ORIGINAL RESEARCH

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# Osteosarcopenic Obesity's Role in Older Adults' Falls and Vertebral Fractures

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## Abstract

**Objective:** The co-occurrence of osteoporosis, sarcopenia, and obesity is known as osteosarcopenic obesity (OSO). This study examined the frequency of OSO in older adult outpatients and its connection to falls and spinal fractures.

**Materials and Methods:** Participants in this cross-sectional study were outpatients 60 years of age or above. The European Working Group on Sarcopenia in Older People 2 (EWGSOP2) determined that the patients had sarcopenia EWGSOP2, had bone densitometry, completed a comprehensive geriatric examination, and were categorized as obese based on their body fat percentage. The researchers diagnosed patients with OSO by selecting those who fulfilled the criteria for poor bone density, diminished muscle strength, decreased walking velocity, and increased body fat percentile. The patients were categorized into four groups: only obese, exclusively osteoporotic obese, purely sarcopenic obese, and OSO patients and thereafter assessed. Fractures detected with radiological assessment.

**Results:** All 317 elderly people contributed to this research, with 12.2% (39 out of 317) identified as having OSO. The occurrence of falls was significantly elevated in OSO patients relative to those in the sarcopenic obese, the osteoporotic obese, and the obese cohorts ($p<0.001$). Moreover, OSO patients demonstrated a markedly higher incidence of vertebral fractures in comparison to the obese, osteoporotic obese, and sarcopenic obese cohorts ($p=0.001$).

**Conclusion:** Older adults with OSO face a heightened risk of falls and vertebral fractures relative to those classified as sarcopenic obese, osteoporotic obese, or obese.

**Keywords:** Falls, elderly individuals, osteosarcopenic obesity, vertebral fractures

## Introduction

Osteosarcopenic obesity (OSO), a newly recognized condition, is defined by the combination of osteoporosis, sarcopenia, and obesity (1,2). A significant amount of evidence exists regarding the prevalence, risk factors, and effects of osteoporosis and obesity, and increasing research on sarcopenia.

Despite the increasing importance of OSO, there exists a paucity of publications, and its frequency is markedly diverse, contingent upon the diagnostic criteria employed for osteopenia, sarcopenia, and obesity. This results from the lack of consensus on the diagnosis of OSO. The National Bone Health Alliance Working Group advocates for the use of Dual-energy X-ray absorptiometry (DXA) in diagnosing osteopenia (3). Moreover, bioelectrical impedance analysis (BIA) for bone mass assessment has recently gained popularity in clinical practice (4). Sarcopenia can be evaluated through various methodologies, including imaging techniques (e.g., BIA, DXA), anthropometric measurements, muscle strength assessments, and physical performance evaluations [e.g., handgrip strength (HGS), chair

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stand, short physical performance battery] (5). The definition of obesity remains a topic of considerable debate. Obesity can be evaluated using body mass index (BMI), body fat percentage, or waist-hip ratio, with the latter indicating visceral fat levels. Few studies have looked at the possible negative impacts of OSO, despite the known link between the rising incidence of OSO components with age and common risk factors and poor health outcomes. OSO correlates with functional impairments, leading to severe problems such as falls and fractures, hence imposing an increased burden on healthcare costs (2,4,6,7).

According to some research, individuals with OSO are significantly more likely to experience falls and fractures than those who only have obesity, sarcopenia, or osteoporosis (4,8,9). It is imperative for each nation to ascertain the prevalence of OSO, assess its link with adverse outcomes such as falls and fractures, and prevent and treat its detrimental repercussions.

This study suggests that the occurrence of falls and spinal fractures is higher in the OSO group relative to the sarcopenic obese, osteoporotic obese, and obese groups. Establishing the prevalence of OSO among older adult outpatients in Turkiye and investigating a correlation between OSO and further fall and fracture episodes were the goals of this study.

## Materials and Methods

### Study Participants

Participants in the study had to be at least 60 years old and outpatients. Before the trial began, each participant provided written informed consent. The exclusion criteria encompassed dementia, parkinsonism and its symptomatic manifestations; malignancy; multiple myeloma; secondary osteoporosis; metabolic bone disorders; medications that may disrupt bone metabolism, including systemic steroid therapy, immunosuppressive agents, heparin, anticonvulsants, and diuretics, as well as patients unable to undergo BIA due to joint prostheses or observable edema.

### Ethical Considerations

This study was authorized by Erciyes University's Clinical Research Ethics Committee (approval number: 2019/136, date: 20.02.2019).

### Clinical Assessments

All patients underwent laboratory tests for serum calcium, albumin, creatinine, plasma parathyroid hormone, and serum 25-hydroxyvitamin D.

### Comprehensive Geriatric Assessment

A geriatric assessment was performed with the patients. A questionnaire was distributed to patients to evaluate their activities of daily living (ADL) and instrumental ADL (IADL). The ADL item on the questionnaire was derived from Katz's Index (10,11), whereas the IADL component was informed by Lawton's Scale (12,13). An ADL score of 6 indicated the patient's independence, whereas a score of 0 indicated dependence. The IADL scale was utilized to assess the total score for each of the eight items, where a score of 0 represents dependence and a score of 8 signifies independence.

Patients' frailty levels were assessed using the FRAIL scale. The FRAIL scale consists of five domains. These factors encompass fatigue, resistance, ambulation, illnesses, and weight loss (14). The categorization of older adults into non-frail, pre-frail, or frail was determined by their overall score on the FRAIL scale. A score of 0 indicated non-frailty, a score of 1-2 indicated pre-frailty, and a score of 3-5 signified frailty.

The following metrics were used to perform anthropometric assessments of the groups: (BMI, kilograms (kg)/$m^2$), weight in kg, and height in centimeters.

The fracture risk assessment tool (FRAX) tool evaluates fracture risk by considering several clinical factors, such as age, weight, height, history of low-trauma fractures, parental hip fractures, smoking status, glucocorticoid use, rheumatoid arthritis, secondary osteoporosis, and alcohol consumption, in addition to bone mineral density (BMD) measurements at the femoral neck. The algorithm forecasts the probability of osteoporotic fractures and major hip fractures over the next ten years (15).

The abridged (7-item) international physical activity questionnaire measured physical activity (16,17).

### Sarcopenia Assessment

All participants completed the a simple questionnaire to rapidly diagnose sarcopeni SARC-F questionnaire (18), which evaluates five key domains: strength, ambulation, chair rise ability, stair climbing, and history of falls. A score of four or above on the SARC-F is considered indicative of a high risk for sarcopenia.

Based on the standards set by the European Working Group on Sarcopenia in the Older 2 (EWGSOP 2), the only indicator of probable sarcopenia is decreased muscle strength. Both decreased muscle mass and decreased muscle strength must be present at the same time for sarcopenia to be diagnosed. The three characteristics of severe sarcopenia are low muscle mass, decreased muscular strength, and decreased walking velocity (19).

Sitting with elbows bent, participants were tested for muscle strength with a Takei TKK5401 Handgrip Dynamometer (Niigata City, Japan). With a minimum (min.) of one minute between each of the three measurements made from the dominant hand, The average value of the three measurements made from the dominant hand, with a min. of one minute between each measurement, was noted. BIA was used to collect electrical

resistance data in ohms. The Janssen et al. (20) equation, which takes into account the impedance data from the BIA instrument (Bodystat Quad Scan 1500, United Kingdom), was used to compute skeletal muscle mass (SMM).

It is recommended that SMM measurements be adjusted using weight or BMI instead of height squared, as the latter can underestimate sarcopenia in overweight or obese older adults (21,22). A recent study in Türkiye indicated that adjustments of SMM based on BMI exhibited a stronger correlation with functioning, physical performance, and frailty than adjustments based on height or weight (21). Accordingly, SMM was standardized to BMI, resulting in the SMM Index (SMMI), expressed in kg per BMI unit (kg/BMI).

Sarcopenia was classified according to EWGSOP 2 criteria, which include an SMMI of less than 1.049 kg/BMI for males and 0.823 kg/BMI for females, as well as HGS levels below 27 kg for males and 16 kg for females. A gait speed of less than 0.8 m/s is indicative of sarcopenia and decreased physical capabilities (19).

### Obesity Assesment

The weight in kg divided by the height in meters squared yields BMI. Using BIA measurements, the body fat percentage (BF%) was computed to determine obesity, with threshold values of BF% ≥37.3 for men and ≥51.1 for women. Using the Zoico approach, the cut-off values for BF% were established based on the 60$^{th}$ percentile of our study sample (23-25).

### Osteoporosis Assessment

The lumbar spine (L1-L4), entire hip, and femoral neck were evaluated for BMD using DXA (DXA; Hologic, QDR 4500 W, Hologic Inc., Waltham, MA, USA). The WHO classified patients by their lowest T-scores: T-scores ≤-2.5 standard deviations classified patients as having osteoporosis, T-scores between -1.0 and -2.5 as having osteopenia, and T-scores >-1.0 as having normal BMD (26).

### Falls Assessment

The frequency of falls was assessed to ascertain if they occurred in the previous year. A 12-month self-reported fall history was also collected.

### Fracture Assessment

An expert physician used radiological evaluation to identify fractures. When the vertebral body's height loss in the anterior, middle, or posterior dimensions exceeds 20%, a diagnosis of vertebral fracture is necessary (27).

### Osteosarcopenic Obesity Assesment

Sarcopenia, obesity, and osteopenia/osteoporosis in one person were considered OSO.

### Statistical Analysis

Data were examined using the Shapiro-Wilk test to identify non-normal distribution median and normal distribution mean ± standard deviation. Categorical variables were shown as frequencies and percentages. The Kruskal-Wallis test and Bonferroni correction were used to compare clinical features in obesity only, osteoporotic obesity only, sarcopenic obesity only, and OSO. A p-value of 0.008 was deemed to be significant following the Bonferroni adjustment for multiple comparisons. The chi-square test compared categorical variables between the four groups.

Univariate analysis was employed to determine risk factors for falls and spinal fractures. A multivariate analysis was conducted to find independent predictors of falls and vertebral fractures, employing relevant variables from the univariate analysis ($p<0.05$). We examined the correlations between OSO and clinical outcomes (falls and vertebral fractures) using multivariable binary logistic regression models, controlling for age, sex, physical activity level, ADL, IADL, and isolated osteoporotic obesity. All statistical analyses were conducted using SPSS software (version 26.0), with $p<0.05$ deemed significant.

## Results

The study initially included 458 patients. A total of 141 participants were eliminated from the trial for not satisfying the predetermined inclusion criteria. Thus, the conclusive sample size for the investigation comprised 317 patients (Figure 1).

Our data demonstrated that 18.3% (58/317) of the patients exhibited obesity, 5.4% (17/317) exhibited both osteoporosis and obesity, and 4.1% (13/317) exhibited sarcopenia and obesity. A total of 12.2% of the study sample (39/317) was OSO (Figure 2).

The median age of the research's sample was 71 (range: 66-76 years), with 83.6% of participants being female. Table 1 presents the demographic and clinical features of the four groups: obese, osteoporotic obese, sarcopenic obese, and OSO. The median age of the OSO cohort was 76 (range: 66-83 years), significantly exceeding that of the other groups ($p<0.001$). The four groups demonstrated similar BMI and smoking status ($p=0.437$ and $p=0.994$, resp.).

Compared to the other three groups, the OSO group had significantly higher FRAX major and neck values and correspondingly lower lumbar total T score, femoral neck T score, and femoral total T score values ($p<0.001$ for all parameters) (Figure 3). The osteoporotic obese group exhibited a significantly lower level of dependence on ADL than the other groups ($p=0.024$). Furthermore, sarcopenic obese patients demonstrated a significantly lower level of dependence based on the IADL scoring system than the other groups ($p=0.039$).

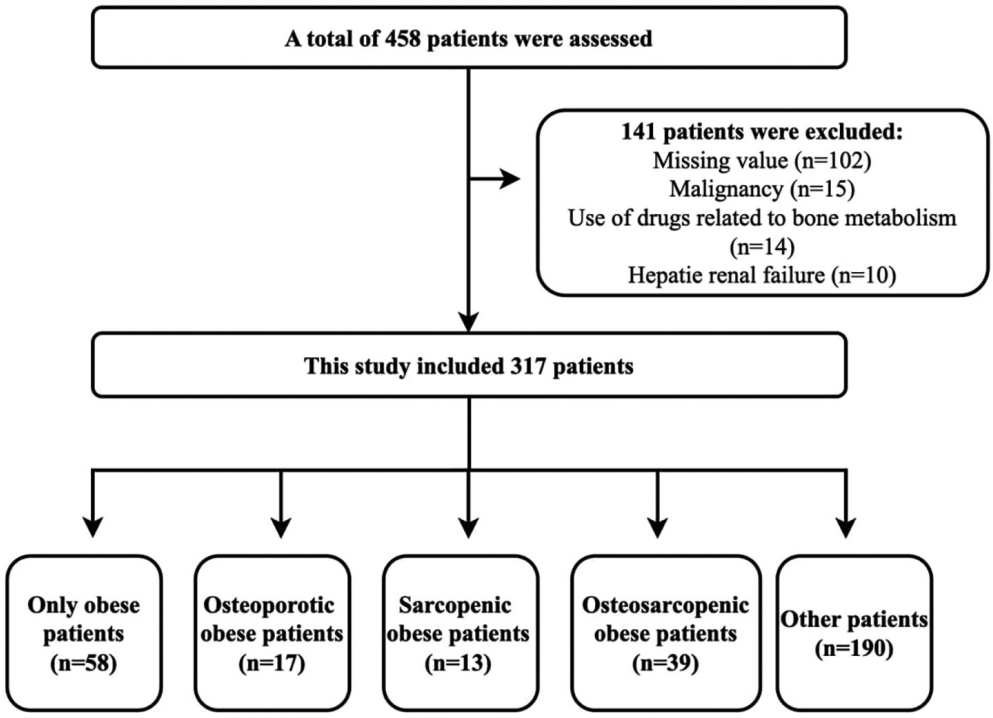


**Figure 1.** Study patient flow chart

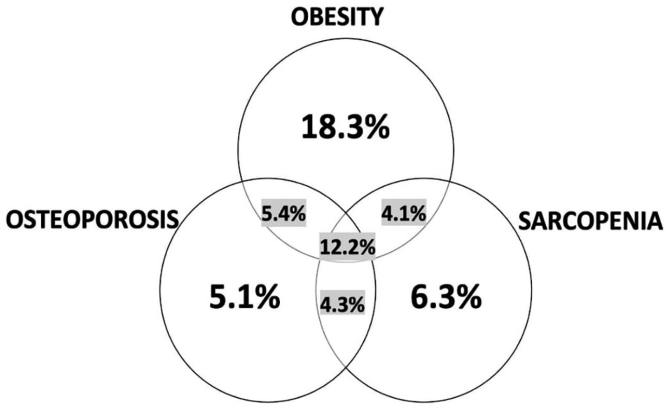


**Figure 2.** The prevalances of obesity, osteoporosis, sarcopenia, and their combinations

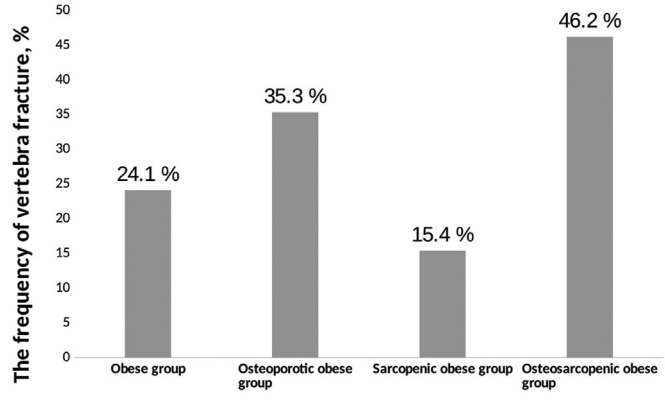


**Figure 3.** Bar chart demonstrainig frequency of vertebra fracure distribution according to groups

OSO patients exhibited significantly higher SARC-F scores than those in the other groups (p=0.025). OSO patients exhibited a significantly lower gait speed than both osteoporotic obese and sarcopenic obese patients; (median: 1.17, 1.25, 1.30 m/sec, respectively; p=0.043). In comparison to the other three groups, the OSO participants demonstrated significantly higher TUG test points than the other three groups (p=0.024).

The HGS of female OSO patients was 12.1 kg (10.3-15.6), significantly lower than the other three groups (p=0.001). Based on the calculation of the metabolic equivalent of task, low levels of physical activity were observed in 53.4% of obese patients, 58.8% of osteoporotic obese patients, and 51.3% of OSO patients (Table 1).

The study found that participants with OSO exhibited a significantly lower SMMI than the other groups (p=0.039 for males and p=0.028 for females). In comparison, to the obese female group (median: 0.93, p=0.008), the osteoporotic obese female group (median: 0.88, p=0.008), and the sarcopenic obese female group (median: 0.88, p=0.008), the OSO female participants had a median waist-to-hip ratio of 0.98, which was significantly higher (Table 1). A total of 36.2%, 47.1%, 30.8%, and 74.4% of obese, osteoporotic obese, sarcopenic obese, and OSO patients experienced falls, respectively. The highest incidence of falls was observed in OSO patients (p<0.001). Additionally, OSO patients demonstrated a markedly greater incidence of vertebral fractures than their counterparts who were only obese, osteoporotic obese, or sarcopenic obese (p=0.001) (Table 1).

**Table 1. Demographic and clinical characteristics of patients**

| | Total (n=317) | Obese group (n=58) | Osteoporotic obese group (n=17) | Sarcopenic obese group (n=13) | Osteosarcopenic obese group (n=39) | p |
|---|---|---|---|---|---|---|
| **Demographic characteristics** | | | | | | |
| Age (years) | 71 (66-76) | 71 (65-74)[a] | 70 (66-76)[a] | 70 (67-76)[a] | 76 (66-83)[b] | **<0.001** |
| Gender<br>Male<br>Female | <br>52 (16.4)<br>265 (83.6) | <br>7 (12.1)[a]<br>51 (87.9) | <br>4 (23.5)[a]<br>13 (76.5) | <br>2 (15.4)[a]<br>11 (84.6) | <br>5 (12.8)[a]<br>34 (87.2) | **0.047** |
| BMI, kg/m$^2$ | 30.3 (26.2-34.7) | 32.8 (29.4-36.6)[a] | 32.7 (31.1-35.4)[a] | 32.9 (29.8-37.1)[a] | 34. 0 (31.8-39.6)[b] | 0.437 |
| Smoking status | 27 (8.5) | 4 (6.9) | 2 (11.8) | 3 (23.1) | 6 (15.4) | 0.994 |
| **Dexa measurement** | | | | | | |
| FRAX major | 6.00 (4.00-9.43) | 4.75 (3.43 to 6.65)[a] | 8.00 (5.90 to 11.50)[b] | 4.80 (3.80 to 6.05)[a] | 11.50 (4.60 to 23.75)[c] | **<0.001** |
| FRAX neck | 1.5 (0.50-3.23) | 0.76 (0.23 to 1.98)[a] | 1.80 (0.95 to 4.65)[b] | 1.00 (0.55-1.90)[a] | 4.05 (0.78 to 8.70)[c] | **<0.001** |
| Lumbar total T score | -1.80 (-2.60 to -1.00) | -1.30 (-2.05 to -0.65)[a] | -2.20 (-3.00 to -1.40)[b] | -1.5 (-1.95 to -0.45)[a] | -3.00 (-3.50 to -2.58)[c] | **<0.001** |
| Femoral neck T score | -1.40 (-2.00 to -0.80) | -0.95 (-1.50 to -0.50)[a] | -2.10 (-2.32 to -0.78)[b] | -1.30 (-1.75 to -0.75)[a] | -2.20 (-2.85 to -1.23)[c] | **<0.001** |
| Femoral total T score | -1.00 (-1.60 to -0.30) | -0.70 (-1.10 to 0.20)[a] | -2.25 (-2.57 to -0.60)[b] | -0.50 (-1.20 to 0)[a] | -2.40 (-3.10 to -0.90)[c] | **<0.001** |
| **Geriatric assessment** | | | | | | |
| Dependent on ADL, n (%) | 61 (19.2) | 13 (22.4)[a] | 3 (17.6[a] | 3 (23.1)[a] | 9 (23.1)[a] | **0.024** |
| Dependent on IADL, n (%) | 146 (46.1) | 28 (48.3)[a] | 8 (47.1)[a] | 5 (38.5)[a] | 19 (48.7)[a] | **0.039** |
| Frailty, n (%)<br>Frail<br>Prefrail<br>Normal | <br>91 (30.2)<br>167 (55.5)<br>43 (14.3) | <br>15 (25.9)<br>40 (69.0)<br>3 (5.1) | <br>5 (29.4)<br>10 (58.8)<br>2 (11.8) | <br>5 (38.5)<br>7 (53.8)<br>1 (7.7) | <br>16 (41.0)<br>19 (48.7)<br>4 (10.3) | 0.096 |
| SARC-F | 3.0 (1.0-5.0) | 2.0 (1.0-6.0)[a] | 2.5 (0.8-5.0)[a] | 3.0 (2.0-5.0)[a] | 4.0 (2.0-5.0)[b] | **0.025** |
| Gait speed (m/sec) | 1.21 (0.91-1.50) | 1.18 (0.99-1.90)[a] | 1.25 (0.79-1.82)[b] | 1.30 (0.98-1.52)[b] | 1.17 (0.94-1.96)[a] | **0.043** |
| TUG | 12.0 (9.6-14.6) | 11.5 (9.0-14.0)[a] | 12.8 (11.6-14.2)[a] | 12.3 (8.7-18.9)[a] | 14.1 (9.8-15.6)[b] | **0.024** |
| Handgrip strength (kg)<br>Male<br>Female | <br>30.0 (19.0-37.5)<br>17.4 (12.3-20.9) | <br>18.5 (12.4-30.7)[a]<br>18.0 (14.0-22.3)[a] | <br>30.0 (30.0-32.0)[b]<br>18.3 (12.9-21.5)[a] | <br>30.0 (27.2-30.0)[b]<br>16.5 (11.3-20.6)[a] | <br>21.5 (11.7-30.0)[a]<br>14.3 (8.9-18.3)[b] | <br>0.052<br>**0.014** |
| MET (minute/week) | 693.0 (57.8-4491.0) | 693.0 (49.5-4410.0) | 2970 (0-3559.0) | 1188.0 (165.0-3039.8) | 4126.50 (470.3-6522.8) | 0.053 |
| Low Physical activity, n (%) | 94 (29.7) | 31 (53.4) a | 10 (58.8)[a] | 6 (46.2)[a] | 20 (51.3)[a] | **0.047** |
| **Antrophometric measurements** | | | | | | |
| SMI (kg/BMI)<br>Male<br>Female | <br>0.91 (0.75-1.11)<br>0.55 (0.48-0.66) | <br>0.86 (0.73-1.24)[a]<br>0.50 (0.44-0.54)[a] | <br>0.78 (0.72-0.78)[a]<br>0.46 (0.42-0.53)[a] | <br>0.86 (0.73-0.95)[a]<br>0.49 (0.45-0.55)[a] | <br>0.77 (0.63-1.09)[a]<br>0.41 (0.38-0.46)[a] | <br>**0.039**<br>**0.028** |
| Fat (%)<br>Male<br>Female | <br>32.1 (27.0-37.1)<br>47.8 (43.8-51.6) | <br>39.0 (36.2-51.8)[a]<br>54.1 (50.0-55.0)[a] | <br>39.3 (30.1-41.3)[a]<br>53.0 (51.0-55.8)[a] | <br>32.9 (26.4-43.0)[a]<br>51.7 (48.9-54.6)[a] | <br>37.0 (33.7-42.1)[a]<br>55.9 (53.7-57.1)[a] | <br>**0.032**<br>**0.044** |

**Table 1. Continued**

| | Total (n=317) | Obese group (n=58) | Osteoporotic obese group (n=17) | Sarcopenic obese group (n=13) | Osteosarcopenic obese group (n=39) | p |
|---|---|---|---|---|---|---|
| BMR (kcal) | 1324.0 (1246.0-1438.0) | 1339 (1257-1442) | 1302 (1136-1449) | 1377 (1179-1572) | 1290 (1253-1477) | 0.907 |
| Waist/hip ratio<br>Male<br>Female | <br>0.96 (0.92-0.98)<br>0.91 (0.87-0.97) | <br>0.98 (0.90-1.01)[a]<br>0.93 (0.89-0.98)[a] | <br>0.92 (0.86-0.92)[a]<br>0.88 (0.84-0.98)[a] | <br>0.94 (0.89-0.96)[a]<br>0.88 (0.84-0.92)[a] | <br>0.99 (0.90-1.02)[a]<br>0.98 (0.85-0.96)[b] | <br>**0.017**<br>**0.008** |
| **Clinical outcomes** | | | | | | |
| Fall, n (%) | 140 (44.2) | 21 (36.2)[a] | 8 (47.1) [b] | 4 (30.8)[a] | 29 (74.4)[c] | **<0.001** |
| Vertebra fracture, n (%) | 89 (28.1) | 14 (24.1)[a] | 6 (35.3)[a] | 2 (15.4)[a] | 18 (46.2)[b] | **0.001** |

Bold values indicate p<0.05
P shows the differences among obese, osteoporotic obese, sarcopenic obese, and osteosarcopenic obese groups based on the Kruskal-Wallis test or chi-square test.
a, b, c were shown based on the Bonferroni post-hoc test results for study groups. Different letters specify the differences among the groups, vice versa
ADL: Activities of daily living, IADL: Instrumental ADL, BMI: Body mass index, BMR: Basal metabolic rate, SMI: Skeletal muscle index, TUG: Timed up go test, SARC-F: A simple questionnaire to rapidly diagnose sarcopeni, MET: Metabolic equivalent of task, FRAX: Fracture risk assessment tool

The multivariate logistic regression model indicated that OSO was strongly correlated with both falls (odds ratio (OR): 2.82, 95% confidence interval (CI): 1.23-5.78, p=0.011) and vertebral fractures (OR: 3.11, 95% CI: 1.32-6.82, p=0.002) (Table 2).

**Table 2. Logistic regression analyses of independent factors associated with fall and vertebra fracture**

| | Odds ratio | 95% CI | p |
|---|---|---|---|
| **Fall** | | | |
| Osteosarcopenic obesity | 3.12 | 1.50-6.45 | **0.002** |
| Age | 1.02 | 0.98-1.05 | 0.342 |
| ADL | 1.49 | 0.79-2.80 | 0.223 |
| IADL | 1.10 | 0.64-1.87 | 0.735 |
| Low physical activity | 2.04 | 0.93-3.71 | 0.072 |
| Presence of osteoporotic obesity | 0.67 | 0.26-1.70 | 0.402 |
| **Vertebra fracture** | | | |
| Osteosarcopenic obesity | 3.36 | 1.58-7.12 | **0.001** |
| Age | 1.09 | 0.93-1.15 | 0.057 |
| ADL | 1.75 | 0.84-3.64 | 0.134 |
| IADL | 1.12 | 0.58-2.18 | 0.731 |
| Low physical activity | 0.79 | 0.39-1.62 | 0.520 |
| Presence of osteoporotic obesity | 0.69 | 0.24-1.03 | 0.061 |

Model 1 is adjusted for age, ADL, IADL, low physical activity, and only the presence of osteoporotic obesity.
Model 2 is adjusted for age, ADL, IADL, low physical activity, and only the presence of sarcopenic obesity.
ADL: Activities of daily living, IADL: Instrumental ADL, CI: Confidence interval

## Discussion

This study examined how OSO affects fractures and falls. The findings indicated that falls and vertebral fractures were markedly more common in people with OSO than in those with obesity, osteoporotic obesity, and sarcopenic obesity.

An examination of prevalence indicated that OSO, obesity, sarcopenic obesity, and osteoporotic obesity occurred at rates of 12.2%, 18.3%, 4.1%, and 5.4%, respectively. Previous investigations in Türkiye revealed OSO prevalence rates of 15.2% and 10.7% (28,29). The research indicates a significant variation in the prevalence of OSO between nations, with rates between 0.88% and 19.0% (2,6).

The criteria used to define each OSO component may vary across studies, leading to inconsistencies in the observed prevalence rates. Various factors, including age, gender, ethnicity, lifestyle, and comorbidities, may affect the incidence of OSO. No consensus exists regarding the optimal strategy for correcting SMM in the diagnosis of sarcopenia among obese older adults. A measurement of BMI or weight, which more accurately represents body size than the square of height, has been suggested to provide more precise outcomes for estimating SMM (30). To diagnose sarcopenia, we employed SMMI (kg/BMI). This was determined by adjusting the SMM with BMI, derived from BIA.

Additionally, BF% was employed to diagnose obesity, in accordance with the recent consensus document from the European Society for Clinical Nutrition and Metabolism and the European Association for the Study of Obesity regarding sarcopenic obesity, which recommends the use of BF% over waist circumference and BMI for obesity diagnosis (30). In the study by Okyar Baş et al. (28) which focused on OSO in Türkiye, ultrasound imaging was used to assess muscle mass for sarcopenia diagnosis, BMI was applied for obesity diagnosis, and the relationship between OSO and frailty was investigated. The results demonstrated a substantial connection between OSO and frailty (28).

A study by Kolbaşı et al. (29) used BIA to measure muscle mass in order to evaluate sarcopenia. Unlike current practice, muscle mass was standardized by height squared. The inquiry into the relationship between OSO and fall risk demonstrated no correlation. Contrarily, we determined that OSO is a risk factor for falls. The study population's demographics, the inconsistent obesity diagnosis criteria, and the SMMI diagnostic criteria used to diagnose OSO, are all responsible for the disparities in results.

The interrelationship among bone, muscle, and adipose tissue has been established. OSO, defined as the coexistence of sarcopenia, osteoporosis, and obesity, is gaining recognition as a significant issue among the elderly (31). Research has shown that older adults with sarcopenic obesity had decreased BMD in the femoral neck compared to those who were just obese (32). This reinforces earlier research showing that those with sarcopenic obesity have lower BMD, highlighting the idea that sarcopenia may increase the risk of low bone mass and fractures. The rise in muscle mass is posited to be essential for the enhancement of BMD, although it may be accompanied by an increase in fat mass. According to the study, sarcopenic obese patients had lower lumbar total and femoral neck BMD than patients who are solely obese, according to the study. Compared to the obese group alone, the sarcopenic obese group had a higher FRAX fracture risk score. Compared to the other groups, the OSO cohort had significantly higher FRAX fracture risk scores and lower lumbar total and femoral neck BMD.

Falling risk is linked to osteosarcopenia. Fall and fracture rates were significantly higher in OSO people than in obese, osteoporotic obese, and sarcopenic obese individuals. This finding emphasises the importance of considering OSO as a newly recognized condition contributing to falls and fractures in patients.

This study represents the inaugural report of this association. The findings of our study indicate people with OSO exhibit a heightened risk of vertebral fractures, as assessed by the FRAX tool, in comparison to obese, osteoporotic obese, and sarcopenic obese patients. By proving that OSO is a separate risk factor for vertebral fractures, our study contributes to the body of existing research.

There was no correlation between gender and outcome variables in the study. This may be attributed to the number of male patients being smaller than the number of female patients. According to the results of our investigation, OSO may have greater clinical effects than any of its constituent parts. It is logical to believe that our findings will stimulate more research, because the vicious loop that OSO causes may result in additional negative outcomes.

The SARC-F questionnaire serves as an immediate screening instrument for clinicians to identify older adults who may be experiencing sarcopenia. FRAX can identify individuals with osteoporosis at elevated risk for fractures without requiring a BMD measurement (33). Although there are several validated screening tests for sarcopenia and osteoporosis (such as SARC-F, Ishii, SARC-CalF, and FRAX), there is currently no screening test for OSO. As research on OSO progresses, it is anticipated that specific screening tools or guidelines may be developed to address this condition and provide targeted recommendations for prevention and management. There is a distinct necessity for more comprehensive interventions and treatment approaches for OSO, which encompasses three critical clinical conditions, exhibits high prevalence, and serves as a major risk factor for falls and fractures. Also, treating these three clinical entities simultaneously may further increase treatment success.

This study is significant since it represents the first examination of the prevalence of OSO in older adults receiving outpatient treatment in Türkiye, along with its association with falls and vertebral fractures. Our study's cross-sectional methodology and the majority of participants being female are drawbacks. No endpoints or clinical consequences were detected. Notwithstanding the compelling findings, we could not ascertain causal linkages or the underlying processes of OSO. Subsequent study ought to concentrate on discovering novel screening instruments for OSO assessment in the elderly and assessing the impact of concurrently treating each component of OSO.

### Study Limitation

A limitation of our study is its cross-sectional methodology, which, combined with the predominance of female participants, may limit generalizability. Additionally, no endpoints or clinical consequences were identified. Despite the compelling findings, we were unable to establish causal relationships or identify the underlying mechanisms of OSO.

## Conclusion

Consequently, it is recommended that elderly patients be screened for fall risk and fracture risk, with appropriate precautions being taken. To effectively investigate the prevalence of OSO, it is essential to establish a universal definition, identify a reliable biomarker, or create validated risk assessment tools for this condition. It is recommended that OSO be considered as an additional component of comprehensive geriatric evaluation.

### Ethics

**Ethics Committee Approval:** This study was authorized by Erciyes University's Clinical Research Ethics Committee (approval number: 2019/136, date: 20.02.2019).

**Informed Consent:** It was obtained.

### Footnotes

### Authorship Contributions

Surgical and Medical Practices: B.E.C., D.K., Concept: Y.S.S.A., Design: S.A., Data Collection or Processing: B.E.C., N.Ö.D.,

Analysis or Interpretation: N.T.Ö., Literature Search: B.E.C., Writing: B.E.C.

**Conflict of Interest:** No conflict of interest was declared by the authors.

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## References

1. Ilich JZ. another impairment in older age: what does osteosarcopenic obesity syndrome mean for middle-aged and older women? J Am Med Dir Assoc. 2017;18:648-650.
2. Ilich JZ, Inglis JE, Kelly OJ, McGee DL. Osteosarcopenic obesity is associated with reduced handgrip strength, walking abilities, and balance in postmenopausal women. Osteoporos Int. 2015;26:2587-2595.
3. Siris ES, Adler R, Bilezikian J, Bolognese M, Dawson-Hughes B, Favus MJ, Harris ST, Jan de Beur SM, Khosla S, Lane NE, Lindsay R, Nana AD, Orwoll ES, Saag K, Silverman S, Watts NB. The clinical diagnosis of osteoporosis: a position statement from the National Bone Health Alliance Working Group. Osteoporos Int. 2014;25:1439-1443.
4. Kelly OJ, Gilman JC, Boschiero D, Ilich JZ. Osteosarcopenic obesity: current knowledge, revised identification criteria and treatment principles. nutrients. 2019;11:747.
5. Guttikonda D, Smith AL. Sarcopenia assessment techniques. Clin Liver Dis (Hoboken). 2021;18:189-192.
6. Szlejf C, Parra-Rodríguez L, Rosas-Carrasco O. Osteosarcopenic obesity: prevalence and relation with frailty and physical performance in middle-aged and older women. J Am Med Dir Assoc. 2017;18:733.
7. Florence CS, Bergen G, Atherly A, Burns E, Stevens J, Drake C. Medical costs of fatal and nonfatal falls in older adults. J Am Geriatr Soc. 2018;66:693-698.
8. Ormsbee MJ, Prado CM, Ilich JZ, Purcell S, Siervo M, Folsom A, Panton L. Osteosarcopenic obesity: the role of bone, muscle, and fat on health. J Cachexia Sarcopenia Muscle. 2014;5:183-192.
9. Hita-Contreras F, Martínez-Amat A, Cruz-Díaz D, Pérez-López FR. Osteosarcopenic obesity and fall prevention strategies. Maturitas. 2015;80:126-132.
10. Katz S, Ford AB, Moskowitz RW, Jackson BA, Jaffe MW. Index of independence in activities of daily living. JAMA: Journal of the American Medical Association. 1970. Available From: https://doi.org/10.1037/t04004-000
11. Arik G, Varan HD, Yavuz BB, Karabulut E, Kara O, Kilic MK, Kizilarslanoglu MC, Sumer F, Kuyumcu ME, Yesil Y, Halil M, Cankurtaran M. Validation of Katz Index of independence in activities of daily living in Turkish older adults. Arch Gerontol Geriatr. 2015;61:344-350.
12. Notter LE. A case for interdisciplinary research. Nurs Res. 1970;19:195.
13. Isik EI, Yilmaz S, Uysal I, Basar S. Adaptation of the lawton instrumental activities of daily living scale to turkish: validity and reliability study. Ann Geriatr Med Res. 2020;24:35-40.
14. Morley JE, Malmstrom TK, Miller DK. A simple frailty questionnaire (FRAIL) predicts outcomes in middle aged African Americans. J Nutr Health Aging. 2012;16:601-608.
15. Kanis JA. Diagnosis of osteoporosis and assessment of fracture risk. Lancet. 2002;359:1929-1936.
16. Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, Pratt M, Ekelund U, Yngve A, Sallis JF, Oja P. International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc. 2003;35:1381-1395.
17. Ayvat E, Kilinç M, Kirdi N. The Turkish version of the physical activity scale for the elderly (PASE): its cultural adaptation, validation, and reliability. Turk J Med Sci. 2017;47:908-915.
18. Malmstrom TK, Miller DK, Simonsick EM, Ferrucci L, Morley JE. SARC-F: a symptom score to predict persons with sarcopenia at risk for poor functional outcomes. J Cachexia Sarcopenia Muscle. 2016;7:28-36.
19. Cruz-Jentoft AJ, Bahat G, Bauer J, Boirie Y, Bruyère O, Cederholm T, Cooper C, Landi F, Rolland Y, Sayer AA, Schneider SM, Sieber CC, Topinkova E, Vandewoude M, Visser M, Zamboni M; Writing group for the European Working Group on Sarcopenia in Older People 2 (EWGSOP2), and the extended group for EWGSOP2. Sarcopenia: revised European consensus on definition and diagnosis. Age Ageing. 2019;48:16-31.
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. Bahat G, Kilic C, Ilhan B, Karan MA, Cruz-Jentoft A. Association of different bioimpedanciometry estimations of muscle mass with functional measures. Geriatr Gerontol Int. 2019;19:593-597.
22. Bahat G, Tufan A, Kilic C, Aydın T, Akpinar TS, Kose M, Erten N, Karan MA, Cruz-Jentoft AJ. Cut-off points for height, weight and Body mass index adjusted bioimpedance analysis measurements of muscle mass with use of different threshold definitions. Aging Male. 2020;23:382-387.
23. Organization WH. Physical Status: The Use and interpretation of anthropometry: report of a WHO expert committee, 1995.
24. Organization WH. Obesity: preventing and managing the global epidemic: report of a WHO consultation, 2000.
25. Zoico E, Di Francesco V, Guralnik JM, Mazzali G, Bortolani A, Guariento S, Sergi G, Bosello O, Zamboni M. Physical disability and muscular strength in relation to obesity and different body composition indexes in a sample of healthy elderly women. Int J Obes Relat Metab Disord. 2004;28:234-241.
26. Organization WH. Assessment of fracture risk and its application to screening for postmenopausal osteoporosis: report of a WHO study group [meeting held in Rome from 22 to 25 June 1992]: World Health Organization, 1994.
27. Lenchik L, Rogers LF, Delmas PD, Genant HK. Diagnosis of osteoporotic vertebral fractures: importance of recognition and description by radiologists. AJR Am J Roentgenol. 2004;183:949-958.
28. Okyar Baş A, Güner Oytun M, Deniz O, Öztürk Y, Kahyaoğlu Z, Ceylan S, Çöteli S, Dikmeer A, İleri İ, Hafızoğlu M, Şahiner Z, Doğu BB, Cankurtaran M, Halil MG. Ultrasonografically assessed osteosarcopenic obesity is associated with frailty in community-dwelling older adults. Nutrition. 2022;103:111827.
29. Kolbaşı EN, Demirdağ F. Prevalence of osteosarcopenic obesity in community-dwelling older adults: a cross-sectional retrospective study. Arch Osteoporos. 2020;15:166.
30. Donini LM, Busetto L, Bischoff SC, Cederholm T, Ballesteros-Pomar MD, Batsis JA, Bauer JM, Boirie Y, Cruz-Jentoft AJ, Dicker D, Frara S, Frühbeck G, Genton L, Gepner Y, Giustina A, Gonzalez MC, Han HS, Heymsfield SB, Higashiguchi T, Laviano A, Lenzi A, Nyulasi I, Parrinello E, Poggiogalle E, Prado CM, Salvador J, Rolland Y, Santini F, Serlie MJ, Shi H, Sieber CC, Siervo M, Vettor R, Villareal DT, Volkert D, Yu J, Zamboni M, Barazzoni R. Definition and diagnostic criteria for sarcopenic obesity: ESPEN and EASO consensus statement. Obes Facts. 2022;15:321-335.
31. Scott D, Chandrasekara SD, Laslett LL, Cicuttini F, Ebeling PR, Jones G. Associations of sarcopenic obesity and dynapenic obesity with bone mineral density and incident fractures over 5-10 years in community-dwelling older adults. Calcif Tissue Int. 2016;99:30-42.
32. Gandham A, Mesinovic J, Jansons P, Zengin A, Bonham MP, Ebeling PR, Scott D. Falls, fractures, and areal bone mineral density in older adults with sarcopenic obesity: A systematic review and meta-analysis. Obes Rev. 2021;22:e13187.
33. Leslie WD, Morin S, Lix LM, Johansson H, Oden A, McCloskey E, Kanis JA; Manitoba Bone Density Program. Fracture risk assessment without bone density measurement in routine clinical practice. Osteoporos Int. 2012;23:75-85.