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Sarcopenia is linked to malnutrition among Palestinian patients aged >50 years admitted for elective surgeries, along with associated factors

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Abstract

Objective: This study aimed to evaluate the prevalence of sarcopenia and malnutrition among patients undergoing elective operations and the associated factors.

Methods: A cross-sectional study design was used to analyze data collected from 111 participants (60 males and 51 females) aged ≥50 years. The European Working Group on Sarcopenia in Older People criteria were used to define sarcopenia; anthropometric measurements, body composition data, and Mini Nutritional Assessment-Short Form questionnaire responses were used to assess the nutritional status of the participants.

Results: The prevalence rates of malnutrition and sarcopenia were 34% and 39%, respectively, in the study population. In addition, we found that malnourished patients were more likely to be female, unemployed, diabetic, and dyslipidemic. The study also showed that patients with sarcopenia were more likely to be older and have diabetes.

Conclusions: Malnutrition, diagnosed using the Mini Nutritional Assessment-Short Form questionnaire, is associated with sarcopenia, female sex, working condition, diabetes, and dyslipidemia. A significant association was reported between sarcopenia, age, and diabetes.

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Introduction

Sarcopenia has been recognized as a progressive and generalized skeletal muscle disease that includes the accelerated loss of muscle mass and function.[1] This condition is associated with an increased risk of adverse outcomes involving frailty, functional decline, falls, and mortality.[2] The European Working Group on Sarcopenia in Older People (EWGSOP) has stated that sarcopenia can be diagnosed if the patient has low lean muscle mass along with either low physical performance or reduced muscle strength.[3] The global estimates of sarcopenia prevalence in older patients vary from 3% to 30% according to the operational definition implemented and the study settings.[4]

Malnutrition is recognized as a condition characterized by deficiency in energy and nutrient supply with negative effects and measurable consequences.[5] Nutritional status plays an important role in health and recovery from illness or injury. Several studies have shown significant correlations between the severity of nutritional deficiencies and a higher risk of related morbid events among the hospitalized older patients and revealed an approximately 30%–50% incidence of malnutrition among hospitalized population.[6]

Malnutrition and sarcopenia are present in parallel and often manifest clinically as a combination of disease burden, inflammation, decreased nutrient intake, decreased body weight, altered immune and endocrine functions, and reduced response to oxidative stress as well as decreased muscle mass, strength, and/or physical function.[7] Disease-related malnutrition and sarcopenia are associated with increases in all-cause mortality, morbidity, length of hospital stay, and functional impairments that lead to a loss of independence and higher healthcare costs. Different mortality rates are reported in malnourished patients and well-nourished patients after hospitalization, and higher mortality is the most common complication in sarcopenia patients.[8] Older age is associated with the risk of comorbidities and physically debilitating conditions that are suggestive of negative clinical outcomes. These conditions such as sarcopenia and malnutrition are partially reversible.[9]

Several studies have assessed the effect of malnutrition sarcopenia on the clinical outcome of restricted types of surgeries.[5,10,11] Other studies have investigated the effect of either sarcopenia, malnutrition, or both on the clinical outcomes of certain medical conditions.[12] A review by Meyer and Valentini[8] showed that several studies have emphasized on the increased length of hospitalization in patients with disease-related malnutrition and sarcopenia. Moreover, the review explained that the higher hospitalization duration was related to increased complications and demographic conditions that lead to high hospital and healthcare costs. Moreover, it demonstrated a higher readmission rate among patients with sarcopenia. Furthermore, it linked the increase in postoperative complications, duration of hospitalization, and health costs with advanced stages of sarcopenia.

A study by Sehouli et al.[5] evaluated the effects of sarcopenia and malnutrition on severe postoperative complications and

overall survival in patients with gynecologic cancer. They revealed that the prevalence of sarcopenia was 32%; 18% of the patients developed severe postoperative complications, and 4% died. A meta-analysis by Simonsen et al.[13] showed that the preoperative incidence of sarcopenia was associated with a significantly higher risk of major complications and total complications, with risk ratios of 1.4 and 1.35, respectively. In a recent study, Ikeda et al.[14] revealed that sarcopenia and malnutrition were independent prognostic factors, with significant hazard ratios of 1.79 and 1.78, respectively. Patients with sarcopenia and malnutrition were categorized as the high-risk group and those without these conditions were categorized into the low-risk group. The survival rate was significantly lower in the high-risk group.

In Palestine, a study by Badrasawi et al. (2020)[15] showed that the sarcopenia prevalence was approximately 27% in patients aged $\geq$60 years. To the best of our knowledge, no studies have explored the effect of malnutrition and sarcopenia on the clinical outcome of the operations. Therefore, this study was conducted to assess the prevalence of sarcopenia and malnutrition among patients aged >50 years who underwent elective surgery and the possible associated factors.

Patients and methods

Study design

This cross-sectional study was conducted at two governmental and three private hospitals in the south of the west bank. The study recruited patients aged $\geq$50 years who were admitted for elective surgery from December 2022 to April 2022. A list of daily elective surgeries was obtained from the Ministry of Health. Upon admission, one day before the operation, data related to the patients' demographic characteristics, medical and surgical histories, and sarcopenia and malnutrition status were collected. Ethical approval was taken from the deanship of scientific research of Palestine Polytechnic University (Ref. no: KA/41/2022); permissions were obtained from the Palestinian Ministry of Health and private hospitals. Furthermore, the study was conducted following the Equator guidelines - STROBE criteria.[16]

Study population

The study population comprised patients aged >50 years who were admitted for general elective surgeries in Hebron hospitals. A convenient sampling method was used to recruit participants who were assessed upon admission before undergoing an operation. Patients who were admitted for daycare surgery, those with lower limb edema, those who were undergoing chemotherapy, and those diagnosed with neurodegenerative diseases were excluded from the study. The sample size was calculated using Open EPI software, considering an alpha level of 0.05, power of 80%, and sarcopenia prevalence of 20%, as evidenced from a previous study.[17] The expected difference was 5%, and the minimum required sample size was 106. Considering the possibility of dropouts, the required sample size was increased to 120.

Data collection

Patients who agreed to join the study were asked to fill out a structured questionnaire by interview. The questionnaire contains five sections. The first section was about sociodemographic characteristics, and the second section was about medical history. The third section was about the nutritional status assessment of the participants. The fourth section was about sarcopenia assessment using sarcopenia assessment

tools. Later on, the clinical outcomes of each patient's operation were documented.

Assessment tools

Sarcopenia assessment tools

An analysis of strength, performance, and muscle mass was performed as per the European consensus definition of the EWGSOP. Grip strength in both hands (name of device) was examined, the timed "Up and Go" test was performed, and skeletal muscle index was calculated; the values of the stronger hand were used. To obtain the skeletal muscle index, the amount of skeletal muscle mass (SMM) was calculated using the formula by Janssen et al., which included a parameter from bioelectrical impedance analysis. Ultimately, skeletal muscle index was calculated as SMM/body mass × 100, where the patients' muscle mass was converted to percentage muscle mass and adjusted for nonskeletal muscle tissues, as originally introduced by Janssen et al.[5,18]

Nutritional status assessment

Nutritional status assessment was performed using anthropometric measurement, body composition, and malnutrition status using the Mini Nutritional Assessment-Short Form (MNA-SF) questionnaire (Arabic version).

Anthropometric measurements

The anthropometric parameters of weight and height were measured; all equipment was adjusted before the measurements were taken to ensure accuracy. Body mass index was calculated as (body in kilogram divided by height squared in meters (kg/m^2)).

Body composition

Body composition was measured using full body sensor OMRON HBF-514C. The fat mass, fat percentage, fat-free mass, soft lean mass, SMM, and basal metabolic rate were extracted from the output provided by the sensor.

Malnutrition measurement

MNA-SF (Arabic version)[19–22] was used for malnutrition screening. The following cutoff points were used to identify the malnutrition risk: (a) normal: 12–14; (b) at risk of malnutrition: 8–11; and (c) malnourished: 0–7.[23–26]

Ethical considerations

The study was approved and monitored by the research ethics committee of the Palestine Polytechnic University (Reference number: KA/41/2022). Each participant was informed of the study purpose, assessment procedures, and potential risks after which they provided signed written consent for study participation. Moreover, the data sheet guaranteed de-identification of patient details to ensure privacy and confidentiality. Permission and approval to conduct the study were obtained from the Palestinian Ministry of Health. The study was conducted as per the guidelines in the Declaration of Helsinki.[27]

Statistical analysis

The Statistical Package for the Social Sciences TM, version 21 was used to analyze the collected data; 5% alpha level and 80% power were considered for all statistical tests. Independent samples t-test and analysis of variance test were used to determine the significance of differences where data were normally distributed. Mann–Whitney U and Kruskal–Wallis tests were used to determine the significance of

differences for data that were not normally distributed. The association of sarcopenia or malnutrition with categorical variables was carried out using the chi-square test.

Results

The sociodemographic characteristics of the patients showed that 54.1% of the patients were males. The median participant age was 60 years (52–67 years). In total, 89.2% of the patients were married, and 38.7% of the patients had received high school education. The mean number of years spent in receiving education was 6.33 ± 4.39 years. In total, 43.2% of the patients were unemployed, 91.9% lived with their families, 48.6% lived in cities, and 40.5% had a monthly income of 1500–3000 Israeli Shekel (ILS). The participants' characteristics are presented in Supplementary File 1. (Supplementary File 1: Table 1: Sociodemographic characteristics, Table 2: Medical history, Table 3: Clinical features of the current surgery).

Figure 1 demonstrates the prevalence of sarcopenia and malnutrition using MNA-SF and their association among the study patients. In total, 37.8% of the patients were categorized into the group at risk of malnutrition. Furthermore, 38.7% of the patients had sarcopenia. Sarcopenia was significantly associated with malnutrition and malnutrition risk according to MNA-SF in our study sample.

With respect to the association between malnutrition according to MNA-SF and sociodemographic variables, female sex

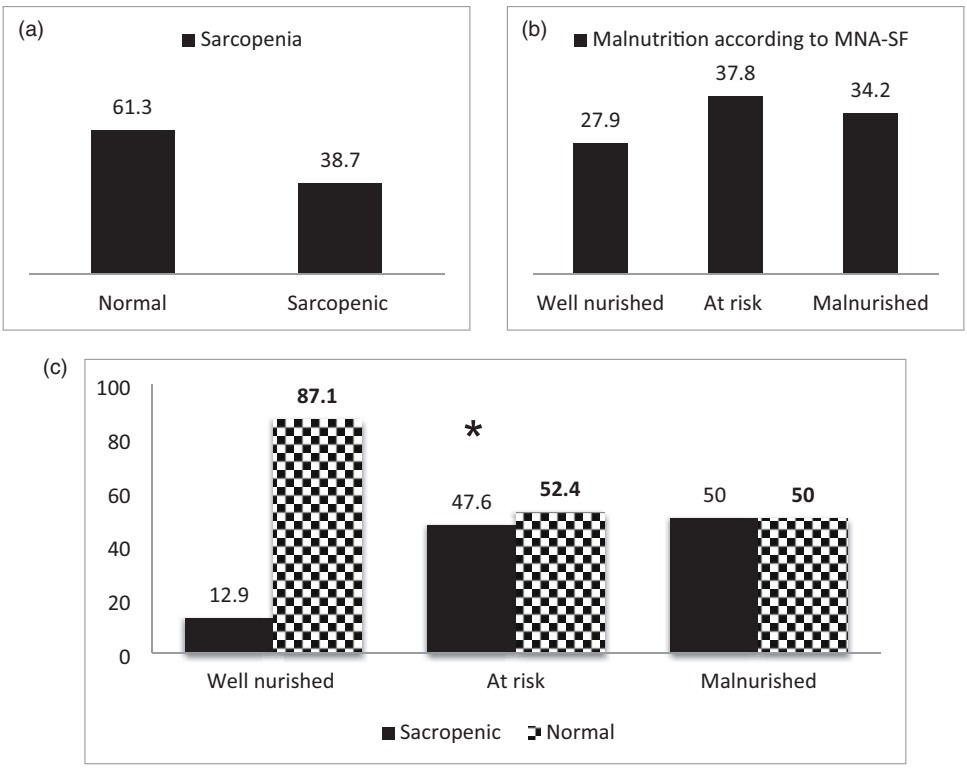

Figure 1. Prevalence of sarcopenia and malnutrition among study patients according to MNA-SF. *significant, $p < 0.05$ using chi-square test. MNA-SF: Mini Nutritional Assessment-Short Form questionnaire

was significantly associated with malnutrition according to MNA-SF ($p < 0.05$). Being unemployed was also associated with malnutrition according to MNA-SF ($p < 0.004$) (Supplementary File 1: Table 4). In terms of medical history, malnutrition was associated with diabetes, ($p < 0.05$) and dyslipidemia ($p < 0.05$), as revealed by the chi-square test. The results are presented in (Supplementary File 1: Table 5). The association between sarcopenia and sociodemographic factors revealed significant association with older age only, $p < 0.05$. (Supplementary File 1: Table 6). In terms of medical history sarcopenia was associated with diabetes mellitus. (Supplementary File 1: Table 7).

Table 1 shows the association between malnutrition risk and surgery-related data among the study participants.

The results revealed that age is significantly associated with sarcopenia ($p < 0.05$), and among comorbidities, only diabetes showed a significant association with sarcopenia ($p < 0.05$).

Table 2 demonstrates the association between sarcopenic status and the clinical outcomes of operations. The detailed results are presented in Supplementary File 1.

Discussion

Several studies have explored the association between diabetes, sarcopenia, and malnutrition according to MNA-SF. Muscle loss in sarcopenia differs between healthy individuals and people with diabetes. Muscle catabolism is enhanced in individuals with diabetes as a result of insulin resistance and attenuated insulin signaling. The association of sarcopenia, diabetes, and malnutrition is a result of metabolic, hormonal, and inflammatory mechanisms that consequently lead to muscle degradation. Malnutrition leads to decreased protein synthesis, increased inflammatory cytokines

Table 1. Association between surgery-related data and malnutrition according to MNA-SF.

	Normal nutrition n = 31	At risk of developing malnutrition n = 42	Malnutrition n = 38	p-value
Variable				
Type of surgery				0.239
Major	20 (64.5)	21 (50)	17 (44.7)	
Minor	11 (35.5)	21 (50)	21 (55.3)	
Admission to the ICU				0.837
Yes	5 (16.1)	5 (11.9)	6 (15.8)	
No	26 (83.9)	37 (88.1)	32 (84.2)	
Duration of ICU admission	2.2 ± 16	4.8 ± 2.7	8.4 ± 6.1	0.083
Postoperative complications				0.261
Yes	8 (25.8)	14 (33.3)	17 (44.7)	
No	23 (74.2)	28 (66.7)	21 (55.3)	
Wound infection				0.55
Yes	10 (32.3)	15 (35.7)	17 (44.7)	
No	21 (67.7)	17 (64.3)	21 (55.3)	
Wound bleeding				0.285
Yes	5 (16.1)	10 (23.8)	4 (10.5)	
No	26 (83.9)	32 (76.2)	34 (89.5)	
Duration of hospitalization	4 (2–7)	4.5 (2.8–9.3)	5 (2–15)	0.542

ICU: intensive care unit.

Table 2. Association between surgery-related data and sarcopenia.

	Sarcopenia n = 43	Nonsarcopenia n = 68	p-value
Variable			
Type of surgery			0.567
Major	21 (48.8)	37 (54.4)	
Minor	22 (51.2)	31 (45.6)	
Admission to the ICU			0.656
Yes	7 (16.3)	9 (86.8)	
No	36 (83.7)	59 (13.2)	
Duration of ICU admission	5.86 ± 4.9	4.5 ± 4.37	0.581
Postoperative complications			0.965
Yes	24 (35.3)	15 (34.9)	
No	44 (64.7)	28 (65.1)	
Wound infection			0.769
Yes	17 (39.5)	25 (36.8)	
No	26 (60.5)	43 (63.2)	
Wound bleeding			0.741
Yes	8 (18.6)	11 (16.2)	
No	35 (81.4)	57 (83.8)	
Duration of hospitalization	5 (5–9)	4.5 (3–10)	0.775

ICU: intensive care unit.

levels (interleukin-6, tumor necrosis factor), and mitochondrial dysfunction, ending with muscular atrophy.[1] Diabetes, especially type 2 diabetes, that occurs as a result of insulin resistance, leads to muscle glucose absorption, resulting in catabolism and muscle degradation.[28] The hyperglycemic state results in oxidative stress and glycation end products, which worsen muscle function.[29]

Diabetes, especially type 2 diabetes is related to a 1.55-fold higher risk of sarcopenia in older adults than in the general population. Therefore, sarcopenia in people with diabetes needs more attention than in those without diabetes.[30] Sarcopenia could be the link between malnutrition and diabetes; a study showed that women with a poor nutritional status were more likely to have sarcopenia with an odds ratio of OR 4.97, while those with type 2 diabetes showed a higher probability of sarcopenia with an odds ratio of 5.52 than nondiabetic women.[31]

The prevalence of malnutrition according to MNA-SF in this study is considered significantly higher than that in the previous study, which was performed among 302 patients using the same screening tool, MNA-SF, showing prevalence rates of 18% in participants at risk of developing malnutrition and 8% in those who were malnourished.[32] However, the prevalence was lower than that in other studies. For instance, Dubhashi and Kayal in their study on 47 patients demonstrated that 10.6% of the cases were at no risk of malnutrition and 89.4% were at risk of malnutrition and malnourished. Kagansky et al. in their study on 414 patients, found that 17.6% of the participants were well-nourished, 33.2% were at risk of malnutrition, and 49.4% were malnourished.[33] According to Soini et al., based on their study of 178 patients, 49% was well-nourished, 48% were at risk of malnutrition, and 3% were malnourished.[34]

Pepersack et al. highlighted the high prevalence of poor nutritional status among geriatric hospitalized patients because they found 82% were at risk and 31% were severely malnourished.[35] Lopez et al. in their study on 89 patients,[36] demonstrated that 7.9% were malnourished, 61.8% were at risk of malnutrition, and 30.3% were well-nourished. Cansado et al. in a study on 531 using MNA, reported that 26.6% of patients were malnourished.[37] This high prevalence could be attributed to the fact that poor nutritional status is linked with numerous factors in older individuals, such as decreased cognitive and functional status, medications, presence of chronic diseases, isolation, poverty, and poor dentition.[38] This should raise concern as the medical staff are usually insufficiently aware of the significance of nutritional assessment in older patients.[33]

According to the present study, malnourished patients are likely to be elder females. This is in accordance with other studies including the Kostecka and Bojanowskain[39] study, and the Ghosh et al. study[40] and other studies.[41,42]

In addition, this study demonstrates a significant association between unemployment and malnutrition as well as between working conditions and malnutrition. This is in accordance with the study by Keshavarzi et al., who revealed that malnourished or at-risk patients were more likely to be unemployed. Furthermore, an Egyptian study confirmed that unemployment is an absolute risk factor for malnutrition among older patients.[43] Unemployment had a significant impact on the malnutrition status in the older population. Those who were unemployed were 3.23 times more likely to be malnourished. This can be attributed to the fact that the employed older individuals possibly could have good financial status, which leads to good access to nutritional foods. Moreover, they are known to depend economically less on the caregivers for the fulfillment of dietary and other basic needs required for good health.[44] Furthermore, studies showed that unemployed older adults were more malnourished than employed ones; thus, being employed and having social support provide economic stability and mental contentment in the older population.[44]

Furthermore, this study showed a significant association between the nutritional status and the presence of diabetes, as the majority of malnourished patients were more likely to be diabetics. Although our study confirmed the association, other studies using MNA-SF could not confirm it[45] because they used different screening tools.[46] However, the present study findings are consistent with those of a study done by Bourdel-Marchasson and Alan Sinclair. Older patients with diabetes, specifically type 2 diabetes, were at high risk of developing both undernutrition and malnutrition. One of the reasons that could explain this is what concluded in the Finestone et al. study as they explored the reasons for this higher risk. Dysphagia was more common in patients with type 2 diabetes, and dysphagia increases the risk of malnutrition.[47] The association between diabetes and poor nutrition can be explained by the fact that diabetes is a chronic and catabolic disease; furthermore, most patients had poorly controlled diabetes, diabetic complications, medications side effects, decrease in functional and cognitive status, loss of taste and smell, poor dentition, isolation, poverty, endocrine and gastrointestinal disorders, loss of appetite due to both disease state and psychosocial factors, sarcopenia, and accelerated muscle mass and strength loss.[48]

In total, 39% of the study participants had sarcopenia. This parallels the prevalence in a meta-analysis and systematic review, which was 37%.[49] The sarcopenia prevalence of hospitalized older adults was substantially higher than that of

community-dwelling according to Cruz-Jentoft et al.[50] It is likely that the sarcopenia prevalence in inpatients depends considerably on the applied definition and that the prevalence is even higher when measured at hospital discharge because of a rapid decline in strength and mass during hospitalization.[49] The finding also is in agreement with the prevalence of 36.4% reported by Wang et al.[51]

Sarcopenia is an age-related syndrome[52] characterized by progressive and generalized loss of SMM and strength; recent findings indicate that sarcopenic patients are more likely to be older. The risk factors for sarcopenia include low body mass index, decreased activity and protein intake, and the presence of chronic diseases.[53] It is also considered a combination of changes in insulin resistance, chronic disease, inflammation, endocrine function, muscle disuse, and nutritional deficiencies. Reduction in growth hormone, insulin-like growth factor-1 (IGF-1), and testosterone levels may lead to the loss of lean body mass and increase in body fat. Additionally, insulin resistance, higher cortisol levels, high levels of inflammatory markers, low vitamin D levels, and immune system changes could contribute to sarcopenia and cause alterations in protein metabolism. All these factors can combine with age to cause sarcopenia; however, sarcopenia tends to be more prevalent in individuals with comorbidities.[53]

Sarcopenia has been linked to chronic diseases; therefore, it is not surprising that the present study found an association between diabetes and sarcopenia. This result is in agreement with that reported by Yuenyongchaiwat et al., who confirmed the association between diabetes and sarcopenia, as diabetic patients were two-fold likely to have sarcopenia.[54] This could be attributed to the presence of type 2 diabetes, an increasingly prevalent metabolic disease worldwide, which has been documented to result in a more rapid decline in muscle mass along with strength and functional capacity, contributing to the mechanism of sarcopenia. Diabetes, especially type 2, is believed to be an important predictive factor of sarcopenia, and the presence of sarcopenia with diabetes could lead to an increased risk of mental health issues, frailty, physical disability, and dependency. Moreover, individuals with type 2 diabetes mellitus are more vulnerable to greater loss in muscle mass, strength, and functional capacity with aging than nondiabetic individuals.[55] A meta-analysis illustrated that sarcopenia and diabetes seem to be reciprocally related and could share similar pathogenetic pathways. Diabetes may lead to sarcopenia, and sarcopenia may lead to lower muscle glucose uptake, hyperglycemia/hyperinsulinemia, and insulin resistance, all known precursors of diabetes. Poor physical performance can be associated with an increased risk of diabetes. Moreover, muscle fat infiltration might also cause insulin resistance promoting both the development of sarcopenia and diabetes.

Limitations

This study is one of the few studies that describe malnutrition screening and sarcopenia among surgery patients in Palestine. However, this study had certain limitations. First, the study's small sample size ($n = 111$) limited the generalizability of the findings in a larger population. A greater sample size would increase the study's statistical power and the reliability of the associations discovered. Second, participants were selected from individuals attending elective procedures, which may not represent the broader surgical patient population. Finally, unreported lifestyle factors, which are key contributors to sarcopenia and malnutrition, such as dietary habits, diet intake, physical activity, and exercise, were not investigated in this study and must be explored in future studies.

Conclusions

The findings of this observational study indicate a notable prevalence of sarcopenia and malnutrition according to MNA-SF among patients aged $\geq$50 years as well as a possible link between these disorders. The study also suggests that sarcopenia is associated with factors such as sex, working conditions, a history of surgical procedures, advanced age, and diabetes. More studies with larger, more varied cohorts are needed to confirm these findings and determine causal relationships.

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Authors' contributions

All authors contributed to the study's conception and design. Material preparation, data collection, and analysis were performed by Ali Shakhshir, May Hamdan, Islam Thaher, Nada Dweik, Ruba Abu Iram, Shurooq Osama, and Manal Badrasawi. The first draft of the manuscript was written by Ali Shakhshir, May Hamdan, Islam Thaher, Nada Dweik, Ruba Abu Iram, Shurooq Osama, and Manal Badrasawi. Additionally, all authors commented on previous versions of the manuscript. All authors have read and approved the final manuscript.

Data availability statement

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declaration of conflicting interests

The authors declare that they have no competing interests.

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References

1. Cruz-Jentoft AJ and Sayer AA. Sarcopenia. *Lancet* 2019; 393: 2636–2646.
2. Cruz-Jentoft AJ, Bahat G, Bauer J; Writing Group for the European Working Group on Sarcopenia in Older People 2 (EWGSOP2), and the Extended Group for EWGSOP2, et al. Sarcopenia: revised European consensus on definition and diagnosis. *Age Ageing* 2019; 48: 16–31.
3. Cruz-Jentoft AJ, Baeyens JP, Bauer JM, et al. Sarcopenia: European consensus on definition and diagnosis: report of the European working group on sarcopenia in older people. *Age Ageing* 2010; 39: 412–423.
4. Cerri AP, Bellelli G, Mazzone A, et al. Sarcopenia and malnutrition in acutely ill hospitalized elderly: prevalence and outcomes. *Clin Nutr* 2015; 34: 745–751.
5. Sehouli J, Mueller K, Richter R, et al. Effects of sarcopenia and malnutrition on morbidity and mortality in gynecologic cancer surgery: results of a prospective study. *J Cachexia Sarcopenia Muscle* 2021; 12: 393–402.
6. Mahakalkar C, Modi S, Yeola M, et al. Malnutrition in hospitalised patients; a real concern in surgical outcomes. *Int J Res Med Sci* 2014; 2: 250–257.
7. Wijarnpreecha K, Panjawatanan P, Thongprayoon C, et al. Sarcopenia and risk of nonalcoholic fatty liver disease: a meta-analysis. *Saudi J Gastroenterol Off Gastroenterol* 2018; 24: 12–17.
8. Meyer F and Valentini L. Disease-related malnutrition and sarcopenia as determinants of clinical outcome. *Visc Med* 2019; 35: 282–291.
9. Amrock LG and Deiner S. The implication of frailty on preoperative risk assessment. *Curr Opin Anaesthesiol* 2014; 27: 330–335.
10. Friedman J, Lussiez A, Sullivan J, et al. Implications of sarcopenia in major surgery. *Nutr Clin Pract* 2015; 30: 175–179.

11. Sugawara K, Yamashita H, Urabe M, et al. Poor nutritional status and sarcopenia influences survival outcomes in gastric carcinoma patients undergoing radical surgery. *Eur J Surg Oncol* 2020; 46: 1963–1970.
12. Ballesteros-Pomar MD, Gajete-Martín LM, Pintor-de-la-Maza B, et al. Disease-related malnutrition and sarcopenia predict worse outcome in medical inpatients: a cohort study. *Nutrients* 2021; 13: 2937.
13. Simonsen C, De Heer P, Bjerre ED, et al. Sarcopenia and postoperative complication risk in gastrointestinal surgical oncology: a meta-analysis. *Ann Surg* 2018; 268: 58–69.
14. Ikeda S, Kodama A, Kawai Y, et al. Preoperative sarcopenia and malnutrition are correlated with poor long-term survival after endovascular abdominal aortic aneurysm repair. *Surg Today* 2022; 52: 98–105.
15. Badrasawi M, Jarradat A, Khodour Z, et al. Sarcopenia prevalence and its correlations with age-related disorders among community-dwelling Palestinian older adults. *JGG* 2020; 68: 126–135.
16. Von Elm E, Altman DG, Egger M; STROBE Initiative, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet* 2007; 370: 1453–1457.
17. Petermann-Rocha F, Balntzi V, Gray SR, et al. Global prevalence of sarcopenia and severe sarcopenia: a systematic review and meta-analysis. *J Cachexia Sarcopenia Muscle* 2022; 13: 86–99.
18. Janssen I, Heymsfield SB and Ross R. Low relative skeletal muscle mass (sarcopenia) in older persons is associated with functional impairment and physical disability. *J Am Geriatr Soc* 2002; 50: 889–896.
19. Abd-Al-Atty MF, Abou-Hashem RM and Abd Elaziz KM. Prevalence of malnutrition in recently hospitalized elderly in Cairo using a valid and reliable short form of Arabic version of Mini-Nutritional Assessment (MNA-SF-A). *Middle East J Age Ageing* 2012; 9: 8–12.
20. Bano R and Alshammari WME. Mini nutritional assessment for hospitalized patients in King Khalid hospital at Hail city in Saudi Arabia. *Elder Heal J* 2016; 2: 50–55.
21. Hallaj FA. Assessment of the nutritional status of residents in homes for the elderly in Lattakia, Syrian Arab Republic. *East Mediterr Health J* 2015; 21: 753–761.
22. El Osta N, El Arab H, Saad R, et al. Assessment of nutritional status of older patients attending a tertiary hospital in Middle Eastern country. *Clin Nutr ESPEN* 2019; 33: 105–110.
23. Rubenstein LZ, Harker JO, Salvà A, et al. Screening for undernutrition in geriatric practice: developing the short-form mini-nutritional assessment (MNA-SF). *J Gerontol A Biol Sci Med Sci* 2001; 56: M366–M372.
24. Vellas B, Villars H, Abellan G, et al. Overview of the MNA–its history and challenges. *J Nutr Heal Aging* 2006; 10: 456.
25. Kaiser MJ, Bauer JM, Ramsch C; MNA-International Group, et al. Validation of the Mini Nutritional Assessment Short-Form (MNA-SF): a practical tool for identification of nutritional status. *J Nutr Health Aging* 2009; 13: 782–788.
26. Guigoz Y. The mini nutritional assessment (MNA) review of the literature-what does it tell us? *J Nutr Heal Aging* 2006; 10: 466.
27. Association WM. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. *JAMA* 2013; 310: 2191–2194.
28. Park SW, Goodpaster BH, Strotmeyer ES; Health, Aging, and Body Composition Study, et al. Accelerated loss of skeletal muscle strength in older adults with type 2 diabetes: the health, aging, and body composition study. *Diabetes Care* 2007; 30: 1507–1512.
29. Semba RD, Ferrucci L, Sun K, et al. Advanced glycation end products and their circulating receptors predict cardiovascular disease mortality in older community-dwelling women. *Aging Clin Exp Res* 2009; 21: 182–190.
30. Takahashi F, Hashimoto Y, Kaji A, et al. Association between geriatric nutrition risk index and the presence of sarcopenia in people with type 2 diabetes mellitus: a cross-sectional study. *Nutrients* 2021; 13: 3729.

31. Velázquez-Alva MC, Irigoyen-Camacho ME, Zepeda-Zepeda MA, et al. Sarcopenia, nutritional status and type 2 diabetes mellitus: a cross-sectional study in a group of Mexican women residing in a nursing home. *Nutr Diet* 2020; 77: 515–522.
32. Kokkinakis S, Venianaki M, Petra G, et al. A comparison of the malnutrition universal screening tool (MUST) and the mini nutritional assessment-short form (MNA-SF) tool for older patients undergoing general surgery. *J Clin Med* 2021; 10: 5860.
33. Kagansky N, Berner Y, Koren-Morag N, et al. Poor nutritional habits are predictors of poor outcome in very old hospitalized patients. *Am J Clin Nutr* 2005; 82: 784–791.
34. Soini H, Routasalo P and Lagström H. Characteristics of the Mini-Nutritional Assessment in elderly home-care patients. *Eur J Clin Nutr* 2004; 58: 64–70.
35. Pepersack T, Corretge M, Beyer I, et al. Examining the effect of intervention to nutritional problems of hospitalised elderly: a pilot project. *J Nutr Heal AGING* 2002; 6: 306–310.
36. Ruiz-López MD, Artacho R, Oliva P, et al. Nutritional risk in institutionalized older women determined by the mini nutritional assessment test: what are the main factors? *Nutrition* 2003; 19: 767–771.
37. Cansado P, Ravasco P and Camilo M. A longitudinal study of hospital undernutrition in the elderly: comparison of four validated methods. *J Nutr Health Aging* 2009; 13: 159–164.
38. Dubhashi SP and Kayal A. Preoperative nutritional assessment in elderly cancer patients undergoing elective surgery: MNA or PG-SGA? *Indian J Surg* 2015; 77: 232–235.
39. Kostecka M and Bojanowska M. An evaluation of the nutritional status of elderly with the use of the MNA questionnaire and determination of factors contributing to malnutrition. a pilot study. *Rocz Panstw Zakl Hig* 2021; 72: 175–183.
40. Ghosh A, Dasgupta A, Paul B, et al. Screening for malnutrition among the elderly with MNA scale: a clinic based study in a rural area of West Bengal. *Artic Int J Contemp Med Res* 2017; 4: 2454–7379.
41. Agarwalla R, Saikia AM and Baruah R. Assessment of the nutritional status of the elderly and its correlates. *J Family Community Med* 2015; 22: 39–43.
42. Lahiri S, Biswas A, Santra S, et al. Assessment of nutritional status among elderly population in a rural area of West Bengal, India. *Int J Med Sci Public Health* 2015; 4: 569–572.
43. Abdelrahman H and Elawam A. Nutrition status in community dwelling older population in an Egyptian urban area. *J Aging Res & Lifestyle* 2014; 3: 1–7.
44. Tamang MK, Yadav UN, Hosseinzadeh H, et al. Nutritional assessment and factors associated with malnutrition among the elderly population of Nepal: a cross-sectional study. *BMC Res Notes* 2019; 12: 246.
45. Vischer UM, Frangos E, Graf C, et al. The prognostic significance of malnutrition as assessed by the Mini Nutritional Assessment (MNA) in older hospitalized patients with a heavy disease burden. *Clin Nutr* 2012; 31: 113–117.
46. Geurden B, Franck E, Weyler J, et al. The risk of malnutrition in community-living elderly on admission to hospital for major surgery. *Acta Chir Belg* 2015; 115: 341–347.
47. Bourdel-Marchasson I and Sinclair A. Elderly patients with type 2 diabetes mellitus-the need for high-quality, inpatient diabetes care. *Hosp Pract (1995)* 2013; 41: 51–56.
48. Ayub LH and Ismail KH. Malnutrition in elderly diabetic patients: a case-control study. *Iraqi J Comm Med* 2018; 2018: 128–132.
49. Ligthart-Melis GC, Luiking YC, Kakourou A, et al. Frailty, sarcopenia, and malnutrition frequently (co-)occur in hospitalized older adults: a systematic review and meta-analysis. *J Am Med Dir Assoc* 2020; 21: 1216–1228.
50. Cruz-Jentoft AJ, Landi F, Schneider SM, et al. Prevalence of and interventions for sarcopenia in ageing adults: a systematic review. Report of the International Sarcopenia Initiative (EWGSOP and IWGS). *Age Ageing* 2014; 43: 748–759.
51. Wang L, Li P, Hu Y, et al. Relationship between preoperative malnutrition, frailty, sarcopenia, body composition, and anthropometry in elderly patients undergoing

major pancreatic and biliary surgery. *Front Nutr* 2023; 10: 1135854.
52. Shi Y, Zhou L, Yan E, et al. Sarcopenia and perioperative management of elderly surgical patients. *Front Biosci (Landmark Ed)* 2021; 26: 882–894.
53. Woo EC and Rodis B. Sarcopenia in elderly surgery. *Ann Acad Med Singap* 2019; 48: 363–369.
54. Yuenyongchaiwat K, Kulchanarat C and Satdhabudha O. Sarcopenia in open heart surgery patients: A cohort study. *Heliyon* 2020; 6: e05759.
55. Wang T, Feng X, Zhou J, et al. Type 2 diabetes mellitus is associated with increased risks of sarcopenia and pre-sarcopenia in Chinese elderly. *Sci Rep* 2016; 6: 38937.