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Assessment of the risk of sarcopenia in individuals with type 2 diabetes

Avaliação do risco de sarcopenia em pacientes diabéticos tipo 2

Abstract

Introduction: Individuals with diabetes often experience an accentuated loss of muscle mass and strength. Thus, the SARC-F and SARC-CALF screening tools are useful for the investigation of the risk of sarcopenia. ***Objective***: Associate the risk of sarcopenia with sociodemographic, economic, clinical, anthropometric and lifestyle variables in individuals with diabetes. ***Methods***: A case-series study was conducted involving male and female adults with type 2 diabetes between 20 and 59 years of age. The assessment of the risk of diabetes was performed using the SARC-F and SARC-CALF instruments. Data were collected on sociodemographic-economic variables, anthropometric measures, clinical conditions and lifestyle for the characterization of the sample and to test associations with the risk of sarcopenia. ***Results***: The sample was composed of 69 patients, with a mean age of 53 ± 7.5 years and a predominance of women (63.8%; 95%CI: 50.7-75.4). The prevalence of risk of sarcopenia was 43.48% and 46.38% based on the SARC-F and SARC-CALF, respectively. Using the SARC-F, no significant associations were found with the variables of interest. Using the SARC-CALF, however, the risk of sarcopenia was associated with body mass index ($p < 0.001$), waist circumference ($p < 0.001$) and smoking habit ($p = 0.027$). ***Conclusion***: Approximately half of the individuals analyzed were at risk of sarcopenia. The SARC-CALF questionnaire was associated with anthropometric variables and the smoking habit and can be considered adequate for the assessment of the risk of sarcopenia, enabling early, effective interventions.

Keywords: Sarcopenia. Type 2 diabetes *mellitus*. Adults.

Resumo

Introdução: Diabéticos podem apresentar perda de força e massa muscular de forma acentuada. Assim, as triagens SARC-F e SARC-CALF são úteis na investigação do risco de sarcopenia. ***Objetivo***: Associar o risco de sarcopenia em pacientes diabéticos com as variáveis sociodemográficas, econômicas, clínicas, antropométricas e de estilo de vida. ***Método***: Estudo do tipo série de casos realizado com adultos diabéticos tipo 2, de ambos os sexos, com idade entre 20 e 59 anos. A avaliação do risco de sarcopenia se deu pela aplicação dos questionários SARC-F e SARC-CALF. Para caracterização da amostra e associação com o risco de sarcopenia, foram coletados dados sociodemográficos e econômicos, medidas antropométricas, condições clínicas e estilo de vida. ***Resultados***: A amostra foi composta por 69 pacientes, com média de idade de 53±7,5 anos e maior proporção de mulheres (63,8%; IC95%: 50,7-75,4). A frequência do risco positivo para sarcopenia segundo o SARC-F e o SARC-CALF foi de 43,48% e 46,38%, respectivamente. O SARC-F não mostrou associação significativa com as variáveis estudadas; já o SARC-CALF associou-se com índice de massa corporal ($p < 0,001$), circunferência da cintura ($p < 0,001$) e hábito de fumar ($p = 0,027$). ***Conclusão***: O risco de sarcopenia foi observado em aproximadamente metade dos

pacientes avaliados. O instrumento SARC-CALF apresentou associação com as variáveis antropométricas e o hábito de fumar, podendo ser considerado satisfatório para avaliar o risco de sarcopenia e intervir de forma precoce e efetiva.

Palavras-chave: Sarcopenia. Diabetes *Mellitus* tipo 2. Adultos.

INTRODUCTION

Sarcopenia is defined as a generalized, progressive muscle disorder in which low strength and muscle depletion are the main determinants for the diagnosis. This condition is associated with a greater likelihood of adverse health outcomes, such as falls, fractures and physical disability, as well as a reduction in quality of life and a greater risk of mortality.[1]

For many years, sarcopenia was considered inherent to the aging process. Currently, however, different causal factors are recognized, such as physical inactivity, smoking and inadequate calorie and protein intake, affecting a large number of individuals irrespective of the age group.[2,3]

Individuals with specific chronic diseases, such as diabetes *mellitus*, have more a more accentuated loss of muscle strength and mass compared to individuals without this disease regardless of age. Although the mechanism that correlates diabetes with sarcopenia has not yet been fully clarified, evidence suggests that insulin resistance is one of the main causes that lead to muscle loss, as the deficiency in the production and activity of this hormone promotes catabolic action.[4]

Although the literature describes an increased risk of muscle loss in individuals with diabetes, the early diagnosis of sarcopenia in this population remains a difficult task. Thus, screening tools for identifying the risk of sarcopenia could provide a simple, easily applied method for the diagnosis of the loss of muscle mass.

The European Working Group on Sarcopenia in Older People (EWGSOP 2) proposes the use of the SARC-F questionnaire as a rapid screening method for the condition. This tool addresses muscle strength and function (strength, walking ability, standing up from a chair, climbing stairs and number of falls) and is also capable of predicting functional impairment, hospitalization, quality of life and mortality.[5]

The SARC-F is the most widely employed screening tool to date. Despite its high specificity, the sensitivity of the SARC-F is low in some samples and can fail to diagnosis the condition in certain individuals.[6] With the aim of improving the instrument in order to obtain more sensitive results, Barbosa-Silva et al.[7] incorporated the measurement of calf circumference (CC) to the original questionnaire for a more discerning assessment of muscle function and the loss of lean mass, enabling the early diagnosis of sarcopenia.[8]

Studies conducted for the identification of the risk of sarcopenia in adults with diabetes are scarce in the literature. Therefore, the aim of the present study was to determine the prevalence of the risk of sarcopenia in adults with type 2 diabetes *mellitus* using the SARC-F and SARC-CALF instruments and test associations with sociodemographic, economic, clinical, anthropometric and lifestyle variables.

METHODS

A case-series study was conducted with a non-probabilistic convenience sample of individuals diagnosed with type 2 diabetes *mellitus* under care at the nutrition outpatient clinic of the endocrinology sector of the hospital affiliated with *Universidade Federal de Pernambuco* [Federal University of Pernambuco] between the months of March and August 2022. The inclusion criteria were adults between 20 and 59 years of age, both sexes, able to undergo the anthropometric assessment and a previous diagnosis of type 2 diabetes *mellitus* based on the values recommended by the *Sociedade Brasileira de Diabetes* [Brazilian Diabetes Society].[9] Bedridden individuals, those with chronic kidney, liver or heart failure, those with neuromuscular diseases, pregnant women, individuals with a past history of stroke with motor sequelae, those with malignant neoplasms and those with physical disabilities that would impede the anthropometric assessment were considered ineligible. Following the application of the eligibility criteria, the final sample comprised 69 individuals.

The following data were collected through interviews with the participants and were recorded on a specific form created by the researchers: age, sex, skin color, schooling in years of study (> or < 10 years), family income (using the monthly minimum wage as reference) and place of residence (capital city/metropolitan region or in-state region).

The anthropometric variables of interest were current weight (kg), height (cm), waist circumference (WC) and calf circumference (CC). Weight and height were determined using the original method recommended by Lohman et al.[10] and were used for the calculation of the body mass index (BMI) (kg/m^2),[11] with subsequent classification as follows: BMI ≤ 24.9 kg/m^2 without excess weight and BMI ≥ 24.9 kg/m^2 with excess weight. Weight was measured with the participant standing erect and barefoot in light clothing on the platform of the Welmy® scale, which has a precision of 100 g and maximum capacity of 200 kg. Height was measured using a stadiometer, with the participant standing erect, arms alongside the body, heels together forming a straight vertical angle with the stadiometer and the occipital and gluteal regions in contact with the ruler of the stadiometer. WC was measured following the recommendation of the World Health Organization at the approximate midpoint between the lower edge of the last palpable rib and the top of the iliac crest.[12] WC ≥ 80 cm and ≥ 94 cm was considered high and indicative of cardiovascular risk in women and men, respectively. CC was measured with the leg bent, forming a 90-degree angle with the knee. CC less than 33 cm for women and 34 cm for men was considered indicative of risk for sarcopenia.[7] All anthropometric measures were performed twice by the same researcher. A third measurement was made if a difference was found between the first two measurements and two closest measurements were used for the calculation of the mean.

The clinical data of interest were the presence of other chronic diseases concomitant with diabetes, time elapsed since the diagnosis of diabetes and chronic use of antihypertensive, oral anti-hyperglycemic agents and insulin. These data were collected through interviews with the participants and complemented with the electronic patient records.

The lifestyle variables of interest were physical activity level and smoking habit. Physical activity level was determined using the short form of the International Physical Activity Questionnaire,[13] which addresses leisure time, moving from place to place, housework and occupational activities. Sedentary behavior, walking and physical activities of moderate and vigorous intensity were investigated and the participants were subsequently classified as active or inactive. With regards to smoking habit, the participants were classified as exposed or not exposed to smoking.[14]

Screening for risk of sarcopenia was performed with the aid of the SARC-F and SARC-CALF instruments. The SARC-F addresses muscle strength, the need for assistance when walking, the capacity to stand up from a chair and climb stairs and the frequency of falls. Each item is scored from 0 to 2 points. The total ranges from 0 to 10 points, with a score ≥ 4 considered indicative of risk of sarcopenia. The SARC-CALF has the same five items as the SARC-F with the addition of CC as an assessment criterion (weight: 10). Thus, women with CC ≤ 33 cm and men with CC ≤ 34 cm (suggestive of low muscle mass) received 10 additional points to the original SARC-F score. The total SARC-CALF score ranges from 0 to 20 points and a score of ≥ 11 points was considered indicative of risk of sarcopenia.

This study received approval from the Human Research Ethics Committee of the hospital complex affiliated with *Universidade Federal de Pernambuco* in compliance with Resolution nº 466/2012 of the *Conselho Nacional de Saúde/Ministério da Saúde* [National Board of Health/Health Ministry] under protocol number 55684722.4.0000.5208.

The data were entered onto an Excel spreadsheet and data analysis was performed with the aid of the Statistical Package for the Social Sciences (SPSS version 15.0). Frequencies of the variables were calculated with respective confidence intervals (CI). The data were presented in graphs and tables. Pearson's chi-square test and Fisher's exact test were used to investigate differences between categories of the explanatory variables in relation to the outcomes. A p-value < 0.05 was considered indicative of a statistically significance difference.

RESULTS

The sample comprised 69 participants, with a predominance of women (63.8%). Mean age was 53 ± 7.5 years. White was the predominant self-declared skin color (42%). More than half of the sample had more than ten years of schooling (56.5%) and were married (60.9%). Most participants (88.4%) had a family income between one and three times the monthly minimum wage. Mean weight was 75.6 ± 21.4 kg and the majority of participants (68.1%) had BMI > 24.9 kg/m².

WC was indicative of cardiovascular risk in 75.4% and low CC was found in 52.2%. Most participants (57.9%) had two or more chronic diseases besides diabetes. Most participants took anti-hypertensive and anti-hypoglycemic medications (79.7% and 97%, respectively). In contrast, insulin use was found in only a small portion of the sample (11.6%). With regards to lifestyle, 75.4% were not exposed to smoking, but more 58% were classified as inactive (Table 1).

Table 1. Characterization of sample according to sociodemographic, anthropometric, clinical and lifestyle variables in individuals with type 2 diabetes in outpatient care at hospital affiliated with *Universidade Federal de Pernambuco* in the year 2022.

Variables	N	%	95% CI
Sociodemographic			
Sex			
Male	25	36.2	24.6–49.3
Female	44	63.8	50.7–75.4
Skin color			
White	29	42	30.4–53.6
Black	24	34.8	23.2–44.9
Brown	16	23.8	14.5–34.8
Schooling			
>10 years	39	56.5	44.9–66.7
<10 years	30	43.5	33.3–55.1
Marital status			
Single	23	33.3	23.2–46.3
Married	42	60.9	47.8–72.4
Widowed	4	5.8	1.4–11.6
Family income			
1-3 x monthly min. wage	61	88.4	79.7–95.7
3-6 x monthly min. wage	8	11.6	4.3–20.3
Place of residence			
Capital/Metropolitan region	40	58	46.4–69.6
In-state	29	42	30.4–53.6
Anthropometric			
BMI			
≤24.9	22	31.9	21.7–43.5
>24.9	47	68.1	56.5-78.3
Waist circumference			
At risk	55	75.4	65.2–85.5
Without risk	17	24.6	14.5–34.8
Calf circumference			
At risk	36	52.2	40.6–63.8
Without risk	33	47.8	36.2–59.4
Clinical			
Concomitant diseases			
None	12	17.4	8.7–27.5
1 disease	24	42.1	29.8-54.4
>2 or more diseases	33	57.9	45.6–70.2
Use of antihypertensive agents			
Yes	55	79.7	69.6–88.4
No	14	20.3	11.6–30.4
Anti-hyperglycemic agents			
Yes	67	97.1	92.8–100
No	2	2.9	0–7.2
Insulin			
Yes	8	11.6	4.3–20.3
No	61	88.4	79.7–95.7
Time since diagnosis of DM			
Up to 5 years	50	72.5	62.3–82.6
> 5 years	19	27.5	17.4–37.7

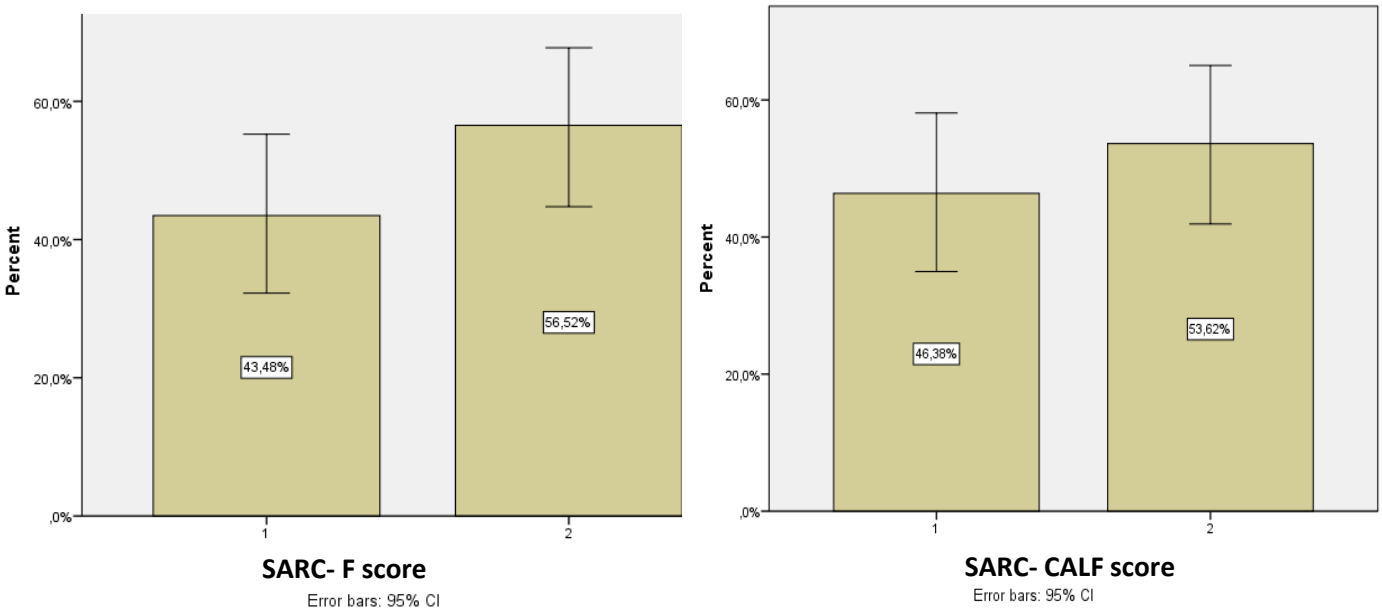
Table 1. Characterization of sample according to sociodemographic, anthropometric, clinical and lifestyle variables in individuals with type 2 diabetes in outpatient care at hospital affiliated with *Universidade Federal de Pernambuco* in the year 2022.

Variables	N	%	95% CI
Lifestyle habits			
Smoking habit			
Exposed to smoking	17	24.6	15.9–34.8
Not exposed to smoking	52	75.4	65.2–84.1
Physical activity level			
Active	29	42	29–53.6
Inactive	40	58	46.4–71

BMI = body mass index; CI = confidence interval
Source: The authors, 2022.

The risk of sarcopenia was found in 43.48% of the sample based on the SARC-F and 46.38% based on the SARC-CALF, as shown in Figure 1.

Figure 1. Frequency of risk of sarcopenia in individuals with diabetes according to SARC-F and SARC-CALF.



Source: The authors, 2022.

Associations between the instruments used to screen for the risk of sarcopenia and the variables of interest in the present study are displayed in Table 2. No significant associations were found between the SARC-F and the variables analyzed. However, when CC was incorporated (SARC-CALF), associations were found with the anthropometric variables BMI ($p < 0.001$) and WC ($p < 0.001$) as well as smoking habit ($p = 0.027$).

Table 2. Factors associated with risk of sarcopenia based on SARC-F and SARC-CALF in individuals with type 2 diabetes in outpatient care at hospital affiliated with *Universidade Federal de Pernambuco* in the year 2022.

Variables	Suggestive SARC-F	Nonsuggestive SARC-F	P	Suggestive SARC-CALF	Nonsuggestive SARC-CALF	p
Sociodemographic						
Sex			1.000			1.000
Male	11 (36.7%)	14 (35.9%)		12 (37.5%)	13 (35.1%)	
Female	19 (63.3%)	25 (61.1%)		20 (62.5%)	24 (64.9%)	
Skin color						0.536
White	15 (50%)	14 (35.9%)		12 (37.5%)	17 (45.9%)	
Black	07 (23.3%)	17 (43.6%)		12 (37.5%)	12 (32.4%)	
Brown	08 (26.7%)	08 (20.5%)		8 (25%)	8 (21.6%)	
Schooling			0.807			1.000
>10 years	16 (53.3%)	23 (59%)		18 (56.2%)	21 (56.8%)	
<10 years	14 (46.7%)	16 (41%)		14 (43.8%)	16 (43.2%)	
Marital status						0.729
Single	8 (26.7%)	15 (38.5%)		10 (31.2%)	13 (35.1%)	
Married	21 (70%)	21 (53.8%)		20 (62.5%)	22 (59.5%)	
Widowed	01 (3.3%)	-		2 (6.2%)	2 (5.4%)	
Family income			0.451			1.000
1-3 x monthly min. wage	28 (93.3%)	33 (84.6%)		28 (87.5%)	33 (89.2%)	
3-6 x monthly min. wage	2 (6.7%)	6 (15.4%)		4 (12.5%)	4 (10.8%)	
Place of residence			1.000			0.811
Capital/Metropolitan region	17 (56.7%)	23 (59%)		18 (56.2%)	22 (59.5%)	
In-state	13 (43.3%)	16 (41%)		14 (43.8%)	15 (40.5%)	
Anthropometric						
BMI			0.117			<0.001
≤24.9	13 (43.3%)	9 (23.1%)		20 (62.5%)	2 (5.4%)	
>24.9	17 (56.7%)	30 (76.9%)		12 (37.5%)	35 (94.6%)	
Waist circumference			*0.783*			*<0.001*
At risk	22 (73.3%)	30 (76.9%)		18 (56.2%)	34 (91.9%)	
Without risk	8 (26.7%)	9 (23.1%)		14 (43.8%)	3 (8.1%)	
Calf circumference			*0.332*			-
At risk	18 (60%)	18 (46.2%)		-	-	
Without risk	12 (40%)	21 (53.8%)		-	-	
Clinical						
Concomitant diseases			0.787			0.790
None	11 (45.8%)	13 (39.4%)		11 (39.3%)	13 (44.8%)	
1 disease	13 (54.2%)	20 (60.6%)		17 (60.7%)	16 (55.2%)	
Time since diagnosis of DM			0.591			0.421
Up to 5 years	23 (76.7%)	27 (69.2%)		25 (78.1%)	25 (65.6%)	
> 5 years	7 (23.3%)	12 (30.8%)		7 (21.9%)	12 (32.4%)	

Table 2. Factors associated with risk of sarcopenia based on SARC-F and SARC-CALF in individuals with type 2 diabetes in outpatient care at hospital affiliated with *Universidade Federal de Pernambuco* in the year 2022.

Variables	Suggestive SARC-F	Nonsuggestive SARC-F	P	Suggestive SARC-CALF	Nonsuggestive SARC-CALF	p
Lifestyle habits						
Smoking habit			0.783			0.027
Exposed to smoking	8 (26.7%)	9 (23.1%)		12 (37.5%)	5 (13.5%)	
Not exposed to smoking	22 (73.3%)	30 (76.9%)		20 (62.5%)	32 (86.5%)	
Physical activity level			1.000			1.000
Active	13 (43.3%)	16 (41%)		13 (40.6%)	16 (43.2%)	
Inactive	17 (56.7%)	23 (59%)		19 (59.4%)	21 (56.8%)	

BMI = body mass index; DM = diabetes mellitus
Pearson's chi-square test and Fisher's exact test
Source: The authors, 2022.

DISCUSSION

Approximately of the individuals with diabetes analyzed in the period of the investigation were at risk of sarcopenia and the prevalence of this condition was slightly higher when using the SARC-CALF instrument. A higher frequency was expected when using this instrument, as the SARC-CALF is more sensitive, according to a study conducted in China[15] that used the same instruments in a population of individuals with type 2 diabetes *mellitus*.

The literature states that the calf muscle is one of the most affected and easily depleted in individuals with uncontrolled diabetes. Thus, persistent hyperglycemia is a facilitating condition for this chronic disease due to the presence of inflammatory cytokines, which contribute to catabolic action.[16]

Although sex was not associated with the assessment tools employed in this study, the frequency of risk was higher in women compared to men when both screening tools for sarcopenia were used. According to the literature, women have a greater decline in muscle mass and a greater risk of sarcopenia in the initial stages of menopause due to the significant reduction in estrogen and other androgens with anabolic action.[17] Although the adult population was considered in this study, average age was 53 years, which may have exerted an influence on the results. Moreover, men choose answers that favor their physical capacity.[18,19]

No significant associations were found with skin color, schooling, family income or place of residence in the present investigation. In contrast, Cristaldo et al.[8] found higher mean scores among individuals from the lowest economic class irrespective of the tool used to screen for sarcopenia. Socioeconomic factors may reflect the organic functioning of individuals, which is more perceptible in older people, as those with low income and schooling can be nearly three times more dependent on others with regards to activities of daily living compared to older people with a higher income and schooling level.[20]

No associations were found between anthropometric variables and the SARC-F. According to Malmstrom et al.,[5] the SARC-F is expected to be associated with muscle functioning and is an instrument with greater specificity that is adequate for identifying individuals with muscle weakness who could benefit from treatment. However, positive associations were found with these variables when CC was incorporated (SARC-CALF). According to Peixoto et al.,[16] CC is positively associated with muscle mass and is a measure capable of estimating muscle quantity, making it a useful marker for screening for the risk of sarcopenia in a more practical manner.

In a study involving individuals with type 2 diabetes, Torres et al.[21] found the prevalence of sarcopenia to be 13.9% based on the SARC-F. However, when using CC alone as indicative of sarcopenia considering <33 cm for women and <34 cm for men, the prevalence increased to 24%, which is similar to what occurred in the present investigation.

The correlation between sarcopenia and diabetes *mellitus* is well established in the literature, as muscle is the target tissue for the uptake of glucose mediated by insulin. During the aging process, however, glucose uptake locations are less efficient. This decline initiates in the adult phase and is more prevalent in individuals with poorly controlled glycemia, as hyperglycemia is a metabolic dysfunction that can potentially damage muscle cells.[22] Thus, the resistance of skeletal muscle to the action of insulin seems to be the link between type 2 diabetes and the risk of the development of sarcopenia.[23]

These data are compatible with the results described in a study involving 35 adults and older people, in which individuals with diabetes exhibited greater loss of muscle mass, endurance and functional capacity throughout the course of the disease in comparison to those without diabetes, irrespective of age.[24]

The results of the present study expand the discussion on the risk of sarcopenia in adults with a BMI indicative of excess weight and a high waist circumference. When obesity and muscle impairment coexist, the two conditions have a synergic effect, increasing the risk of mortality as well as aggravating disability and chronic noncommunicable diseases, such as diabetes, since the increase in visceral fact is related to insulin resistance.[25]

A study conducted in southern Brazil with 327 older people found that a large portion of individuals at risk for sarcopenia had excess weight (34.3%), with a WC indicating central obesity in both sexes.[26] In another study developed in the Federal District of Brazil involving adults with and without diabetes *mellitus* (DM), those with DM had a higher WC, BMI and waist-to-hip ratio compared to those without DM and also had a lower calf circumference, demonstrating the presence of sarcopenic obesity.[27]

Although sarcopenic obesity was not the object of the present study, these findings merit attention, as both sarcopenia and obesity are associated with energy-nutritional disorders and exert a negative impact on health, increasing the risk of morbidity and mortality.[28]

Poor muscle quality is commonly described as myosteatosis, which is defined as the pathological deposition of fat (steatosis) in skeletal muscle (myo). This is a physiopathological process involving the ectopic storage of fat in muscle due to excess calorie intake or the saturation of adipose tissue and is more prevalent among older people.[29,30]

In the present study, no correlation was found between the risk of sarcopenia and physical activity level, which is compatible with results described in a previous study developed with adults in the city of Presidente Prudente, state of São Paulo, Brazil, in which no association was found between the practice of physical activity and sarcopenia in individuals of both sexes. However, an inverse association was found between the practice of physical activity and sarcopenic obesity, with a greater occurrence of aggravation in insufficiently active individuals.[31]

In contrast, Barbosa-Silva et al.[32] found a positive association between a sedentary lifestyle and sarcopenia. In the present study, we found that, irrespective of the addition of CC to the SARC-F, inactive individuals had higher scores compared to those who were physically active at work. Cristaldo et al.[8] describe similar results, reporting that the presence of disease and functional limitations that emerge with the advance in age can exert a negative impact on the performance of labor activities. Moreover, labor activities tend to cease among older individuals due to retirement.[33]

Our results show that individuals at risk of sarcopenia based on the SARC-CALF were or had been exposed to smoking. Confortin et al.[34] also found that individuals who had been or remained exposed to smoking were more likely to have sarcopenia. Indeed, this habit is considered a risk factor for the development of the condition, as smokers seem to have less muscle mass compared to non-smokers.[35,36] This may be explained by the fact that smoking causes the degradation of proteins in skeletal muscles. Thus, the pre-sarcopenic effect of smoking is related to the substantial decline in muscle mass and strength, exerting an impact on functional decline and the loss of independence.[37]

The results of this study call attention to the need to expand investigations in the field, especially with the adult population, as studies in the literature addressing the initial process of sarcopenia in younger individuals are scarce. We encourage the development of studies to enable the establishment of cause-and-effect relationships and the obtainment of more robust results.

Some limitations of the present study should be considered. The cross-sectional design limits the establishment of causal relationships. Moreover, the population of adults with diabetes was recruited from a single center and composed non-hospitalized patients. This led to a small sample size, which can limit the generalizability of the results.

However, our findings can contribute to the clinical practice of nutritionists and other professionals in the health field, as the questionnaires employed are easy to administer, inexpensive and of considerable importance to initiating the screening for sarcopenia in individuals with diabetes while still in the adult phase.

CONCLUSION

The risk of sarcopenia was found in approximately half of the individuals with type 2 diabetes *mellitus* analyzed. The SARC-CALF instrument was associated with anthropometric variables (body mass index and waist circumference) and the smoking habit and can be considered adequate and practical for the assessment of the risk of sarcopenia, as the reduction in muscle mass can be determined by calf circumference. Thus, adults with type 2 diabetes *mellitus* should be encouraged to practice physical activity and control glycemia, along with adequate calorie and protein intake.

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