Jurnal Info Kesehatan
Vol. 22, No. 2, June 2024, pp. 221-234
P-ISSN 0216-504X, E-ISSN 2620-536X
DOI: *10.31965/infokes.Vol22.Iss2.1476*
Journal homepage:*https://jurnal.poltekkeskupang.ac.id/index.php/infokes*

RESEARCH Open Access

The Relationship of Dietary Pattern and Sarcopenia in Type II Diabetes Mellitus Patients

Veronika Merika Kedang[1a], Ahmad Syauqy[2b*], Ani Margawati[2c]

[1] Postgraduate Program of Nutrition Sciences, Faculty of Medicine, Diponegoro University, Central Java, Indonesia
[2] Department of Nutrition Sciences, Faculty of Medicine, Diponegoro University, Central Java, Indonesia

[a] Email address: learaga031213@gmail.com
[b] Email address: syauqy@fk.undip.ac.id
[c] Email address: animargawati@gmail.com

Received: 2 May 2024 Revised: 19 May 2024 Accepted: 7 June 2024

Abstract
Diet plays an important role in managing mass, and muscle strength and preventing diseases related to malnutrition. A dietary pattern that contains several nutrients has a role in improving muscle performance and reducing the incidence of sarcopenia. This study aims to determine the relationship between dietary patterns and the incidence of sarcopenia in subjects with type 2 diabetes mellitus. This study was a cross-sectional study conducted on 150 subjects with type 2 diabetes mellitus aged 40 years or older. Multivariate logistic regression tests were conducted to measure the effect of adherence to each dietary pattern on the possibility of sarcopenia. Three dietary patterns were identified through analysis of major components. After adjusting for confounding variables, subjects with healthy dietary patterns on the highest tertile had a lower odds ratio for developing sarcopenia (OR 0.584; 95% CI 0.070-4.865; p=0.000). In contrast, adherence to unhealthy dietary patterns was not associated with sarcopenia (OR 1.508; 95% CI 0.305-7.452; p=0.612). Similarly, adherence to a mixed dietary pattern did not affect the likelihood of sarcopenia (OR 1.297; 95% Cl 0.341-4.931; P=0.704). This study shows that adherence to a healthy dietary pattern is associated with a lower chance of developing sarcopenia in people with type II diabetes mellitus.

Keywords: Dietary Patterns, Sarcopenia, Muscle Mass, Muscle Strength, Walking Speed, Type II Diabetes Mellitus.

Corresponding Author:

Ahmad Syauqi
Department of Nutrition Sciences, Faculty of Medicine, Diponegoro University, Central Java, Indonesia
Email: syauqy@fk.undip.ac.id

1. INTRODUCTION

Sarcopenia is a condition where the skeletal muscle is involuntarily resorbed, leading to decreased muscle strength and function (Cruz-Jentoft et al., 2019; Sun et al., 2021). This condition has recently been identified as a new complication in patients with diabetes. The prevalence of sarcopenia varies, depending on age groups studied, ethnicities, associated comorbidities, and diagnostic criteria employed. For community-dwelling elderly individuals, the prevalence ranges from 9.9% to 40% (Mayhew et al., 2019), while among the elderly with type 2 diabetes mellitus (T2DM), it ranges from 15% to 44%, depending on the diagnostic criteria used (Shaikh et al., 2020; Wang et al., 2016).

Sarcopenia has multiple causes, including chronic disorders such as neurological, inflammatory, and autoimmune diseases, malnourishment, hypogonadism, any chronic systemic illness, and multiple drugs, especially glucocorticoids (Borba et al., 2019). Diabetes is one of the most common causes of sarcopenia. Impaired muscle function contributes to a sedentary life. The pathogenesis of sarcopenia is complicated and associated with aging, sedentary lifestyle, nutritional factors, increased production of reactive oxygen species, increased levels of proinflammatory cytokines, hormonal changes, and decreased neuromuscular function (Chen et al., 2021; Tan et al., 2021). Nutritional causes of sarcopenia include inadequate energy and protein intake, low blood levels of vitamin D, and inadequate intake of carotenoids and antioxidants (Yakout et al., 2019).

The link between sarcopenia and diabetes mellitus is due to the presence of similar risk factors between both conditions. Sarcopenia may be caused by inadequate energy and nutritional factors. Nutritional factors are linked to dietary patterns, which are defined as the quantities, proportions, variety, or combination of different foods, drinks, and nutrients in diets, and the frequency with which they are habitually consumed. Dietary pattern (DP) is the general profile of food and nutrient consumption which is characterized based on the usual eating habits (Snetselaar, et al., 2021). The analysis of dietary patterns gives a more comprehensive impression of the food consumption habits within a population (Omage & Omuemu, 2018). It may be better at predicting the risk of diseases than the analysis of isolated nutrients or foods because the joint effect of various nutrients involved would be better identified.

A dietary pattern containing several nutrients may have a role in improving muscle performance and decreasing the incidence of sarcopenia (Göbl & Tura, 2022). In the people of East Nusa Tenggara, especially in Belu Regency, the diet pattern is commonly high in carbohydrate, vegetable, and legume intake but low in animal and fruit food intake (Carolina & Wahju, 2020). This may increase the risk of sarcopenia. Therefore, the purpose of this study was to determine the relationship of dietary patterns with the incidence of sarcopenia in patients with type II Diabetes Mellitus at Gabriel Manek General Hospital, SVD Atambua.

2. RESEARCH METHOD

This study used a cross-sectional design with purposive sampling the outpatient room of Gabriel Manek General Hospital, SVD Atambua. A total of 183 individuals with age ≥ 40 year met the criteria of type two diabetes mellitus between November 2023 until January 2024. After excluding the individuals ($n = 23$) who had been unable to walk independently or used assistive devices and ($n = 10$) who did not cooperate and withdrew during the research, a total of 150 subjects were finally recruited for analysis in this study. Ethical approval for this research was received from the research ethics committee of the Faculty of Medicine, Diponegoro University, Indonesia (*Ethical Clearance* No. 542/EC/KEPK/FK-UNDIP/XI/2023).

Definition and assessment of sarcopenia. Sarcopenia is defined as low muscle mass, decreased muscle strength, and/or slow walking speed. It is assessed based on the guidelines

of the Asian Working Group of Sarcopenia (AWGS). In men, low muscle mass index is <7.0 kg/m² and muscle strength decreases when <26 kg. In women, low muscle mass index is <5.7 kg/m² and muscle strength decreases when <18 kg. Walking speed decreases when <0.8 (m/s) (Chen et al., 2020).

Dietary pattern assessment. Trained nutritionists collected dietary data using food frequency questionnaires (FFQs). The FFQs contained 25 food items that represent typical East Nusa Tenggara food patterns. Participants were asked how often they consumed each food item. The frequency scores were used to obtain a dietary pattern, which was classified into tertiles (Syauqy et al., 2018b).A healthy diet is characterized by a higher intake of foods with higher benefits in improving health (such as fruits and vegetables, whole grains, fish, lean meats, low-fat dairy, nuts, and olive oil), but lower in energy. Unhealthy diet patterns are characterized by low nutrient food intake (for example, refined grains, sweets, and animal products that are high in saturated fat) while mixed diet patterns are characterized by food intake consisting of a mixture of healthy and unhealthy diet patterns (Dominguez et al. 2022).

Anthropometric measurements are taken by trained health professionals using standard protocols and tools such as ONEMED brand Microtoice for height measurement and bioelectrical impedance analysis instrument (brand Omron HBF-375) for measuring body weight (kg) and body fat (%). Body mass index (BMI) is calculated as body weight divided by height square and classified as normal nutritional status (18.5-25 kg/m³), undernutrition status (< 18.5 kg/m³), and over nutritional status (> 25 kg/m³) (Kementerian Kesehatan RI, 2014). Waist and hip circumference are measured using a tape measure and used to calculate waist-to-hip ratio, which is defined as low (< 0.90 for men and < 0.85 for women) and high (≥ 0.90 for men and ≥ 0.85 for women) (Syauqy et al., 2018a).

Biochemical measurements. We used laboratory test data from patient medical records with the provision of test results that will be used if Fasting blood glucose levels (FGP) ≥ 126 mg/dl. Blood glucose levels 2 hours postprandial > 200 mg/dl, and Hemoglobin A1c (HbA1c) levels are ≥ 6.5%.

Demographic and lifestyle characteristics such as gender, age, duration of suffering from type 2 diabetes mellitus, metformin consumption, and physical activity were collected using questionnaires. The duration of suffering from type 2 diabetes mellitus dichotomy is ≤ 5 years and >5 years. Physical activity using the pre-developed PASE (Physical Activities Scale for Elderly) questionnaire was categorized as less (total score < 17), moderate (total score ≥ 17), and good (total score ≥ 22)(VandeBunte et al. 2022).

The study used chi-square and ANOVA tests to determine differences in variables between subjects with sarcopenia and different dietary patterns. Multivariate logistic regression analysis was used to compare the relationship between dietary patterns and sarcopenia. The models were adjusted for various factors, and SPSS 26 software was used for analysis with a significance level of $p \leq 0.05$.

3. RESULTS AND DISCUSSION

Table 1. Study's Subject Characteristics

Characteristics	Sarcopenia (%)		Total (N= 150)	p-value
	Yes (n= 77)	No (n= 73)		
Age (mean ± SD)	60.91±9.63	55.04±9.60	58.25±10.02	0.000
40-59	57.1	42.9	56.7	0.048
≥60	34.2	65.8	43.3	
Sex				
Male	61.0	41.1	51.3	0.023
Female	39.0	58.9	48.7	
Weight (kg)	46.59±5.35	57.28±6.02	51.44± 7.77	0.000

Height (cm)	161.65± 4.44	163.82±8.32	162.64±6.56	0.044
BMI (kg/m2)	17.82±1.86	21.48± 2.97	19.48±3.03	0.000
Illness duration (years)				
≤ 5	1.3	69.9	34.7	0.000
>5	98.7	30.1	65.3	
Waist (cm)	83.42±6.62	98.38±7.19	90.20±10.14	0.000
Hip circumference (cm)	97.85±83	105.30±5.61	101.23±6.38	0.000
Waist-hip ratio	0.85± 0.04	0.93±0.06	0.88± 0.07	0.000
% body fat	26.23± 5.15	27.78± 5.36	26.93± 5.28	0.073
Muscle mass index (kg/m2)	6.44± 1.14	8.16± 1.56	7.22± 1.59	0.000
Muscle strength (kg)	19.35± 3.51	24.92± 3.39	21.98± 3.93	0.000
Walking speed (m/s)	0.74± 0.23	1.08± 0.25	0.90± 0.29	0.000
Physical activity (%)				
Less	76.6	4.1	40.7	0.000
Moderate	15.6	11.0	14.0	
Good	7.8	84.9	45.3	
HbAIc Levels (%)	7.30±0.73	6.76±0.93	7.06±0.87	0.000
Random blood glucose (mg/dl)	158.90±15.66	151.09±21.59	154.56±19.09	0.011
Blood glucose 2 hours postprandial (mg/dl)	265.88±45.60	242.74±62.32	255.39±54.86	0.010
Metformin consumption (%)				
Consumed	13.0	94.5	52.7	0.000
Not consumed	87.0	5.5	47.3	
Total intake				
Energy (kcal)	1083.66± 30.26	1363.91± 37.97	1210.71± 26.39	0.000
Protein (gr)	43.46±1.30	56.66± 1.42	49.45± 1.09	0.000
Fat (gr)	31.59±1.28	35.03± 1.54	33.15± 0.99	0.086
Carbohydrate (gr)	204.70±4.25	236.19±5.40	218.97± 3.60	0.000

Table 1 shows that the research analyzed participants' sarcopenia conditions and found that the majority of those affected were older than 60 years. The study revealed a significant relationship between body weight, height, and nutritional status with the incidence of sarcopenia. Patients with type II diabetes mellitus who have had pain for over five years had a higher incidence of sarcopenia. The research found a significant relationship between muscle mass index, muscle strength, and walking speed with the incidence of sarcopenia. HbA1C levels were also associated with sarcopenia. In addition, the study found a significant relationship between low physical activity and sarcopenia.

Table 2. Loading of Dietary Factors and Patterns Resulting from Principal Component Analysis for 25 Food Groups

Food Group	**Factor I (Unhealthy dietary pattern)**	**Factor II (Mix dietary pattern)**	**Factor III (Healthy dietary pattern)**
Rice/flour/corn products	0.154	**0.488**	0.098
Root crops	0.162	**-0.287**	-0.036
Whole grains	-0.097	-0.166	**0.613**

Staple food ingredients cooked in oil	**0.353**	0.076	0.063
Nuts	-0.160	-0.274	**0.380**
Soya bean	-0.242	-0.119	**0.367**
Dairy products and dairy products	0.046	0.099	**-0.250**
Light colored vegetables	0.094	**0.531**	-0.069
Dark colored vegetables	0.050	-0.248	**0.516**
Egg	0.244	0.049	**0.296**
Fish and seafood	-.0.007	0.190	**0.339**
Meat	0.194	**-0.523**	0.057
Poultry	0.106	**0.516**	0.193
Fast food	**0.648**	0.123	0.094
Processed foods	**0.517**	-0.349	-0.306
Fried food	**0.374**	0.313	-0.204
Animal organs	0.011	**0.250**	-0.020
Fruits	0.096	0.137	**0.501**
Processed fruit	-0.023	**-0.298**	-0.261
Traditional snacks	**0.360**	0.204	0.008
Jam/honey	**0.734**	-0.074	-0.058
Sweet drinks	**0.621**	-0.061	0.044
Sweet dessert	**0.629**	0.037	-0.061
Tea and coffee	**0.597**	0.202	-0.193
Alcoholic beverages	**0.342**	-0.129	0.189

Table 2 shows that three dietary patterns have emerged. The first factor is referred to as unhealthy dietary patterns, which consists of ten highly loaded food groups such as staple foods cooked in oil, fast food, processed foods, fried foods, traditional snacks, jams/honey, sugary drinks, sugary desserts, tea and coffee, and alcoholic beverages. The second factor, labeled mixed diet pattern, includes seven types of food comprising high consumption of rice/flour/corn products, root crops, light-colored vegetables, meat, poultry, animal organs, and processed fruits. The third factor called a healthy dietary pattern, includes eight food groups consisting of high consumption of whole grains, nuts, soybeans, dairy and processed products, dark-colored vegetables, eggs, fish and seafood, and fruits. Factor 1 explains 12.13% of intake variance, factor 2 explains 7.56% of the variance, and factor 3 explains 7.62% of the variance. The total variance of the three factors was 27.31%, and the eigenvalue of the three factors was greater than 1.5.

Table 3. Test the characteristics of research subjects with diet

Variables	Unhealthy Dietary Pattern				Mixed Dietary Pattern				Healthy Dietary Pattern			
	T1	T2	T3	p	T1	T2	T3	p	T1	T2	T3	p
Age (mean±sd)	50.54± 9.87	60.42± 10.18	58.80± 9.59	0.045	56.10± 9.21	60.48± 9.94	58.18± 10.58	0.091	59.40± 10,13	59.34± 9,7	56.02± 9.98	0.156
Age category												
40-59	66.0	38.0	58.0	0.015	64.0	44.0	54.0	0.134	54.0	50.0	58.0	0.725
≥60	34.0	62.0	42.0		36.0	56.0	46.0		46.0	50.0	42.0	
Sex												
Male	64.0	52.0	38.0	0.034	48.0	60.0	46.0	0.317	42.0	54.0	58.0	0.250
Female	36.0	48.0	62.0		52.0	40.0	54.0		58.0	46.0	42.0	
Weight (kg)	44.14± 1.17	49.93± 4.14	60.24± 5.43	0,000	49.85± 6.32	52.21± 9.40	52.25± 7.17	0.211	51.02± 7.38	52.27± 7.81	51.44± 7.77	0.657
Height (cm)	159.86± 3.57	164.48± 4.02	163.58± 9.47	0.001	163.36 ± 7.05	160.90 ± 6.65	163.66± 5.56	0.069	163.26± 6,85	162.48± 7.06	162.1± 5.78	0.700
BMI (kg/m2)	17.29± 0.68	18.47± 1.57	22.69± 2.93	0.000	18.67± 1.81	20.24± 3.87	19.53± 2.72	0.034	19.15± 2.63	19.87± 3.33	19.42± 3.10	0.484
Illness duration												
≤ 5 years	40.0	28.0	36.0	0.439	44.0	28.0	32.0	0.216	36.0	22.0	46.0	0.040
>5 years	60.0	72.0	64.0		56.0	72.0	68.0		64.0	78.0	54.0	
Waist circumference (cm)	79.26±0.86	81.75± 1.04	89.96± 4.51	0.000	82.84± 4.92	82.01± 5.79	84.11± 5.32	0.419	83.44± 5.17	83.96± 5.58	83.56± 5.29	0.877
Hip circumference(cm)	93.96±2.57	98.13± 0.56	102.32± 3.74	0.000	97.64± 4.55	98.9± 4.32	98.70± 4.06	0.470	98.21± 3.82	98.11± 4.18	98.11± 4.94	0.992
Waist Hip Ratio	0.84± 0.03	0.83± 0.03	0.87± 0.05	0.000	0.84± 0.03	0.86± 0.05	0.85± 0.04	0.464	0.84± 0.03	0.86± 0.04	0.85± 0.04	0.483

% Body fat	22.80±1.60	29.19± 1.85	35.18± 3.17	0.000	27.70± 5.02	29.51± 6.18	29.95± 5.28	0.101	28.88± 5.76	29.46± 5.92	28.83± 5.06	0.824
Muscle Mass Index(kg/m²)	7.50± 1.78	7.17± 1.29	6.98± 1.66	0.254	7.53± 1.74	7.14± 1.54	6.98± 1.48	0.217	6.92± 1.30	7.05± 1.71	7.68± 1.66	0.037
Muscle strength (kg)	23.15± 3.37	22.43± 4.15	20.51± 3.83	0.512	22.17± 4.03	22.07± 3.47	21.53± 4.17	0.537	20.71± 3.62	21.72± 3.74	23.56± 3.95	0.001
Walking speed (m/s)	0.87± 0.29	0.89± 0.34	0.93± 0.24	0.570	0,.93± 0.27	0.87± 0.28	0.89± 0.32	0.537	1.22± 0.21	0.83± 0.13	0.63± 0.14	0.000
Physical activity												
Less	46.0	34.0	42.0		40.0	42.0	40.0		34.0	58.0	30.0	
Moderate	10.0	20.0	12.0	0.567	10.0	14.0	18.0	0.816	18.0	4.0	20.0	0.018
Good	44.0	46.0	46.0		50.0	44.0	42.0		48.0	38.0	50.0	
HbAIc Levels (%)	7.30± 0.78	7.35±0.87	7.42± 0.80	0.790	7.53± 0.84	7.20± 0.73	7.33± 0.85	0.131	8.16± 0.58	7.27± 0. 43	6.63± 0.55	0.000
Fasting blood glucose(FPG) (mg/dl)	148.96± 20.59	151.94± 23.15	152.30± 21.56	0.703	152.34 ±21.04	151.12 ± 22.73	149.74± 21.65	0.837	174.26± 10.83	150.94± 9.42	128.00± 11.56	0.000
Blood sugar 2 hours post-prandial(mg/dl)	247.58± 59.08	248.96± 54.83	265.24± 61.97	0.250	258.82 ± 58.21	250.72 ± 56.81	252.24± 62.29	0.768	264.58± 35.57	261.40± 32.24	195.80± 41.55	0.000

Metformin consumption (%)												
Consumed	56.0	58.0	44.0	0.317	56.0	52.0	50.0	0.829	50.0	42.0	66.0	0.050
Not consumed	44.0	42.0	56.0		44.0	48.0	50.0		50.0	58.0	34.0	
Total intake												
Energy (kkal)	869.50± 26.93	1136.59± 35.47	1749.95 ± 43.06	0.000	1173.08 ± 61.53	1295.27± 65.69	1287.69± 62.15	0.312	1276.68± 65.40	1251,28 ± 62.85	1228.08 ± 62.47	0.864
Protein (gr)	50.51± 1.95	49.76± 2.03	48.08± 1.73	0.656	50.53± 1.81	47.60± 1.91	50.21± 1.98	0.494	37.66± 0.98	46.73± 1.04	63.95± 1.30	0.000
Fat (gr)	21.44± 0.95	36.18± 0.56	46.70± 1.47	0.000	32.36± 1.79	35.22± 1.78	36.74±1.84	0.023	35.88± 1.73	34.60± 1.84	33.84± 1.86	0.726
Carbohydrate (gr)	179.82± 3.85	212.60± 2.27	264.54± 4.89	0.000	207.54 ± 6.02	221.57 ± 6.42	227.84± 6.03	0.042	225.19± 5.78	216.97± 7.12	214.80± 5.74	0.466

*The value is presented as % for category variables or mean ± SD for continuous variables; *The p value is obtained from the chi-square test for category variables and the anova test for continuous variable.*

Table 3 shows the characteristics of study subjects across categories of dietary tertile. The highest tertile (T3) of the three dietary patterns was dominated by study subjects who had suffered from type II diabetes mellitus > 5 years. Significant differences were found between tertiles related to weight, height, and nutritional status in dietary pattern I (unhealthy dietary pattern). In contrast to this dietary pattern, there were no significant differences between tertiles related to weight, height, and nutritional status in dietary pattern 2(mixed dietary pattern) and dietary pattern 3 (healthy dietary pattern). Table 3 also reveals differences in average energy, protein, fat, and carbohydrate intake between tertile categories of each dietary pattern.

Table 4. Risk Estimation For Sarcopenia and Its Components Across Tertile Dietary Patterns

Variables		Unhealthy Dietary Pattern		Mixed Dietary Pattern		Healthy Dietary Pattern	
		Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Low Muscle Mass Index	T1	1	1	1	1	1	1
	T2	1.085 (0.491-2.395)	1.146 (0.244-5.382)	1.273 (0.579-2.795)	1.290 (0.303-5.502)	0.444 (0.199-0.989)	0.542 (0.162-1.807)
	T3	1.496 (0.679-3.294)	1.969 (0.468-8.282)	1.000 (0.454-2.203)	1.342 (0.329-5.474)	0.345 (0.153-0.777)	0.674 (0.192-2.367)
	p	0.569	0.442	0.786	0.641	0.024	0.000
Low muscle strengths	T1	1	1	1	1	1	1
	T2	1.084 (0.493-2.384)	1.180 (0.265-5.252)	1,287 (0.575-2.881)	1.040 (0.290-3.727)	0.663 (0.302-1.472)	0.880 (0.241-3.209)
	T3	1.379 (0.628-3.029)	1.412 (0.357-5.585)	1.090 (0.484-2.455)	1.157 (0.303-4.421)	0.351 (0.152-0.814)	0.510 (0.132-1.972)
	p	0.706	0.519	0.822	0.732	0.044	0.000
Low-speed walking	T1	1	1	1	1	1	1
	T2	1.278 (0.578-2.825)	1.383 (0.236-8.083)	1,381 (0.627-3.040)	1.120 (0.273-4.590)	0.568 (0.257-1.256)	0.607 (0.122-3.015)
	T3	1.385 (0.627-3.058)	1.953 (0.356-10.712)	1.000 (0.452-2.213)	1.417 (0.349-5.762)	0.343 (0.152-0.775)	0.589 (0.120-2.897)
	p	0.703	0.489	0.650	0.571	0.032	0.000
Sarcopenia	T1	1	1	1	1	1	1
	T2	1.282 (0.577-2.849)	1.307 (0.239-7.146)	1.278 (0.578-2.852)	1.194 (0.311-4.589)	0.615 (0.279-1.359)	0.701 (0.083-5.903)
	T3	1.390 (0.626-3.084)	1.508 (0.305-7.452)	1.086 (0.489-2.411)	1.297 (0.341-4.931)	0.375 (0.167-0.842)	0.584 (0.070-4.865)
	p	0.700	0.612	0.827	0.704	0.032	0.000

Table 4 shows the Odds Ratio (OR) for sarcopenia and its components across tertile dietary patterns. The highest tertile of an unhealthy dietary pattern has a greater chance of sarcopenia incidence than other tertiles. There was no significant association with sarcopenia in mixed dietary patterns. A healthy dietary pattern has a lower chance of developing sarcopenia and its components.

In this study, three main dietary patterns were identified using factor analysis techniques: dietary pattern 1 (unhealthy dietary pattern), dietary pattern 2 (mixed diet pattern), and dietary pattern 3 (healthy dietary pattern). The study found no significant association between dietary

pattern 1 (unhealthy dietary pattern) and the incidence of sarcopenia, even after controlling for potential confounders such as gender, age, nutritional status, physical activity, duration/length of suffering from type II diabetes mellitus, HbA1C levels, and metformin consumption habits. This dietary pattern is similar to the Western dietary pattern and is known to have a high content of fast food, sweet foods, oily foods, and alcohol consumption, which can reduce muscle mass, and strength, and increase inflammatory mediators (Bagheri et al., 2021).

Dietary pattern 2 (mixed dietary pattern) is characterized by high levels of consumption of rice/flour/corn products, root crops, light-colored vegetables, meat, poultry, animal organs, and processed fruits. However, adherence to this pattern was not associated with a decrease in the likelihood of sarcopenia even after adjusting for confounding variables (Ganapathy & Nieves, 2020). Several previous studies have shown that animal protein as a source of essential amino acids did not significantly affect the increase in muscle mass (Granic et al., 2020) and that diets high in saturated fat can influence the occurrence of sarcopenia due to increased catabolism such as inflammation and oxidative stress as well as fat accumulation leading to muscle aging (Enos et al., 2013).

In contrast to dietary pattern 1 and dietary pattern 2, adherence to dietary pattern 3 (healthy dietary pattern) was found to significantly reduce the likelihood of sarcopenia, even after adjusting for other possible confounding variables. This healthy diet pattern is similar to the Mediterranean diet, and several studies have reported positive effects on reducing the risk of chronic diseases such as diabetes mellitus (Bagheri et al., 2021). Results from this study also showed that participants who consumed fruits, nuts, and dairy daily had a lower risk of sarcopenia. Fruits and nuts provide abundant antioxidants, which can contribute to reducing oxidative stress and preventing or reducing muscle breakdown (Nishikawa et al., 2021). Legumes are also rich in vegetable proteins, unsaturated fatty acids, phytochemicals, vitamins, and minerals, which may act synergistically to prevent and manage sarcopenia in older adults (Del Río-Celestino & Font, 2020). Therefore, plant-derived protein can be the most appropriate source to meet protein requirements in older adults with or at risk of type II diabetes mellitus (Göbl & Tura, 2022).

The study also examined the relationship between diet and the three components of sarcopenia by comparing the average levels of those components across the tertiles of each diet. In this study found no significant relationship between unhealthy dietary pattern and mixed dietary pattern with low muscle mass index, muscle strength and walking speed even after adjusting for confounding variables. However, in the case of healthy dietary pattern the direction of the relationship is significant as expected. Muscle mass index, muscle strength, and walking speed increase with more adherence to the diet. A longitudinal study found that greater adherence to a "westernized" dietary pattern was associated with an increased risk of muscle mass, lower muscle strength and slow walking speed, after a three-and-a-half-year follow-up period (Talegawkar et al., 2012). In another study, men with a diet high in red meat had poorer physical performance than those with a low meat pattern (Oh et al., 2014).

The study also found that animal protein intake was not significantly associated with sarcopenia, and in fact, a diet high in animal protein was found to have an insignificant association with sarcopenia. However, animal protein intake was associated with an increased risk of overall type 2 diabetes mellitus compared to vegetable protein intake. Foods high in saturated fats, such as red meat and butter, were found to increase the prevalence of sarcopenia compared to a relatively healthy diet of unsaturated fats, olive oil, and vegetable fats.

Dietary pattern 3 (healthy dietary pattern) as a whole is better in maintaining muscle mass, muscle strength, and walking speed than diet pattern 1 (unhealthy dietary pattern) and dietary pattern 2 (mixed dietary pattern). A cross-sectional study found that in women, higher fruit and vegetable variation scores were associated with higher mid-arm muscle areas (Kojima

et al., 2015). Another cross-sectional study found that adherence to healthy dietary patterns such as the Mediterranean dietary was associated with better muscle mass outcomes in women, but not in men (Shahar et al., 2012). The intake of alkaline-producing foods such as fruits and vegetables contained in this dietary pattern is also known to prevent acidosis and as a consequence maintain muscle mass and strength during aging and prevent the possibility of sarcopenia (Papadopoulou et al., 2023). One cross-sectional study found a healthier diet was significantly associated with higher hand grip strength in women but not men. A healthier variety of foods is associated with a lower risk of decreased grip strength in the future (Bollwein et al., 2013). High adherence to healthy dietary patterns such as the Mediterranean has also been linked to better walking speed, better physical function, and a slower decline in mobility over time (Bagheri et al., 2021)Two cross-sectional studies found a link between adherence to healthy dietary patterns such as the Mediterranean diet and faster walking speed (better physical performance)(León-Muñoz et al., 2015)(Xu et al., 2012). A healthier variety of foods was also associated with a lower risk for a decrease in walking speed in the future (Bollwein et al., 2013)

Strengths and limitations. This study supports further information about the relationship between dietary patterns and the incidence of sarcopenia in people with type 2 diabetes mellitus in adult and elderly populations. The limitations in this study are first, the nature of the cross-sectional study limits the ability to generalize the results of this study. Second, due to budget constraints, researchers used BIA for muscle mass estimation, while computerized tomography (CT scan), magnetic resonance imaging (MRI) and dual-energy X-ray absorptiometry (DEXA) were more accurate than BIA. Nevertheless, this method is considered a valid and reliable method and is generally applied in previous studies. Third, it should also be remembered that loss of muscle mass and muscle strength is different in men and women, so an accurate gender stratification analysis is needed to determine the relationship between dietary patterns with muscle mass and muscle strength. However, due to the small sample size and given that separating the sexes in the analysis resulted in a small number of people in each category, researchers did not conduct such an analysis.

4. CONCLUSION

It has been found that dietary patterns can play a crucial role in managing sarcopenia in patients with type II diabetes mellitus. Studies have shown that a healthy diet has a protective relationship with sarcopenia and its components. However, there is no relationship between an unhealthy dietary pattern and a mixed dietary pattern with sarcopenia and its components. There is a higher chance of sarcopenia incidence with these dietary patterns.

This study suggests that a healthy dietary pattern, similar to the Mediterranean diet, can help prevent or reduce the risk of sarcopenia in older adults. Plant-derived protein may be the most appropriate source to ascertain protein requirements in older adults with or at risk of type II diabetes mellitus. Fruits, nuts, and legumes provide abundant antioxidants and nutrients that can contribute to reducing oxidative stress and preventing or reducing muscle breakdown.

ACKNOWLEDGMENTS

The authors express their gratitude to the Ministry of Health of the Republic of Indonesia, specifically the directorate general of health workers, as well as the Belu district government in NTT for their support in the author's achievement of the M.Gizi degree. In addition, the author was also given scholarships by the Ministry of Health of the Republic of Indonesia through the Directorate General of Health Workers.

REFERENCES

Bagheri, A., Hashemi, R., Heshmat, R., Motlagh, A. D., & Esmaillzadeh, A. (2021). Patterns of nutrient intake in relation to sarcopenia and its components. *Frontiers in Nutrition*, *8*, 645072. https://doi.org/10.3389/fnut.2021.645072

Bollwein, J., Diekmann, R., Kaiser, M. J., Bauer, J. M., Uter, W., Sieber, C. C., & Volkert, D. (2013). Dietary quality is related to frailty in community-dwelling older adults. *Journals of Gerontology - Series A Biological Sciences and Medical Sciences*, *68*(4), 483–489. https://doi.org/10.1093/gerona/gls204

Borba, V. Z. C., Costa, T. L., Moreira, C. A., & Boguszewski, C. L. (2019). Mechanisms of Endocrine Disease: Sarcopenia in endocrine and non-endocrine disorders. *European journal of endocrinology*, *180*(5), R185-R199. https://doi.org/10.1530/EJE-18-0937

Carolina, & Wahju, E. H. (2020). Kajian Agroekologi terhadap Strategi Pemenuhan Kebutuhan Pangan Masyarakat di Kabupaten Belu Nusa Tenggara Timur. *Pangan*, *25*(2), 83–94.

Chen, L. K., Woo, J., Assantachai, P., Auyeung, T. W., Chou, M. Y., Iijima, K., Jang, H. C., Kang, L., Kim, M., Kim, S., Kojima, T., Kuzuya, M., Lee, J. S. W., Lee, S. Y., Lee, W. J., Lee, Y., Liang, C. K., Lim, J. Y., Lim, W. S., … Arai, H. (2020). Asian Working Group for Sarcopenia: 2019 Consensus Update on Sarcopenia Diagnosis and Treatment. *Journal of the American Medical Directors Association*, *21*(3), 300-307.e2. https://doi.org/10.1016/j.jamda.2019.12.012

Chen, X., Hou, L., Zhang, Y., & Dong, B. (2021). Analysis of the Prevalence of Sarcopenia and Its Risk Factors in the Elderly in the Chengdu Community. *Journal of Nutrition, Health and Aging*, *25*(5), 600–605. https://doi.org/10.1007/s12603-020-1559-1

Cruz-Jentoft, A. J., Bahat, G., Bauer, J., Boirie, Y., Bruyère, O., Cederholm, T., Cooper, C., Landi, F., Rolland, Y., Sayer, A. A., Schneider, S. M., Sieber, C. C., Topinkova, E., Vandewoude, M., Visser, M., Zamboni, M., Bautmans, I., Baeyens, J. P., Cesari, M., … Schols, J. (2019). Sarcopenia: Revised European consensus on definition and diagnosis. In *Age and Ageing* (Vol. 48, Issue 1, pp. 16–31). Oxford University Press. https://doi.org/10.1093/ageing/afy169

Del Río-Celestino, M., & Font, R. (2020). The health benefits of fruits and vegetables. *Foods*, *9*(3), 1–4. https://doi.org/10.3390/foods9030369

Dominguez, L. J., Veronese, N., Baiamonte, E., Guarrera, M., Parisi, A., Ruffolo, C., ... & Barbagallo, M. (2022). Healthy aging and dietary patterns. *Nutrients*, *14*(4), 889. https://doi.org/10.3390/nu14040889

Enos, R. T., Davis, J. M., Velázquez, K. T., McClellan, J. L., Day, S. D., Carnevale, K. A., & Murphy, E. A. (2013). Influence of dietary saturated fat content on adiposity, macrophage behavior, inflammation, and metabolism: Composition matters. *Journal of Lipid Research*, *54*(1), 152–163. https://doi.org/10.1194/jlr.M030700

Ganapathy, A., & Nieves, J. W. (2020). *Nutrition and Sarcopenia—What Do We Know?12*(6), 1755. https://doi.org/10.3390/nu12061755

Göbl, C., & Tura, A. (2022). Focus on Nutritional Aspects of Sarcopenia in Diabetes: Current Evidence and Remarks for Future Research. *Nutrients*, *14*(2), 1–7. https://doi.org/10.3390/nu14020312

Granic, A., Jagger, C., Davies, K., Adamson, A., Kirkwood, T., Hill, T. R., Siervo, M., Mathers, J. C., & Sayer, A. A. (2016). Effect of dietary patterns on muscle strength and physical performance in the very old: Findings from the newcastle 85+ study. *PLoS ONE*, *11*(3), 1–17. https://doi.org/10.1371/journal.pone.0149699

Granic, A., Mendonça, N., Sayer, A. A., Hill, T. R., Davies, K., Siervo, M., Mathers, J. C., & Jagger, C. (2020). Effects of dietary patterns and low protein intake on sarcopenia risk in

the very old: The Newcastle 85+ study. *Clinical Nutrition*, *39*(1), 166–173. https://doi.org/10.1016/j.clnu.2019.01.009

Kementerian Kesehatan RI. (2014). *Peraturan Menteri Kesehatan Republik Indonesia Nomor 41 Tentang Pedoman Gizi Seimbang*. Jakarta: Kementerian Kesehatan Republik Indonesia

Kojima, N., Kim, M., Saito, K., Yoshida, H., Yoshida, Y., Hirano, H., Obuchi, S., Shimada, H., Suzuki, T., & Kim, H. (2015). Lifestyle-related factors contributing to decline in knee extension strength among elderly women: A cross-sectional and longitudinal cohort study. *PLoS ONE*, *10*(7), 1–13. https://doi.org/10.1371/journal.pone.0132523

León-Muñoz, L. M., García-Esquinas, E., López-García, E., Banegas, J. R., & Rodríguez-Artalejo, F. (2015). Major dietary patterns and risk of frailty in older adults: A prospective cohort study. *BMC Medicine*, *13*(1), 1–9. https://doi.org/10.1186/s12916-014-0255-6

Mayhew, A. J., Amog, K., Phillips, S., Parise, G., McNicholas, P. D., De Souza, R. J., ... & Raina, P. (2019). The prevalence of sarcopenia in community-dwelling older adults, an exploration of differences between studies and within definitions: a systematic review and meta-analyses. *Age and ageing*, *48*(1), 48-56. https://doi.org/10.1093/ageing/afy106

Nishikawa, H., Fukunishi, S., Asai, A., Yokohama, K., Ohama, H., Nishiguchi, S., & Higuchi, K. (2021). Sarcopenia, frailty and type 2 diabetes mellitus (Review). *Molecular Medicine Reports*, *24*(6), 1–8. https://doi.org/10.3892/mmr.2021.12494

Nugraha, G. (2022). *Teknik Pengambilan dan Penanganan Spesimen Darah Vena Manusia untuk Penelitian*. LIPI Press.

Oh, C., No, J. K., & Kim, H. S. (2014). Dietary pattern classifications with nutrient intake and body composition changes in Korean elderly. *Nutrition Research and Practice*, *8*(2), 192–197. https://doi.org/10.4162/nrp.2014.8.2.192

Omage, K., & Omuemu, V. O. (2018). Assessment of dietary pattern and nutritional status of undergraduate students in a private university in southern Nigeria. *Food Science and Nutrition*, *6*(7), 1890–1897. https://doi.org/10.1002/fsn3.759

Papadopoulou, S. K., Detopoulou, P., Voulgaridou, G., Tsoumana, D., Spanoudaki, M., Sadikou, F., Papadopoulou, V. G., Zidrou, C., Chatziprodromidou, I. P., Giaginis, C., & Nikolaidis, P. (2023). Mediterranean Diet and Sarcopenia Features in Apparently Healthy Adults over 65 Years: A Systematic Review. *Nutrients*, *15*(5), 1–17. https://doi.org/10.3390/nu15051104

Shahar, D. R., Houston, D. K., Hue, T. F., Lee, J. S., Sahyoun, N. R., Tylavsky, F. A., Geva, D., Vardi, H., & Harris, T. B. (2012). Adherence to mediterranean diet and decline in walking speed over 8 years in community-dwelling older adults. *Journal of the American Geriatrics Society*, *60*(10), 1881–1888. https://doi.org/10.1111/j.1532-5415.2012.04167.x

Shaikh, N., Harshitha, R., & Bhargava, M. (2020). Prevalence of sarcopenia in an elderly population in rural South India: a cross-sectional study. *F1000Research*, *9*, 175. https://doi.org/10.12688/f1000research.22580.1

Shang, X., Scott, D., Hodge, A. M., English, D. R., Giles, G. G., Ebeling, P. R., & Sanders, K. M. (2016). Dietary protein intake and risk of type 2 diabetes: Results from the Melbourne Collaborative Cohort Study and a meta-analysis of prospective studies. *American Journal of Clinical Nutrition*, *104*(5), 1352–1365. https://doi.org/10.3945/ajcn.116.140954

Snetselaar, L. G., de Jesus, J. M., DeSilva, D. M., & Stoody, E. E. (2021). Dietary Guidelines for Americans, 2020-2025: Understanding the Scientific Process, Guidelines, and Key Recommendations. *Nutrition today*, *56*(6), 287–295. https://doi.org/10.1097/NT.0000000000000512

Sun, T., Ma, Z., Gao, L., Wang, Y., & Xie, H. (2021). Correlation between Sarcopenia and Arteriosclerosis in Elderly Community Dwellers: A Multicenter Study. *Journal of Nutrition, Health and Aging*, *25*(5), 692–697. https://doi.org/10.1007/s12603-021-1624-4

Syauqy, A., Hsu, C. Y., Rau, H. H., & Chao, J. C. J. (2018a). Association of dietary patterns, anthropometric measurements, and metabolic parameters with C-reactive protein and neutrophil-to-lymphocyte ratio in middle-aged and older adults with metabolic syndrome in Taiwan: A cross-sectional study. *Nutrition Journal*, *17*(1), 1–12. https://doi.org/10.1186/s12937-018-0417-z

Syauqy, A., Hsu, C. Y., Rau, H. H., & Chao, J. C. J. (2018b). Association of dietary patterns with components of metabolic syndrome and inflammation among middle-aged and older adults with metabolic syndrome in Taiwan. *Nutrients*, *10*(2), 1–12. https://doi.org/10.3390/nu10020143

Talegawkar, S. A., Bandinelli, S., Bandeen-Roche, K., Chen, P., Milaneschi, Y., Tanaka, T., Semba, R. D., Guralnik, J. M., & Ferrucci, L. (2012). A higher adherence to a mediterranean-style diet is inversely associated with the development of frailty in community-dwelling elderly men and women. *Journal of Nutrition*, *142*(12), 2161–2166. https://doi.org/10.3945/jn.112.165498

Tan, V. M. H., Pang, B. W. J., Lau, L. K., Jabbar, K. A., Seah, W. T., Chen, K. K., Ng, T. P., & Wee, S. L. (2021). Malnutrition and Sarcopenia in Community-Dwelling Adults in Singapore: Yishun Health Study. *Journal of Nutrition, Health and Aging*, *25*(3), 374–381. https://doi.org/10.1007/s12603-020-1542-x

VandeBunte, A., Gontrum, E., Goldberger, L., Fonseca, C., Djukic, N., You, M., ... & Casaletto, K. B. (2022). Physical activity measurement in older adults: Wearables versus self-report. *Frontiers in Digital Health*, *4*, 869790. https://doi.org/10.3389/fdgth.2022.869790Wang, T., Feng, X., Zhou, J., Gong, H., Xia, S., Wei, Q., Hu, X., Tao, R., Li, L., Qian, F., & Yu, L. (2016). Type 2 diabetes mellitus is associated with increased risks of sarcopenia and pre-sarcopenia in Chinese elderly. *Scientific Reports*, *6*. https://doi.org/10.1038/srep38937

Xu, B., Houston, D. K., Locher, J. L., Ellison, K. J., Gropper, S., Buys, D. R., & Zizza, C. A. (2012). Higher healthy eating index-2005 scores are associated with better physical performance. *Journals of Gerontology - Series A Biological Sciences and Medical Sciences*, *67 A*(1), 93–99. https://doi.org/10.1093/gerona/glr159

Yakout, S. M., Alkahtani, S. A., Al-Disi, D., Aljaloud, K. S., Khattak, M. N. K., Alokail, M. S., Reginster, J. Y., Sabico, S., & Al-Daghri, N. M. (2019). Coexistence of Pre-sarcopenia and Metabolic Syndrome in Arab Men. *Calcified Tissue International*, *104*(2), 130–136. https://doi.org/10.1007/s00223-018-0477-2