectively. In general, patients who were not well-nourished were considered as undernutrition (risk of malnutrition + malnutrition). The MNA test is composed of simple measurements and 18 brief questions that can be completed in < 10 min, anthropometric measurement questions related to BMI, weight loss, brachial circumference, and CC; global assessment (6 questions related to lifestyle, medication, and mobility); and dietary questionnaire and subjective assessment (8 questions related to number of meals, food and fluid intake, autonomy of feeding, and self-perception of health and nutrition) [15].

Statistical analysis

Data were analyzed using SPSS, version 22. Descriptive statistics for patient characteristics and pre-existing chronic disease states were calculated based on the general population and nutritional status. Mean and standard deviation were summarized and compared using *t* test, and proportions were summarized and compared using Chi square tests for categorical variables. Univariate regressions were carried out to examine the relationship between the associated factors and undernutrition, risk of malnutrition and malnutrition, separately in older patients with obesity. Age-sex adjusted (Model 1), multivariable and multivariable-adjusted

regressions were carried out to examine the association using logic regression (OR and 95% CI) for the outcomes. Model 2 multivariable analysis was performed with adjustments for age, sex, number of medications, cardiac failure, dementia, Parkinson's disease. In Model 3 multivariable analysis, decreased CC and dynapenia were added to the confounders in Model 2.

Results

Of 1911 patients, 51% were female, with a mean age of 77.34 ± 8.0 years, 12.4% had malnutrition and 31.6% had malnutrition risk. Of these patients, 1.2% were underweight, 19.0% were of normal weight, 31.1% were overweight, and 48.7% were obese. 28.2% of them were obesity stage 1, 14.8% were obesity stage 2 and 5.7% were obesity stage 3. According to the BMI categories of the patients, the malnutrition percentages were 72.7%, 27.2%, 11.3%, 5.9%, 5.7%, and 6.4%, respectively, while the malnutrition risk frequency was 27.3%, 40.1%, 34.5%, 24.3%, 29.3%, and 29.4%, respectively (see Fig. 1).

Of 1911 patients, 931 (48.7%) were obese. Of these, 539 (57.9%), 283 (30.4%) and 109 (11.7%) had stage 1, stage 2 and stage 3 obesity, respectively. With a mean age of 75.5 ± 7.5 years, 45.9% of the geriatric obese were female, of whom 6.0% were malnourished and 26.3% were at risk of malnutrition (i.e., 32.3% undernutrition). The characteristics of patients with obesity according to well-nourishment, malnutrition risk and malnutrition are shown in Table 1. Accordingly, age, female ratio, widowed and those living with their children, the number of medications used, and the presence of heart failure, Parkinson's disease and dementia were statistically different between the groups ($p < 0.05$). Concerning well-nourishment to malnutrition, there was a significant increase in the frequency of falls, dynapenia, decreased CC, and GDS scores, while BADL, IADL, and Tinetti scores decreased ($p < 0.05$) (see Table 1)**.** In the univariate analysis, the results of undernutrition, malnutrition risk and malnutrition according to different parameters between the groups are shown in Table 2.

Table 3 shows that after adjusting for age and gender, in those with undernutrition compared to those well-nourished, adverse effects on dynapenia, BADL, IADL, falls, GDS and Tinetti scores were statistically significant ($p < 0.05$), but no correlation was found with decreased CC (Model 1). In the Model 2 multivariate analysis, adjustment was made according to age, gender, number of medications, heart failure, dementia, and Parkinson's disease. Dynapenia {Odd Ratio (OR): 1.92 [95% confidence interval (CI): 1.22–3.02]} was associated with falls (OR: 1.68 (95% CI: 1.10–2.60)] in those with undernutrition ($p < 0.05$). In addition, BADL [OR: 0.93 (95% CI 0.91–0.95)], IADL [OR: 0.82 (95% CI: 0.80–0.86)], GDS [OR: 2.0 (95% CI: 1.30–2.27)], and negative impact on Tinetti [OR: 0.91 (95% CI: 0.88–0.94)] scores was statistically significant ($p < 0.05$). In Model 3, in addition to the confounders in Model 2, decreased CC and dynapenia were added to the adjustment, and the significant association of undernutrition with falls, deterioration in BADL, IADL, Tinetti scale, and GDS-15 scores remained ($p < 0.05$) (see Table 3).

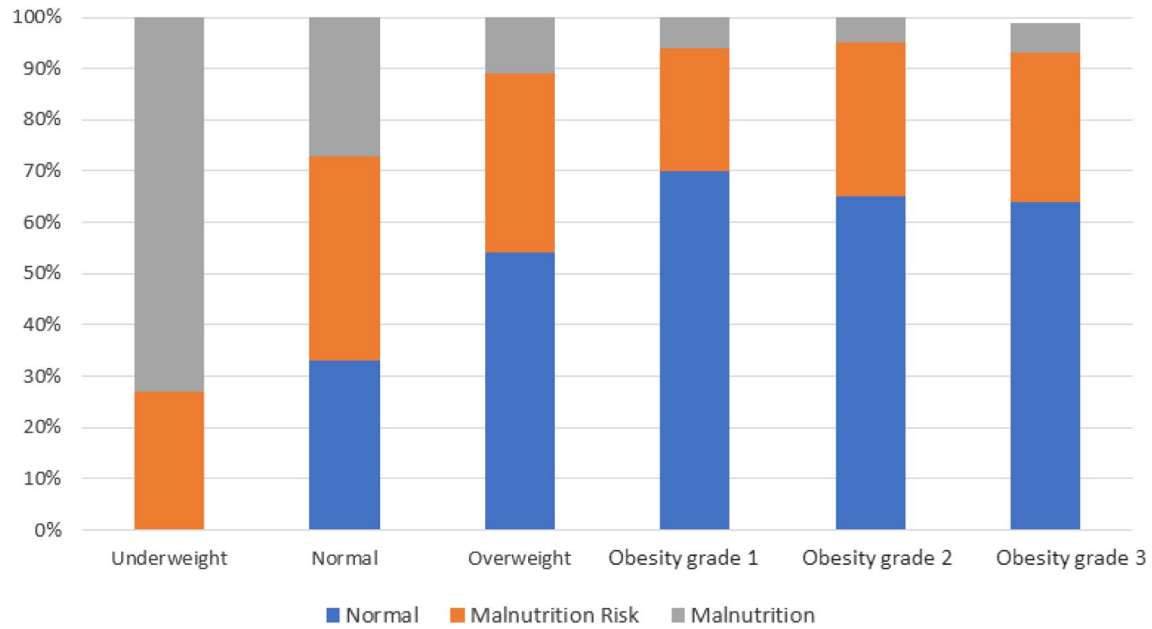

Fig. 1 Nutritional status in different weight status

Table 1 Characteristics of patients

Characteristic	Well-nourished ($n=630$)	Malnutrition risk ($n=245$)	Malnutrition ($n=56$)	*P* value
Age	74.7 ± 7.5	77.3 ± 7.2	77.1 ± 7.4	< 0.001
Gender (female) %	42.9	46.9	77.5	< 0.001
Education status %				
≤ 5 years	82.5	82.0	92.3	0.328
Marital status %				
Married	56.2	48.3	37.0	< 0.001
Single	3.7	4.7	3.7	
Widowed	16.2	24.6	48.1	
Divorced	23.9	22.4	11.2	
Living status %				
With spouse	54.5	46.0	34.5	< 0.001
With children	13.7	21.8	41.8	
Others	31.8	32.2	23.7	
Body mass index (kg/m^2)	34.9 ± 4.2	35.3 ± 4.5	35.6 ± 5.1	0.441
Number of drugs used	5.0 ± 31	6.3 ± 3.1	7.5 ± 3.5	< 0.001
Comorbidities %				
HT	73.5	72.1	81.8	0.431
DM	58.7	65.8	54.5	0.101
CAD	32.6	30.3	16.4	0.154
COPD	9.3	13.1	7.3	0.190
CVD	11.5	16.1	16.4	0.152
CHF	6.1	11.5	14.5	< 0.05
PVD	3.7	3.7	3.6	1.000
PD	2.7	7.4	7.4	< 0.05
OA	23.7	24.7	20.0	0.761
Dementia	17.1	41.4	29.5	< 0.001
Geriatric assessment				
MNA	26.2 ± 1.6	21.1 ± 1.5	15.1 ± 2.0	< 0.001
Mid-arm circumference (cm)	30.9 ± 1.6	30.7 ± 3.7	30.9 ± 4.1	0.733
Calf circumference (cm)	38.0 ± 4.3	38.1 ± 4.1	30.9 ± 4.1	0.729
Calf circumference ≤ 31 cm %	3.4	3.3	9.1	< 0.001
BADL	90.7 ± 9.2	77.6 ± 19.6	63.8 ± 26.8	< 0.001
IADL	18.2 ± 5.2	12.4 ± 7.0	8.2 ± 6.9	< 0.001
Dynapenia %	58.2	74.0	81.1	< 0.001
Falls %	26.1	44.9	48.1	< 0.001
GDS-15	3.7 ± 3.5	7.3 ± 4.1	8.2 ± 4.3	< 0.001
Tinetti balance and gait test	12.2 ± 3.0	10.7 ± 3.8	7.8 ± 5.2	< 0.001

BADL basic activities of daily living, *CAD* coronary artery disease, *CHF* congestive heart failure, *COPD* chronic obstructive pulmonary disease, *CVD* cerebrovascular disease, *DM* diabetes mellitus, *GDS* geriatric depression scale, *HT* hypertension, *IADL* instrumental activities of daily living, *MNA* Mini-Nutritional Assessment, OA osteoarthritis, *PAD* peripheral artery disease, *PD* Parkinson's disease

Discussion

Approximately, half of the patients admitted to the geriatric outpatient clinic in the present study were obese, and one out of three geriatric obese patients had undernutrition. Age, gender, marital and living status, number of medications used, presence of heart failure, Parkinson's disease and dementia were identified as potentially important factors in the deterioration of nutritional status in geriatric obese patients. However, regardless of these factors, undernutrition was associated with decreased functional capacity, impaired balance, gait, falls, and depressed mood.

Table 2 Bivariate relationships between nutritional status and related variables in obese older patients

	OR	95% CI	*P*	OR	95%CI	*P*	OR	95%CI	*P*
Age	1.05	1.02–1.06	< 0.001	1.05	1.02–1.07	< 0.001	1.04	1.00–1.10	< 0.05
Gender (female)	1.45	1.10–1.91	< 0.001	1.20	0.88–1.60	0.250	3.91	2.10–7.30	< 0.001
Dementia	3.02	1.91–4.76	< 0.001	3.43	2.10–5.57	< 0.001	2.03	0.98–4.22	0.056
PD	2.74	1.44–5.22	< 0.05	2.72	1.40–5.33	< 0.05	2.61	1.20–5.90	< 0.05
CHF	2.10	1.30–3.40	< 0.05	1.99	1.19–3.32	< 0.05	2.85	0.92–8.80	0.068
CC	1.30	0.64.2.64	0.460	0.97	0.42–2.22	0.949	2.87	1.03–7.94	< 0.05
Dynapenia	2.76	1.92–4.01	< 0.001	2.04	1.46–2.86	< 0.001	3.10	1.50–6.26	< 0.05
BADL	0.92	0.91–0.94	< 0.001	0.93	0.91–0.94	< 0.001c	0.91	0.89–0.93	< 0.001
IADL	0.86	0.83–0.88	< 0.001	0.86	0.85–0.89	< 0.001	0.80	0.77–0.84	< 0.001
Falls	2.02	1.63–2.94	< 0.001	2.30	1.70–3.13	< 0.001	2.63	1.50–4.61	< 0.001
GDS	1.30	1.23–1.34	< 0.001	1.26	1.20–1.31	< 0.001	1.30	1.20–1.40	< 0.001
Tinetti	0.89	0.87–0.92	< 0.001	0.89	0.87–0.91	< 0.001	0.87	0.84–0.90	< 0.001

BADL basic and instrumental activities of daily livings, *CC* calf circumference, *CHF* congestive heart failure, *GDS* geriatric depression scale, *IADL* instrumental activities of daily living, *PD* Parkinson's disease

Table 3 The association between undernutrition and related outcomes in multivariable analysis

	Model 1			Model 2			Model 3		
	OR	95% CI	*P*	OR	95% CI	*P*	OR	95% CI	*P*
CC	1.20	0.57–2.41	0.664	1.62	0.4–6.2	0.44		–	
Dynapenia	2.76	1.92–4.01	< 0.001	1.92	1.22–3.02	< 0.001		–	
BADL	0.93	0.92–0.93	< 0.001	0.93	0.91–0.95	< 0.001	0.92	0.91–0.94	< 0.001
IADL	0.84	0.82–0.87	< 0.001	0.82	0.80–0.86	< 0.001	0.82	0.78–0.86	< 0.001
Falls	2.02	1.63–2.94	< 0.001	1.68	1.10–2.60	0.019	1.71	1.10–2.67	< 0.005
GDS	1.30	1.23–1.34	< 0.001	2.00	1.30–2.27	< 0.001	1.20	1.11–1.26	< 0.001
Tinetti	0.89	0.87–0.92	< 0.001	0.91	0.88–0.94	< 0.001	0.91	0.88–0.94	< 0.001

BADL basic and instrumental activities of daily livings, *CC* calf circumference, *GDS* geriatric depression scalem, *IADL* instrumental activities of daily living

In the literature, obesity is regarded as a problem of children, adolescents or young adults rather than older adults, and is only now emerging as a problem among the older population [8]. However, among adults aged 40–69 years, 52.8% are in the overweight category, of whom 7% become obese within 1 year and 16% within 3 years [16]. Therefore, geriatric obesity, the importance of which has not been sufficiently recognized to date, will become an even more serious and unavoidable problem as the world ages in the future. Indeed, in another study carried out in Turkey, the frequency of overweight and obese among older patients was found to be similar to the present study [12]. In a recent US study that included 7261 patients over 60 years of age, the frequency of underweight, normal, overweight and obese was observed to be 1.4%, 25.1%, 36.6%, and 36.6%, respectively [8]. Compared to the present findings, the proportion of those who were underweight was similar, while the ratio of overweight and older obese people in the US study differed (overweight was higher and obesity was lower in the US study). This may be owing to the older age of the present sample, lower educational level, sociodemographic differences, and that this study was conducted on outpatient clinic patients as opposed to the general older population. Moreover, one-third of these geriatric obese had undernutrition. In a study conducted by Turkbeyler et al. [12] in a geriatric outpatient clinic in Turkey, but using the MNA-Short form, it was found that 33.7% of geriatric patients were diagnosed with both obesity and malnutrition or were at risk of malnutrition [12]. Since both undernutrition and obesity have many negative consequences, it may be considered that the presence of both conditions in the same older patient may lead to much worse outcomes.

Moreover, undernutrition in geriatric obese may easily be overlooked if only BMI is taken into account. Therefore, we aimed to investigate the possible risk factors for undernutrition in geriatric obese patients, suggesting that increased age, female gender, being unmarried and living with another spouse, using more medications, having heart failure, Parkinson's disease and dementia were detected more commonly in those with undernutrition (especially in those with malnutrition). These are indeed known risk factors that can lead to malnutrition, with or without obesity

[17–19]. With increased age, the decrease in the sense of taste and smell, difficulties in swallowing and chewing, and loss of appetite can reduce food intake [20].

Moreover, difficulties in activities of daily living, such as shopping and cooking may limit food consumption. However, these causes are more common in neurodegenerative diseases (3.0 times more in those with dementia and 2.74 times in those with Parkinson's disease). For example, in Parkinson's disease, motor symptoms, high-dose levodopa therapy and neuropsychiatric symptoms and dysphagia increase the tendency for malnutrition [21]. Eating problems, including behaviors such as refusal to eat, keeping food in the mouth, or spitting food out are among the dementia-related behavior disorders. In addition, wandering, agitation, and repetitive behaviors can increase energy consumption in patients with dementia who are already have an energy deficit, resulting in undernutrition [19]. In light of these possible mechanisms, the risk of undernutrition may arise even from the prodromal period of dementia [19]. Another important point is that drugs, such as acetylcholinesterase inhibitors or anti-parkinsonian drugs, prescribed for treatment of certain dementia subtypes are likely to cause weight loss, which makes it complicated to address malnutrition in patients with dementia [21, 22]. In addition to these drugs, many of the drugs frequently used in older patients also reduce appetite as a side effect and may increase the tendency for undernutrition by causing dry mouth, dysphagia, constipation, and cognitive impairment due to their anticholinergic effects [23]. Finally, heart failure was associated with a 2.85 times greater risk of malnutrition and twofold with undernutrition. In a study by Chien et al., in which the mean age was 50 years, the number of obese-malnourished people with heart failure was higher and they had higher comorbidity burden and inadequacy in cardiac remodeling [18]. Therefore, if an older patient is both obese and undernourished, this may complicate the management of the existing clinical condition.

Undernutrition was associated with decreased functional competence, increased falling, impaired balance functions, and increased depressive symptoms among all confounders. So far, obesity itself has been shown to be associated with functional disability in older people, but the contribution of nutritional impairment has not been investigated until now. According to the present results, undernutrition in geriatric obesity may be one of the reasons that an increase dependency in daily living activities is observed. Moreover, this negative effect persists when adjustment is made according to the components of sarcopenia, such as CC and muscle strength. Dietary patterns with more phytonutrient-rich plant foods, tea, omega-3-rich fish, and other protein-rich foods such as shellfish or milk have reduced the prevalence of frailty [24]. Both consuming high-calorie foods that will result in obesity and consuming small amounts of vegetables, fruits and proteins that may bring about deterioration of nutritional status impair functionality [25] which may also increase factors such as malnutrition and risk of malnutrition frailty and orthostatic hypotension that increase falls and depressive symptoms and impair balance-walking functions [26, 27]. In addition, on the contrary, depression may reduce the motivation of older adults for healthy eating, or in those with functional inability, it can adversely affect daily life activities such as shopping and cooking, thus impairing nutritional status [27, 28].

The strengths of the present study include the large sample size, detailed geriatric evaluation of all the patients, and evaluation of comorbid diseases. Moreover, the evaluation of malnutrition and malnutrition risks according to obesity subgroups and the use of MNA long form are further strengths. However, findings from the present study must be considered in light of its limitations. These can be summarized as the cross-sectional and retrospective design of the study, not investigating metabolic syndrome, not evaluating micronutrients and serum albumin levels, but evaluating only BMI values.

Conclusions

In the present study, approximately half of older patients who were admitted to the outpatient clinic were obese and there was malnutrition or malnutrition risk in one out of every three older obese patients. Obesity and undernutrition were more likely to occur together in older patients with dementia, Parkinson's disease, and heart failure. Therefore, one should be vigilant for undernutrition in older obese patients with these comorbid diseases. In addition, reviewing the number of medications at each visit and removing inappropriate medications from treatment may improve nutritional status. Since undernutrition is associated with decreased functional capacity, impaired balance and gait, falling, and depressed mood, it is recommendable to screen older obese patients for nutritional status. While recommending weight loss in elderly obese patients, attention should be paid to the development of malnutrition and malnutrition risk. Thus, related complications may be avoided.

Author contributions Conceptualization: PS; data curation: NK and OI; formal analysis: PS; supervision: LS; writing—original draft: PS and SKO; writing—review and editing: PS, SKO, and LS.

Funding The authors did not receive support from any organization for the submitted work.

Availability of data and materials Data are available on request by contacting the corresponding author (dr.pinarsoysal@hotmail.com).

Declarations

Conflict of interest The authors have no relevant financial or non-financial interests to disclose.

Ethics approval Ethical approval was obtained by the ethics committees of Bezmialem Vakif University.

Statement of human participants and/or animals All the procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Declaration of Helsinki and its later amendments.

Consent to participate Informed consent was provided by each participant or a legal guardian before participating in the study.

Consent for publication Not applicable.

References

1. Lorenzo-López L, Maseda A, de Labra C et al (2017) Nutritional determinants of frailty in older adults: a systematic review. BMC Geriatr 17:1–13. https://doi.org/10.1186/S12877-017-0496-2/TABLES/1
2. Soysal P, Veronese N, Arik F et al (2019) Mini Nutritional Assessment Scale-Short Form can be useful for frailty screening in older adults. Clin Interv Aging 14:693. https://doi.org/10.2147/CIA.S196770
3. Söderström L, Rosenblad A, Thors Adolfsson E et al (2017) Malnutrition is associated with increased mortality in older adults regardless of the cause of death. Br J Nutr 117:532–540. https://doi.org/10.1017/S0007114517000435
4. London AG (2016) Malnutrition and obesity coexist in many countries, report finds. BMJ. https://doi.org/10.1136/bmj.i3351
5. Kobylińska M, Antosik K, Decyk A et al (2022) Malnutrition in obesity: is it possible? Obes Facts 15:19–25. https://doi.org/10.1159/000519503
6. Argyrakopoulou G, Konstantinidou SK, Dalamaga M et al (2022) Nutritional deficiencies before and after bariatric surgery: prevention and treatment. Curr Nutr Rep. https://doi.org/10.1007/S13668-022-00400-9
7. Kaidar-Person O, Person B, Szomstein S et al (2008) Nutritional deficiencies in morbidly obese patients: a new form of malnutrition? Part A: vitamins. Obes Surg 18:870–876. https://doi.org/10.1007/S11695-007-9349-Y
8. Lynch DH, Petersen CL, Fanous MM et al (2022) The relationship between multimorbidity, obesity and functional impairment in older adults. J Am Geriatr Soc. https://doi.org/10.1111/JGS.17683
9. Lebenbaum M, Zaric GS, Thind A et al (2018) Trends in obesity and multimorbidity in Canada. Prev Med 116:173–179. https://doi.org/10.1016/J.YPMED.2018.08.025
10. Keramat SA, Alam K, Sathi NJ et al (2021) Self-reported disability and its association with obesity and physical activity in Australian adults: results from a longitudinal study. SSM Popul Health 14:100765. https://doi.org/10.1016/J.SSMPH.2021.100765
11. Volkert D, Beck AM, Cederholm T et al (2019) ESPEN guideline on clinical nutrition and hydration in geriatrics. Clin Nutr (Edinburgh, Scotland) 38:10–47. https://doi.org/10.1016/J.CLNU.2018.05.024
12. Turkbeyler IH, Ozturk ZA, Gol M, et al (2020) Malnutrition and Obesity Prevalences in Geriatric Patients. Progress in Nutrition 22:e2020017–e2020017. https://doi.org/10.23751/PN.V22I3.7954
13. Wei J, Jiao J, Chen CL et al (2022) The association between low calf circumference and mortality: a systematic review and meta-analysis. European geriatric medicine. https://doi.org/10.1007/S41999-021-00603-3
14. WHO. Global database on Body Mass Index: BMI Classification. Geneva: World Health Organization. (2006) WHO/Europe | Nutrition - Body mass index - BMI. https://www.euro.who.int/en/health-topics/disease-prevention/nutrition/a-healthy-lifestyle/body-mass-index-bmi. Accessed 25 Feb 2022
15. Soysal P, Smith L, Dokuzlar O et al (2019) Relationship between nutritional status and insomnia severity in older adults. J Am Med Dir Assoc 20:1593–1598. https://doi.org/10.1016/J.JAMDA.2019.03.030
16. DeJesus RS, Croghan IT, Jacobson DJ et al (2022) Incidence of obesity at 1 and 3 years among community dwelling adults: a population-based study. J Prim Care Community Health 13:21501319211068630. https://doi.org/10.1177/21501319211068632
17. Liu H, Jiao J, Zhu M et al (2022) Nutritional status according to the short-form mini nutritional assessment (MNA-SF) and clinical characteristics as predictors of length of stay, mortality, and readmissions among older inpatients in china: a national study. Front Nutr. https://doi.org/10.3389/FNUT.2022.815578
18. Chien SC, Chandramouli C, Lo CI et al (2021) Associations of obesity and malnutrition with cardiac remodeling and cardiovascular outcomes in Asian adults: A cohort study. PLoS Med 18:e1003661. https://doi.org/10.1371/JOURNAL.PMED.1003661
19. Soysal P, Dokuzlar O, Erken N et al (2020) The relationship between dementia subtypes and nutritional parameters in older adults. J Am Med Dir Assoc 21:1430–1435. https://doi.org/10.1016/J.JAMDA.2020.06.051
20. Soysal P, Isik AT (2016) Effects of acetylcholinesterase inhibitors on nutritional status in elderly patients with dementia: a 6-month follow-up study. J Nutr Health Aging 20:398–403. https://doi.org/10.1007/S12603-015-0603-Z
21. Jiang Z, Ou R, Chen Y et al (2021) Prevalence and associated factors of malnutrition in patients with Parkinson's disease using CONUT and GNRI. Parkinsonism Relat Disord. https://doi.org/10.1016/J.PARKRELDIS.2021.11.032
22. Soysal P, Isik AT, Stubbs B et al (2016) Acetylcholinesterase inhibitors are associated with weight loss in older people with dementia: a systematic review and meta-analysis. J Neurol Neurosurg Psychiatry 87:1368–1374. https://doi.org/10.1136/JNNP-2016-313660
23. Naharci MI, Katipoglu B, Tasci I (2022) Association of anticholinergic burden with undernutrition in older adults: a cross-sectional study. Nutr Clin Pract Off Publ Am Soc Parenteral Enteral Nutr. https://doi.org/10.1002/NCP.10821
24. Soysal P, Isik AT, Arik F et al (2019) Validity of the mini-nutritional assessment scale for evaluating frailty status in older adults. J Am Med Dir Assoc 20:183–187. https://doi.org/10.1016/J.JAMDA.2018.07.016
25. Rempe HM, Calvani R, Marzetti E et al (2020) Are health behaviors and self-rated health related to cardiovascular health and functional performance? results from the lookup 7+ cross-sectional survey among persons aged 65+. J Nutr Health Aging 24:379–387. https://doi.org/10.1007/S12603-020-1342-3

26. Kocyigit SE, Soysal P, Ates Bulut E et al (2018) Malnutrition and malnutrition risk can be associated with systolic orthostatic hypotension in older adults. J Nutr Health Aging 22:928–933. https://doi.org/10.1007/S12603-018-1032-6
27. Islam MZ, Disu TR, Farjana S et al (2021) Malnutrition and other risk factors of geriatric depression: a community-based comparative cross-sectional study in older adults in rural Bangladesh. BMC Geriatr 21:1–11. https://doi.org/10.1186/S12877-021-02535-W
28. Eroles-Busquets M, García-Cerdán MR, Mejías-Serrano MT et al (2021) Study of the prevalence of the risk of malnutrition in the non-institutionalized population over 65 years old attended in a health center in Barcelona. Enfermeria Clin (Engl Ed) 31:71–81. https://doi.org/10.1016/J.ENFCLI.2020.10.028