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Original research article

Nutrition, functional independence, and sarcopenia in elderly men and women

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Abstract

Introduction: Sarcopenia is a severe condition affecting muscle mass, strength, and/or muscle function. It is influenced by various risk factors, including malnutrition. The consequences of this condition are significant and can limit a patient's independence in daily activities.

Objective: The aim of this cross-sectional study was to investigate the relationship between malnutrition, sarcopenia, and functional independence.

Methods: Malnutrition was assessed using the Mini Nutritional Assessment (MNA) scale, functional independence was measured using the Barthel Index (BI) questionnaire, and sarcopenia was diagnosed using recommended methods, including the Short Physical Performance Battery (SPPB).

Results: The study included 68 patients with an average age of 76 years (min. 65, max. 93). The sample consisted of 24 men (35.3%), including 5 men diagnosed with sarcopenia, and 44 women (64.7%), including 16 women diagnosed with sarcopenia. Among patients with sarcopenia, a significant correlation was found between patients' age and individual MNA (r_{Sp} = –0.2236), SPPB (r_{Sp} = –0.2236) and BI (r_{Sp} = –0.6324) test scores. Furthermore, a statistically significant difference was observed in patients with sarcopenia between the SPPB and MNA tests (p = 0.00005) and the SPPB and BI tests (p = 0.00006).

Conclusion: Sarcopenia has a multifactorial origin, not solely related to patients' age. Our study showed a higher prevalence of sarcopenia in women and demonstrated a significant mutual influence between malnutrition, sarcopenia, and functional independence. Timely diagnosis and targeted intervention are crucial in managing this condition.

Keywords: Functional independence; Malnutrition; Sarcopenia; Seniors

Introduction

The term sarcopenia is derived from two Greek words: "sarx", meaning flesh, and "penia", defined as loss (Dhillon and Hasni, 2017). Coined by Irwin Rosenberg in 1989, sarcopenia was described as the loss of muscle mass associated with aging. However, the definition of sarcopenia has evolved and changed over time. Currently, sarcopenia is defined as an age-related condition characterized by low muscle mass, low muscle strength, and/or low muscle function (Zanker et al., 2019). In 2017, sarcopenia was included in the International Classification of Diseases ICD-10-CM under the code M62.84 (Topinková, 2019).

Several risk factors contribute to the development of sarcopenia, including lifestyle, immobility, chronic inflammation, malignancies, and advanced organ failure (heart, lungs, liver, and kidneys). Nutrition also plays a significant role in muscle health, with sarcopenia linked to insufficient energy and/or protein intake due to malabsorption or gastrointestinal disorders (Marzetti et al., 2017). All these factors have adverse effects, primarily leading to an increased risk of falls, fractures, and limited independence in daily activities (Sergi et al., 2016). Sarcopenia can also occur secondarily, especially after chronic illnesses (Smith et al., 2022).

Prevention and treatment of sarcopenia are rapidly advancing, and when designing preventive and therapeutic interventions, quantitative and qualitative losses of skeletal muscle should be considered (Cruz-Jentoft et al., 2010). A unified operational definition of sarcopenia has not yet been established, and consequently, specific guidelines for its treatment are currently unavailable (Reginster et al., 2016). However, evidence suggests that certain therapeutic approaches could help prevent the adverse consequences of sarcopenia or delay its onset (Cruz-Jentoft et al., 2019). These include physical activity counseling, primarily focusing on resistance progressive training, compensating for vitamin D, and ensuring adequate protein intake in the diet (Beaudart et al., 2016).

Materials and methods

This cross-sectional study aimed to investigate the mutual relationship between malnutrition, level of independence, and sarcopenia, which was assessed, among other methods, using

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the Short Physical Performance Battery (SPPB). The study also examined the correlation between patients' age, a characteristic determined through questionnaire surveys, and its impact on the parameters.

The nutritional status of patients was assessed using the Mini Nutritional Assessment (MNA), comprising 18 items divided into 4 domains. The first domain focused on anthropometric measurements (weight, height, arm, and calf circumference), the second domain assessed dietary aspects (number of full meals per day, types of food consumed, amount of fluids ingested, and assistance with food intake), the third domain evaluated the general condition of the patient (independence, number of prescribed medications, mobility, mental state, pressure sores or skin defects, and the presence of serious illnesses in the last 3 months), and the fourth domain dealt with subjective assessment (perception of health and nutritional status). Each item was assigned a corresponding score, with a maximum total of 30 points. Scores ranging from 30 to 24 indicated a normal nutritional status, 23.5 to 17 points suggested a risk of malnutrition, and 17 points and below indicated malnutrition (Guigoz et al., 1996). This nutritional assessment tool is freely available from the Nestlé Nutrition Institute website (2009).

Independence was assessed using the Barthel Index (BI), which addressed ten areas of patient independence in daily activities. The evaluated areas included feeding, bathing, grooming, dressing, bowel and bladder continence, toilet use, transfers from bed to chair, walking on a flat surface, and stair climbing. Each item was assigned a corresponding score, with a maximum total of 100 points. Scoring between 100 and 96 points denoted an independent patient, 95 to 65 points indicated mild dependency, scores between 60 and 45 points represented moderate dependency, and a range of 40 to 0 points signified high dependency (Mahoney and Barthel, 1965). For this study, the BI from the Institute of Health Information and Statistics of the Czech Republic website was utilized, which is freely accessible (Institute of Health Information..., 2018).

Physical fitness, agility, balance, and stability were evaluated using the Short Physical Performance Battery (SPPB). This test comprised three functional areas – balance, gait speed over a 4-meter distance, and repeated chair stands. The maximum SPPB score was 12 points. Scores from 12 to 10 points indicated good physical fitness. Scores from 9 to 7 points indicated reduced physical fitness and required clinical assessment and intervention (pre-frailty). If a patient scored 6 points or fewer, they were classified as frail seniors with a high risk of future dependence (Guralnik et al., 1994). This tool could be used without permission or fees; however, consent was obtained for the test translated into the Czech language (Berková et al., 2013).

The research sample consisted of 68 patients hospitalized in long-term care facilities and subsequent care units in selected healthcare facilities. Inclusion criteria were: age over 65 years, patients fluent in Czech or Slovak, minimum hospitalization of 1 month in the selected facility, willingness to participate in the study, and a Mini Mental State Examination (MMSE) score of at least 21 points. The Czech version of the MMSE was adopted from the Geriatrics and Gerontology publication (Kalvach et al., 2004). The cutoff value of 21 points in the MMSE test was set to eliminate result distortion. It was crucial for all patients to comprehend the instructions provided in the individual tests and tools and subsequently execute these instructions.

Patients were included in the research sample from April 2021 to February 2023, and their data were subsequently coded using Microsoft Office Excel. The data were further statistically processed using StatSoft software, and the Wilcoxon test was employed. The dependence between individual indicators was assessed using the Spearman correlation coefficient. The significance level was set at 5%.

Results

Our sample included a total of 68 patients, comprising 44 women (64.7%) and 24 men (35.3%). The sample was further divided into patients without diagnosed sarcopenia (47 patients in total) and patients with sarcopenia (21 patients in total). Characteristics related to gender and age are presented in Table 1.

Table 1. Overview of the research sample

	Without sarcopenia (N = 47)			With sarcopenia (N = 21)		
Age	Men (%) n = 19	Women (%) n = 28	Total number of men; women in %	Men (%) n = 5	Women (%) n = 16	Total number of men; women in %
65–69	10 (52.7%)	8 (28.6%)	41.7%; 18.2%	1 (20%)	1 (6.3%)	4.2%; 2.3%
70–79	6 (31.5%)	12 (42.9%)	25%; 27.3%	1 (20%)	7 (43.8%)	4.2%; 16%
80 and more	3 (15.8%)	8 (28.6%)	12.5%; 18.2%	3 (60%)	8 (50%)	12.5%; 18.2%

Results of testing in patients without identified sarcopenia

In this sample, there were a total of 19 men and 28 women. The sample consisted of patients for whom sarcopenia was not identified according to the established parameters of the European Working Group on Sarcopenia in Older People (EWGSOP).

The individual results were further divided by gender, where the results of the MNA, BI, and SPPB tests were evaluated. In the MNA test, both women and men achieved an identical average score of 25 points (SD = 1.44; SD = 1.42), indicating a normal nutritional status. In the BI test, women achieved an average of 87 points (SD 11.52), and men achieved an average of 90 points (SD = 11.38), categorizing these patients as mildly dependent. The last assessed test was the SPPB. In this test, both men and women achieved an identical average score of 10 points (SD = 1.06; SD = 1.16), indicating good physical fitness.

Correlation analysis using the Spearman correlation coefficient examined the correlation between individual tests and the age of patients without identified sarcopenia. The analysis revealed a statistically significant correlation between patients' age and individual tests.

From this correlation analysis, a statistically significant correlation was found between the age of women and the results of the MNA test (r_{Sp} = –0.4493), the age of women and men and the SPPB test (r_{Sp} = –0.7281; r_{Sp} = –0.5817), and the age of women and men and the BI test (r_{Sp} = –0.3944; r = –0.7431).

The results indicate that the higher the age of patients, the lower their scores in the individual tests. Detailed descriptions of the correlation analysis for men and women are provided in Table 2.

Table 2. Patients without identified sarcopenia – correlation between age and individual tests

	Spearman's correlation coefficient	Age	MNA	SPPB	BI
Men	Age	1.000000			
	MNA	–0.273344	1.000000		
	SPPB	–0.581769	0.377323	1.000000	
	BI	–0.743108	0.355167	0.397816	1.000000
Women	Age	1.000000			
	MNA	–0.449314	1.000000		
	SPPB	–0.728190	0.552709	1.000000	
	BI	–0.394417	0.626869	0.700285	1.000000

Note: MNA – Mini Nutritional Assessment; SPPB – Short Physical Performance Battery, BI – Barthel Index.

Results of testing in patients with identified sarcopenia

In this sample, there were a total of 5 men and 16 women. In the MNA test, women scored an average of 17 points (SD = 2.26), indicating a risk of malnutrition. In contrast, men achieved an average score of 15 points (SD = 1.72), categorizing them as malnourished. In the BI test, women scored an average of 60 points (SD = 11.31), and men scored an average of 50 points (SD = 7.45), placing both genders in the moderately dependent category. The last assessed test was the SPPB, where both men and women scored 2 points (SD = 1.34), categorizing them as frail seniors with a high risk of future dependency.

Now, let's focus on the Spearman's correlation coefficient, which was calculated from individual results in patients with sarcopenia. A detailed breakdown for men and women is provided in Table 3. From this correlation analysis, it was found that there was a statistically significant correlation between the age of patients with sarcopenia and individual tests.

From this correlation analysis, it was found that there was no statistically significant correlation between the age of patients with sarcopenia and individual tests. However, the results for men indicate that the higher their age, the lower their scores were in the individual tests. Nevertheless, for women, the results suggest that a negative correlation was observed only in the MNA test, while the correlations for the SPPB and BI tests were positive. However, these positive correlation results are not statistically significant.

Patients with sarcopenia and the relationship between the SPPB Test and MNA Test

The Wilcoxon test was used to determine the relationship between the SPPB test and the MNA test. A detailed description of the individual test results is provided in Table 4. Patients diagnosed with sarcopenia obtained an average score of 17 points in the MNA test. No patient fell into the "normal nutritional status" category. Twelve patients (57.14%) were classified as "at risk of malnutrition", and nine patients (42.86%) were classified as "malnourished". Our research revealed that patients with lower SPPB scores also had poorer nutritional status, falling into the "at risk of malnutrition" or "malnourished" categories. A statistically significant difference was found between the SPPB and MNA tests (p = 0.00005). Patients with lower SPPB scores exhibited deteriorated nutritional status according to the MNA test.

Table 3. Patients with identified sarcopenia – correlation between age and individual tests

	Spearman's correlation coefficient	Age	MNA	SPPB	BI
Men	Age	1.000000			
	MNA	–0.223607	1.000000		
	SPPB	–0.223607	1.000000	1.000000	
	BI	–0.632456	0.707107	0.707107	1.000000
Women	Age	1.000000			
	MNA	–0.037863	1.000000		
	SPPB	0.154243	0.334911	1.000000	
	BI	0.317032	0.471100	0.007776	1.000000

Note: MNA – Mini Nutritional Assessment; SPPB – Short Physical Performance Battery, BI – Barthel Index.

Table 4. Relationship between SPPB and MNA tests

Nutritional status assessed by MNA	Physical fitness, agility, balance, and stability assessed by SPPB	*n* by SPPB	*n* by MNA	Arithmetic mean MNA; SPPB	Min. MNA; SPPB	Max. MNA; SPPB	*p*-value
Normal nutritional status	Good physical fitness	0	0	0; 0	0; 0	0; 0	$p = 0{,}00005$
Risk of malnutrition	Reduced physical fitness	0	11	18.81; 0	17; 0	21; 0	
Malnutrition	Frail senior	21	10	15.2; 2.5	13; 0	16.5; 5	

Note: SPPB – Short Physical Performance Battery; MNA – Mini Nutritional Assessment.

Patients with sarcopenia and the relationship between the SPPB Test and BI Test

The Wilcoxon test was used to determine the relationship between the SPPB test and the BI test. A detailed description of the individual test results is provided in Table 5. Patients diagnosed with sarcopenia had an average BI score of 55.95 points (SD = 11.02). Three patients (14.29%) were highly dependent, 14 patients (66.66%) were moderately dependent, and 4 patients (19.05%) were classified as mildly dependent. For further statistical analysis, the "moderate dependence" category was combined with the "high dependence" category. No patients were classified as independent. Our research revealed that patients with lower SPPB scores also had lower BI scores. A statistically significant difference was found between the SPPB and BI tests ($p = 0.00006$). Patients with lower SPPB scores also exhibited diminished self-sufficiency in the BI test.

Table 5. Relationship between SPPB and BI tests

Independence assessed by BI	Physical fitness, agility, balance, and stability assessed by SPPB	*n* by SPPB	*n* by BI	Arithmetic mean BI; SPPB	Min. BI; SPPB	Max. BI; SPPB	*p*-value
High dependence + Moderate dependence	Frail senior	21	18	52.1; 2.5	40; 0	60; 5	$p = 0.00006$
Mild independence	Reduced physical fitness	0	3	72.5; 0	65; 0	80; 0	
Independence	Good physical fitness	0	0	0; 0	0; 0	0; 0	
Malnutrition	Frail senior	21	10	15.2; 2.5	13; 0	16.5; 5	

Note: SPPB – Short Physical Performance Battery; BI: Barthel Index.

Discussion

Our cross-sectional study indicates that patients with sarcopenia are more vulnerable to malnutrition (as measured by MNA) and reduced independence (as measured by BI). The aim was to explore the relationship between malnutrition, sarcopenia, and independence. Additionally, we examined the correlation between patients' age and the various tests.

A total of 68 patients were included in our cross-sectional study, of which 21 exhibited signs of sarcopenia, placing them in the sarcopenia group. Focusing on the results comparing the SPPB and MNA tests, our study revealed that patients diagnosed with sarcopenia had poorer nutritional status. All 21 patients were categorized either as "at risk of malnutrition" (12 patients; 57.14%) or in the "malnourished" category (9 patients; 42.86%). In our study, the average MNA score was 15 points, and the average SPPB score was 2 points. Our findings align with a study conducted in France in 2021 (Damanti et al., 2021), where 499 patients had an average SPPB score of 3.05 points and an average MNA score of 10.35 points. The results of the SPPB test differed by only 1 point; however, in both, our study and the French study, patients were classified into the same category as "frail seniors with a high risk of dependence in future". The variance in point outcomes may be attributed to a difference in the number of patients. Additionally, the average result in the MNA test varied. The difference between our study and the French study was 5 points; nevertheless, patient categorization remained the same, falling under the "malnourished" category. While the study results align, certain limitations are present. One limitation is that the French study was conducted in nursing homes, unlike our study, which took place in a long-term care facility and in post-acute care units. Another limitation of this study is that the French study was conducted on a sample size of 499 patients, as opposed to our study, which involved a sample of 68 patients.

This discrepancy in scores could be attributed to differences in sample size. The average MNA scores differed by 5 points, yet patients were still categorized as "malnourished". However, both studies shared the category of "frail senior, high risk of future disability".

Comparing the SPPB and BI tests also provided compelling results. In our study, the average BI score was 55.95 points, indicating moderate to high dependence. The average SPPB score was 2 points. Our results demonstrated that patients with lower SPPB scores also had lower BI scores. These findings are consistent with a study conducted in Japan (Kamo et al., 2018) that included 276 patients living in care homes. Among these, 112 had sarcopenia, with an average BI score of 38 points (categorized as "highly dependent"), significantly lower than our study. The average SPPB score in the Japanese study was 1.4 points, categorizing patients as "frail senior, high risk of future disability". In this regard, our study concurs with the

Japanese study. The authors of the Japanese study concluded that reduced muscle mass does not significantly impact BI abilities. However, reduced muscle strength and physical function do affect BI performance.

In conclusion, our study found that patients with low SPPB scores also had lower BI scores. However, there are differences between the studies. The Japanese study identified sarcopenic patients based on the Asian Working Group for Sarcopenia (AWGSOP) criteria, including 112 patients in care homes. In our study, we utilized the EWGSOP algorithm, identifying 21 hospitalized patients with sarcopenia. Nonetheless, both studies had similar inclusion criteria, such as age over 65 and conditional hospitalization.

Sarcopenia is an age-related condition, and its prevalence increases due to the aging population (Petermann-Rocha et al., 2021). The prevalence of sarcopenia is higher in long-term care patients (14–33%) compared to community-dwelling individuals (1–29%) (Cruz-Jentoft et al., 2014). Our research involved patients aged over 65, hospitalized in long-term care and subsequent care units. Out of the total 68 patients examined, 21 were diagnosed with sarcopenia, accounting for 30.9%. Among these, 16 were women and 5 were men, indicating a higher prevalence of sarcopenia among women in our sample. These findings align with a study in China (Wang et al., 2022), where sarcopenia prevalence was 12.47% in women and 8.33% in men. However, this prevalence could vary due to different ethnic populations; our study was conducted in the Czech Republic, while the Chinese study included a diverse ethnic population, including Asians.

Nevertheless, a review study by Papadopoulou et al. (2020) indicated a higher prevalence of sarcopenia in men (14%) than in women (12%). However, this conclusion is conflicting because the review included patients of different ethnicities, including the Asian population, whereas our study was conducted in the Czech Republic. This conclusion was also supported by Topinková (2018) in her review study, stating that women are more frequently affected by sarcopenia, always in the same age category.

Study limitations

This cross-sectional study has several limitations, primarily the small sample size. This is mainly attributed to data collection during a period of worsened epidemiological conditions in the Czech Republic. We were also unable to balance the research sample, particularly concerning gender. The time-consuming nature of the tests is another limitation of our cross-sectional study.

However, despite the mentioned limitations, we believe that the results of the study are valuable, especially in terms of the consequences of sarcopenia itself.

Conclusion

Sarcopenia was identified in 30.9% of patients hospitalized in long-term care and subsequent care units. A statistically significant relationship was found between sarcopenia and nutritional status, as well as between sarcopenia and independence in these patients. It is crucial to identify sarcopenia as early as possible using valid methods and tests that are key to its identification. Early identification of sarcopenia allows for interventions that support the treatment of this condition, promote the senior's return to independence, and enhance the chance of reintegrating into their environment.

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Ethical aspects and conflict of interest

The authors have no conflict of interest to declare.

Vzájemný vztah malnutrice, stupně soběstačnosti a sarkopenie u mužů a žen seniorského věku

Souhrn

Úvod: Sarkopenie je závažné onemocnění, které postihuje svalovou hmotu a také svalovou sílu a/nebo funkci svalů. Má mnoho rizikových faktorů, mezi něž se řadí také malnutrice. Důsledky této nemoci jsou závažné a mohou se taktéž projevit omezením soběstačnosti pacienta v činnostech každodenního života.

Cíl: Cílem průřezové studie bylo zjistit, zda existuje vzájemný vztah mezi malnutricí, sarkopenií a soběstačností.

Metodika: Malnutrice byla hodnocena pomocí škály Mini Nutritional Assessment (MNA), soběstačnost pomocí dotazníku Barthel Index (BI) a sarkopenie pomocí doporučených diagnostických metod, včetně Short Physical Performance Battery (SPPB).

Výsledky: Soubor tvořilo 68 pacientů průměrného věku 76 let (min. 65, max. 93). Tento soubor tvořilo 24 mužů (35,3 %), z toho 5 mužů se zjištěnou sarkopenií, a 44 žen (64,7 %), z toho 16 žen se zjištěnou sarkopenií. U pacientů se sarkopenií byla nalezena významná korelace mezi věkem pacientů a jednotlivými testy MNA (r_{Sp} = –0,2236), SPPB (r_{Sp} = –0,2236) a BI (r_{Sp} = –0,6324). Dále byl nalezen statisticky významný rozdíl u pacientů se sarkopenií mezi testem SPPB a MNA (p = 0,00005) a testem SPPB a BI (0,00006).

Závěr: Sarkopenie má multifaktoriální původ, který souvisí nejen s věkem pacientů. V naší studii byla vyšší prevalence sarkopenie u žen a byla prokázána významná míra vzájemného ovlivnění malnutrice, sarkopenie a soběstačnosti. Stěžejní u této nemoci je včasná diagnostika a cílená intervence.

Klíčová slova: malnutrice; sarkopenie; senioři; soběstačnost

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