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Association of muscle strength and muscle mass with body mass index and insulin treatment in older patients with type 2 diabetes mellitus admitted to geriatric outpatient clinic

Geriatri polikliniğine başvuran tip 2 diabetes mellituslu hastalarda kas gücü ve kas kütlesinin vücut kitle indeksi ve insülin tedavisiyle ilişkisi

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ABSTRACT

Aim: The aim of this study was to investigate the hand grip strength and muscle mass of older patients with type 2 diabetes mellitus in relation to body mass index and insulin treatment.

Materials and Methods: A total of 123 older patients with diabetes mellitus ≥65 years of age were admitted to geriatric outpatient clinic of a university hospital between October 2015 and October 2019. Demographic data, medical records, laboratory results, hand grip strength and muscle mass were derived from the hospital records, retrospectively.

Results: The patients were grouped according to body mass index and usage of insulin treatment. There was a negative correlation between body mass index and hand grip strength (p = 0,002), and a positive correlation between body mass index and muscle mass index (p = 0,001). No significant differences for hand grip strength and muscle mass index were observed between insulin treatment group and non-insulin treatment group.

Conclusion: In type 2 diabetes mellitus patients with normal weight and obesity, anthropometric differences should be considered to identify true sarcopenic patients. Assessment of muscle strength, and also evaluation of muscle quality might be more valuable than assessment of muscle mass for those patients.

Keywords: Elderly, muscle strength, muscle mass, diabetes mellitus, insulin treatment.

ÖZ

Giriş: *Bu çalışmanın amacı, 65 yaş üstü diabetes mellituslu hastaların kas gücü ve kas kütlesinin vücut kitle indeksi ve insülin tedavisi ile ilişkisini araştırmaktır.*

Gereç ve Yöntem: *Çalışmaya Ekim 2015 – Ekim 2019 tarihleri arasında bir üniversite hastanesi Geriatri polikliniğine başvurmuş 65 yaş ve üzeri 123 diabetes mellituslu hasta dahil edilmiştir. Demografik bilgiler, tıbbi kayıtlar, laboratuvar sonuçları, el sıkma gücü, kas kütlesi ölçümleri hastane kayıtlarından retrospektif olarak kaydedilmiştir.*

Bulgular: *Hastalar, insülin kullanımına ve vücut kitle indeksine göre gruplandırıldı. Hastaların vücut kitle indeksi ve el sıkma güçleri arasında negatif bir korelasyon (p = 0,002), vücut kitle indeksi ile kas kütle indeksi arasında ise pozitif bir korelasyon saptandı (p = 0,001). İnsülin kullanan ve kullanmayan hastaların el sıkma gücü ve kas kütlesi ölçümleri arasında ise anlamlı fark saptanmadı.*

Sonuç: *Normal kilolu ve obez diabetes mellituslu hastalar arasında, gerçek sarkopenik hastaları tespit etmek için, antropometrik farklılıklar göz önünde tutulmalıdır. Bu hastalarda kas kütlesinin değerlendirilmesinden çok, kas gücü ve hatta kas kalitesinin değerlendirilmesi daha faydalı olabilir.*

Anahtar Sözcükler: *Yaşlı, kas gücü, kas kütlesi, diabetes mellitus, insülin tedavisi.*

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INTRODUCTION

Diabetes mellitus (DM) is a metabolic disease that negatively impacts the quality of life in old age (1). Changes occur in body composition with aging, and these changes also appear to affect insulin secretion. Thus, advanced age is an important risk factor for the developing type 2 DM (2). In addition, DM is one of the most important reasons for muscle weakness (3, 4). Diabetes mellitus negatively affects muscle function and functional status in older adults. A study found that older adults with DM have lower muscle strength than those without DM (5).

Insulin has an anabolic effect on muscle tissue by increasing intracellular protein intake (6), and insulin treatment could positively affect muscle function and functional status due to its anabolic effect (7). Poor glycemic control and insulin resistance are associated with reduced muscle mass in older adults with DM (8). Lower endogenous insulin secretion contributes to the loss of muscle mass in DM patients (8).

In another study, Insulin treatment was shown to affect gait speed, but not muscle mass and muscle strength (9). It is reported that body mass index (BMI) would also have an impact on muscle mass and muscle strength (10, 11).

The association of the muscle strength and mass with insulin treatment and BMI is not well known. In this study, the association of the muscle strength and mass with insulin treatment and BMI was investigated in older adults with DM.

MATERIALS AND METHODS

Study Population

In this study, patients aged 65 years and over admitted to the geriatric outpatient clinic of a university hospital between October 2015 and October 2019 were evaluated. 357 of 1403 patients had type 2 DM. 123 patients with complete data and a diagnosis of DM for at least 2 years were included in the study. The exclusion criteria and the number of patients excluded are given in Figure-1.

BMI, body mass index; DM, diabetes mellitus.

Ethical standards

The research protocol was approved by the local ethics committee (Approval Date and Number: 11/12/2019; 19-12T/48). Each participant was informed about the study and signed a consent form.

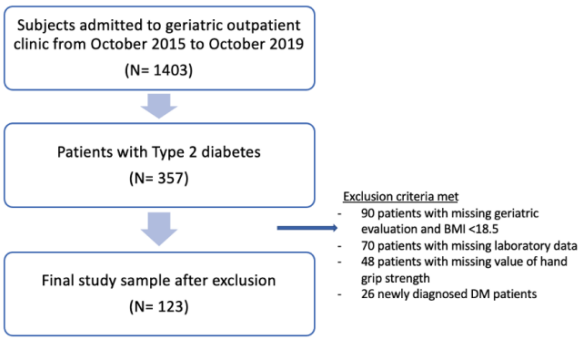

Figure-1. Flow chart of patients enrolled in the study.

Assessment of muscle strength and muscle mass

Muscle strength was assessed by hand grip strength. The patients were asked to squeeze the Takei digital hand dynamometer with their best performance while standing with arm by their side with full elbow extension. This process was repeated three times with one minute intervals, and the average of three measurements was recorded. There are several different cut-off points to determine low muscle strength. The recommended cut-off thresholds for hand grip strength are 32 / 22 kg (male / female) in the Turkish population (12). Recently, these cut-off points were determined as 27 / 16 kg (male / female) by The European Working Group on Sarcopenia in Older People-2 (EWGSOP) (13). We used the Turkish population specific cut-off points for hand grip strength in this study. Patients who had hand grip strength below those cut-off points have been defined as 'possible sarcopenia'.

Bioelectrical impedance analysis was used for the measurement of muscle mass (Tanita Mc 780 ST). The fat free mass (FFM) values of the patients were determined with the bioelectrical impedance analysis with an empty stomach and bladder. Skeletal muscle mass (SMM) measurement was calculated using the following formula validated from FFM: [SMM (kg) = 0,566 × FFM] (14). Skeletal muscle mass index (SMMI) was calculated as skeletal muscle mass (SMM) (kg) divided by the square of height in meters (m^2) (15). The cut-off value for SMMI was taken as <9.2 kg / m^2 in men and <7.4 kg / m^2 in women (12). Patients who had both low hand-grip strength and low SMMI was considered to have sarcopenia (13).

Comprehensive geriatric assessment

Comprehensive geriatric assessment provides appropriate and accurate assessment of the older adults with an interdisciplinary approach (16).

Mini Nutritional Assessment

Mini Nutritional Assessment (MNA) is used for screening and diagnosis of malnutrition, and has been shown to be sensitive for malnutrition in older adults. A score of 24 and more identifies patients with a normal nutritional status (17).

Mini Mental State Assessment

Mini Mental State Assessment (MMSA) is one of the rapid cognitive screening tests that is frequently preferred in older adults. The individual's orientation, memory, attention and language ability are evaluated out of 30 points (18).

Geriatric Depression Scale-15 Short Form

Geriatric depression scale-short form (GDS-SF) is a 15-question test applied easily and quickly, and it evaluates depressive symptomatology of the individual. Depression should be suspected of 5 points or more according to 'yes' and 'no' answers (19).

Katz Activities of Daily Living scale

Katz Activities of Daily Living scale is an instrument that is evaluated over 6 points by asking questions about bathing, dressing, going to the toilet, transferring, continence, and feeding (20).

Lawton Brody Instrumental Activities of Daily Living scale

Lawton Brody Instrumental Activities of Daily Living scale (Lawton Brody IADL scale) is a valuable instrument that assess necessary life skills for independent living such as personal hygiene, dressing and clothing care, health care, cooking, eating, nutrition, financial management (21). In Lawton Brody IADL scale, a point between 0 and 13 means dependency, between 14 and 22 means semi-dependency, and 22 and over means independency (22).

Anthropometric measurements

The BMIs of the patients were calculated as their weight (in kilograms) divided by the square of their height (in meters) (kg / m^2). BMI was classified as; 18.5 to 24.99 means normal weight, 25 to 29.99 means overweight, 30 or over means obese. Patients with BMI of less than 18.5 kg/m^2 were excluded from the study.

Statistical analysis

Statistical analyses were performed using SPSS v.25. Descriptive statistics were given as mean ± standard deviation, median (minimum – maximum), frequency, ratio, where appropriate. Student's t test was used to compare two groups of variables with normal distribution, and Mann Whitney U test was used to compare two groups of variables without normal distribution. Chi-square and Kruskal-Wallis tests were used for comparisons of three or more groups. The Mann–Whitney U-test was used when the aim was to show a difference (found with the Kruskal-Wallis test) between two groups. Spearman correlation analysis was used to evaluate the relationships between variables.

RESULTS

Characteristics of the study population

The mean age of 123 patients was 73.6 $\pm$ 6.6 (65-92) years. 46 patients (37.4%) were male. 31 (25%) of the patients were living alone. 34 patients were treated with insulin and 60 patients (48.8%) were taking only metformin. The second most prevalent drug in DM treatment was dipeptidyl peptidase-4 inhibitor (DPP-4). Mean Katz Activities of Daily Living score was 5.2 $\pm$ 0.8, mean Lawton Brody IADL score was 18.6 $\pm$ 0.03, MNA score was 24.2 $\pm$ 4.2 and 65% of patients had normal nutritional status. Mean GDS score was 2.8 $\pm$ 3.1, and mean MMSA score was 25.7 $\pm$ 5.2. We found urinary incontinence in 59 patients, polypharmacy in 43 patients, the risk or presence of malnutrition in 43 patients, in terms of geriatric syndromes. The demographic characteristics of the patients are presented in Table-1.

Table-1. The demographic characteristics of the patients.

	All (n=123)	Insulin (+) (n=34)	Insulin (-) (n=89)	P value
Age (years)	73 (65-92)	72 (65–88)	73 (65-92)	0.775
Female sex (%)	62.6	61.8	62.9	0.906
Living alone (%)	25.2	5.7	19.5	0.466
Hypertension (%)	74	67.6	76.4	0.322
Hyperlipidemia (%)	17.1	17.6	16.9	0.917
CAD (%)	35	52.9	28.1	0.01
Dementia (%)	8.9	8.8	9	0.642*
Medication (n)	6 (1-16)	8 (2-15)	5 (1-16)	0.001
Polypharmacy (%)	63.4	88.2	53.9	0.000
Urinary incontinence (%)	48	47.1	48.3	0.901
Katz score	5 (2-6)	5 (2-6)	5 (2-6)	0.413
LBIADL	22 (0-23)	18 (4-23)	22 (0-23)	0.006
MNA**	25.5 (7.5-29.5)	24 (11-29)	26 (7.5-29.5)	0.024
BMI (kg/m^2)	28.8 (19-56.2)	29.4 (19-47.3)	28.8 (19.1-56.2)	0.581
Obese (%)	43.9	47.1	42.7	
Overweight (%)	37.4	29.4	40.4	
Normal weight (%)	18.7	23.5	16.9	
Hand grip strength (kg)**	22 (6-45)	21 (6-34.3)	23 (8-45)	0.291
Probable sarcopenia (%)	69.1	76.5	66.3	0.275
FFM (kg)	47.5 (33.1-80.7)	51.1 (33.1-80.7)	46.3 (34.4-70.7)	0.536
SMMI (kg/m^2)	10.9 (7-15.8)	11.2 (7-15.4)	10.8 (7.4-15.8)	0.549
Sarcopenia (%)	1.6	2.9	1.1	0.478*
MMSA	27 (8-30)	27 (15-30)	27 (8-30)	0.302
GDS	2 (0-15)	2 (0-14)	2 (0-15)	0.814
FBG (mg/dl)**	124 (76- 409)	156 (76-409)	114.5 (78-206)	0.000
Cr**	0.89 (0.5 – 4.6)	0.98 (0.56-4.6)	0.88 (0.5-1.191)	0.518
HbA1c**	6.7 (5.2 – 16.2)	7.5 (5.5-16.2)	6.5 (5.2-12.3)	0.000

*Fisher's exact test; ** Missing data

CAD, Coronary artery disease; CVA, Cerebrovascular accident; LBIADL, The Lawton Instrumental Activities of Daily Living Scale; MNA, Mini Nutritional Assessment; BMI, body mass index; FFM, free fat mass; SSMI, Skeletal muscle mass index; MMSA, mini mental state assessment; GDS, geriatric depression score; FBG, fasting blood glucose; Cr, creatinine; HBA1c, glycolyzed hemoglobin

Table-2. The distribution of BMI and insulin therapy in patients with DM

		BMI classification			
		Normal weight 18.5-24.9	Overweight 25-29.9	Obese 30 and over	Total
Insulin therapy	No	15	36	38	89
	Yes	8	10	16	34
Total		23	46	54	123

BMI, body mass index; DM, diabetes mellitus.

Associations of hand-grip strength, muscle mass and possible sarcopenia with BMI

It was observed that there was significant association between the hand grip strength and BMI groups (Chi-Square = 8.023, df = 2; p = 0.018). No significant difference was observed neither between overweight and normal weight patients nor between overweight and obese patients (p = 0.85, p = 0.214, respectively). A significant difference was found in the hand grip strength between normal weight patients and obese patients (p = 0,04). Negative correlation was observed between BMI and hand-grip strength of the patients (r = -0,278, p = 0,002). Hand-grip strength was lower in patients with high BMI. Significant and positive correlation was observed between BMI and SMMI (kg / m^2), and SMMI (kg / m^2) increased as BMI increased (r = 0,516, p=0,001). There was no significant difference between BMI groups in terms of possible sarcopenia (p = 0.735).

Associations of hand-grip strength, muscle mass and possible sarcopenia with using insulin therapy

The incidence of cardiovascular disease and the presence of polypharmacy were higher in patients with insulin therapy than in patients without insulin therapy. There was no difference between the groups in terms of use of statin and angiotensin converting enzyme inhibitors which may affect muscle strength and mass (p = 0.467 and p = 0.814, respectively). In addition, IADL scores were lower in patients with insulin therapy than in patients without insulin therapy.

The mean value of BMI was 31.1$\pm$ 7.5 kg / m^2 in patients with insulin therapy, and there was no significant difference between the two groups. The mean value of the muscle strength in patients with insulin therapy was 21.2 $\pm$ 6.9 kg. There was no significant difference in the values of handgrip strength and SMMI between two groups. There was also no significant difference between these groups in terms of the presence of possible sarcopenia and sarcopenia (p = 0.275).

The effect of insulin therapy on handgrip strength and muscle mass within BMI groups

Handgrip strength and SMMI were compared within the BMI groups according to use of insulin therapy. No significant difference was found in the handgrip strength and SMMI in the ideal weight, overweight and obese groups compared to use of insulin therapy or not (handgrip strength p = 0.456, 0.431, 0.595 and SMMI p = 0.651, 0.299, 0.747, respectively). Both individuals with sarcopenia were in the normal weight group, and there was no significant difference in possible sarcopenia and sarcopenia within BIA groups in terms of using insulin therapy (probable sarcopenia p = 0.666, 0.064, 0.555 and sarcopenia p = 0.585, none, none, respectively). Table-2 shows the distribution of BMI and insulin therapy in patients with DM.

DISCUSSION

In this study, the relationships between hand grip strength, muscle mass and BMI, and insulin therapy were investigated in older patients with type 2 DM. Since patients with a BMI under 18.5 were not included in the study, the effect of being underweight was excluded. This study found that there was a negative correlation between BMI and hand grip strength, and a positive correlation between BMI and SMMI. No significant relationship was found between insulin therapy and hand grip strength or muscle mass.

Results of a study conducted in older Asian patients with DM were similar to our study; there was a positive correlation between BMI and SMMI (23). However, since sarcopenia was defined according to The Asian Working Group for Sarcopenia (AWGS) in this study, relationship between BMI and hand grip strength was not investigated, and the number of patients with only low hand grip strength was not determined. In a study conducted with type 2 DM patients in the outpatient setting, BMI with a cut-off point of 24.4 kg / m^2 predicted sarcopenia as much as walking speed (24).

In another study, type 2 DM Japan patients aged 20 years and older were followed at least 9 months, similarly they found that insulin therapy did not affect hand grip strength. However, unlike our study, this study showed that insulin therapy was found to be protective against SMMI decline. In the same study, change in SMMI in a year was correlated with BMI (25). Similarly, Ferrari et al. followed up type 2 diabetic patients for 3 years, and they showed no effect of insulin therapy on the hand grip strength (9).

In our study, it was found that insulin therapy had no effect on muscle strength and muscle mass within BMI groups. Although studies on the general population have found a relationship

between BMI and the presence of sarcopenia (10, 11), there has been no research on older patients with DM.

Prevalence of probable sarcopenia was estimated by only handgrip strength as recommended by EWGSOP2. Probable sarcopenia was found in 69.1% of patients with DM, while sarcopenia was found in only 1.6% of patients with DM. In the literature, the prevalence of sarcopenia varies between 12% and 18% in older patients with type 2 DM according to the AWGS and increases to 40% in DM patients aged older than 80 years (23, 24, 26). The prevalence of sarcopenia varies between 2% and 4% according to EWGSOP2. It is lower than prevalence of sarcopenia by AWGS algorithm, and it is similar to our study (27, 28).

Our study has some limitations. One of limitations is the small sample size (n = 123) since this study was conducted in a single center. Another limitation is the lack of data evaluating muscle function such as gait speed. Information such as vitamin D level, smoking history, exercise or presence of diabetic neuropathy, which may affect muscle function, are also missing.

CONCLUSION

Diabetes mellitus is one of the crucial chronic diseases that is common in advanced age, and affects the quality of life and functional status. This study was conducted on patients without low BMI values, and this feature of the study may have led to high muscle mass values to be measured. In order to identify true sarcopenic patients in older patients with normal weight and obese DM, anthropometric differences should be considered. Evaluation of muscle quality might be more useful in overweight and obese patients, and the association of BMI and muscle strength needs further investigation. In our study, the effect of insulin therapy on muscle mass and muscle strength was not shown in older diabetic patients. Prospective longitudinal studies are needed in this topic.

Conflict of interest

The authors declare that they have no conflict of interest.

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