

The prevalence of sarcopenic obesity and its relationship with type 2 diabetes in a nursing home

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Abstract. – OBJECTIVE: Diabetes mellitus (DM), sarcopenia, and sarcopenic obesity (SO) in the elderly were related to frailty, morbidity, and mortality. The aim of this study was to determine the contribution of diabetes mellitus to the prevalence of SO in a nursing home residents.

SUBJECTS AND METHODS: This cross-sectional study included 397 old-aged (≥ 65 years) nursing home residents dwelling in Darulaceze Directorate Kayisdagi Campus of Istanbul. Exclusion criteria included < 65 years of age, residing for less than a month, acute medical problems, and severe cognitive impairment (mini-mental state examination test score ≤ 10). Demographic characteristics, anthropometric measurements, nutritional status, and handgrip strength were evaluated for each participant. Sarcopenia was defined according to the European Working Group on Sarcopenia in Older People (EWGSOP) II criteria and obesity was defined with body mass index (BMI) ≥ 30 kg/m². SO was the concomitant existence of sarcopenia and obesity together.

RESULTS: Mean age of the participants was 77.95 ± 7.94 (65-101) years (n=397). The prevalence of probable sarcopenia was significantly higher in non-obese patients when compared to obese (48.1% vs. 29.3%, $p=0.014$), which was similar after the exclusion of malnourished residents. In DM patients (n=63), the prevalence of obesity, probable sarcopenia and sarcopenic obesity were 30.2%, 42.2%, and 13.3%, which were 20.4%, 43.2%, and 6.5% in non-DM residents, respectively.

CONCLUSIONS: Although they did not reach statistical significance, obesity and sarcopenic obesity were more prevalent among diabetic patients in a nursing home.

Key Words:

Sarcopenia, Obesity, Diabetes mellitus, Nursing home, Aged.

Introduction

The prevalence of diabetes mellitus (DM) and obesity increase with aging. About 9.3% of the adult population worldwide have DM and this rate can be up to 19.9% after the age of 65¹. In DM patients, both muscle strength and muscle mass decrease due to a number of factors including glucose toxicity, insulin resistance, genetic factors, diabetic neuropathy, atherosclerosis, impaired mitochondrial function, inflammation, and immobility². Obesity drives an inflammatory response due to increased macrophage activity in adipose tissue. Moreover, insulin resistance accelerates muscle protein degradation through the loss of muscle mass³.

Sarcopenia is a syndrome characterized by progressive loss of muscle strength and/or muscle mass, leading to adverse consequences such as physical disability, frailty, decreased quality of life, morbidity, and mortality⁴. Age, gender, malnutrition (MN), comorbidities, immobility, and medications can affect the prevalence of sarcopenia. According to a 2019 report⁵ published by the European Working Group on Sarcopenia in Older People (EWGSOP), lower muscle strength alone is related to altered muscle function and is defined as probable sarcopenia, which is important when it is difficult to measure muscle mass. In the same report, coexistence of lower muscle strength and lower muscle mass was defined as confirmed sarcopenia and the associated reduced physical performance was defined as severe sarcopenia. Handgrip strength (HGS) is a simple but effective way to measure muscle strength⁶.

Sarcopenic obesity (SO) is the coexistence of sarcopenia and obesity, increased with ageing

and defined as a geriatric syndrome with a risk of synergistic complications caused by both sarcopenia and obesity⁷. SO is associated with a greater risk of disability, cardiovascular and metabolic diseases, mortality, and cognitive impairment^{8,9}. In a recent study¹⁰, it was reported that 12% of the patients in nursing home had SO.

In this study, our aim was to investigate the contribution of diabetes mellitus to the prevalence of SO in a nursing home in Turkey.

Subjects and Methods

Study Design

The cross-sectional study included 397 old-age (≥ 65 years) nursing home residents dwelling in the Darulaceze Directorate Kayisdagi Campus of Istanbul between 2018-2020. Inclusion criteria were ≥ 65 years of age and absence of any acute medical problem. Exclusion criteria included < 65 years of age, residing for less than a month, acute medical problem (s), and severe cognitive impairment (mini-mental state examination test score ≤ 10). Based on the inclusion and exclusion criteria, 397 out of the 539 residents were included in the study. The study protocol was approved by the Local Ethics Committee (Approval No: 2020/316). Each subject provided a verbal and written informed consent before participation.

Data Collection

Demographic and clinical characteristics including age, gender, body height, weight, body mass index (BMI), mid-upper arm circumference (MUAC), calf circumference (CC), medications, and medical history were recorded for each participant. Patients with (I) Fasting plasma glucose ≥ 126 mg/dl, (II) random plasma glucose ≥ 200 mg/dl + diabetes symptoms, (III) HgbA1c $\geq 6.5\%$ (≥ 48 mmol/mol), and (IV) postprandial glucose ≥ 200 mg/dl measured 2 hours after the oral glucose tolerance test were considered as diabetes mellitus¹¹.

Anthropometric Measurements

Body mass index (BMI, kg/m^2) is calculated by dividing body weight in kilograms by body height in meters squared. Circumference of the upper arm measured from the midpoint between the shoulder and olecranon was MUAC (cm). After flexion of the knees and ankles to 90° angle CC was measured from the broadest part of the calf.

Nutritional Status

Mini Nutritional Assessment (MNA) test was used to assess nutritional status¹². MNA-Short Form (MNA-SF) was used to screen nutritional status and in case of low screening score (< 12), additional 12 questions were answered to diagnose MN. MN was diagnosed with MNA score < 17 ¹³.

Sarcopenia and Sarcopenic Obesity

Handgrip strength (HGS) was measured using a standardized hand dynamometer (Jamar; Duluth, MN, USA) by taking the highest value obtained after three measurements from the dominant hand. If the patient could use one hand, the measurement was done with that hand. Lower cut-off point for HGS was < 27 kg for men and < 16 kg for women for EWGSOP II, and probable sarcopenia was defined as a lower HGS⁵. Obesity was defined as BMI ≥ 30 kg/m^2 . SO was defined as coexistence of probable sarcopenia and obesity¹⁴.

Statistical Analysis

The data were analyzed using the SPSS 25.0 (Statistical Package for Social Science; IBM Corp., Armonk, NY, USA). Categorical variables were compared using Chi-square test. In the comparison of continuous variables, parametric variables were compared using Student's *t*-test and nonparametric variables were compared using Mann-Whitney U test. Three or more groups were compared using One-Way ANOVA test, followed by post-hoc Tukey test. Games-Howell post-hoc test was used when the assumption of homogeneity of variances was not met, and Mann-Whitney U test was used for multiple comparisons. Correlations were assessed using Spearman's Correlation Coefficient. A *p*-value of < 0.05 was considered statistically significant.

Results

397 residents participated in this study (mean age, 77.9 ± 7.9 years, 49% women). The prevalence of DM, obesity, MN, and MN risk were 15.9%, 21.9%, 18.9%, and 24.7%, respectively. Of all, 5.4% of the residents had both DM and obesity together. No significant difference was found between DM and non-DM residents, with regard to age, gender, anthropometric measurements,

Table I. Characteristic of the patients.

| | Total (n = 397) | DM (n = 63) | Non-DM (n = 334) | p |
|--------------------------|-----------------|-------------|------------------|-------|
| Age (mean ± SD) | 77.9 ± 7.9 | 76.7 ± 8.2 | 78.2 ± 7.9 | 0.181 |
| Gender (women, %) | 49.1 | 49.2 | 49.1 | 0.988 |
| Weight (kg) | 64.4 ± 16.9 | 65.3 ± 16.9 | 63.1 ± 16.9 | 0.359 |
| BMI (kg/m ²) | 26.3 ± 6.1 | 26.4 ± 5.5 | 25.8 ± 6.0 | 0.421 |
| MUAC (cm) | 27.2 ± 4.1 | 27.8 ± 4.6 | 26.6 ± 4.3 | 0.071 |
| CC (cm) | 33.3 ± 5.9 | 33.6 ± 5.0 | 35.2 ± 6.0 | 0.033 |
| Obesity (%) | 21.9 | 30.2 | 20.4 | 0.119 |
| MN (%) | 18.9 | 20.6 | 18.6 | 0.834 |
| MN risk (%) | 24.7 | 22.2 | 25.1 | 0.738 |

BMI: Body mass index, CC: Calf circumference, DM: Diabetes mellitus, MN: Malnutrition, MUAC: Mid-upper arm circumference.

obesity, and MN (Table I). Although obesity was more prevalent in DM patients, this difference did not show statistical significance (30.2 vs. 20.4%, $p=0.119$) (Table I).

The mean HGS of DM and non-DM residents were 31.4±9.6 and 28.7±8.5 kg ($p=0.172$) in men, and 17.3±5.6 and 16.4±6 kg in women ($p=0.561$), respectively. The prevalence of probable sarcopenia in the whole study population was 42.9%, while it was 42.2% and 43.3% ($p=0.907$) in DM and non-DM groups and 30.0% and 27.7% after the exclusion of residents with MN or MN risk ($p=0.808$), respectively. DM patients showed lower CC (33.6±5.0 cm vs. 35.2±6.0 cm, $p=0.033$). Although the prevalence of SO was higher in DM residents compared to non-DM residents, this difference did not show statistical significance (13.3% vs. 6.5%, $p=0.132$, Table II).

Prevalence of MN, MN risk, and probable sarcopenia was lower in obese residents compared to non-obese residents (MN: 0 vs. 16.9%, $p<0.001$; MN risk: 12.9 vs. 36.5%, $p<0.001$; probable sarcopenia: 23.9 vs. 48.1%, $p=0.014$). Although probable sarcopenia was 2.2-fold higher in non-obese residents, no significant difference was established after the exclusion of residents with MN and MN risk (Table III).

Discussion

Sarcopenia is more prevalent in nursing home residents than in the community-dwelling elderly due to the higher prevalence of chronic diseases, inactivity, and malnutrition in such residents¹⁵. The difference among the prevalence rates of sarcopenia reported in the literature is related to the employment of different cut-off points and the use of different measurement tools for evaluating HGS, muscle mass, and physical activity. The importance of HGS in diagnosing sarcopenia has been emphasized in the EWGSOP II criteria. Detection of lower HGS together with lower muscle mass confirms the diagnosis of sarcopenia, and concurrent lower physical performance is related to the presence of severe sarcopenia⁵. Lera et al¹⁶ reported the prevalence of sarcopenia as 19.1% in the community-dwelling elderly. This rate was reported as 41.0-59.0% in a recent systemic meta-analysis¹⁵ and as 15.0%-68.0% in other studies¹⁷⁻²⁷ (Table IV). In our study, the prevalence of sarcopenia was 42.9%.

Sarcopenia has been reported to be more prevalent in DM patients due to impaired muscle health and function caused by vascular and mitochondrial dysfunction²⁸. Park et al²⁹ observed lower muscle strength in diabetic men than in

Table II. Prevalence of sarcopenia in DM and non-DM individuals

| | | Non-DM (mean ± SD) | DM (mean ± SD) | p |
|----------------------|--------|--------------------|----------------|-------|
| Muscle strength (kg) | Male | 28.7 ± 8.5 | 31.4 ± 9.63 | 0.172 |
| | Female | 16.4 ± 6.1 | 17.3 ± 5.6 | 0.561 |
| Probable Sarcopenia | | 43.2% | 42.2% | 0.907 |
| Probable Sarcopenia* | | 27.7% | 30.0% | 0.808 |
| Sarcopenic obesity | | 6.5% | 13.3% | 0.132 |

*Probable sarcopenia in those without malnutrition or malnutrition risk. DM: Diabetes mellitus.

Table III. Prevalence of malnutrition, malnutrition risk, and sarcopenia in obese and non-obese residents.

| | | Obese | Non-Obese | p |
|----------------------|--------|------------|------------|---------|
| Malnutrition | | 0 | 16.9 | < 0.01* |
| Malnutrition Risk | | 12.9 | 36.5 | < 0.01* |
| Muscle Strength (kg) | Male | 29.1 ± 8.2 | 29.4 ± 9.0 | 0.891 |
| | Female | 20.1 ± 6.2 | 15.1 ± 5.4 | 0.001* |
| Probable Sarcopenia | | 29.3% | 48.1% | 0.014* |
| Probable Sarcopenia* | | 26.9% | 29.1% | 0.785 |

*Probable sarcopenia in those without malnutrition or malnutrition risk.

those without DM. In our study, 42.2% of DM patients were detected with probable sarcopenia. The higher prevalence of sarcopenia in our population compared to those reported in the literature (Table IV) could be related to the measurement of probable sarcopenia instead of confirmed sarcopenia.

Malnutrition (MN) and sarcopenia are often underestimated in obese patients, and malnutrition is usually manifested by micronutrient deficiencies³⁰. Sarcopenia can develop due to various conditions including atherosclerosis, hormonal changes, inflammatory response accelerated by increased adipose tissue, insufficient physical activity, and rapid muscle damage⁷. Anthropometric changes during aging (increased fat mass with decreased muscle mass), chronic systemic inflammation, insulin resistance, and lifestyle changes (protein malnutrition and de-

creased physical activity) play a role in the pathogenesis of DM, sarcopenia, and obesity³¹. In the literature, there are different descriptions of SO, and low muscle mass is usually assessed by appendicular skeletal muscle mass index (ASMI). However, ASMI can underdiagnose sarcopenia in obese individuals; therefore, it is better to use muscle strength to predict sarcopenia in obese individuals⁵. The prevalence of sarcopenia gradually decreases from underweight to obesity¹⁶. A meta-analysis of 11 studies observed that the presence of SO increased the risk of type 2 DM, and the prevalence of sarcopenia was 42% in obese/overweight adults³². The prevalence of SO varies among the studies due to the differentiation of study designs, geographic regions, diagnostic tools, and seasons⁸. In a German study³³, the prevalence of SO was reported as 0% in a nursing home. In our study, the prevalence of

Table IV. A literature review of the sarcopenia and sarcopenic obesity in DM patients residing in nursing homes.

| Study | Number of patients | Prev. sarcopenia (%) | Prev. SO (%) | Diagnostic tool | Prev. sarcopenia in DM (%) | Prev. SO in DM (%) |
|-------------------------------|--------------------|----------------------|--------------|-------------------------------------|----------------------------|--------------------|
| Lim et al ¹⁷ | 565 | | 16.7/5.7 | ASM/Height ² (men/women) | | |
| Kim et al ¹⁸ | 414 | | | ASMI | 15.7 | |
| Halil et al ¹⁹ | 711 | 68.0 | 22.0 | HGS + CC | | |
| Saka et al ²⁰ | 402 | 73.3 | | MAMA, CC, HGS | | |
| Santos et al ²¹ | 128 | 15.6 | 10.1 | Low ALMI + GS | | |
| Batsis et al ²² | 599 | | 47.6 | ALM (FNIH) | | |
| Farmer et al ²³ | 52931 | 15 | 4 | HGS: 30/20 | | |
| Veronese et al ²⁴ | 54676 | 18.7 | | AWGS or EWGSOP | 28.4 | |
| Cui et al ²⁵ | 132 | | | AWGS | 28.8 | |
| Nakanishi et al ²⁶ | 1,137 | | | AWGS | 12.4 | |
| Izzo et al ²⁷ | | | | | 7 to 29.3 | |
| Our study | 397 | 42.9 | 7.9 | EWGSOP II (HGS) | 42.2 | 13.3 |

ASM – Appendicular skeletal mass, ALMI – Appendicular lean mass index, AWGS – Asia Working Group for Sarcopenia, CC – Calf circumference, EWGSOP – European Working Group on Sarcopenia in Older People, EWGSOP II – European Working Group on Sarcopenia in Older People Updated Definition, FNIH – Foundation for the National Institutes of Health Biomarkers Consortium Sarcopenia Project, GS - Gait speed, HGS – Handgrip strength, MAMA – Mid-arm muscle area.

sarcopenia was 42.2% and the prevalence of SO was 13.3% in DM patients. Additionally, the prevalence of SO was higher in DM patients than in non-DM individuals. These findings implicate that although obesity seems to have a protective role against sarcopenia, the latter is more common in diabetic obese patients. On the other hand, our findings also showed that the higher prevalence of sarcopenia in non-obese residents was associated with MN.

Limitations

Limitations of the study include that it is a single center study with limited number of patients. Second, we measured muscle function with muscle strength, and we did not include muscle mass to diagnose confirmed sarcopenia according to EWGSOP2 diagnostic criteria. This was mainly because the study was done in a nursing home and using dual X ray absorptiometry or MRI were impossible in that setting to measure muscle mass. It was indicated previously that measurement of the skeletal muscle mass with bioelectrical impedance analysis could give false results in obese elderly. So, we used probable sarcopenia during the diagnosis of sarcopenic obesity.

Conclusions

Our findings indicated that the DM is associated with higher prevalence of obesity and SO among nursing home residents. Additionally, diabetic obese patients had higher prevalence of sarcopenia when compared to non-DM individuals. The higher prevalence of sarcopenia in non-obese residents was associated with malnutrition. Further studies are needed to evaluate SO in DM in different populations.

Conflict of Interest

The authors declare no competing interests. All data generated or analyzed during this study are included in this published article.

Ethics Approval

The study protocol was approved by the Istanbul University Local Ethics Committee, Turkey. Clinical trial registration number: 2020/316, approval date: 06.03.2020.

Informed Consent

All patients gave written informed consent before inclusion in the study, which complies with the Declaration of Helsinki.

Authors' Contribution

M.A. collected data and wrote and reviewed the manuscript. C.K.O. and Y.G. collected data and performed analysis, helped writing the manuscript, and conceptualization. O.Y.E. collected data, measurement, and performed analysis. S.N.E. took a role in visualization reviewed and supervised the manuscript. T.S.A. and B.S. took a role in methodology, supervision, and conceptualization. All authors approved the manuscript submission for publication.

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