

# Impacts of combined osteopenia/osteoporosis and sarcopenia on balance and quality of life in older adults

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## ABSTRACT

**OBJECTIVE:** Combined osteopenia/osteoporosis and sarcopenia is a major public health problem for old adults. In this study, we aimed to evaluate the impacts of combined osteopenia/osteoporosis with sarcopenia on balance and quality of life in patients older than 65 years.

**METHODS:** In this study, 77 patients with sarcopenia, who were older than 65 years, were included. The diagnosis of sarcopenia was made according to the diagnostic criteria developed by The European Working Group on Sarcopenia in Older People (EWGSOP). Bone densitometry was performed to screen for osteoporosis or osteopenia. The balance was assessed with the anterior-posterior stability index (APSI), medial-lateral stability index (MLSI), and the general stability index (OSI), which were calculated using a Biodex Stability System device (BSS). The quality of life was assessed using SF-36.

**RESULTS:** Patients with sarcopenia were included in this study. Of them, 40 had osteoporosis and 37 had osteopenia. The measures of balance and the OSI, APSI, and MLSI values were low in both groups of patients, but they were statistically significantly lower in the sarcopenia with osteoporosis group compared to the sarcopenia with osteopenia group ( $p=0.01$ ;  $p=0.002$ ;  $p=0.04$ , respectively). The quality of life was lower in all sub-categories of SF-36, excluding the mental health when sarcopenia was accompanied by osteoporosis compared to the joint occurrence of sarcopenia with osteopenia ( $p<0.05$ ).

**CONCLUSION:** Our study suggests that the joint occurrence of osteoporosis with sarcopenia is associated with a risk of balance loss, a decrease in quality of life, and a potentially increased fracture risk in older adults.

*Keywords: Balance; osteoporosis; quality of life; sarcopenia.*

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Sarcopenia is a disorder with generalized and progressive loss of muscle mass, strength, and function. It is a disease of old individuals primarily [1]. Alterations in the body composition with loss of muscle mass and function occur in time with increasing age. These changes may lead to poor physical performance, weakness, mobility impairments, loss of balance, falls, and disability, eventually becoming severe health

problems in aging individuals. The prevalence of sarcopenia in community-based studies ranges from 1% to 29%. This rate is approximately 10% of the old people [2]. In 2017, a study from Turkey investigating the prevalence of sarcopenia by the decades reported that sarcopenia prevalence was 15.4% in the age group of 60–69 years and that it increased to 36.5% after 80 years [3].

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It has been demonstrated that walking speed declines gradually in old individuals. The decline in walking speed is more pronounced in the presence of sarcopenia [4]. Walking speed is a major diagnostic criterion of sarcopenia, defining walking speed almost as a vital sign. Sarcopenia diagnosis is made in old individuals according to the sarcopenia algorithm recommended by The European Working Group on Sarcopenia in Older People (EWGSOP)[5].

Several factors causing sarcopenia are involved in the development of osteoporosis, too. These factors include reduced physical activity, protein-poor diet, chronic inflammatory processes, and hormonal changes [6]. It is reported that individuals with repeated falls in medical history develop a fear of falling and they start to exhibit avoidance behavior toward the activities of daily living, resulting in an eventual reduction in mobility. Therefore, it can be suggested that a vicious cycle starts with a reduction in physical performance and balance loss in old individuals due to sarcopenia and contributing osteoporosis; resulting in fear of falls, which leads to a gradual decrease in physical activities, completing the vicious cycle with more pronounced sarcopenia and osteoporosis [7].

Muscles and bones are considered to compose a functional unit not only because of their close anatomical neighborhood but due to their involvement with the paracrine and endocrine signaling as well. Anatomical, cellular, and biochemical changes occur in the muscle tissue along with aging and these are associated with overlapping similar pathways involved in the alterations of bone mineral density and bone microarchitecture.

Osteoporosis and sarcopenia are associated with increased morbidity and mortality in the older population. With the increased average life expectancy of the world's population, the concept of quality of life in old individuals has become one of the most important goals. Identifying the relationship between osteoporosis and sarcopenia is of considerable importance in developing preventive approaches for people at advanced ages.

In this study, we aimed to investigate the impacts of combined osteopenia/osteoporosis and sarcopenia on balance and quality of life in old individuals.

## MATERIALS AND METHODS

### Study Design and Population

The study sample included individuals; who were at least 65 years old and who were admitted to our outpatient

clinic. This study was approved by the local ethics committee (2017/75).

The inclusion criteria for this study required the individuals to be 65 years old or older and score at least 17 on the Mini-Mental State Examination [8]. The exclusion criteria were the inability to move without assistance, the self-reported presence of acute pain in the lower or upper limbs, physical disability, cardiac or respiratory disorders, history of stroke, cancer cachexia, medication-induced anorexia, an untreated chronic disease or mental illness, severe arthritis, and/or inflammatory diseases. Informed consent was obtained from all participants included in this study.

### Measurements

#### Clinical Chemistry

Serum levels 25-OH-vitamin D3 were analyzed using an on-line SPE HPLC device compatible with tandem mass spectrometry (LC-MS/MS). MS7100 and MS7000 ClinMass® Complete Kits were used.

#### Balance Test with the Biodex Stability System (BSS)

Biodex Stability System (BSS) (Biodex Medical Systems, Shirley, 2000, New York) was used for quantifying the balance parameters in this study. Antero-Posterior Stability Index (APSI), Medial-Lateral Stability Index (MLSI) and Overall Stability Index (OSI) were tested by an expert while the study participants were undergoing the test with their eyes open. The foot platform of BSS could be set at eight levels by changing the resistance level. Level 8 provided the most stable and level 1 provided the least stable platforms. The measurements were made on the balance platform with the participants on bare feet opened at the width of their shoulders, their knees 15° twisted, and their hands combined on the chest. The test started at level 8 and ended at level 4. A high value indicated that a substantial movement occurred far from the patient's center of balance, while a low number indicated that a minimal movement occurred during the test [9]. To reduce the fear of falling, the individuals were convinced that they would not fall during the test on the mobile platform. Until the test was completed, an observer continued to stand next to the device. None of the individuals fell during the test (Fig. 1).

#### Definition of Osteopenia and Osteoporosis

Total and regional bone mass density (BMD) ( $\text{g}/\text{cm}^2$ ) and total and regional lean mass were evaluated by du-



**FIGURE 1.**  
A patient in the  
balance test.

al-energy X-ray absorptiometry (DEXA) [Hologic QDR 4500 W (SIN 49584), Waltham, MA, USA]. BMD was classified according to the World Health Organization (WHO) criteria based on the T-score of the lumbar spine and/or femoral neck and/or total hip as follows: normal (T-score  $> -1.0$  SD), osteopenia ( $-1.0 \geq$  T-score  $> -2.5$  SD), and osteoporosis (T-score  $\leq -2.5$  SD) [10].

### Definition of Sarcopenia

We used the definition and algorithm of sarcopenia developed by EWGSOP to identify individuals with sarcopenia [5]. According to this algorithm, firstly, the walking speed was determined in individuals over 65 years. A walking speed of less than 0.8 m/sec indicated the risk of sarcopenia, indicating that further evaluation was needed with the handgrip strength test (HGS). If the HGS test results were low, too, then, a selected method of muscle mass measure should be used.

All participants performed a 3-meter-walking speed test and the results were expressed in meters per second. The participants' performance was determined by referencing the cut-off points recommended by the EWGSOP [5]. A walking speed of  $\leq 0.8$  m/s was considered to indicate an impaired physical performance. Muscle strength was assessed by measuring HGS with a Jamar hydraulic hand dynamometer using a validated protocol

[11]. HGS was measured when the participant was in the sitting position with the elbow in  $90^\circ$  flexion and the wrist in the neutral position. Patients were asked to apply the maximum grip strength three times with both hands. At least a 30 second-period was allowed between each testing episode. The maximum value obtained during the HGS tests of each participant was accepted as the grip strength value to be included in the data analysis [11]. HGS cut-off values were reported to be  $< 32$  kg and  $< 22$  kg in males and females, respectively, in the Turkish population [12].

Body composition was evaluated with bioimpedance analysis (BIA) using a Tanita BC 532 model body analysis monitor. BIA predicts the volume of fat and lean body mass. The test itself is not costly, easily administered, and appropriate for ambulatory patients. The results are reported to be reproducible. In our study, we measured the fat-free mass (FFM) with BIA. Then, we calculated the skeletal muscle mass (SMM) using the following equation:  $SMM \text{ (kg)} = 0.566 * FFM \text{ (lean mass)}$ . Skeletal muscle mass index (SMMI) was calculated using the following formula:  $Skeletal \text{ muscle mass (kg)}/\text{height squared (m}^2)$  [13]. The cut-off values for SMMI were  $9.2 \text{ kg/m}^2$  in males and  $7.4 \text{ kg/m}^2$  in females [12].

### Quality of Life

Short-Form Health Survey (SF-36) was used for assessing the quality of life [14]. SF-36 was previously translated into Turkish and validated for use in the Turkish population. SF-36 is a self-report generic outcome measure to evaluate the quality of life, comprising 36 items distributed into eight subdimensions, which are physical functioning, general health, pain, mental health, social functioning, vitality, role limitations due to physical problems, and role limitations due to emotional problems. The scores of the subdimensions can be in the range from 0 to 100, with lower scores indicating low quality of the life.

### Statistical Analysis

SPSS for Windows version 17.0 software was used for the statistical analyses. We conducted descriptive analyses to summarize the patients' baseline characteristics (e.g., age, gender, body mass index and HGS) and presented the results in mean  $\pm$  standard deviation. Quantitative variables were tested for normality using the Shapiro Wilk test. The independent t-test was used for analyzing the normally distributed variables. The Mann-Whitney U test was used for testing the differences in

**TABLE 1.** Basic characteristics of study subjects

	Sarkopenia with osteopenia (n=37)	Sarkopenia with osteoporosis (n=40)	p
Age (year)	71±4.5	71.5±5.7	0.94
Gender (F/M)	26/11	33/7	0.28
BMI (kg/m <sup>2</sup> )	30.4±7.4	28.2±3.5	0.13
Serum vitamin D levels (ng/ml)	20±11.2	23.2±19.1	0.92
Hand grip strength (kg)	18.5±4.3	15.8±3.8	<b>0.005*</b>
Usual gait speed (m/s)	0.55±0.2	0.59±0.1	0.70
Skeletal muscle mass index (kg/m <sup>2</sup> )	6.9±0.4	6.78±0.1	0.68

BMI: Body mass index; \*: Statistically significant at p<0.05.

**TABLE 2.** Results of balance testing

Biodex stability system	Sarkopenia with osteopenia (n=37)	Sarkopenia with osteoporosis (n=40)	p
OSI	4.03±1.71	5.04±1.80	<b>0.01*</b>
APSI	3.27±1.29	4.30±1.55	<b>0.002*</b>
MLSI	3.01±1.21	3.71±1.71	<b>0.04*</b>

APSI: Antero-Posterior Stability Index; MLSI: Medio-Lateral Stability Index; OSI: Overall Stability Index; \*: Statistically significant at p<0.05.

balance indices (OSI, APSI, and MLSI). Gender differences between osteoporotic and osteopenic patients were tested with the chi-square test.

## RESULTS

In this study, 77 patients with sarcopenia were included. The mean age of the participants was 71.3±5.1 years (min: 65 max: 85). The mean vitamin D levels of the patients were 21.7±15.8 (min: 3 max: 73) ng/ml. The demographic data of the study patients are presented in Table 1.

The measures of balance in all tested directions were statistically significantly lower in the osteoporosis group (p=0.01, p=0.002, p=0.04 for OSI, APSI, and MLSI, respectively) compared to the osteopenia group (Table 2).

The quality of life scores was statistically significantly lower in all subdimensions, excluding the mental health, in patients with combined osteoporosis and sarcopenia (p<0.05) compared to the patients with osteopenia and sarcopenia (Table 3).

## DISCUSSION

The results of our study showed that the joint occurrence of osteoporosis and sarcopenia was related to a potential loss of balance and reduction in quality of life in the older population. The combination of osteopenia/osteoporosis and sarcopenia is more prevalent in the old age, predisposing the individuals to a high risk of falls, fractures, and eventual functional decline. To our knowledge, our study is the first study in quantifying the balance parameters objectively along with the quality of life in individuals with combined sarcopenia and osteopenia/osteoporosis. It is reported in the literature that loss of balance and a decline in the quality of life develop in old individuals when sarcopenia is accompanied by osteoporosis.

The pathophysiology of muscle and bone loss reveals overlapping features. There is an intense and complex interaction between these two tissue types mechanically (the mechanostat hypothesis) [15] and biochemically (e.g., with the involvement of estrogen, testosterone, GH, IGF-1, IL-6, and osteocalcin) [16]. Previous studies cat-

**TABLE 3.** Health-related quality of life

SF-36 subscales	Sarkopenia with osteopenia (n=37)	Sarkopenia with osteoporosis (n=40)	p
Physical functioning	66.08±8.17	44.75±6.78	<b>0.00*</b>
Role limitations due to physical problems	43.24±20.11	14.37±17.80	<b>0.00*</b>
Role limitations due to emotional problems	75.65±31.09	29.98±31.82	<b>0.00*</b>
Vitality	46.48±9.49	36.62±11.05	<b>0.00*</b>
Emotional well-being	52.54±12.26	54.80±9.72	0.672
Social functioning	59.45±15.97	50.00±12.00	<b>0.00*</b>
Pain	39.72±10.00	31.55±9.17	<b>0.00*</b>
General health	53.67±8.63	40.25±7.24	<b>0.00*</b>

SF-36: Short-form-36; \*: Statistically significant at  $p < 0.05$ .

egorized individuals with combined osteopenia/osteoporosis and sarcopenia as osteosarcopenic (OS) or sarco-osteopenic due to the interactions between the bone and muscle tissue [17]. Yu et al. [18] have recently conducted a study on male osteosarcopenia patients, reporting a 3.5-fold increased risk of fractures and they have reported that the risk is significantly higher compared to the presence of sarcopenia or osteopenia alone. Although this study was conducted only on males, it provided insight into potential additional risks associated with osteosarcopenia.

Drey et al. [19] reported that osteosarcopenia occurred much more prevalently compared to the presence of either sarcopenia and osteopenia alone, stressing that both the bone and muscle tissue should be treated in old individuals suffering from actual osteoporosis and fractures.

Balance is the postural fit performed either at rest or during activity to sustain the center of gravity on the supporting surface. The musculoskeletal system is a major contributor to maintain balance. Increasing age is associated with a reduction in the number of muscle fibers and a reduction in the number of cross-sections of the remaining fibers (fiber atrophy), leading to muscle weakness, which is a major factor involved in the loss of balance. Maintaining the balance during mobility in patients with sarcopenia becomes difficult due to the emerging coordination deficits resulting from the poor physical performance of the striated muscles executing this function. Although it has not been clarified yet whether the declining muscle strength is the cause or the result of osteoporosis, the relationship between muscle strength and bone mineral density (BMD) has been shown in studies [20]. In particular, the trunk muscle strength is

important in maintaining the balance during the daily activities of life. A gradual immobilization developing in association with increasing age occurs due to a sedentary lifestyle and confers a risk factor for reductions in muscle strength and BMD [21].

Handgrip strength alone or in combination with BMD should be used for identifying the individuals having an increased risk of fractures [22]. Our study may conclude the same results, too, as HGS was significantly lower and the balance parameters were significantly poor in the patients with osteoporosis. Loss of balance can be considered as an increased risk factor for fractures.

The potential for having a low quality of life (QOL) is not surprising in old individuals diagnosed with sarcopenia. Several studies are available in the literature, evaluating the quality of life in individuals suffering from sarcopenia and osteoporosis. Although the disease-specific QOL scales are recommended for each of these disorders, we preferred to use a generic measure of QOL [23]. In the patients with osteoporosis, we found lower scores in all subdimensions of SF-36, excluding the mental health subcategory. There was not a significant difference between the osteopenic and osteoporotic groups in terms of the mental health scores and the scores were lower in both groups, compared to Turkish norms. This may suggest that not only physical health but also mental health is affected in the patients suffering from tissue loss both in bones and muscles.

There are several reasons to consider the potential beneficial effects of vitamin D on muscle and bone tissues, according to the results of the recent reviews performed by various experts and scientific societies [24, 25]. In our

study, insufficient vitamin D levels were found in both groups; therefore, the observed differences in the balance parameters in both groups could not be associated with the lower vitamin D levels.

We recognize that our study has some limitations. The major limitation is the relatively small sample size. Secondly, we did not include any patients with sarcopenia alone; therefore, we could not perform any comparisons with individuals having a normal BMD.

In conclusion, we found balance loss in the old individuals with combined sarcopenia and a significant loss in bone mass, impairing their QOL in both physical and social aspects. Therefore, an assessment of bone parameters will identify individuals with a higher risk of fractures. Also, an assessment of muscle parameters will allow for screening for other major risk factors of general health. Further prospective long-term studies are warranted to confirm our study results and to develop assessment tools to evaluate sarcopenia along with the existing tools used for evaluating the fracture risk (such as FRAX Assessment Tool).

**Ethics Committee Approval:** The Inonu University Clinical Research Ethics Committee granted approval for this study (217/75).

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

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**Authorship Contributions:** Concept – RB; Design – RB; Supervision – RB; Materials – RB, BE; Data collection and/or processing – RB, SA; Analysis and/or interpretation – RB, SA; Literature review – RB, BE; Writing – RB; Critical review – YE.

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