Universidade Federal do Rio Grande do Sul

Faculdade de Medicina

Programa de Pós Graduação em Ciências Médicas: Endocrinologia

Prevalência de Sarcopenia e Fatores Associados em Pacientes com

Diabetes Melito tipo 2

Mauren Minuzzo de Freitas

Porto Alegre, abril de 2019

Universidade Federal do Rio Grande do Sul

Faculdade de Medicina

Programa de Pós Graduação em Ciências Médicas: Endocrinologia

Prevalência de Sarcopenia e Fatores Associados em Pacientes com

Diabetes Melito tipo 2

Dissertação apresentada como requisito parcial para a obtenção do título de Mestre em Endocrinologia à Universidade Federal do Rio Grande do Sul, Programa de Pós-Graduação em Ciências Médicas: Endocrinologia.

Orientadora: Tatiana Pedroso de Paula

Mauren Minuzzo de Freitas

Porto Alegre, abril de 2019

DEDICATÓRIA

À minha família, razão da minha vida.

AGRADECIMENTOS

Esta dissertação de mestrado segue o formato proposto pelo Programa de Pós-Graduação em Ciências Médicas: Endocrinologia: Faculdade de Medicina, Universidade Federal do Rio Grande do Sul. Será constituída de um referencial teórico e um artigo original.

SUMÁRIO

CAPÍTULO I

CAPÍTULO II

LISTA DE TABELAS E FIGURAS

LISTA DE ABREVIATURAS

ADL   Activities of Daily Living

ASM   Appendicular skeletal muscle

BIA   Eletrical bioimpedance

BMI   Body mass índex

BP   Blood pressure

CC   Calf Circumference

CP   Circunferência da panturrilha

CRP   C-reactive protein

DCNT   Doenças crônicas não transmissíveis

DEXA   Densitometria óssea/dual energy x-ray absorptiometry

DM   Diabete mellitus

ESR   Erythrocyte sedimentation rate

EWGSOP   European Working Groupon Sarcopenia in Older People

FAM   Força do aperto de mão

FFQ   Food frequency questionnaire

HbA1C   Hemoglobina glicada/glicated hemoglobin

HDL   High density lipoprotein

HS	Handgrip strength
IMM	Índice de massa muscular
IADL	Instrumental Activities of Daily Living
LDL	Low density lipoprotein
MM	Massa muscular/muscle mass
MS	Muscle strength
OMS	Organização Mundial da Saúde
PROT-AGE	International study group to review dietary protein needs with aging
SMI	Skeletal muscle mass index
SD	Standard deviation
TUG	Timed Up and Go test
UAE	Urinary albumin excretion
WC	Waist circumference
WHO	World Health Organization

RESUMO

A sarcopenia é uma condição relacionada à idade, caracterizada por perda progressiva e generalizada da massa e função do músculo esquelético (baixa força muscular e/ou baixo desempenho físico). A literatura demonstra que a sarcopenia é maior e ocorre mais precocemente em pacientes com diabetes melito (DM) tipo 2, mas sua real prevalência é desconhecida. O objetivo deste trabalho foi avaliar a prevalência de sarcopenia e fatores associados em pacientes idosos (≥60 anos) que apresentam DM tipo 2. O presente estudo transversal foi realizado no Hospital de Clínicas de Porto Alegre (HCPA) entre 2017 e 2018, com triagem de pacientes do serviço de endocrinologia do hospital. Foram incluídos indivíduos com ≥60 anos, portadores de DM tipo 2 e com capacidade para deambular. Pacientes com eventos cardiovasculares recentes, creatinina sérica >2,0 mg/dl, em uso de corticosteróides e índice de massa corporal (IMC) >40kg / m^2 foram excluídos. O diagnóstico de sarcopenia foi realizado de acordo com os critérios do *European Working Group on Sarcopenia in Older People* (EWGSOP). Para avaliação da massa muscular (MM) foram utilizados dados obtidos através de bioimpedância elétrica (BIA - Inbody®). Assim, foi calculada a MM apendicular (soma da MM dos braços e pernas) e o valor obtido foi dividido pela altura ao quadrado, obtendo o índice de massa muscular esquelética (IMM = MM apendicular / $altura^2$). A força muscular foi avaliada pela força do aperto de mão (FAM) utilizando dinamômetro manual (Jamar®) e o desempenho físico pelo teste timed up-and-go (TUG). A presença de sarcopenia foi considerada quando IMM≤8,50 kg kg/m^2 para homens e ≤5,75 kg/m^2 para mulheres, associada à pelo menos mais um dos seguintes critérios: FAM<20 kg para mulheres e <30 kg para homens e/ou TUG>20s. Foram incluídos 242 pacientes com idade de 68,3 ± 5,6 anos, 54% do sexo feminino, 78% da cor branca e duração do DM de 14,0 (8-22) anos. A glicose plasmática da amostra foi de 152 ± 54 mg/dl e HbA1c de 7.8 ± 1.5%, IMC 29,5 ± 4,5 kg/m^2, circunferência da cintura (CC) 101 ± 15cm nas mulheres e 105 ± 12cm nos homens. A prevalência geral de sarcopenia foi de 16,9%, sendo maior nos homens (73% vs. 27%). Os pacientes com sarcopenia caminharam menos [3164 (2227-4574) vs. 4031 (3007-5676) passos, p=0.004], e apresentaram menor circunferência da panturrilha [35,0 ± 3,9 vs. 37,5 ± 3,3; p=0,000] que o grupo sem sarcopenia. Na análise multivariada por regressão de Poisson, ser do sexo masculino aumenta a prevalência de sarcopenia em 33% [3,330 (1,747-6,350);

p<0,001] e caminhar mais de 5401 passos / dia tem um efeito protetor de 70% para a prevalência de sarcopenia [0,306 (0,127-0,739); p=0,029]. Além disso, a cada ano de idade a mais houve um aumento de cerca de 6% na prevalência de sarcopenia [1,061 (1,015-1,108); p = 0,009]. A prevalência de sarcopenia em pacientes idosos com DM tipo 2 foi de 16,9%. Homens apresentaram maior prevalência que as mulheres e caminhar mais de 5401 passos ao dia teve um efeito protetor de 70% para a sarcopenia nesses pacientes. A caminhada além de ser um exercício que não requer habilidades especiais pode ter um papel protetor para a sarcopenia em indivíduos idosos com DM tipo 2.

ABSTRACT

Sarcopenia is an age-related condition characterized by progressive and generalized loss of skeletal muscle mass and function (low muscle strength and / or poor physical performance). The literature demonstrates that sarcopenia is larger and occurs earlier in patients with type 2 diabetes mellitus (DM), but its actual prevalence is unknown. The objective of this study was to evaluate the prevalence of sarcopenia and associated factors in elderly patients with type 2 DM .A cross-sectional study was performed at the *Hospital de Clínicas de Porto Alegre (HCPA)* from 2017 to 2018. Were included participants aged ≥ 60 years with type 2 DM and able to walk. Patients with recent cardiovascular events, serum creatinine >2.0 mg/dl, use of corticosteroids and body mass index (BMI) >40 kg / m² were excluded. The diagnosis of sarcopenia was performed according to the European Working Group on Sarcopenia in Older People (EWGSOP) criteria. For the evaluation of muscle mass (MM), data obtained using electrical bioimpedance (BIA - Inbody®) were used. The appendicular skeletal muscle mass (ASM) was calculated (sum of the MM of the arms and legs) and the value obtained was divided by the squared height, obtaining the skeletal muscle mass index (SMI = MM appendicular / height²). Muscle strength was accessed by handgrip strength (HS) using a manual dynamometer (Jamar®) and physical performance was assessed by the timed up-and-go test (TUG). The presence of sarcopenia was considered when SMI <8.50 kg kg / m² for men and ≤5.75 kg / m² for women associated with at least one of the following criteria HS <20Kg for women and <30Kg for men and/or TUG >20s. We included 242 patients aged 68.3 ± 5.6 years, 54% women, 78% white and DM duration of 14.0 (8-22) years. Fasting plasma glucose was 152 ±54 mg/dl, HbA1c 7.8 ± 1.5%, BMI 29.5 ± 4.5 kg / m², waist circumference (WC) was 101 ± 15 cm for women and 105 ± 12 cm for men. The prevalence of sarcopenia was 16.9% and was higher in men than women (73% vs. 27%). Patients with sarcopenia walked less [3164 (2227-4574) vs. 4031 (3007-5676) steps, p=0.004] and had lower calf circumference [35.0 ± 3.9 vs. 37.5 ± 3.3; p=0.000] than the group without sarcopenia. In the multivariate analysis by Poisson regression, male sex increases the prevalence of sarcopenia by 33% [3.330 (1.747-6.350); p<0.001] and walking more than 5401 steps / day has a protective effect of 70% for the prevalence of sarcopenia [0.306 (0.127-0.739); p=0.029]. In addition, at each year of age there was an increase of about 6% in the prevalence of sarcopenia

[1.061 (1.015-1.108); p = 0.009]. The prevalence of sarcopenia in elderly patients with type 2 DM was 16.9%. Men had more sarcopenia than women and walking more than 5,401 steps / day has a protective effect of 70% for the prevalence of sarcopenia in this patients. Walking, a popular and effective physical active that has no special skills might play a protective role in sarcopenia in elderly patients with type 2 DM.

CAPÍTULO I

REFERENCIAL TEÓRICO

Envelhecimento

O envelhecimento é definido como um processo progressivo e complexo, no qual ocorrem alterações biológicas, funcionais, psicológicas que com o passar do tempo tendem a determinar uma acentuada perda da capacidade que o indivíduo possui de se adaptar ao meio ambiente[1]. Biologicamente, o envelhecimento é associado ao acúmulo de uma grande variedade de danos moleculares e celulares que com o tempo leva a uma perda gradual nas reservas fisiológicas e consequente aumento do risco de doenças crônicas não transmissíveis (DCNT) e um declínio geral na capacidade intrínseca do indivíduo[2].

A Organização Mundial da Saúde (OMS) define como idoso o indivíduo de 65 anos ou mais para aqueles de países desenvolvidos e 60 anos ou mais para os indivíduos de países subdesenvolvidos[3].

Atualmente, vem ocorrendo uma mudança na estrutura etária da população brasileira. Essa chamada transição demográfica demonstra que a proporção de idosos e a expectativa de vida têm aumentado. Segundo dados do Instituto Brasileiro de Geografia e Estatística (IBGE), houve um crescimento de 18% na população idosa (≥60 anos), cerca de 4,8 milhões de novos idosos, entre o período de 2012 a 2017[4]. Este número deve aumentar para 41,5 milhões, em 2030, e 73,5 milhões, em 2060[4]. Não só no Brasil, mas no mundo todo vem se observando essa tendência de envelhecimento da população nos últimos anos. Estima-se que em 2050 a população idosa corresponda a 22% da população mundial, cerca de 2 bilhões de habitantes[5]. Esse envelhecimento

populacional, associado ao aumento da expectativa de vida acarreta, na população idosa, uma maior suscetibilidade a eventos adversos, complicações clínicas e aumento de DCNT, como obesidade, hipertensão e diabetes (DM) tipo 2[6].

Essas transformações trazem desafios para a sociedade em geral, principalmente para profissionais e sistemas de saúde; impondo a necessidade de se repensar a dimensão da oferta de serviços e ações necessários à manutenção da qualidade de vida, proteção e cuidado específicos para idosos.

Diabetes Melito tipo 2

O DM tipo 2 representa 90-95% de todos os tipos de diabetes e é a forma mais comum da doença, ocorre geralmente na vida adulta, e tem sua prevalência aumentada conforme a idade, estando associado ao excesso de peso e obesidade na maioria dos casos[7].

Segundo a OMS, a população adulta mundial com DM é de 422 milhões[8]. No Brasil, atualmente, há cerca de 14 milhões de pacientes com DM e a projeção para 2040 é que este número duplique[9]. Nos idosos estima-se que o DM tipo 2 atinja 18 a 20% das pessoas com mais de 60 a 65 anos de idade[10]. A presença de DM tipo 2 nesta faixa etária, promove uma aceleração do declínio da massa muscular, redução da capacidade funcional, gerando maior dependência e risco de institucionalização, bem como, aumento da taxa de mortalidade[11].

O DM tipo 2 representa um dos maiores problemas de saúde pública em nosso país em razão da acentuada morbimortalidade[12] e dos altos custos envolvidos no seu tratamento[10]. Além disso, os idosos com DM tipo 2 formam uma população heterogênea, pois englobam tanto pacientes recém diagnosticados que ainda gozam da

saúde quanto pacientes diagnosticados há anos, que apresentam as complicações crônicas decorrentes da doença.

Sarcopenia

Definição e classificação

A sarcopenia foi descrita inicialmente por Rosenberg em 1989, como uma redução da massa muscular global, que ocorre ao longo do envelhecimento[13]. No entanto, foi demonstrado que é necessário mensurar a funcionalidade, além da quantidade de massa muscular[14]. Em 2010, o *European Working Group on Sarcopenia in Older People* (EWGSOP)[15] apresentou um Consenso com uma nova definição para sarcopenia: uma síndrome caracterizada pela perda progressiva e generalizada da massa musculoesquelética acompanhada de desfechos adversos como perda de força muscular e do desempenho físico e que tem como consequência o aumento do risco de efeitos indesejáveis como incapacidade física, perda de autonomia, perda de qualidade de vida e morte[16,17,18]. Esta síndrome apresenta duas classificações: sarcopenia primária, relacionada apenas com a idade e envelhecimento, e sarcopenia secundária, quando associada a causas identificáveis, tais como: inatividade, doenças associadas à falência de órgãos ou sistemas, doenças inflamatórias, câncer ou malignidade, doenças endócrinas e má nutrição[15]. Na maioria dos idosos é reconhecida como uma síndrome multifatorial geriátrica, pois não é possível caracterizar cada indivíduo em sarcopenia primária ou secundária[15]. E segundo o grau de severidade, o EWGSOP de 2010 propôs a classificação da sarcopenia em três estágios: pré-sarcopenia (baixa massa muscular sem perda de força ou desempenho físico), sarcopenia (perda de massa muscular associada a diminuição da força muscular ou do baixo desempenho físico) e sarcopenia grave (perda de todos os três critérios diagnósticos)[15].

Nos últimos anos, a sarcopenia tem sido amplamente estudada e muitos avanços foram observados na compreensão do músculo e seu papel nesta síndrome[19]. Assim, em 2018, o mesmo EWGSOP apresentou um novo Consenso[19] com a revisão do critério diagnóstico, propondo um novo algoritmo para avaliação de sarcopenia. A sarcopenia é agora considerada uma doença muscular (insuficiência muscular), com baixa força muscular ultrapassando o papel da baixa MM como principal determinante. As diretrizes revisadas verificaram que a força é melhor do que a massa na previsão de resultados adversos[19].

Neste novo Consenso a triagem dos pacientes em risco é feita com o questionário SARC-F[20] e a avaliação é feita pelo critério da força muscular (força do aperto de mão e/ou teste senta e levanta). A confirmação da suspeita de sarcopenia se dá com o critério de baixa MM, que antes era considerado o primeiro critério para avaliação de sarcopenia. Somente depois de identificados a baixa força muscular e a baixa MM que se avalia a severidade da sarcopenia através de testes de desempenho[19].

Neste novo Consenso, também foi proposta a classificação da sarcopenia em aguda e crônica. Sarcopenia com duração menor que 6 meses é considerada uma condição aguda, enquanto a sarcopenia com duração ≥6 meses é considerada uma condição crônica[26]. Geralmente o quadro agudo está relacionado a uma doença ou lesão aguda, enquanto a sarcopenia crônica pode estar associada a doenças crônicas e condições progressivas e aumenta o risco de mortalidade[19].

Mecanismos associados

Existem diversos mecanismos envolvidos na síndrome, como a atrofia das fibras musculares, diminuição do número de unidades motoras e acúmulo de gordura no músculo[15]. Diversas são as razões para declínio da MM que ocorre com a idade, entre

elas: o estado nutricional (redução da ingestão proteica e energética), redução da síntese proteica, processo neurodegenerativo, atrofia das fibras musculares, fatores endócrinos, imobilidade e inatividade física, influência genética, disfunção mitocondrial, apoptose a autofagia[21].

Os principais fatores envolvidos neste declínio da MM são a nutrição inadequada e inatividade física[22]. Em relação à nutrição, o consumo de proteína, especialmente de origem animal, pode influenciar na preservação da MM em idosos. O consumo proteico foi positivamente associado à MM total, MM apendicular e MM do tronco em mulheres idosas[23]. Tanto é que a diminuição do consumo de proteínas foi associado à diminuição de força, diminuição da massa muscular e a prevalência de sarcopenia[24.] De fato, estudo com idosos coreanos com ≥60 anos demonstrou que o consumo menor que 1,2 g/kg de peso foi associado à sarcopenia[24]. Além disso, a ingestão de proteínas parece promover uma perda menor na MM como foi observado em idosos institucionalizados nos quais a ingestão de quantidades maiores que 1,1g/proteína/kg/dia (maior quintil de consumo) levou a uma perda 40% menor na MM se comparada aos idosos que consumiram 0,7g/proteína/ kg/dia[25].

Também a inatividade física tem influência no declínio da MM, entretanto, a prática de atividade física é um fator que parece ter os resultados promissores, tanto na prevenção quanto no tratamento da sarcopenia[24,25,26]. No mesmo estudo coreano citado anteriormente, a sarcopenia também foi significativamente associada a menor atividade física[24]. A média total de MET (estimativa de equivalente metabólico) foi significativamente maior nos participantes sem sarcopenia do que naqueles com sarcopenia[24]. Em idosos vivendo instituições de longa permanência, foi demonstrado que a sarcopenia apresentou menor probabilidade de estar presente entre os pacientes envolvidos na atividade física de lazer por uma hora ou mais por dia[27].

Além disso, a associação de aumento do consumo de proteina e prática de exercícios parece potencializar os efeitos na MM, principalmente no aumento de força[28]. Assim, estes dois fatores modificáveis pode colaborar em longo prazo para um menor número de quedas, aumento da mobilidade e independência do idoso[29].

Perda de massa muscular em idosos

Estima-se que a partir da terceira década de vida, ocorre uma perda de aproximadamente 1% da MM ao ano e esta perda é progressiva com o avançar da idade, podendo chegar até 30% aos 80 anos[30]. O declínio da MM é um agravante na população idosa. Pacientes idosos com sarcopenia tem quatro vezes mais chance de desenvolver incapacidade física do que idosos que possuem MM normal[31]. Em uma coorte com duração de oito anos, o risco de incapacidade física foi 27% maior nos idosos com sarcopenia grave quando comparado aos não sarcopênicos[32]. A sarcopenia também está associada à maior ocorrência de quedas e hospitalizações em idosos, piorando a qualidade de vida e estando associada a um aumento da mortalidade[33-36].

Prevalência de sarcopenia em idosos

A prevalência de sarcopenia em idosos varia amplamente entre 4,6% a 75% de acordo com a idade[31, 37-43]. Esta ampla variação de resultados deve-se a vários fatores: etnia, gênero, idade e métodos utilizados para definir sarcopenia. Estudos que utilizaram um único critério diagnóstico de sarcopenia (baixa MM aferida pelo IMM) encontraram prevalência de 13-24% em idosos com menos de 70 anos e atingindo mais de 50% naqueles com mais de 80 anos[31,37,38]. Outro fator que pode aumentar a prevalência de sarcopenia é o avanço da idade. Estudo que avaliou 883 idosos americanos hispânicos e não hispânicos encontrou uma prevalência de sarcopenia de 13,5% a 24% nos idosos com idade entre 65 e 70 anos e de 60% nos idosos com mais de 80 anos[31].

Também o gênero pode influenciar resultados de prevalência. A prevalência de sarcopenia é maior nas mulheres e este achado costuma ser comum em diversas populações. No Reino Unido, um estudo conduzido em 1.787 idosos demonstrou prevalência de sarcopenia de 7,9% nas mulheres e de 4,6% nos homens[39]. No Japão, idosos com >65 anos foram estratificados em quintis de idade. A prevalência de sarcopenia nas mulheres foi de 22,1%, sendo que ocorreu o aumento da condição conforme a idade nos dois gêneros[40]. Estudo brasileiro que avaliou idosos saudáveis com >60 anos residentes em áreas urbanas observou uma prevalência de 16,1% nas mulheres e de 14,4% nos homens[41]. Uma metanálise que incluiu 31 estudos brasileiros e um total de 9.416 pacientes com 60 anos ou mais, encontrou uma prevalência de sarcopenia de 20% nas mulheres e 12% nos homens[42].

Entretanto há estudos referenciando maior prevalência de sarcopenia nos homens[15,37,38,39,43]. Estudo em idosos americanos com mais de 60 anos encontrou uma prevalência de sarcopenia de 30,8% nos homens e de apenas 10,2% nas mulheres[37] Em estudo realizado em idosos chineses, a prevalência nos homens foi de 23,6% enquanto nas mulheres foi de 18,6%[43]. Em idosos coreanos foi encontrada uma prevalência de 12,4% nos homens e de 0,1% nas mulheres[38].

A ampla variação na prevalência de sarcopenia encontrada nos estudos pode ser explicada, além das diferenças nas definições de sarcopenia utilizadas, pela diversidade de métodos diagnósticos utilizados para aferir a redução de MM, pelas diferentes populações estudadas e pelos pontos de corte adotados para a avaliação da massa muscular[15].

Critérios diagnósticos e técnicas de avaliação

O critério diagnóstico para sarcopenia segundo o Consenso de 2010[15] é baseado na presença de baixa massa muscular associada a pelo menos um ou a ambos os critérios de perda da função muscular: perda de força muscular ou baixo desempenho físico[15]. Os critérios recomendados pelo EWGSOP 2010 para o diagnóstico de sarcopenia podem ser visualizados na Tabela 1.

Entretanto, segundo o Consenso de 2018[19] (Figura 1), a triagem dos pacientes em risco de sarcopenia é feita com o questionário SARC-F[20] e a avaliação é feita pelo critério da força muscular (força do aperto de mão e/ou teste senta e levanta)[19]. A confirmação da suspeita de sarcopenia se dá com o critério de baixa MM, que pode ser aferido por bioimpedância elétrica (BIA) ou densitometria óssea (*Dual Energy X-ray Absorptiometry* - DEXA)[19]. Após a identificação da baixa força muscular e baixa MM é feita a avaliação da severidade da síndrome através de testes de desempenho como os testes *Short Physical Performance Battery* (SPPB), velocidade de marcha e *Timed Up and Go* (TUG)[19].

Assim, a escolha correta dos instrumentos para obtenção de tais variáveis se faz fundamental. Para avaliar estes critérios, existem vários métodos e o maior desafio é estabelecer um parâmetro preciso e que apresente sensibilidade suficiente para demonstrar as mudanças que podem ocorrer em cada indivíduo.

Massa muscular

O Consenso Europeu de sarcopenia[15] recomenda que na prática clínica, para a medida de MM deva ser usada a DEXA ou a BIA. De fato, já foi demonstrado que existe uma forte correlação entre estes dois métodos para avaliação de MM[44]. Além

disso, este método de referência para estimativa da MM também apresentou forte correlação com a técnica de ressonância magnética[30].

Baumgartner utilizou o DEXA e propôs uma fórmula para obter o IMM corrigido pela altura (IMM = MM apendicular / altura²). Com base nesses dados, considerou sarcopênicos indivíduos abaixo de dois desvios padrão da média específica para o sexo, resultando nos pontos de corte de 7,26kg/m² para homens e 5,45kg/m² para mulheres[31]. Apesar da avaliação da MM por DEXA ser um método fidedigno, seu alto custo dificulta a utilização tanto na prática clínica como em pesquisa[15]. Duas décadas depois foi proposto outro critério para avaliação do IMM que utilizou a BIA para avaliação da MM. Os pontos de corte da MM total relativa à altura, propostos foram de 8,50kg/m² para homens e 5,75kg/m² para mulheres[32]. Outros pontos de corte foram propostos em diferentes populações e estudos, mesmo após o Consenso de 2010[15]. Atualmente, o EWGSOP de 2018 propõe a utilização do seguinte ponto de corte para baixo IMM: <7,0 kg/m² para homens e <5,5kg/m² para mulheres[19].

Em relação às medidas antropométricas, o EWGSOP recomenda a aferição da circunferência da panturrilha (CP), pois esta se correlaciona positivamente com a MM, além de ser um método de baixo custo e fácil aplicação[15,45]. Valores inferiores a 31 centímetros indicam redução de MM[46]. Entretanto, na população brasileira, valores da CP ≤34 cm para homens e ≤33 cm para as mulheres são indicativos de redução da MM[47].

Força Muscular

A força de preensão manual é o método recomendado pelo EWGSOP, extensamente utilizado e o mais citado na literatura acerca do tema, estando fortemente relacionada à potência muscular das extremidades inferiores, extensão de joelho e CP[48].

É aferida com dinamômetro de mão, sendo uma medida simples que se correlaciona bem com a força muscular das pernas[15]. Segundo o Consenso de 2010, valores abaixo de 30kg para homens e 20 kg para mulheres são considerados como baixa força muscular[15,] enquanto no Consenso de 2018 os pontos de corte são < 27 kg para homens e < 16 kg para mulheres[19].

Desempenho Físico

Para avaliar o desempenho físico existe uma variedade de testes: teste curto de desempenho físico (*short physical performance battery* [SPPB])[49], teste de velocidade de marcha habitual[49], teste "*timed up and go*" (TUG)[50], teste da potência de subir escada, teste senta e levanta entre outros[15]. Os testes fornecem informações sobre equilíbrio, desempenho e incapacidade física[15].

Tabela 1. Diagnóstico de sarcopenia segundo critérios do *European Working Group on Sarcopenia in Older People* (EWGSOP) 2010.

Critério*	Método
1. Massa muscular reduzida	DEXA
	BIA
	CP
2. Força muscular reduzida	FAM
	Flexão ou extensão do joelho
3. Desempenho físico reduzida	SPPB
	TUG
	SL

* O diagnóstico baseia-se na ocorrência do critério 1 mais critério 2 e/ou critério 3[15]. DEXA, densitometria óssea; BIA, bioimpedância elétrica; CP, circunferência da panturrilha; FAM, força do aperto de mão; SPPB, *short physical performance battery*; TUG, timed up and go; SL, senta e levanta.

Figura 1. Algoritmo para diagnóstico de sarcopenia segundo o *European Working Group on Sarcopenia in Older People* (EWGSOP) 2018.
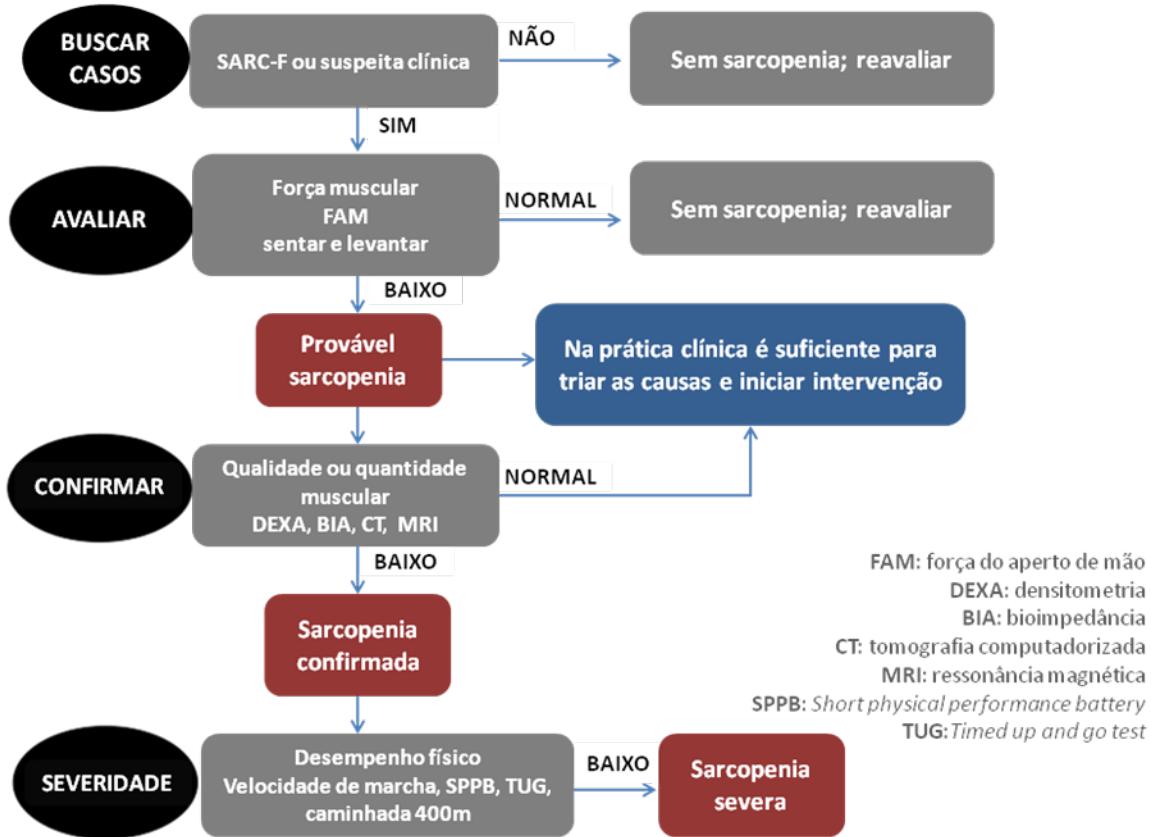
Diabetes tipo 2 e diminuição da massa muscular

O diabetes parece ter implicações na força e qualidade musculares[51-55]. Em estudo de coorte que avaliou a perda de MM e de força muscular em 485 idosos com DM tipo 2 observou menor força e qualidade musculares nos idosos com DM quando comparados aos controles[55]. Além disso, os autores relacionaram o pior controle glicêmico e maior tempo de DM a uma piora da qualidade muscular[55.] Na população coreana verificou-se que o controle glicêmico inadequado (HbA1c ≥8,5%) foi associado ao comprometimento da qualidade muscular em homens idosos[56]. Estes estudos demonstram a importância do controle do DM para um melhor prognóstico muscular.

Por fim, estudos têm sugerido que o uso de medicações próprias para DM como a metformina, tiazolidinedionas e inibidores da DPP-4 podem influenciar beneficamente na massa muscular de pacientes jovens[57], e promover atenuação da perda de MM em pacientes idosos[58,59].

Diabetes tipo 2 e sarcopenia

Apesar de existirem poucos estudos em pacientes com diabetes,[60,61,62] a sarcopenia parece ser mais prevalente nesta população. A maioria dos estudos avaliando a relação entre sarcopenia e diabetes são na população asiática. Estudo coreano que incluiu pacientes com e sem diabetes acima de 40 anos, encontrou uma prevalência de sarcopenia de 15,7% nos indivíduos com DM tipo 2 e de 6,9% nos indivíduos sem DM[60]. Neste estudo, o diagnóstico de sarcopenia foi definido a partir do IMM ajustado para peso, com dados provenientes da DEXA[37]. Alternativamente, os autores também utilizaram o critério baseado no cálculo do IMM ajustado pela altura, observando uma maior prevalência de sarcopenia (5,3%) nos pacientes com DM do que os sem a doença (2,0%)[60]. Já em estudo com 166 japoneses com DM tipo 2 e idade ≥30 anos a prevalência de sarcopenia foi de 7,2%[61]. Neste estudo, a definição de sarcopenia utilizada foi a proposta pelo consenso asiático (Asian Working Group for Sarcopenia) que assim como o europeu envolve baixo IMM (ajustado pela altura), baixa força de preensão palmar e baixa velocidade de marcha[62].

Nos indivíduos idosos, a prevalência de sarcopenia em pacientes com diabetes tem demostrado ser mais evidente. Em chineses ≥65 anos com DM tipo 2 foi encontrada uma prevalência de sarcopenia de 14,8%, enquanto no grupo controle a prevalência foi de 11,2%[63]. Além disso, estes idosos com DM tipo 2 apresentaram maior risco (OR = 1,37, IC95% = 1,02-2,03) de ter sarcopenia e pré sarcopenia (OR = 1,73, IC95% =

1,10–2,83) em comparação com indivíduos sem a patologia[63]. Já em japoneses diabéticos ≥65 anos, a prevalência de sarcopenia foi de 22,5%, sendo de 19% nos homens e 27,1 % nas mulheres[64]. Entretanto, outro estudo com 213 idosos japoneses com ≥60 anos encontrou uma prevalência maior de sarcopenia nos homens (20,4% vs. 18.1%)[65].

A patogênese da sarcopenia no diabetes é um conceito desafiador, o impacto do DM na sarcopenia não é completamente conhecido e múltiplos mecanismos têm sido propostos para aceleração da sarcopenia nestes pacientes, entre eles: aumento do dano oxidativo, inflamação subclínica e resistência à insulina[66,67]. Além disso, no Brasil, dados em relação à prevalência de sarcopenia em pacientes com DM tipo 2 não são conhecidos, nem há estudos específicos sobre os fatores associados à sarcopenia em idosos com esta patologia. O esclarecimento destas questões, além de fornecer um melhor entendimento da possível contribuição da sarcopenia como um determinante da maior morbimortalidade observada em pacientes com DM, é de extrema relevância na medida em que pode levar ao desenvolvimento de intervenções específicas para melhorar desfechos nestes pacientes. Assim, o objetivo deste estudo foi avaliar a prevalência de sarcopenia e fatores associados em pacientes ≥60 anos que apresentam DM tipo 2.

REFERÊNCIAS

1. Freitas E. Tratado de Geriatria e Gerontologia. 4. ed. Rio de Janeiro: Guanabara Koogan, 2016.

2. World Health Organization (WHO) – Relatório Mundial de Envelhecimento e Saúde. Geneva: World Health Organization; 2015.

3. World Health Organization (WHO) – Active Ageing – A Police Framework. A Contribution of the World Health Organization to the second United Nations World Assembly on Aging. Madrid, Spain, April, 2002.

4. Estatística-IBGE, I. B. de G. e. Projeções da população: Brasil e unidades da federação: revisão 2018. Brasília: Ministério da Saúde; 2011. 40, 56p.

5. United Nations, Department of Economic and Social Affairs, Population Division (2015). World Population Ageing, 2015.

6. Ministério da Saúde. Plano de ações estratégicas para o enfrentamento das doenças crônicas não transmissíveis (DCNT) no Brasil 2011-2022. Brasília: Ministério da Saúde; 2011.

7. Standards of Medical Care in Diabetes-2016: Summary of Revisions. Diabetes Care. 2016;39 (Suppl 1): 4-5.

8. Word Health Organization. Global Report on Diabetes. Geneva: World Health Organization; 2016.

9. International Diabetes Federation. IDF Diabetes Atlas. Bélgica: Internacional Diabetes Federation; 2015.

10. Sociedade Brasileira de Diabetes. Diretrizes da Sociedade Brasileira de Diabetes: 2015-2016. São Paulo: AC Farmacêutica; 2016.

11. M. Sue Kirkman, Vanessa Jones Briscoe, N. C. et. al. Diabetes in Older Adults. *Diabetes Care* 35, 2650–2664 (2012).

12. Tancredi M, Rosengren A, Svensson A-M, Kosiborod M, Pivodic A, Gudbjörnsdottir S, et al. Excess Mortality among Persons with Type 2 Diabetes. N. Engl. J. of Med. 2015;373(18):1720-32.

13. Rosenberg IH. Summary comments. Am J Clin Nutr. 1989;50(5):1231-3.

14. Janssen I, Baumgartner R, Ross R et al. Skeletal muscle cutpoints associated with elevated physical disability risk in older men and women. Am J Epidemiol 2004; 159: 413–21.

15. Cruz-Jentoft AJ, Baeyens JP, Bauer JM, Boirie Y, Cederholm T, Landi F, et al. Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People. Age Ageing. 2010;39(4):412-23.

16. Delmonico MJ, Harris TB, Lee JS et al. Alternative definitions of sarcopenia, lower extremity performance, and functional impairment with aging in older men and women. J Am Geriatr Soc 2007; 55: 769–74.

17. Goodpaster BH, Park SW, Harris TB et al. The loss of skeletal muscle strength, mass, and quality in older adults: The health,aging and body composition study. J Gerontol A Biol Sci Med Sci 2006; 61: 1059–6.

18. Kim JH, Lim S, Choi SH, Kim KM, Yoon JW, Kim KW, et al. Sarcopenia: an independent predictor of mortality in community-dwelling older Korean men. J Gerontol A Biol Sci Med Sci. 2014;69(10):1244-52.

19. Cruz-Jentoft AJ, Bahat G, Bauer J, et al. Sarcopenia: revised European consensus on definition and diagnosis. Age Ageing 2019;48:16-31.

20. Malmstrom TK, Morley JE. SARC-F: A simple questionnaire to rapidly diagnose sarcopenia. J Am Med Dir Assoc 2013;14:531e532.

21. Ali S, Garcia JM. Sarcopenia, cachexia and aging: diagnosis, mechanisms and therapeutic options - a mini-review. Gerontology. 2014;60(4):294-305.

22. Baum JI, Kim IY, Wolfe RR. Protein Consumption and the Elderly: What Is the Optimal Level of Intake? Nutrients. 2016;8(6).

23. Isanejad M, Mursu J, Sirola J, Kroger H, Rikkonen T, Tuppurainen M, et al. Association of protein intake with the change of lean mass among elderly women: The Osteoporosis Risk Factor and Prevention - Fracture Prevention Study (OSTPRE-FPS). J Nutr Sci. 2015;4:e41.

24. Oh C, Jeon BH, Reid Storm SN, Jho S, No JK. The most effective factors to offset sarcopenia and obesity in the older Korean: Physical activity, vitamin D, and protein intake. Nutrition. 2016; 33:169-173.

25. Houston DK, Nicklas BJ, Ding J, Harris TB, Tylavsky FA, Newman AB, et al. Dietary protein intake is associated with lean mass change in older, community-dwelling adults: the Health, Aging, and Body Composition (Health ABC) Study. Am J Clin Nutr. 2008;87(1):150-5.

26. Raguso CA, Kyle U, Kossovsky MP, et al. A 3-year longitudinal study on body composition changes in the elderly: role of physical exercise. Clin Nutr. 2006;25:573-580.

27. Landi F, Liperoti R, Fusco D, Mastropaolo S, Quattrociocchi D, Proia A, et al. Prevalence and risk factors of sarcopenia among nursing home older residents. J Gerontol A Biol Sci Med Sci. 2012;67(1):48-55.

28. Fiatarone MA, O'Neill EF, Ryan ND, et al. Exercise training and nutritional supplementation for physical frailty in very elderly people. N Engl J Med. 1994;330(25):1769–1775.

29. Bonnefoy M, Cornu C, Normand S, et al. The effects of exercise and protein-energy supplements on body composition and muscle function in frail elderly individuals: a long-term controlled randomised study. Br J Nutr 2003;89:731-9.

30. Ali S, Garcia JM. Sarcopenia, cachexia and aging: diagnosis, mechanisms and therapeutic options - a mini-review. Gerontology. 2014;60(4):294-305.

31. Baumgartner RN, Koehler KM, Gallagher D, Romero L, Heymsfield SB, Ross RR, et al. Epidemiology of sarcopenia among the elderly in New Mexico. Am J Epidemiol. 1998;147(8):755-63.

32. Janssen I. Influence of sarcopenia on the development of physical disability: the Cardiovascular Health Study. J Am Geriatr Soc. 2006;54(1):56-62.

33.   Tanimoto Y, Watanabe M, Sun W, Sugiura Y, Hayashida I, Kusabiraki T, et al. Sarcopenia and falls in community-dwelling elderly subjects in Japan: Defining sarcopenia according to criteria of the European Working Group on Sarcopenia in Older People. Arch Gerontol Geriatr. 2014;59(2):295-9.

34.   Vetrano DL, Landi F, Volpato S, Corsonello A, Meloni E, Bernabei R, et al. Association of sarcopenia with short- and long-term mortality in older adults admitted to acute care wards: results from the CRIME study. J Gerontol A Biol Sci Med Sci. 2014;69(9):1154-61.

35.   Rizzoli R, Reginster JY, Arnal JF, Bautmans I, Beaudart C, Bischoff-Ferrari H, et al. Quality of life in sarcopenia and frailty. Calcif. Tissue Int. 2013;93(2):101-20.

36.   Brown JC, Harhay MO, Harhay MN. Sarcopenia and mortality among a population-based sample of community-dwelling older adults. J Cachexia Sarcopenia Muscle. 2016;7(3):290-8.

37.   Janssen I, Heymsfield SB, Ross R. Low relative skeletal muscle mass (sarcopenia) in older persons is associated with functional impairment and physical disability. J Am Geriatr Soc. 2002;50(5):889-96.

38.   Kim YS, Lee Y, Chung YS, Lee DJ, Joo NS, Hong D, et al. Prevalence of sarcopenia and sarcopenic obesity in the Korean population based on the Fourth Korean National Health and Nutritional Examination Surveys. J Gerontol A Biol Sci Med Sci. 2012;67(10):1107-13.

39.   Patel HP, Syddall HE, Jameson K, Robinson S, Denison H, Roberts HC, et al. Prevalence of sarcopenia in community-dwelling older people in the UK using the European Working Group on Sarcopenia in Older People (EWGSOP) definition: findings from the Hertfordshire Cohort Study (HCS). Age Ageing. 2013;42(3):378-84.

40.   Yamada M, Nishiguchi S, Fukutani N, Tanigawa T, Yukutake T, Kayama H, et al. Prevalence of sarcopenia in community-dwelling Japanese older adults. JAMDA. 2013;14(12):911-5.

41.   Alexandre Tda S, Duarte YA, Santos JL, Wong R, Lebrao ML. Prevalence and associated factors of sarcopenia among elderly in Brazil: findings from the SABE study. J Nutr Health Aging. 2014;18(3):284-90.

42. Diz JB, Leopoldino AA, Moreira BS, Henschke N, Dias RC, Pereira LS, et al. Prevalence of sarcopenia in older Brazilians: A systematic review and meta-analysis. Geriatr Gerontol Int. 2016.

43. Chien MY, Huang TY, Wu YT. Prevalence of sarcopenia estimated using a bioelectrical impedance analysis prediction equation in community-dwelling elderly people in Taiwan. J Am Geriatr Soc 2008;56:1710-1715.

44. Augustemak de Lima LR, Rech CR, Petroski EL. [Use of bioelectrical impedance for the estimation of skeletal muscle mass in elderly men]. Arch Latinoam Nutr. 2008;58(4):386-91.

45. Rolland Y, Lauwers-Cances V, Cournot M et al. Sarcopenia, calf circumference, and physical function of elderly women: a cross-sectional study. J Am Geriatr Soc 2003; 51: 1120–4.

46. Lauretani F, Russo CR, Bandinelli S, Bartali B, Cavazzini C, Di Iorio A, et al. Age-associated changes in skeletal muscles and their effect on mobility: an operational diagnosis of sarcopenia. J Appl Physiol. 2003;95(5):1851-60.

47. Barbosa-Silva TG, Bielemann RM, Gonzalez MC, Menezes AM. Prevalence of sarcopenia among community-dwelling elderly of a medium-sized South American city: results of the COMO VAI? study. J Cachexia Sarcopenia Muscle. 2016;7(2):136-43.

48. Leong DP, Teo KK, Rangarajan S et al. Prognostic value of grip strength: findings from the Prospective Urban Rural Epidemiology (PURE) study. Lancet 2015; 386: 266–73.

49. Guralnik JM, Ferrucci L, Pieper CF, et al. Lower extremity function and subsequent disability: consistency across studies, predictive models, and value of gait speed alone compared with the short physical performance battery. J Gerontol A Biol Sci Med Sci. 2000;55(4):M221-31.

50. Podsiadlo D, Richardson S. The timed "Up & Go": a test of basic functional mobility for frail elderly persons. J Am Geriatr Soc. 1991;39(2):142-8.

51. Park SW, Goodpaster BH, Strotmeyer ES, Kuller LH, Broudeau R, Kammerer C, et al. Accelerated loss of skeletal muscle strength in older adults with type 2 diabetes: the health, aging, and body composition study. Diabetes Care. 2007;30(6):1507-12.

52. Park SW, Goodpaster BH, Lee JS, Kuller LH, Boudreau R, de Rekeneire N, et al. Excessive loss of skeletal muscle mass in older adults with type 2 diabetes. Diabetes Care. 2009;32(11):1993-7.

53. Kim KS, Park KS, Kim MJ, Kim SK, Cho YW, Park SW. Type 2 diabetes is associated with low muscle mass in older adults. Geriatr Gerontol Int. 2014;14 (Suppl 1):115-21.

54. Wong E, Backholer K, Gearon E, Harding J, Freak-Poli R, Stevenson C, et al. Diabetes and risk of physical disability in adults: a systematic review and meta-analysis. Lancet Diabetes Endocrinol. 2013;1(2):106-14.

55. Park SW, Goodpaster BH, Strotmeyer ES, de Rekeneire N, Harris TB, Schwartz AV, et al. Decreased muscle strength and quality in older adults with type 2 diabetes: the health, aging, and body composition study. Diabetes. 2006;55(6):1813-8.

56. Yoon JW, Ha YC, Kim KM, Moon JH, Choi SH, Lim S, et al. Hyperglycemia Is Associated with Impaired Muscle Quality in Older Men with Diabetes: The Korean Longitudinal Study on Health and Aging. Diabetes Metab J. 2016;40(2):140-6.

57. Cetrone M, Mele A, Tricarico D. Effects of the antidiabetic drugs on the age-related atrophy and sarcopenia associated with diabetes type II. Curr Diabetes Rev. 2014;10(4):231-7.

58. Lee CG, Boyko EJ, Barrett-Connor E, Miljkovic I, Hoffman AR, Everson-Rose SA, et al. Insulin sensitizers may attenuate lean mass loss in older men with diabetes. Diabetes Care. 2011;34(11):2381-6.

59. Rizzo MR, Barbieri M, Fava I, Desiderio M, Coppola C, Marfella R, et al. Sarcopenia in Elderly Diabetic Patients: Role of Dipeptidyl Peptidase 4 Inhibitors. JAMDA. 2016.

60. Kim TN, Park MS, Yang SJ, Yoo HJ, Kang HJ, Song W, et al. Prevalence and determinant factors of sarcopenia in patients with type 2 diabetes: the Korean Sarcopenic Obesity Study (KSOS). Diabetes Care. 2010;33(7):1497-9.

61.   Mori H, Kuroda A, Ishizu M, et al. Association of accumulated advanced glycation end-products with a high prevalence of sarcopenia and dynapenia in patients with type 2 diabetes. J Diabetes Investig. 2019;1–9.

62.   Chen, LK, Lee, WJ, Peng, LN, *et al*. Asian Working Group for Sarcopenia. Recent advances in sarcopenia research in Asia: 2016 update from the Asian Working Group for Sarcopenia. J Am Med Dir Assoc 2016; 17: 767, e1–7.

63.   Wang, T, Feng, X, Zhou, J, *et al*. Type 2 diabetes mellitus is associated with increased risks of sarcopenia and pre-sarcopenia in Chinese elderly. Sci Rep 2016; 6: 1-7.

64.   Ida S, Kaneko R, Nagata H, et al. Association between sarcopenia and sleep disorder in older patients with diabetes. Geriatr. Gerontol. Int. 2019;1–5.

65.   Nishimura A, Harashima SI, Hosoda K, Arai H, Inagaki N. Sex-related differences in frailty factors in older persons with type 2 diabetes: a cross-sectional study.Ther Adv Endocrinol Metab. 2019; 10: 1-14

66.   Leenders M, van Loon LJ. Leucine as a pharmaconutrient to prevent and treat sarcopenia and type 2 diabetes. Nutr Rev. 2011;69(11):675-89.

67.   Cobo A, Vazquez LA, Reviriego J, Rodriguez-Manas L. Impact of frailty in older patients with diabetes mellitus: An overview. Endocrinol Nutr. 2016;63(6):291-303.

CAPITULO II

Prevalence of Sarcopenia and Associated Factors in Patients with type 2 Diabetes Melito

Mauren Minuzzo de Freitas

Luciana Verçoza Viana

Vanessa Lopes Preto de Oliveira

Thaiciane Grassi

Maria Elisa Peinado Muller

Renata Asnis Schuchmann

Tatiana Pedroso de Paula

Serviço de Endocrinologia, Hospital de Clínicas de Porto Alegre, Universidade Federal

do Rio Grande do Sul, Brasil

Address to:

Tatiana Pedroso de Paula

Divisão de Endocrinologia, Hospital de Clínicas de Porto Alegre

Rua Ramiro Barcelos, 2350, Prédio 12, 4º andar 90035-003 – Porto Alegre, RS, Brasil

E-mail: tatiana.ppaula@gmail.com

Telefone: + 55 51 3359 8127 Fax: + 55 51 3359 8777

Abstract

Objectives: The aim of study was to establish the prevalence of sarcopenia and associated factors in elderly patients with type 2 diabetes mellitus (DM).

Design: Cross-sectional study

Setting and Participants: Elderly outpatients ≥60 years with type 2 DM able to walk, were recruited at the DM ambulatory of hospital de Clinicas de Porto Alegre, from 2017 to 2018. We excluded patients with recent cardiovascular events, serum creatinine >2.0 mg/dl, use of corticosteroids and BMI >40kg/m².

Methods: The diagnosis of sarcopenia was performed according to the EWGSOP criteria. Muscle mass (MM) was assessed using bioelectrical impedance (BIA). Muscle strength (MS) was assessed using the handgrip strength (HS) and physical performance was evaluated using Timed up and go (TUG) test.

Results: We included 242 patients aged 68.3 ± 5.6 years, 54% women, 78% white and DM duration was 14(8-22) years. Fasting plasma glucose was 152 ± 54 mg/dl, HbA1c 7.8 ± 1.5%, and BMI 29.5 ± 4.5 kg/m². The prevalence of sarcopenia was 16.9% and most of them were men (73%). Patients with sarcopenia walked less [3164 (2227-4574) vs. 4031 (3007-5676) steps/day, p=0.004]. GLM Poisson model was performed to assess sarcopenia. Male sex increases the prevalence of sarcopenia by 33% [3.330 (1.747-6.350); p<0.001] and walking more than 5,401 steps / day has a protective effect of 70% for the prevalence of sarcopenia [0.306 (0.127-0.739); p=0.029]. And finally, age had an impact of 6% in prevalence of sarcopenia [1.061 (1.015-1.108); p=0.009].

Conclusions and implications: Prevalence of sarcopenia was 16.9% according to EWGSOP 2010. In type 2 DM patients, the factors related to sarcopenia were male sex and age. Walking more than 5401 steps had a protective effect for sarcopenia and this activity might play a protective role in elderly type 2 DM individuals.

Key words: Sarcopenia, type 2 diabetes, elderly

Introduction

Sarcopenia is a syndrome characterized by progressive and generalized loss of skeletal muscle mass (MM) and function according the 2010 European Consensus (EWGSOP1)[1]. Sarcopenia increases risk of adverse outcomes such as physical disability, progression of chronic diseases, poor quality of life and risk of death in elderly people[2,3,4]. Several techniques can be used to diagnosis this syndrome[1]. Therefore, its prevalence varies significantly, mainly, because of criteria tools and methods used for diagnosis and by associated factors like gender, ethnicity, and lifestyle[5].

This syndrome can reach 5-13% in elderly people between 60-70 years and 11-50% in those over 80 years old[1]. A systematic review found that the prevalence of sarcopenia, according to the EWGSOP 2010 criteria, was 1–29% in the community, 14–33% in long term care setting, and 10% in acute hospital care[5].

In patients with diabetes mellitus (DM) the prevalence of sarcopenia were not fully understand, mostly, because multiple mechanisms have been proposed for acceleration of sarcopenia in these patients[6]. Furthermore, previous data demonstrated that loss and altered muscle function are greater and occur early in patients with type 2 DM[7, 8]. In addition, patients with this pathology demonstrated reduced MM, strength and muscular quality when compared to patients without DM[9].

The pathogenesis and associated factors of sarcopenia in DM is a challenging concept. Although studies of sarcopenia in older adults with diabetes are scarce, it is believed that type 2 DM can accelerate the aging process[10]. Therefore, the aim of the present study was to evaluate the prevalence of sarcopenia and possible associated factors in elderly patients with type 2 DM.

Methods

Patients

This cross-sectional study was conducted in 242 outpatients with type 2 DM recruited at the Endocrine division of the Hospital de Clinicas de Porto Alegre, Brazil, from Abril 2017 to November 2018. Patients aged ≥60 years with type 2 DM were included, according World Health Organization (WHO) definition for elderly in

developing countries[11]. The diabetes was defined as subjects over 30 years of age at onset of diabetes, no previous episode of ketoacidosis or documented ketonuria. The exclusion criteria were: recent cardiovascular events and physical disability in order to exclude patients with some immobility that interferes in MM, as were patients with plasma creatinine >2 mg/dl and BMI >40 kg/m². Patients that use of medications that could potentially influence in MM as well as cardiac pacemaker, presence of edema or other water disorders that affect the results of electrical bioimpedance (BIA) were excluded.

The study was designed and conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving patients were approved by the Hospital Research Ethics Committee/Research and Graduate Group (GPPG) according to Resolution 466/2012[12]. Written informed consent was obtained from all patients.

Clinical Evaluation

After signed inform consent, participants underwent a clinical examination and interview to assess demographic data and lifestyle characteristics. Cardiovascular outcomes were diagnosed in the presence of previous cardiac events confirmed by imaging tests or disability, current symptoms of intermittent claudication and WHO cardiovascular questionnaire for angina, infarction and intermittent claudication[13]. Blood pressure (BP) was measured twice with a digital sphygmomanometer (Omron®HEM-705CP) on the left arm and with the person in the seated position, after a 5-minute rest[14].

Nutritional assessment

Body weight and height were measured using an anthropometric scale, with measurements recorded to the nearest 100g for weight and to the nearest 0.1 cm for height. BMI was calculated and overweight in elderly were classified by WHO criteria[15]. Waist circumference (WC) was measured midway between the lowest rib margin and the iliac crest, near the umbilicus, using flexible nonstretch fiberglass tape. Usual diet were assessed through a food frequency questionnaire (FFQ) validated in patients with type 2 DM[16], which was applied by a dietitian. Reported intake of food groups were converted into daily consumption. The Brazilian food composition table

was used to evaluate the nutritional composition of the FFQ items[17]. Data intake from nutrients were expressed in crude amounts (g/day), as a percentage of total energy and adjusted to total energy[18]. Sources of protein content were also evaluated.

Laboratory measurements

Plasma glucose was determined by enzymatic UV hexokinase method, serum and 24h creatinine by Jaffé reaction, and HbA1c by HPLC procedure (4-6%). Lipid profile was determined by enzymatic colorimetric method. LDL cholesterol was calculated using the Friedwald formula (LDL = Total Cholesterol - (HDL Cholesterol – Triglycerides/5)[19]. Non-HDL cholesterol was calculated by the difference between total cholesterol and HDL-cholesterol. Complete blood count was measured by light absorbance/impedance/flow cytometry. C-reactive protein (CRP) was determined by immunoturbidimetry, Erythrocyte sedimentation rate (ESR) by kinetic photometry, and serum albumin by colorimetric green bromocresol method. 25-Hydroxyvitamin D was determined by chemiluminescence. Sodium was measured by indirect selective ion electrode, urea by UV enzyme, and urinary albumin excretion (UAE) by immunoturbidimetry method.

Assessment of sarcopenia

Our protocol was proposed in 2017 when Sarcopenia was defined according to the EWGSOP 2010 criteria[1]: low MM associated with reduced strength and/or physical performance.

Muscle mass

The MM was assessed through electric BIA[20] (InBody® 230, Seoul, South Korea), which provides total and segmental MM through the arms and legs in kilograms (kg). These values were used to calculate appendicular skeletal muscle mass (ASM): *ASM (kg) = MM arms + MM legs.*

Skeletal muscle mass index (SMI) was determined by ASM divided by height squared (ASM/ht^2)[21]. The cut-off values for low MM were≤ 8.50 kg kg/m^2 in men and ≤ 5.75 kg/m² in women[22]. We also evaluated calf circumference (CC). Measures ≤34cm for men and ≤33 for women were indicative of low MM[23].

Muscle strength

Muscle strength (MS) was assessed by handgrip strength (HS) measured by a hydraulic dynamometer (Jamar®, Bolingbrook, IL, USA)[24]. Three measurements were performed on each hand, with a 60-second interval between them, and the mean was considered. Values less than 30 kg for men and 20 kg for women were classified as reduction of [25] MS.

Step counting, physical performance and functional status assessment

Usual physical activity was objectively measured by step counting with a (Omron HJ-321, Omron Health care Co., Kyoto, JPN). Participants wore pedometers for seven days, attached to the waistband of their clothing during waking hours, except when bathing or swimming. Participants were encouraged not to alter their usual physical habits during these seven days. The pedometer memory also provides data from all period on the daily distance walked in kilometers. Physical performance was evaluated by TUG test[26]. Scores >20 seconds were considered low physical performance[26]. Functional status was assessed through two instruments: Katz Index[27] to evaluate independence in Activities of Daily Living (ADL) and Lawton and Brody Scale[28] to evaluate Instrumental Activities of Daily Living (IADL). Both instruments provide information about functional skills needed to live independently in community.

Diagnostic of sarcopenia

Following the EWGSOP 2010 criteria, participants were considered with sarcopenia when they presented low MM plus either low MS or low physical performance. The diagnostic criteria for sarcopenia were: ***Low SMI + (Low HS or Low TUG)***[1]

Study protocol

In first visit, patients underwent an interview and clinical examination for collection of demographic and anthropometric data. All tests to evaluate sarcopenia were also performed. Pedometer was delivered and patients were advised to initiate the device use in the next morning. Also, instructions about laboratory exams were given. In the second visit, (day 8) patients did the BIA test, answered the FFQ and pedometers

returned to research center. All tests and exams were delivered to participants at the end of protocol.

Statistical Analyses

Results were expressed as mean (±SD) and median (interquartile range) for continuous variables and as frequencies and percentages for categorical variables. Variables with a non-Gaussian distribution were log-transformed before analysis and Shapiro-Wilk test was used to verify the distribution of the data. Unpaired Student's t test, Mann-Whitney U test, and Pearson Chi Square were used as appropriate.

We classified patients according the presence of sarcopenia and according to the international study group to review dietary protein needs with aging (PROT-AGE)[29] recommendations of protein intake (≥1.2 g/kg or ≤1.2g/kg). The number of steps was assessed in quartis of steps/day. Poisson regression was performed with robust analysis of variance for the presence of sarcopenia according to results in univariate analysis or their biological importance. P values <0.05 (two tailed) were considered significant. Analyses were performed by SPSS version 21.0. The sample size of 241 patients was based on sarcopenia prevalence of 17% found in a meta-analysis[30] with elderly Brazilian patients without type 2 DM.

Results

Figure 1 shows the protocol flowchart. Of 1132 screened patients, 890 were excluded mainly due to <60 years old and had serum creatinine >2mg/dl. Final analyses were performed per protocol and we included 242 patients. Most patients were white (78%), 54% females, and 40% had regular alcohol consumption. Mean age was 68.3±5.6 years old, Fasting plasma glucose was 152±54 mg/dl, HbA1c was 7.8 ± 1.5%, and duration of DM was 14(8-22) years. Office systolic and diastolic blood pressure was 144±20/79±11 mm Hg, respectively. BMI was 29.5±4.5 kg/m², waist circumference were 101±15 cm for females and 105±12 cm for males. Pedometer analysis showed a median of 3946 (2837–5406) steps per day.

Of all participants, 43% had low HS, 7.4% had low physical performance, and 18.6% had low calf circumference. According to ASM results 29.8% of patients had low MM. The percentage of low MS in older adults with normal physical performance was 33.3%. The prevalence of sarcopenia was 16.9%.

Table 1 shows patients characteristics according to presence of sarcopenia. As expected, participants with sarcopenia were older and had lower BMI than participants without sarcopenia (p<0.05). Although men had more sarcopenia (73%), they were not older than women (68.4 ± 6 vs. 68.1 ± 3, p = 0.727). Moreover, patients with sarcopenia walk less [3164 (2227-4574) vs. 4031 (3007-5676) steps/day, p=0.004] than the group without sarcopenia. Regarding body composition and anthropometric data participants with sarcopenia had lower body fat, sum of leg MM, ASM, calf and waist circumference than non sarcopenic participants (p<0.05). Furthermore antidiabetics and antihypertensive drugs did not differ between groups (p>0.05). Patients with sarcopenia had higher values of CRP and lower values of total cholesterol than patients without sarcopenia [4.3 ± 5.4 vs 3.48 ± 3.5; p <0.035]. Instruments to assess functional status were not different between groups.

Table 2 shows daily intake of calories and nutrients of patients according to the presence of sarcopenia. Percentage of total energy from macronutrients and crude intake of macronutrients (g/day) did not differ between groups. When we adjusted crude intake of macronutrients for total energy intake, results did not change. Concerning different sources of protein intake, both groups had similar intake of animal and vegetable sources (p>0.05).

Characteristics of patients according to protein intake recommendations establish by the PROT-AGE group were evaluated. Only 34.7% of the patients reported intake ≥1.2 g/kg/day of protein. In addition, intake above 1.2 g/kg/day of protein did not differ in both groups (data not show).

The number of steps was assessed in quartis of steps/day for multivariate analysis. GLM Poisson model was performed with robust analysis of variance in order to evaluated sarcopenia (**Figure 2**). Significant associated factors to sarcopenia (gender and number of steps) on univariate analysis were used as covariates and the model was adjusted for age. Walking more than 5401 steps / day has a protective effect of 70% for the prevalence of sarcopenia [0.306 (0.127 – 0.739); p = 0.029]. Male sex increases the prevalence of sarcopenia by 33% [3.330 (1.747 – 6.350); p<0.001] and finally, age had an impact in prevalence of sarcopenia. It means that in our sample at each one year of age there is an increase about 6% in the prevalence of sarcopenia [1.061 (1.015-1.108); p=0.009].

Discussion

The current cross-sectional study was performed to evaluate the prevalence of sarcopenia in Brazilian older adults (≥ 60 years) with type 2 DM. Our study found a prevalence of sarcopenia of 16.9%, based on EWGSOP 2010 criteria[1]. In this study, the tools to assessment of sarcopenia were also loss of MS and function[5]. Similar results were found in elderly healthy Brazilian´s study with a prevalence of 15.4%[31]. Studies of prevalence of sarcopenia in type 2 DM individuals are still scarce. However, studies have been demonstrate that the prevalence of sarcopenia in this population varies from 11.6% to 22.5%[32,33,34]. It is known that de prevalence of sarcopenia varies depending the definition and methods of assessment. There is still no standard definition for assessment of sarcopenia, which is difficult to estimate its real prevalence. Data from a previous systematic review showed wide variation in results of prevalence (1-29%)[5] and differences between populations, methods to assess MM, MS and physical performance were probably the factors associated to this wide variation[1,35].

In our study age had important impact in prevalence of sarcopenia. In Poisson model, at each year of age there was an increase about 6% in the prevalence of sarcopenia. Indeed, evidence-based data indicated that the prevalence of sarcopenia for healthy subjects increase in people >80 years and reach up to 50%[36]. It has been observed that MM and strength begins to decline in the third decade of life and this reduction occurs more rapidly form the fifth decade onwards. Similarly, physical function declines with age, and this decline is pronounced in sedentary individuals[37].

Sex can also influence prevalence outcomes. In our sample, the prevalence of sarcopenia in women and men were 8.5% and 26.8% (p<0.001), respectively. About our 41 patients with sarcopenia, 73.2% were male. These results were different of the majority of reports [38,39,40], however, previous studies using the same criteria and cut off point as we used showed similar outcomes [6,10]. Although the prevalence of sarcopenia in general was more common in elderly women it seems to be more accentuated in men when they have >80 years[4] and in men with diabetes*.

Our study observed that patients with sarcopenia had low ASM and BMI. Sarcopenia is commonly observed as a result of age-related loss of MM. Approximately

75% of MM is located in the appendicular area and 15 a 20% of the elderly population have a deficiency in MM[37]. The quantity of MM is associated to physical performance and the prevention of fractures[41]. In individuals with type 2 DM there is a greater decline in MM, leg muscle strength, and muscle quality[7,8,9]. Furthermore, leg lean mass and ASM were lower in older men with diabetes[4]. In fact, high BMI might attenuate this loss of MM[4].

Patients with sarcopenia walk less than patients without this syndrome. Previous data demonstrated that low physical activity was directly associated with sarcopenia[5]. Moreover, reduction of steps counting might induce a loss of leg lean mass and this decline promotes a reduction in the ability of the muscle to generate force[42]. In our study, walking above 5401 steps/day had a protective effect of 70% for the prevalence of sarcopenia. Definitely, physical activity had a positive effect on MM[43]: slight activities might prevent loss of MM and sarcopenia[45]. Despite resistance training is an important tool to increase MM and strength in the elderly[46], walking also had positive effects in MM and possibly this exercise is more appropriated and acceptable for elderly people[45]. Indeed, it has been found that walking promote better adherence than more intense exercise[43].

Patients with sarcopenia had higher values of CRP than the group without sarcopenia. Chronic inflammation associated with oxidative stress, were possible factors involved in the mechanism of sarcopenia and DM[47]. In addition, age may increase the inflammation. In fact, there is strong evidence that increased levels of inflammatory markers, including CRP, are associated with medical conditions such as DM and also play a role in the functional decline and low MM in older persons[46].

The matched intake of macronutrients across groups might be explained by FFQ tool. Despite this FFQ was validate to use in patients with type 2 DM[16], it may not the best tool to assess usual diet in elderly[48]. Even when we adjusted crude intake to total energy and analyzes sources of protein intake results did not change. Elderly usually has low intake of protein mainly due to decreased of appetite and tooth loss. Unfortunately FFQ used was not strong enough to verify if protein intake reduced between groups.

Concerning the new proposed parameters of European Consenso 2018 (EWGSOP2)[49] the prevalence of sarcopenia in our sample was 7%. EWGSOP2 focuses

on low MS, evaluated by HS, as a key characteristic of sarcopenia. Low muscle quantity and quality is used to confirm the sarcopenia diagnosis, and performance tests was used only to classify the severity of sarcopenia[49]. Also, women had more sarcopenia than men (88% vs. 52%; p = 0.001). Although participants with sarcopenia had lower BMI than individuals without sarcopenia (24±3 kg/m² vs. 30±4 kg/m²; p <0.001), age and number of steps did not differ between groups (p>0.05).

We suspect that this huge difference between the two consensus were due to changes in SMI and HS cut-off points. Mainly, because in our analysis we used the parameter for men of low SMI <8,5 kg/m² and now the EWGSOP2 recommends SMI <7,0 kg/m²[49].

The present study had some limitations that must be considered. First, a potential limitation would be that the cross-sectional nature of this study precluded our ability to identify any cause-effect relationships. Because of this study design we also cannot exclude the possibility of reverse causality, particularly in the relationship between DM and sarcopenia. Patients with type 2 DM may have more sarcopenia, just as sarcopenia may predispose more to DM. Moreover both conditions occur in elderly. In our study, the same reverse causality could occur with the associated factor identified in our study. Physical activity and clinical comorbidities influence the outcome, and vice-versa. Second, we used BIA for measuring MM. Despite the limitation that is not the standard technique, prediction equations have been validated for multiethnic adults and reference values established for older subjects with this technique[50]. Thus, BIA might be a good alternative to apply in clinical practice and research[1]. Another shortcoming could involve dietary records.

The food-frequency techniques used in our study are limited due to the lack of accuracy for quantitative data[15]. In addition, FFQ does not seem to be the best tool for elderly. In this population, it tended to underestimate the energy and nutrient intake[45].

Despite the forementioned limitations, we identified the prevalence of sarcopenia in the elderly with type 2 DM and some factors associated with this syndrome. As far as we known, this is the first study to evaluated sarcopenia in type 2 DM patients in Brazil. Moreover, we used pedometer which is a direct measure of step counting and provide an adequate assessment of physical activity.

Conclusion

The present cross-sectional study found a prevalence of sarcopenia of 16.9% in patients with type 2 DM. The impact of DM on sarcopenia is not fully understood and multiple mechanisms have been proposed for acceleration of sarcopenia in these patients[35]. On the other hand, some important factors had a protective effect for this syndrome. Walking more than 5401 steps / day has a protective effect of 70% for the prevalence of sarcopenia and age had an impact in prevalence of sarcopenia in type 2 DM patients. Walking, a popular and effective physical active that has no special skills might play a protective role in sarcopenia.

References

1. Cruz-Jentoft AJ, Baeyens JP, Bauer JM, Boirie Y, et al. Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People. Age Ageing. 2010;39(4):412-23.

2. Janssen I, Baumgartner R, Ross R et al. Skeletal muscle cutpoints associated with elevated physical disability risk in older men and women. Am J Epidemiol 2004; 159: 413–21.

3. Landi F, Liperoti R, Fusco D, et al. Prevalence and risk factors of sarcopenia among nursing home older residents. J Gerontol A Biol Sci Med Sci. 2012;67(1):48-55.

4. Kim JH, Lim S, Choi SH, et al. Sarcopenia: an independent predictor of mortality in community-dwelling older Korean men. J Gerontol A Biol Sci Med Sci. 2014;69(10):1244-52.

5. Cruz-Jentoft AJ, Landi F, Schneider SM, et al. Prevalence of and interventions for sarcopenia in ageing adults: a systematic review. Report of the International Sarcopenia Initiative (EWGSOP and IWGS). Age Ageing. 2014;43: 748–759.

6. Umegaki H. Sarcopenia and frailty in older patients with diabetes mellitus. Geriatr Gerontol Int. 2016;16:293–299.

7. Park SW, Goodpaster BH, Strotmeyer ES, et al. Accelerated loss of skeletal muscle strength in older adults with type 2 diabetes: the health, aging, and body composition study. Diabetes Care. 2007;30(6):1507-12.

8. Leenders M, Verdijk LB, van der Hoeven L, et al. Patients with type 2 diabetes show a greater decline in muscle mass, muscle strength, and functional capacity with aging. JAMDA. 2013;14(8):585-92.

9. Park SW, Goodpaster BH, Strotmeyer ES, et al. Decreased muscle strength and quality in older adults with type 2 diabetes: the health, aging, and body composition study. Diabetes. 2006;55(6):1813-8.

10. Morley JE, Malmstrom TK, Rodriguez-Manas L, Sinclair AJ. Frailty, sarcopenia and diabetes. J Am Med Dir Assoc. 2014;15:853–859.

11. World Health Organization (WHO). Active Ageing – A Police Framework. A Contribution of the World Health Organization to the second United Nations World Assembly on Aging. Madrid, Spain, 2002.

12. Conselho Nacional de Ética em Pesquisa. Resolução 466/12. 2012.

13. Rose GA BH, Gillum RF, Prineas RJ. Cardiovascular survey methods. WHO Monograph Series nº 56. 1982;2nd ed.:pp.123-65.

14. James PA, Oparil S, Carter BL, Cushman WC, Dennison-Himmelfarb C, Handler J, et al. 2014 evidence-based guideline for the management of high blood pressure in adults: report from the panel members appointed to the Eighth Joint National Committee (JNC 8). JAMA. 2014;311(5):507-20.

15. Lipschitz D.A. Screening for nutritional status in the elderly. Primary Care, 1994; 21(1):55-67.

16. Sarmento RA, Antonio JP, Riboldi BP, Montenegro KR, Friedman R, de Azevedo MJ, et al. Reproducibility and validity of a quantitative FFQ designed for patients with type 2 diabetes mellitus from southern Brazil. Public Health Nutr. 2014;17(10):2237-45.

17. Núcleo de Estudos e Pesquisas em Alimentação (NEPA) – Tabela Brasileira de Composição de Alimentos (TACO). 1ª ed. Campinas: NEPA – UNICAMP, 2004.

18. Willet W. Nutritional Epidemiology.2ª edition.Oxford University Press. ISBN 0-19-512297-6

19. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. Clin Chem. 1972;18(6):499-502.

20. Janssen I, Heymsfield SB, Baumgartner RN, Ross R. Estimation of skeletal muscle mass by bioelectrical impedance analysis. J Appl Physiol (1985) 2000;89:465–471.

21. Baumgartner R, Koehler K, Gallagher D et al. Epidemiology of sarcopenia among the elderly in New Mexico. Am J Epidemiol 1998; 147: 755–63.

22. Janssen I, Baumgartner RN, Ross R, et al. Skeletal muscle cutpoints associated with elevated physical disability risk in older men and women. Am J Epidemiol 2004;159:413–421.

23. Barbosa-Silva TG, Bielemann RM, Gonzalez MC, Menezes AM. Prevalence of sarcopenia among community-dwelling elderly of a medium-sized South American city: results of the COMO VAI? study. J Cachexia Sarcopenia Muscle. 2016;7(2):136-43.

24. Bohannon RW, Peolsson A, Massy-Westropp N, et al. Reference values for adult grip strength measured with a Jamar dynamometer: a descriptive meta-analysis. Physiotherapy. 2006;92(1):11–5.

25. Laurentani F, Russo C, Bandinelli S et al. Age-associated changes in skeletal muscles and their effect on mobility: an operational diagnosis of sarcopenia. J Appl Physiol 2003; 95:1851–60.

26. Podsiadlo D, Richardson S. The timed "Up & Go": a test of basic functional mobility for frail elderly persons. J Am Geriatr Soc. 1991;39(2):142-8.

27. Katz S, Ford AB, Moskowitz RW, Jackson BA, Jaffe MW. Studies of Illness in the Aged. The Index of Adl: A Standardized Measure of Biological and Psychosocial Function. JAMA. 1963;185:914-9

28. Lawton MP, Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. Gerontologist. 1969;9(3):179-86.

29. Bauer J, Biolo G, Cederholm T, et al. Evidence-based recommendations for optimal dietary protein intake in older people: A position paper from the prot-age study group. J Am Med Dir Assoc. 2013;14(8):542–59.

30. Diz JB, Leopoldino AA, Moreira BS, Henschke N, Dias RC, Pereira LS, et al. Prevalence of sarcopenia in older Brazilians: A systematic review and meta-analysis. Geriatr Gerontol Int. 2016.

31. Alexandre Tda S, Duarte YA, Santos JL, et al. Prevalence and associated factors of sarcopenia among elderly in Brazil: findings from the SABE study. J Nutr Health Aging. 2014;18(3):284-90.

32. Ida S, Kaneko R, Nagata H, et al. Association between sarcopenia and sleep disorder in older patients with diabetes. Geriatr. Gerontol. Int. 2019;1–5.

33. Nishimura A, Harashima SI, Hosoda K, Arai H, Inagaki N. Sex-related differences in frailty factors in older persons with type 2 diabetes: a cross-sectional study.Ther Adv Endocrinol Metab. 2019 Mar 5;1

34. Ogama N, ,Sakurai T, Kawashima S, et al. Association of Glucose Fluctuations with Sarcopenia in Older Adults with Type 2 Diabetes Mellitus. J. Clin. Med. 2019, *8*(3), 319.

35. Bijlsma AY, Meskers CG, Ling CH, et al. Defining sarcopenia: The impact of different diagnostic criteria on the prevalence of sarcopenia in a large middle aged cohort. Age (Dordr), 2013, 35(3), 871–881.

36. von Haehling S, Morley JE, Anker SD. An overview of sarcopenia: facts and numbers on prevalence and clinical impact. J Cachexia Sarcopenia Muscle. 2010;1(2):129–133.

37. Shaw SC, Dennison EM, Cooper C. Epidemiology of sarcopenia: determinants throughout the life course. Calcif Tissue Int. 2017;101:229–47.

38. Yamada M, Nishiguchi S, Fukutani N, et al. Prevalence of sarcopenia in community-dwelling Japanese older adults. JAMDA. 2013;14(12):911-5

39. Patel HP, Syddall HE, Jameson K, et al. Prevalence of sarcopenia in community-dwelling older people in the UK using the European Working Group on Sarcopenia in Older People (EWGSOP) definition: findings from the Hertfordshire Cohort Study (HCS). Age Ageing. 2013;42(3):378-84.

40. Rosenberg IH. Summary comments. Am J Clin Nutr. 1989;50(5):1231-3.

41. Cooper C, Dere W, Evans W, et al. Frailty and sarcopenia: definitions and outcome parameters. Osteoporosis international: a journal established as result of cooperation between the European Foundation for Osteoporosis and the National Osteoporosis Foundation of the USA. 2012;23(7):1839-48.

42. Kim SH, Kim TH, Hwang HJ. The relationship of physical activity (PA) and walking with sarcopenia in Korean males aged 60 years and older using the fourth Korean National Health and nutrition examination survey (KNHANES IV-2, 3), 2008-2009. Arch Gerontol Geriatr. 2013;56(3):472–477.

43. Raguso CA, Kyle U, Kossovsky MP, et al. A 3-year longitudinal study on body composition changes in the elderly: role of physical exercise. Clin Nutr. 2006;25:573-580.

44. Peterson MD, Sen A, Gordon PM. Influence of Resistance Exercise on Lean Body Mass in Aging Adults: A Meta-Analysis. Med Sci Sports Exerc. 2011 February;43(2):249-258.

45. Davison, R. C., & Grant, S. (1993). Is walking sufficient exercise for health? Sports Medicine, 16, 369–373.

46. Cesari M, Penninx BW, Pahor M, et al. Inflammatory markers and physical performance in older persons: the InCHIANTI study. J Gerontol A Biol Sci Med Sci. 2004;59:242-248.

47. Schaap, L, Pluijim, SMF, Deeg, DJH, Visser, M. Inflammatory markers and loss of muscle mass (sarcopenia) and strength. *Am J Med* 2006; 119: 526.e9– 526.e17.

48. Procter-Gray E, Olendzki B, Kane K, et al. Comparison of Dietary Quality Assessment Using Food Frequency Questionnaire and 24-hour-recalls in Older Men and Women. AIMS Public Health 2017; 3;4(4):326-346.

49. Cruz-Jentoft AJ, Bahat G, Bauer J, et al. Sarcopenia: revised European consensus on definition and diagnosis. Age Ageing 2019;48:16-31.

50. Janssen I, Heymsfield SB, Wang ZM, Ross R. Skeletal muscle mass and distribution in 468 men and women aged 18-88 yr. J Appl Physiol. 2000;89(1):81-8.

Table 1. Patients characteristics according to presence of sarcopenia

	Without sarcopenia	With sarcopenia	P
Clinical and Demographic characteristics			
N (%)	201 (83.1)	41 (16.9)	
Age, y	67.8± 5.5	70.3 ± 5.8	.011*
Male sex, n (%)	82 (41)	30 (73)	.000[†]
Diabetes duration (y)	15 (9-28)	18(8-21)	.113*
White ethnicity, n (%)	153 (85.4)	35 (76.1)	.223[†]
BMI (kg/m^2)	30.2 ± 4.3	25.9 ± 3.9	.000*
Current smoking, n (%)	13 (6.5)	0 (0)	.133[†]
Alcohol consumption (yes), n (%)	78 (39)	19 (46)	.386[†]
Step counting (mean of 7 days)	4031 (3007-5676)	3164 (2227-4574)	.004[‡]
Systolic blood pressure (mmHg)	143.4 ± 8.9	150.1 ± 24.4	.102*
Diastolic blood pressure (mmHg)	79.3 ± 10.6	79.3 ± 11.2	.991*
Hypertension, n (%)	181 (90)	34 (83)	.183[†]
Antihypertensives, n (%)	181 (90)	35 (85.4)	.406[†]
Katz Index (parcial dependence), n (%)	3 (1.5)	0 (0)	.572[†]
Lawton scale (parcial dependence), n (%)	11 (5.5)	3 (7.3)	.433[†]
Diabetes Medication			
Oral antidiabetics, n (%)	193 (96)	37 (90.2)	.126[†]
Insulin, n (%)	100 (50)	17 (41.5)	.392[†]
Body Composition (BIA) and Anthropometric Data			
Fat mass (%)	35.1 ± 8.2	30.5 ± 8.3	.001*

Fat mass (kg)	28.2 ± 8.8	21.6 ± 8.0	.000*
Muscle mass (kg)	28.2 ± 5.9	26.2 ± 6.5	.056*
Sum of leg muscle mass (kg)	15.4 ± 3.6	13.8 ± 3.0	.008*
ASM (kg)			
Female	18.1 ± 3.0	13.3 ± 1.6	.000*
Male	25.7 ± 3.1	21.0 ± 2.4	.000*
Calf circunference (cm)	37.5 ± 3.3	35.0 ± 3.9	.000*
Waist circunference (cm)			
Female	102.5 ± 14.1	90.3 ± 16.0	.008*
Male	107.2 ± 9.8	99.3 ± 13.5	.001*
Laboratory parameters			
Fasting glucose (mg/dl)	151.9 ± 53.9	142.3 ± 47.4	.291*
Glycated hemoglobin (%)	7.8 ± 1.5	8.0 ± 1.6	.353*
Total cholesterol (mg/dl)	167.9 ± 44.8	146 ± 39.5	.002*
HDL cholesterol (mg/dl)	46.5 ± 14.1	46.2 ± 12.4	.895*
Triglycerides (mg/dl)	137 (103-219)	125 (81- 200)	.068‡
Albumin (g/dl)	4.4 ±0.3	4.5 ± 0.22	.180*
Serum creatinine (mg/dl)	1.1 ± 2.9	1.0 ± 0.3	.699*
25-hydroxyvitamin D (ng/ml)	23.0 ± 8.1	25.6 ± 10.4	.137*
Urinary creatinine (mg/24h)	1240.9 ± 370.3	1195.3 ± 290.0	.458*
Urinary sodium (mEq/24h)	201.4 ± 141.7	183.2 ± 65.6	.812‡
Urinary urea (g/24h)	24.2 ± 9.1	22.2 ± 7.0	.234*
CRP (mg/l)	3.48 ± 3.5	4.3 ± 5.4	.035‡
ESR (mm/h)	13 (6-24)	7 (5-18)	.097‡

Data expressed as mean ± SD, median (CI), or number of patients with the analyzed characteristic (%).
y, years; BMI, body mass index; BIA, electrical bioimpedance, ASM, appendicular skeletal muscle; CRP, C-reactive protein; ESR, erythrocyte sedimentation rate, Katz index evaluate activities of daily living; Lawton scale evaluate instrumental activities of daily living.
* Student's "t" test,
† Pearson Chi Square,
‡Mann-Whitney

Table 2. Daily intake of nutrients of type 2 diabetic patients according to the presence of sarcopenia

	Without sarcopenia n = 201	With sarcopenia n = 41	P
Total Energy intake (kcal)	1616.5 ± 550.9	1661.5 ± 491.2	.631*
Protein			
Total energy intake (%)	20.8 ± 4.3	19.7 ± 4.0	.158*
Crude intake (g)	83.7 ± 33.6	81.5 ± 26.6	.697*
Adjusted intake (g)	84.0 ± 20.8	79.7 ± 16.0	.213*
Animal source adjusted (g)	55.1 (43 – 70)	48.2 (39 – 65)	.258‡
Vegetable source adjusted (g)	12.9 (10 – 15)	13.9 (10 – 19)	.114‡
Fat			
Total energy intake (%)	26.1 ± 6.0	24.6 ± 6.0	.134*
Crude intake (g)	47.0 ± 20.5	46.1 ± 18.7	.778*
Adjusted intake (g)	47.3 ± 11.36	45.0 ± 10.0	.216*
Carbohydrate			
Total energy intake (%)	53.8 ± 8.7	56.4 ± 8.5	.074*
Crude intake (g)	216.7 ± 80.8	232.8 ± 73.5	.237*
Adjusted intake (g)	217.6 ± 37.7	228.0 ± 32.3	.102*

Data expressed as mean ± standard deviation.
* Student's "t" test,
‡Mann-Whitney
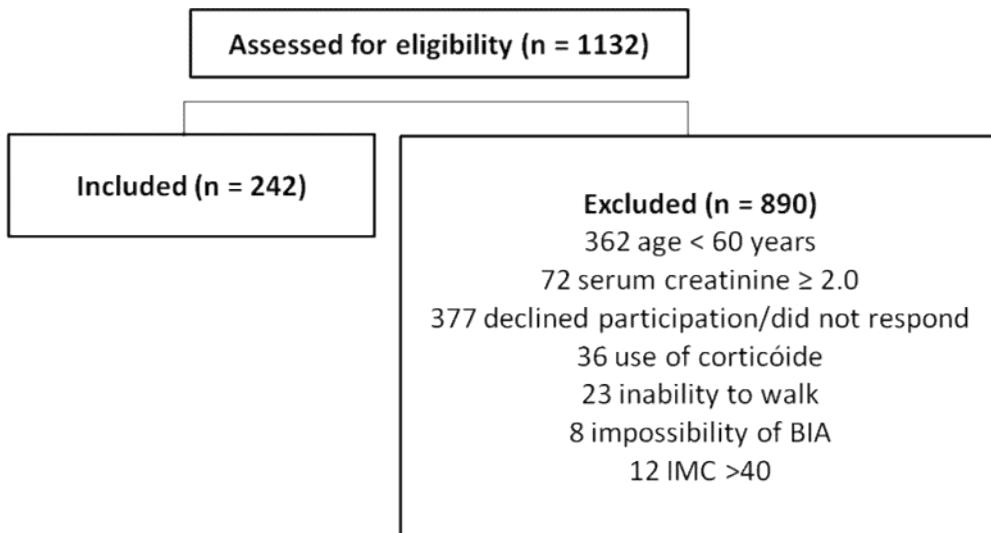
**Figure 1**. Flowchart of study participants.
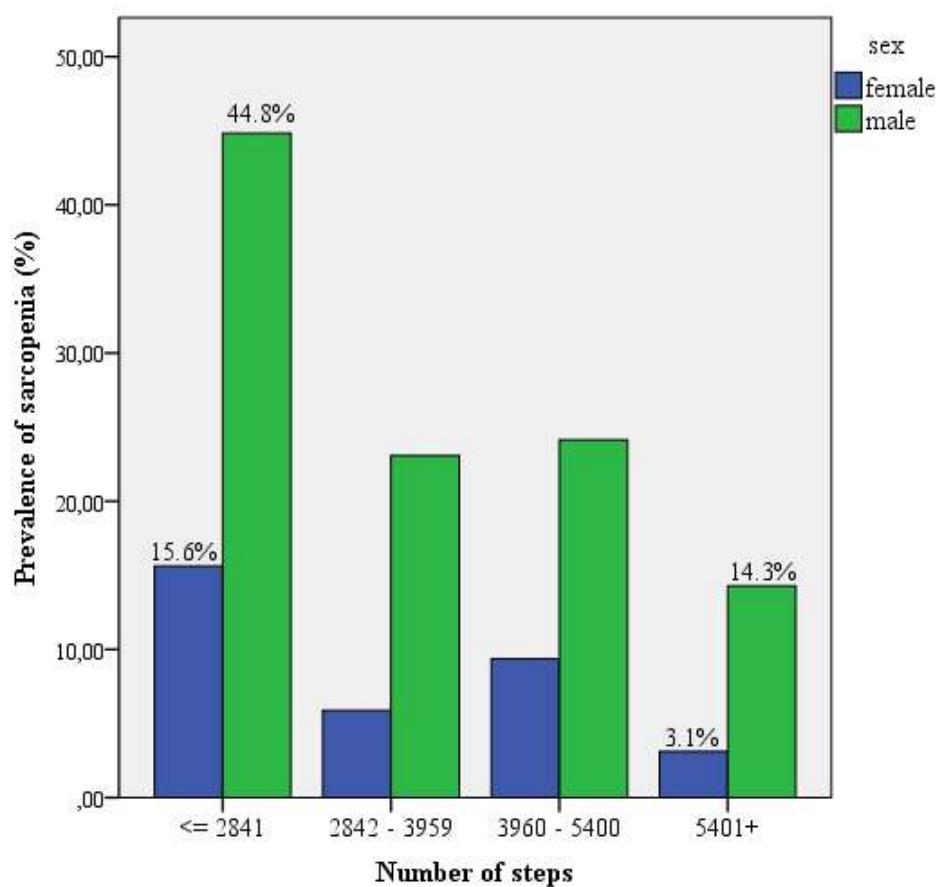
Figure 2. Prevalence of sarcopenia according to step counting in type 2 DM patients.