Association between dietary nutrient intake and sarcopenia in older adults

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Abstract

Introduction: There is increasing interest in modifiable factors that may be effective in both the prevention and treatment of sarcopenia. Although there is a growing evidence of the importance of nutrition in the treatment of sarcopenia, studies examining the relationship between nutrient intake and sarcopenia in older adults are limited. The aim of this study was to examine the association between nutrient intake and sarcopenia in older adults. **Methods:** The case-control observational study included 115 older adults (≥ 65 years), 26 of whom were classified as sarcopenic. Sarcopenia was assessed according to the European Working Group on Sarcopenia in Older People (EWGSOP) diagnostic criteria. Habitual dietary intake was assessed with the 3-day weighed dietary record over two weekdays and one weekend day. The weight of food intake in grams was converted into energy, macronutrient and micronutrient amounts using the online OPEN (Open Platform for Clinical Nutrition) dietary assessment tool. The mini nutritional assessment (MNA) was used to assess the nutritional status. Differences in nutrient intake and nutritional status between the sarcopenic and non-sarcopenic groups were evaluated. Risk factors were determined using logistic regression with sarcopenic status as the outcome. **Results:** Seven nutrients (n-3 fatty acid, vitamin D, vitamin K, vitamin C, vitamin B1, vitamin B7, and vitamin B9) were all statistically significantly lower in the sarcopenic compared to the non-sarcopenic group ($p < .05$). An increased risk of sarcopenia ($R^2 = .756$) was found in older adults with low dietary intakes of n-3 fatty acids. After accounting for possible covariates, the evidence for an association between n-3 fatty acid and sarcopenia is partially explained by age, body mass index, presence of diabetes mellitus, hypertension, and physical activity level. **Discussion and conclusions:** Sarcopenic older adults differed in terms of intake of seven nutrients compared with non-sarcopenic older adults.

Adequate intake in some of these nutrients have been repeatedly shown to be valuable in preserving muscle mass and protecting against normal decline in the elderly, both in randomized controlled trials and in cohort analyses. Given that nutrition may influence the development of sarcopenia, nutrition intervention may represent a feasible measure for preventing or postponing age-related decline in muscle mass and function.

Keywords: nutrition, sarcopenia, n-3 fatty acid, vitamin D, nutritional assessment

Introduction

Sarcopenia is defined as the presence of low muscle strength, low muscle quantity/quality and low physical performance (Morley et al., 2011; Cruz-Jentoft et al., 2019). Today it is recognized as an age-related disease with ICD-10-CM (M62.84) code (Anker et al., 2016). The overall estimates of prevalence of sarcopenia in older adults worldwide is 10% (Shafiee et al., 2017), while it may be as high as 30% in community-dwelling populations and even higher than 30% for populations in long-term care (Cruz-Jentoft et al., 2014). The consequences of having sarcopenia are reflected in loss of independence due to impaired physical performance, increased risk of mobility disorders, falls and fractures and impaired ability to perform activities of daily living, leading to nursing home admission, depression, hospitalization, and even death (Landi et al., 2013; Correa-de-Araujo and Hadley 2014; Cruz-Jentoft and Sayer 2019). In addition, its presence is associated with other comorbidities, such as osteoporosis, diabetes mellitus, insulin resistance, obesity, and chronic kidney disease, which have an important impact on the public health burden (Beaudart et al., 2014; Kim et al., 2014; Pacifico et al., 2020).

Multiple risk factors contribute to the aetiology of sarcopenia. Changes in muscle morphology, neurodegenerative process, anabolic and sex hormone production or sensitivity, protein balance, increased oxidative stress, inflammation and genetic predisposition are important risk factors (Roubenoff, 2003; Fulle et al., 2004; Can et al., 2016; Coen et al., 2019; Bauer, 2021; Priego et al., 2021). which leads to reduced mobility, fragility and loss of independence. This process called sarcopenia is secondary to several factors such as sedentary lifestyle, inadequate nutrition, chronic inflammatory state and neurological alterations. However, the endocrine changes associated with aging seem to be of special importance in the development of sarcopenia. On one hand, advancing age is associated with a decreased secretion of the main hormones that stimulate skeletal muscle mass and function (growth hormone, insulin-like growth factor 1 (IGF[sbnd]I) Along with these changes in older adults, decreased basal metabolic rate and increased dietary protein needs are also detected (Wilson and Morley, 2003; Bauer et al., 2013; Boirie, 2014). Besides these endogenous factors, inadequate nutrition and a sedentary lifestyle also contribute to the complex aetiology of sarcopenia (Rolland et al., 2008; Walrand et al., 2011;

Volkert et al., 2018; Beaudart et al., 2019). Many of them are not modifiable since they are caused by progressive, irreversible processes contributing to reduced muscle mass and strength (Rolland et al., 2008; Cruz-Jentoft and Sayer 2019). Therefore, there is rising interest in studies that point to the influence of modifiable factors such as nutrition and lifestyle, because these factors may be effective for both the prevention and treatment of sarcopenia. Proper nutrition is an important determinant of health and can contribute to protection against the negative impact of age-related changes of body composition and muscle quality decline (Volkert et al., 2018; Beaudart et al., 2019). Evidence shows significantly lower dietary nutrient intakes of at least 3-6 nutrients in sarcopenic compared to non-sarcopenic older adults (ter Borg et al., 2016; Beaudart et al., 2019). Results of some studies have led to the proposition that n-3 fatty acid along with vitamin D, protein intake and physical activity as a combined intervention could be effective in the management of sarcopenia (Borie et al., 2014; Wu et al., 2020). Antioxidant nutrients (carotenoids, selenium and vitamins E and C) intake have also been associated with sarcopenia (Lauretani et al., 2007; Chen et al., 2014; Welch et al., 2020).

Studies that evaluate the association between nutrient intake and sarcopenia in older adults is limited. To fill this gap, this study aims to evaluate the differences in nutrition intake among sarcopenic and non-sarcopenic older adults.

Methods

Study design and participants

This case-control observational study is set to identify nutritional factors that differ in sarcopenic and nonsarcopenic groups of older adults.

Study participants were older adults (≥ 65 years) selected from our previous study (Urzi et al., 2017). The sample was composed of 115 participants, 26 of whom had sarcopenia; 75 older adults living in a nursing home and 40 free-living older adults (29% of men; average age 77.7 ± 10.3 years). Sarcopenia was assessed according to the EWGSOP diagnostic criteria (Cruz-Jentoft et al., 2010). For details on health-related data, body composition measurements and sarcopenia assessment see our original publication (Urzi et al., 2017). We conducted our study in compliance with the principles of the Declaration of Helsinki. The study was approved by the Republic of Slovenia National Medical Ethics Committee (No. 0120-313/2015-6 KME 105/06/16).

Dietary Intake and Malnutrition Assessment

Habitual dietary intake was assessed with the 3-day weighed dietary record over two weekdays and on one weekend day. The weight of food intake in grams was converted into energy, macronutrient and micronutrient amounts using the online OPEN (Open Platform for Clinical Nutrition dietary assessment tool (<http://www.opkp.si>)).

The mini nutritional assessment (MNA) was used to assess the nutritional status. Malnutrition indication scores ranged from 17 to 30 points. Participants were classified according to achieved scores as follows: from 24 to 30 points (normal nutritional status), from 17 to 23.5 points (at risk of malnutrition), and less than 17 points (malnourished) (Vellas et al., 1999).

Statistical analysis

Data were analysed using SPSS version 25 (SPSS Inc., Chicago, IL). For continuous variables, we calculated mean values, standard deviations, and medians. Categorical variables are expressed as numbers and percentages.

Normality in the distribution of variables was tested with the Shapiro-Wilk test. The homogeneity of variances was tested by Leven's test for equality of variances. For continuous variables, differences in participant's characteristics between those with and without sarcopenia were examined using the unpaired Student's t-test or Mann-Whitney U test. For categorical variables, comparisons between groups were made using the χ^2 -test. Risk factors were determined using logistic regression with sarcopenic status as the outcome. Initially, those dietary factors that were significantly different between groups were included in a multivariate model to determine the best predictor of sarcopenic status. Those factors that were significant at the $p = .05$ level were included in the multivariate model, having taken into consideration possible covariates, to determine whether the dietary intake differences between the groups were related to sarcopenia. The following covariates were included for the evaluation of dietary intake: sex, age, body mass index, MNA malnutrition category, energy intake, diabetes mellitus, hypertension, heart disease, depression, chronic obstructive pulmonary disease (COPD) and physical activity level. All statistical tests were 2-sided. A p value lower than .05 was considered statistically significant.

Results

Baseline characteristics of study participants in relation to the presence of sarcopenia according to EWGSOP (Cruz-Jentoft et al., 2010) diagnostic criteria are presented in Table 1 and Table 2. We found lower body mass index ($t(113) = 2.839, p = .005$), skeletal muscle index ($U = 439, z = -4.801, p < .001$), gait speed ($U = 440, z = -4.794, p < .001$), and grip strength ($U = 319, z = -5.605, p < .001$) in the sarcopenic group. The sarcopenic participants also reported a lower level of physical activity than the nonsarcopenic older adults ($U = 761, z = -2.792, p = .005$), and had significantly higher rates of diabetes mellitus ($\chi^2(1) = 5.25, p = .022$), and hypertension ($\chi^2(1) = 5.59, p = .018$). The risk of malnutrition was higher ($\chi^2(1) = 10.45, p = .001$) in the sarcopenic (42.3%) comparing to the non-sarcopenic group (13.5%). None of the participants were malnourished.

Table 1: Characteristic of study participants in relation to the presence of sarcopenia by EWGSOP diagnostic criteria

Variables	Non sarcopenic (n = 89)	Sarcopenic (n = 26)	T-test / Mann-Whitney
	M (SD)	M (SD)	p-values
Age (years)	75.2 (10.0)	86.2 (5.98)	< .001
Body height (cm)	163.0 (8.7)	159.3 (8.9)	.063
Body mass (kg)	74.0 (13.0)	62.8 (11.6)	< .001
Body mass index (kg/m ²)	28.1 (5.5)	24.7 (3.8)	.005
Skeletal muscle index (kg/m ²)	7.79 (1.22)	6.59 (1.02)	< .001
Gait speed (m/s)	0.92 (0.43)	0.46 (0.18)	< .001
Grip strength (kg)	28.0 (9.34)	16.6 (6.07)	< .001
Physical activity level	1.38 (0.13)	1.30 (0.96)	.005

Table 2: Nutritional and health status of study participants in relation to the presence of sarcopenia by EWGSOP diagnostic criteria

Variables	Non sarcopenic	Sarcopenic	χ ² -test
	n (%)	n (%)	p-values
Mini Nutritional Assessment			
Normal nutritional status	77 (86.5)	15 (57.7)	.001
At risk of malnutrition	12 (13.5)	11 (42.3)	
Malnourished	0 (0)	0 (0)	
Chronic obstructive pulmonary disease	3 (3.4)	1 (3.8)	/
Type 2 diabetes	12 (13.5)	8 (30.8)	.022
Hypertension	29 (32.6)	14 (53.8)	.018
Heart disease	10 (11.2)	4 (15.4)	.463
Other diseases	35 (39.3)	13 (50.0)	.365

Note. EWGSOP = European Working Group on Sarcopenia in Older People. Sarcopenia: low muscle mass, cut off point ≤ 8.87 kg/m² (in men) and ≤ 6.42 kg/m² (in women) and low muscle strength (men < 30 kg; women < 20 kg) and/or low physical performance (gait speed < 0.8 m/s).

Comparison of dietary intake between sarcopenic and nonsarcopenic older individuals

The dietary intake of the sarcopenic and nonsarcopenic groups are shown in Table 2. Energy intake does not differ between the groups, but when expressed as energy intake per kg of body mass per day, the sarcopenic group shows higher values compared to the non-sarcopenic group (24.9 vs. 28.8 g/kg per day; $U = 1689$, $z = 3.544$, $p < .001$). The sarcopenic participants also have a higher protein intake (1.13 vs. 0.95 g/kg bw/d; $t(113) = -3.592$, $p < .001$). Compared with the PROT-AGE recommendations for dietary protein intake (Bauer et al., 2013), the proportion of older adults with dietary protein intake lower than 1.0

/kg bw/d were 19% and 57% for sarcopenic and non-sarcopenic older adults, respectively. Intakes lower than 1.2 g/kg bw/d amounted to 69% for the sarcopenic and 89% for the non-sarcopenic group. Greater daily protein intake in the sarcopenic group was not reflected in the differences in branch chain amino acid (BCAA) ($p = .981$) or leucine ($p = .931$) intake between the two groups.

There were no significant differences in daily intake of carbohydrate ($p = .229$), fat ($p = .583$), and saturated fatty acid ($p \geq .24$). Other nutrients like n-3 fatty acid ($U = 544$, $z = -4.099$, $p < .001$), vitamin D ($U = 750$, $z = -2.721$, $p = .007$), vitamin K ($U = 691$, $z = -3.116$, $p = .002$), vitamin C ($U = 843$, $z = -2.099$, $p = .036$), vitamin B1 ($U = 690$, $z = -3.112$, $p = .002$), vitamin B7 ($U = 680$, $z = -3.189$, $p = .001$), and vitamin B9 ($U = 589$, $z = -3.798$, $p < .001$) were all lower in the sarcopenic compared to the non-sarcopenic group. Intakes of all other nutrients did not differ between the two groups ($p \geq .062$). The proportion of individuals whose usual intake of n-3 fatty acid was below the RDA (Reference dietary values DACH, 2004) was 100% in the sarcopenic group and 83.1% in the nonsarcopenic group. Vitamin D intake was lower than the RDA in both the sarcopenic and nonsarcopenic group (in 100% and 87.6% of individuals, respectively). Folic acid intake was substantially lower than the RDA in the sarcopenic and nonsarcopenic group (in 100% and 89.9% of individuals, respectively). Thiamine intake was also lower than the RDA in both the sarcopenic and nonsarcopenic group (92.3% and 53.9%, respectively). Dietary supplement users in nonsarcopenic group was 9 % (supplement: 9 % vitamin D, 4 % n-3 fatty acid, 2 % vitamin C and 1 % vitamin B), while none of the sarcopenic participants used supplements.

Table 3: Average daily dietary intakes by non-sarcopenic and sarcopenic older adults

Characteristic	Non sarcopenic (n = 89)	Sarcopenic (n = 26)	T-test / Mann-Whitney
	M (SD)	M (SD)	p-values
Energy (kcal)	1809 (375)	1786 (329)	.392
Energy (kcal / kg BM / day)	24.9 (6.03)	28.8 (4.75)	< .001
Protein (g / kg BM / day)	0.95 (0.24)	1.13 (0.18)	< .001
Carbohydrates (g)	221 (55.4)	211 (50.5)	.229
% Energy from Carbohydrates	48.9 (6.92)	47.2 (4.91)	.172
Fat (g)	70.0 (19.8)	72.3 (15.2)	.583
% Energy from Fat	34.7 (6.51)	36.5 (4.92)	.205
BCAA (g)	9.81 (2.37)	9.80 (1.63)	.981
Leucine (g)	4.05 (0.95)	4.03 (0.67)	.931
Palmitic acid (g)	10.5 (3.20)	11.2 (2.20)	.249
Stearic acid (g)	4.57 (1.55)	4.74 (0.98)	.489
n-3 fatty acid (g)	1.04 (0.76)	0.57 (0.14)	< .001
n-6 fatty acid (g)	8.73 (4.33)	8.36 (3.07)	.904
Vitamin D (µg)	4.40 (6.59)	1.44 (0.38)	.007
Vitamin E (mg)	10.1 (2.98)	8.92 (2.09)	.062

Characteristic	Non sarcopenic (n = 89)	Sarcopenic (n = 26)	T-test / Mann-Whitney
Vitamin K (µg)	138 (112)	77.7 (27.2)	.002
Vitamin C (mg)	76.6 (39.8)	57.7 (18.5)	.036
Vitamin B1 (mg)	0.97 (0.33)	0.76 (0.11)	.002
Vitamin B2 (mg)	1.27 (0.31)	1.24 (0.23)	.714
Vitamin B5 (mg)	3.91 (0.97)	3.51 (0.63)	.072
Vitamin B6 (mg)	1.34 (0.44)	1.15 (0.19)	.091
Vitamin B7 (µg)	20.1 (11.2)	12.8 (5.03)	.001
Vitamin B9 (mg)	0.21 (0.08)	0.15 (0.02)	< .001
Vitamin B12 (µg)	2.89 (1.29)	2.55 (0.54)	.349
Potassium (g)	2.54 (0.58)	2.31 (0.39)	.131
Calcium (g)	0.74 (0.22)	0.81 (0.18)	.161
Magnesium (g)	0.32 (0.12)	0.27 (0.04)	.166
Phosphorus (g)	1.02 (0.25)	0.99 (0.20)	.570
Iron (g)	13.1 (3.68)	11.8 (2.12)	.088
Copper (mg)	1.37 (0.40)	1.30 (0.24)	.290
Selenium (µg)	51.0 (16.6)	45.1 (12.9)	.175
Zinc (mg)	7.90 (1.99)	7.65 (0.29)	.784

Note. BM – body mass, BCAA – branched-chain amino acid, Vitamin B1 – thiamine, Vitamin B2 – riboflavin, Vitamin B5 – pantothenic acid, Vitamin B7 – biotin, Vitamin B9 – folate.

Risk factors associated with sarcopenia

The results of the multiple regression analysis to identify possible dietary risk factors of sarcopenia are presented in Table 4. Dietary intake of n-3 fatty acid was significantly associated with sarcopenia. Differences in n-3 fatty acids, with 45% lower intake in the sarcopenic compared with the nonsarcopenic group, was found to be associated with sarcopenia in the unadjusted model (OR 0.039, 95% CI 0.002-0.793, $p = .035$). Differences in vitamin D, K, C, B1, B7, and B9 intake between the groups, did not achieve statistical significance in this model ($p \geq .377$).

Table 4: Regression coefficients and odds ratios (and 95% CIs) for dietary risk factors associated with sarcopenia

Factor	β -value	Model I	
		p-value	Odds ratio (95% CI)
n-3 fatty acid (g)	-3.232	.035	0.039 (0.002-0.793)
Vitamin D (µg)	-0.059	.786	0.943 (0.617-1.441)
Vitamin K (µg)	-0.006	.386	0.994 (0.981-1.007)
Vitamin C (mg)	0.010	.529	1.010 (0.980-1.040)
Vitamin B1 (µg)	-1.726	.450	0.178 (0.002-15.71)
Vitamin B7 (µg)	-0.007	.895	0.993 (0.897-1.100)
Vitamin B9 (µg)	-0.013	.377	0.987 (0.959-1.016)

Note. Binary logistic analyses were used to estimate the odds ratio (OR) and 95% confidence interval (CI) of dietary factors related to sarcopenia.

In Table 5 the model after controlling for sex, age, body mass index, MNA malnutrition category, energy intake, diabetes mellitus, hypertension, heart disease, depression, COPD and physical activity level is shown. An increased risk of sarcopenia ($R^2 = 0.756$) was found in older adults with a low dietary intake of n-3 fatty acid (OR 0.002, 95% CI 0.000-0.461, $p = .025$), body mass index (OR 0.611, 95% CI 0.438-0.853, $p = .004$), physical activity level (OR 0.001, 95% CI 0.000-0.873, $p = .048$), with the presence of diabetes mellitus (OR 0.006, 95% CI 0.000-0.170, $p = .003$), hypertension (OR 0.063, 95% CI 0.005-0.768, $p = .030$), and were older (OR 1.172, 95% CI 1.016-1.352, $p = .030$). Sex, MNA malnutrition category, energy intake, heart disease, depression, and COPD did not achieve statistical significance in this model ($p \geq .092$).

Table 5: Regression coefficients and odds ratios (and 95% CIs) for risk factors associated with sarcopenia

Factor	β -value	Model II	
		p-value	Odds ratio (95% CI)
n-3 fatty acid (g)	-6.226	.025	0.002 (0.000-0.461)
Age (years)	0.159	.030	1.172 (1.016-1.352)
Physical activity level	-12.527	.048	0.000 (0.000-0.873)
Body mass index (kg/m ²)	-0.492	.004	0.611 (0.438-0.853)
Diabetes mellitus (presence)	-5.039	.003	0.006 (0.000-0.170)
Hypertension (presence)	-2.768	.030	0.063 (0.005-0.768)

Note. Binary logistic analyses were used to estimate the odds ratio (OR) and 95% confidence interval (CI) of factors related to sarcopenia. Adjusted model for sex, age, body mass index, MNA malnutrition categories, energy intake, diabetes mellitus, hypertension, heart disease, depression, COPD and physical activity level.

Discussion

Deficiencies in both macronutrients and micronutrients can be considered as a risk factor for sarcopenia, because such deficiencies can accelerate age-dependent changes in body composition, involving the loss of muscle mass, strength and function (Walrand et al., 2011; Volkert et al., 2018; Beaudart et al., 2019). We aimed to investigate nutritional factors that may be associated with the aetiology of sarcopenia by comparing the habitual dietary intake of the sarcopenic and nonsarcopenic groups of older adults.

The findings show that older adults in the sarcopenic group were more likely at risk of malnutrition (42.3%) than those in the nonsarcopenic group (13.5%) and demonstrate a higher rate of co-morbidities such as diabetes mellitus and hypertension. According to the MNA, although none of the participants was malnourished, 20% were at risk of malnutrition. The proportion of older adults who are malnourished or at risk of malnutrition vary depending on the cohort in the study. We found that the proportion of participants at risk of malnutrition was as high as 42.5% in the nursing homes (Lardiés-Sánchez et

al., 2017), or 9% among community-dwelling older adults (ter Borg et al., 2016). Although we observed significant differences in the MNA malnutrition category between the sarcopenic and nonsarcopenic group, as in other studies (ter Borg et al., 2016; Lardiés-Sánchez et al., 2017), it was not identified as a covariate for some of the observed nutrient intake differences.

The energy intake of the present population was 7.1-8.6MJ (1696.9 kcal - 2055.4 kcal) including intake of carbohydrate 48-49 En%, protein 15-16 En%, and fat 33-35 En%. These results are in line with the intake data of older adults from systematic literature review (ter Borg et al., 2015), and other studies (van Rossum et al., 2011; ter Borg et al., 2016) that indicates suboptimal macronutrient intakes among older adults. We did not observe significant differences in energy intake between the sarcopenic and nonsarcopenic group, similar to the results of Maastricht Sarcopenia Study (ter Borg et al., 2016).

Even though the greater proportion of the sarcopenic participants meet the lower range of evidence-based recommendations for optimal dietary protein intake of 1.0 g/kg bw/d (Bauer et al., 2013), the inadequate nutrition pattern of this group was reflected in the insufficient daily amount of seven nutrients (n-3 fatty acid, vitamins D, K, C, thiamine, biotin and folic acid). Besides, the evidence shows that protein intake alone is not sufficient to preserve muscle quality but it is rather an interplay of group of nutrients that contribute to the prevention of sarcopenia (Verlaan et al., 2018). The literature suggests that adequate intake of proteins (1.2 g/kg bw/d), n-3 fatty acids, and vitamin D, combined with physical exercise, forms part of an integrated management of sarcopenia (Boirie et al., 2014; Wu et al., 2020).

A significantly lower intake of thiamine, biotin, and folate (21%, 36%, and 28%, respectively) was observed in our sarcopenic group compared to the non-sarcopenic group. The literature review (ter Borg et al., 2015; ter Borg et al., 2016; Beaudart et al., 2019) identified six nutrients (thiamin, riboflavin, vitamin D, Ca, Mg and Se) of potential concern as a result of a high prevalence of micronutrient inadequacy in diets among older adults in Europe. Furthermore, a possible link between vitamins B and the aetiology of sarcopenia was proposed (ter Borg et al., 2016; Bulut et al., 2017; Aytekin, 2018). The mechanisms are mainly related to the reduced activity of vitamin B₁ dependent enzymes in mitochondria, and folate deficiency with hyperhomocysteinaemia. Deficiencies in these vitamins can include impairments in oxidative metabolism, and mitochondrial function, leading to inflammatory responses associated with increased production of reactive oxygen species and excitotoxicity, which causes muscle protein degradation (ter Borg et al., 2016; Aytekin, 2018).

The comparison of vitamin D intake between the groups showed a significantly lower vitamin D intake in the sarcopenic group of 67%. Furthermore, none of the sarcopenic participants were supplemented with vitamin D. Supportive evidence shows the clinical relevance of vitamin D supplementation in the treatment and prevention of sarcopenia (Cangussu et al., 2015; Verlaan et al., 2018).

We observed a 45% lower n-3 fatty acids intake in the sarcopenic group compared to the nonsarcopenic group. The findings of our study show that a higher dietary intake of n-3 fatty acid in the nonsarcopenic group was associated with a significantly reduced risk of sarcopenia. The analyses considered possible covariates and indicated that the association between n-3 fatty acid and sarcopenia is partially explained by age, body mass index, presence of diabetes mellitus, hypertension, and physical activity level.

Various randomized controlled trials and cohort analysis shows a significant role of the dietary intake of n-3 fatty acids in preventing sarcopenia and muscle loss (Ganapathy and Nieves, 2020). Besides, it was shown that n-3 fatty acid supplementation directly stimulates muscle protein synthesis in older adults and may be effective for muscle mass gain (Smith et al., 2011). Some previous studies have discovered that the prevalence of chronic disease is interrelated with systemic chronic low-grade inflammation, which contributes to the loss of muscle mass, strength and function through several cytokine signalling pathways (Kim et al., 2014; Dalle et al., 2017). It was suggested that nutrients like n-3 fatty acids might have the potential of preventing and reducing numerous chronic conditions caused by inflammatory factors by decreasing the level of inflammatory cytokines, and prevent the loss of muscle mass, strength and function associated with age-related sarcopenia (Smith, 2016; Buoite et al., 2018).

Certain limitations must be taken into consideration. Based on the cross-sectional design of the study, no conclusion can be made on the cause-effect relationship between sarcopenia and nutrient factors. Therefore, research along with longitudinal design and controlled bias would be useful in providing further clarification on the effects of the differences in nutrient intake regarding the risk of sarcopenia.

Conclusions

Musculoskeletal health is important for the functionality and independence of older adults, and we showed that some nutrients as well as dietary patterns offer protective effects against age-related declines in muscle mass and function.

The present results suggest that sarcopenic older adults have important dietary deficiencies in n-3 fatty acids, vitamin D, vitamin C and some vitamin B. The inadequate intake of these nutrients could be viewed as a risk factor for sarcopenia, although prospective studies are needed to confirm these findings.

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