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**Original Research Article**

# Osteoporosis and its relationship with sarcopenia in elderly patients

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## ABSTRACT

**Background:** Osteoporosis and sarcopenia are two chronic conditions that are associated with aging and leading to an increase in bone fragility and fracture susceptibility. The objective of this study was to find out the relationship between osteoporosis and sarcopenia in elderly patients.
**Methods:** This hospital-based cross-sectional descriptive study was conducted in the Department of Medicine, Cumilla Medical College Hospital, Bangladesh, from January 2020 to January 2021 in 100 elderly patients who are suffering from osteoporosis.
**Results:** A total of 100 elderly osteoporotic patients were studied. The median age was 66±7, 88% females. Regarding different co morbidities diabetes mellitus (DM), hypertension (HTN), ischemic heart disease (IHD), dyslipidemia, osteoarthritis (OA) and chronic kidney disease (CKD), 31 (31%), 23 (23%), 7 (7%), 9 (9%), 21 (21%) and 5 (5%) respectively. Among 100 cases, 71 (71%) patients were osteoporotic and 29 (29%) patients were severe osteoporotic, where vertebral compression fracture, femoral neck fracture and both are 18 (18%), 6 (6%) and 5 (5%) respectively. Sarcopenia is more common in severe osteoporotic patient and that is 72.4%. Hand grip strength 17.76±5.94 kg in right hand and 16±5.71 kg in left hand. Appendicular skeletal muscle mass (ASMM) index was 5.39±0.86 kg/m$^2$. Correlation of appendicular skeletal muscle mass (ASMM) index along with BMD of lumber spine (T-score) and BMD of femoral neck (T-score) were significant and the Pearson correlation coefficient were 0.264 and 0.356 respectively. Correlation between sarcopenia and osteoporosis was significant (p=0.008).
**Conclusion:** There is an intimate relationship between osteoporosis and sarcopenia. The prevalence of sarcopenia is higher in severe osteoporotic patient. Both conditions are significantly correlated to each other.

**Keywords:** Osteoporosis, Sarcopenia, Elderly, Bone mineral density, Appendicular skeletal muscle mass, Hand grip strength

## INTRODUCTION

Sarcopenia and osteoporosis are two chronic conditions, which are frequently diagnosed in frail elderly patients, both conditions imposing significant burden on the individual and public health domains.[1,2] Osteoporosis is defined as a systemic skeletal disease characterized by low bone mass and micro architectural deterioration of bone tissue. Both the conditions leading to an increase in bone fragility and fracture susceptibility.[3] Osteoporosis is usually symptomless but it may present with fracture and acute pain. The most obvious clinical manifestations of osteoporosis are back pain, loss of height over time, dowager's hump a stooped posture and pathologic fractures The most prevalent sequelae are compression

fractures of the vertebral bodies, ribs, proximal femurs, humeri and distal radiuses.

Sarcopenia is a disease characterized by a progressive and global loss of muscle mass and muscle function with advancing age, which leads to a non-negligible impact on daily life activities.[4,5] Symptoms of sarcopenia include a decrease in muscle mass, muscle weakness, loss of endurance, poor balance and trouble climbing stair. The strength of muscle does not depend solely on muscle mass. It was observed that the relationship between muscle strength and muscle mass is not linear.[6,7]

The United Nations defines elderly individuals as those aged 60 years and above.[8] According to the World Population Prospects 2019, one in every eleven people is aged 65 years or older.[9] A report released by the World Health Organization (WHO) on the occasion of the International Day of Older Persons highlighted that the number of people over 60 years is projected to double by 2050.[10] In Bangladesh, the 2011 national census reported that 7.7% of the population were elderly. Among them, the largest proportion belonged to the 60–64 years age group.[11]

Bone and muscle closely interact with each other not only anatomically, but also biochemically and metabolically, which is well expressed by the concept of "bone-muscle unit". There is a linear association observed between osteoporosis and sarcopenia.[12] The correlation between these diseases has been widely reported, leading to the development of the term "osteosarcopenia" to diagnose those patients suffering from both of the diseases.[12]

Several studies also show the correlation between low bone mineral density (BMD) and sarcopenia in both men and women.[13] European male aging study group shows that sarcopenia was associated with osteopenia and osteoporosis in their study on 679 men age between 40 to 79 years.[14] It was observed that high appendicular lean muscle mass and strength were positively associated with higher BMD and sarcopenia was associated with lower BMD.[15] Moreover, a recent study by Locquet et al showed that the decline in muscle performance was related to the decline in bone microarchitecture.[16] This study also observed that subjects with incident sarcopenia had an approximately 5-fold increased risk of concomitant osteoporosis. There is a dynamic relationship between impaired muscle and bone health. There is also an obvious association between the concomitant incidences of osteoporosis and sarcopenia.[16]

The objective of this study was to find out the relationship between osteoporosis and sarcopenia in elderly patients.

## METHODS

This hospital-based cross-sectional descriptive study was conducted in the Department of Medicine, Cumilla Medical College Hospital, Bangladesh, from January 2020 to January 2021. A total of 100 elderly patients (≥60 years) diagnosed with osteoporosis were enrolled. The study population included both admitted and outpatient individuals with clinical suspicion of muscle wasting or weakness.

### *Sample selection*

*Inclusion criteria*

Inclusion criteria included individual aged ≥60 years, confirmed osteoporosis (T-score ≤ -2.5) and willingness to provide informed consent.

*Exclusion criteria*

Exclusion criteria included individual who refused to participate, critically ill patients, known neuromuscular disorders (myopathy, neuropathy), conditions affecting muscle or bone metabolism and use of steroids, bisphosphonates, lipid-lowering agents, antipsychotics, antiretrovirals, antimalarials, or chemotherapy.

### *Data collection and study procedure*

Ethical clearance was obtained from the Institutional Review Board of Cumilla Medical College. Written informed consent was taken from all participants or their legal guardians. Data collection included demographic details, medical history, and physical examination. Bone mineral density (BMD) was assessed using dual-energy X-ray absorptiometry (DEXA). Sarcopenia was diagnosed according to EWGSOP2 criteria through hand grip strength (dynamometer), appendicular skeletal muscle mass index (ASMMI, DEXA), and timed up and go test (TUG). Data were analyzed using statistical package for the social sciences (SPSS) version 20. Continuous variables were expressed as mean±SD, and categorical data as proportions. Chi-square, student's t-test, and Pearson correlation were applied, with significance set at $p<0.05$.

## RESULTS

Table 1 presents baseline demographic and social characteristics of the study population. The majority of participants were aged 60–69 years (74%), predominantly female (88%), all were married, and most were housewives (80%).

Table 2 summarizes the co-morbidities observed among the study population. Diabetes mellitus (DM) was the most common co-morbidity, present in 31% of patients, followed by hypertension (HTN) in 23% and osteoarthritis (OA) in 21%. Other co-morbid conditions included dyslipidemia (9%), ischemic heart disease (IHD) (7%), and chronic kidney disease (CKD) (5%).

Table 3 summarizes the clinical and functional characteristics of the study group, highlighting reduced

BMD, diminished hand grip strength, low walking speed, and low ASMMI, all of which are consistent with sarcopenic and osteoporotic features.

**Table 1: Baseline demographic characteristics of the study population.**

| Characteristics | Frequency (n) | % |
|---|---|---|
| **Age group (years)** | | |
| 60–69 | 74 | 74 |
| 70–79 | 20 | 20 |
| 80–89 | 4 | 4 |
| ≥90 | 2 | 2 |
| **Mean±SD** | 66±7 | |
| **Sex** | | |
| Male | 12 | 12 |
| Female | 88 | 88 |
| **Marital status** | | |
| Married | 100 | 100 |
| **Occupation** | | |
| Housewife | 80 | 80 |
| Service holder | 6 | 6 |
| Farmer | 6 | 6 |
| Business | 5 | 5 |
| Labour | 3 | 3 |

**Table 2: Co-morbidities of study population.**

| Co-morbidities | Frequency | % |
|---|---|---|
| **Diabetes mellitus** | 31 | 31 |
| **Hypertension** | 23 | 23 |
| **Ischemic heart disease** | 7 | 7 |
| **Osteoarthritis** | 21 | 21 |
| **Chronic kidney disease** | 5 | 5 |
| **Dyslipidemia** | 9 | 9 |

**Table 3: Clinical parameters related to osteoporosis and sarcopenia.**

| Parameter | Mean ± SD |
|---|---|
| **BMD (T-score, gm/cm²)** | |
| Lumbar spine | -3.29±1.04 (0.804±0.14) |
| Femoral neck | -3.09±1.56 (0.632±0.17) |
| **Walking speed (m/sec)** | 0.65±0.12 |
| **TUG (sec)** | 13.5±3.2 |
| **Hand grip strength (kg)** | |
| Right | 17.76±5.94 |
| Left | 16.0±5.71 |
| **BMI (kg/m²)** | 24.15±4.57 |
| **ASMMI (kg/m²)** | 5.39±0.86 |

Table 4 presents the correlation between bone mineral density (BMD) and appendicular skeletal muscle mass index (ASMMI) in the study population. A positive correlation was observed between ASMMI and BMD at both sites.

Specifically, the correlation between lumbar spine BMD and ASMMI was r=0.264, which was statistically significant (p=0.008). The correlation between femur neck BMD and ASMMI was r=0.356, indicating a positive association, although the p value was not reported (Figures 1 and 2).

**Table 4: Correlation between BMD and ASMMI.**

| BMD site | Correlation coefficient (r) | Significance (p value) |
|---|---|---|
| **Lumbar spine** | 0.264 | 0.008 |
| **Femur neck** | 0.356 | |

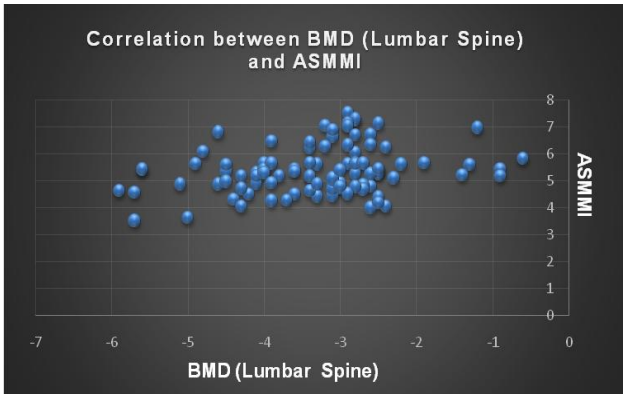


**Figure 1: Correlation between BMD-lumbar spine (T-score) and appendicular skeletal muscle mass (ASMM) index.**

*Correlation coefficient is 0.264

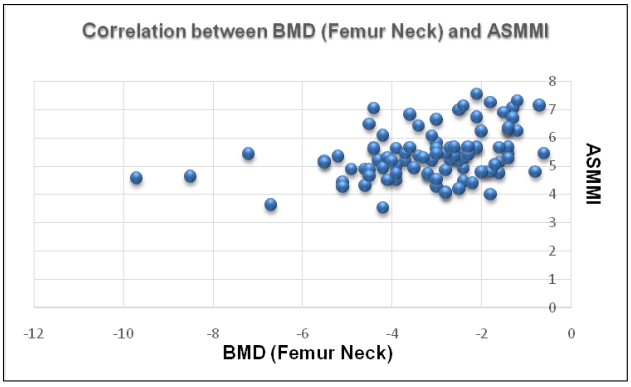


**Figure 2: Correlation between BMD-femur neck (T-score) and appendicular skeletal muscle mass (ASMM) index.**

*Correlation coefficient is 0.356

## DISCUSSION

Sarcopenia has come a long way since Irwin Rosenberg first suggested the term to apply to age-related muscle mass.[17] Osteoporosis is a systemic skeletal disorder characterized by reduced bone mass and deterioration of bone microarchitecture, leading to increased bone fragility and a higher risk of fractures.

Osteoporotic fractures represent a major source of morbidity in the population. Sarcopenia, on the other hand, is a progressive muscle disease resulting from lifelong adverse changes in muscle, primarily affecting older adults, though it may also develop earlier. The diagnosis of sarcopenia is based on reduced muscle strength, decreased muscle mass and quality, and impaired physical performance.[18] It is a major clinical problem in public health of older people; with some adverse outcomes such as disability, poor quality of life, and increased risk of death.[19,20] Sarcopenia has also been found to be a major reason for poor outcomes in persons with diabetes mellitus.[21]

This observational cross-sectional study was done among 100 elderly patients who were osteoporotic admitted in medicine department, Cumilla Medical College Hospital. Among 100 patients gender distribution revealed female was 88 (88%) and male was 12 (12%). In this study mean age was 66 years, minimum age was 60 years and highest age was 95 years. Among the respondence 74% case were at age group 60-69 years and only 2% case were at age group >90 years. All patients were married and 63% patients were live in rural area. Most of them were primary educated (35%) and 80% patients were housewife.

Confortin et al showed that in their study among 598 subjects (63–93 years) in the sample, 65.4% were women.[22] In our study most osteoporotic patient were female (88%) and maximum were housewife (80%). All patients were married and maximum were in 7th decade as elderly people was the study population. As study sampling technique was purposive and convenient type these data may not represent the actual scenario of Bangladesh.

Regarding different co morbidities DM, HTN, IHD, dyslipidemia, OA and CKD 31 (31%), 23 (23%), 7 (7%), 9 (9%), 21 (21%) and 5 (5%) respectively.

Morley et al showed in their study that sarcopenia has also been found to be a major reason for poor outcomes in persons with DM. In our study diabetes mellitus is also the most common co morbidities.[23]

Among 100 cases, 71 (71%) patients were osteoporotic and 29 (29%) patients were severe osteoporotic where 18 (18%) patients experienced only vertebral compression fracture, 6 (6%) patient experienced only femoral neck fracture and 5 (5%) patients experienced both vertebral compression fracture and femoral neck fracture. In the present study, 61 (61%) patients were identified as sarcopenic, while 39 (39%) were non-sarcopenic. Iannuzzi-Sucich et al reported a sarcopenia prevalence of 22.6% in women and 26.8% in men, with subgroup analysis showing higher rates in individuals aged 80 years or above—31.0% in women and 52.9% in men. According to other available literature, sarcopenia affects approximately 5–10% of people aged 65 years or older, with a higher prevalence observed among osteoporotic individuals.[24–26] In a study by Intriago et al, 65% of participants were found to have sarcopenia, of which 9% had sarcopenia alone and 56% had osteosarcopenia.[27] These findings indicate that the prevalence of sarcopenia increases with greater bone mass loss. Since all participants in our study were elderly and osteoporotic, sarcopenia was notably higher, affecting 61% of the study population.

Association between osteoporosis and sarcopenia revealed among 71 osteoporotic patients 40 were sarcopenic and among 29 severe osteoporotic patients, 21 were sarcopenic. Sarcopenia is more common in severe osteoporotic patient and that is 72.4%.

Confortin et al showed that the proportion of osteopenia/osteoporosis was higher in women and sarcopenia was associated with osteopenia/osteoporosis in the population from Florianópolis multiple study also have revealed that sarcopenia is the most important cause of frailty in older persons.[22]

Sarcopenia and osteoporosis in older people: a systematic review and meta-analysis done by Barbara et al showed that meta-analysis of prevalence of sarcopenia in patients with low-energy fracture (n=9) was 46%. in our study also revealed that sarcopenia was more common in osteoporosis and fracture group which indicate increase the risk of fraility.[28]

Sarcopenia corresponds to a progressive and generalized loss of muscle mass with either a loss of muscle strength or a loss of physical performance.[12]

In our study BMI 24.15±4.57 kg/m$^2$. T-score of lumbar spine, T-score of neck of femur were -3.29±1.04, -3.09±1 respectively. Walking speed and TUG were 0.65±0.12 5 m/sec and 13.5±3.2 seconds respectively. Hand grip strength 17.76±5.94 kg in right hand and 16±5.71 kg in left hand. Appendicular skeletal muscle mass (ASMM) index was 5.39±0.86 kg/m$^2$.

Sarcopenia and osteoporosis in older people: a systematic review and meta-analysis done by Barbara et al showed that the mean bone mineral density (n=5) and T-score (n=3) of femoral neck was significantly lower in sarcopenic participants. In our study T-score of lumbar-spine, T-score of neck of femur were -3.29±1.04, -3.09±1 respectively.

Correlation of ASMM index along with BMD of lumber spine (T-score) and BMD of femoral neck (T-score) were significant and the Pearson correlation coefficient were 0.264 and 0.356 respectively. Correlation between sarcopenia and osteoporosis was significant (p=0.008).

Sarcopenia and osteoporosis in older people: a systematic review and meta-analysis done by Barbara et al showed that meta-analysis of prevalence of sarcopenia in patients

with low-energy fracture (n=9) was 46% (95% CI 44, 48; p<0.001).

Confortin et al showed that the proportion of altered BMD was 52.1% for total BMD, 62.5% for lumber spine-BMD, and 70.9% for femoral neck-BMD in women, while for men, altered BMD proportion was 29.3% for total BMD, 24.5% for lumber spine-BMD, and 64.9% for femoral neck-BMD.[22] After adjustments, sarcopenia was associated with increased odds of altered lumber spine-BMD and femoral neck-BMD.

Kim et al showed in their study that, there was a positive correlation between muscle mass and BMD by using ASMM/Ht2 as an index for sarcopenia.[29] Especially through the ROC curve, ASMM/Ht2 well reflected the risk of osteoporosis and indicated the best cut-off values (men 6.85 kg/m$^2$, women 5.96 kg/m$^2$) for sarcopenia. In our study ASMM index along with BMD of lumbar spine (T-score) and BMD of femoral neck (T-score) were also strongly correlated and p value was 0.008 that is significant at p<0.05. But a long-term, observational study with a larger population is needed to validate our results.

Postmenopausal hormone changes, especially estrogen deficiency, are risk factors for osteoporosis.[30,31] Skeletal muscle can be affected by aging, low nutrition, disuse, inflammation, and hormone imbalance, that lead to develop sarcopenia, which is associated with frailty, cachexia, osteoporosis, metabolic alterations, and mortality. long-term resistance exercise and a balanced diet providing sufficient amounts of proteins/ essential amino acid, calcium, vitamin D and various micronutrients, testosterone and some drug (anamorelin, myostatin, and activin-2 receptor inhibitors) can improve these condition as well as can slow the progression of disease.

### *Limitations*

The present study has several limitations that should be considered when interpreting the findings. First, it was conducted at a single center, which may limit the generalizability of the results to other settings. Second, the sample size was relatively small, reducing the statistical power to detect subtle associations. Finally, convenient sampling was employed, which may introduce selection bias and affect the representativeness of the study population.

## CONCLUSION

Osteoporosis and sarcopenia are two common age-related chronic disorder. A large portion of osteoporotic patients are suffering from sarcopenia. Both diseases are common in female patients and associate with multiple co morbidity among which diabetes is common. Correlation between BMD and ASMM index are significant. Existence of both diseases in elderly patients are affecting both life expectancy and quality of life. World population is aging and the increase in life expectancy is often unhealthy. In particular, musculoskeletal aging, which leads to sarcopenia, osteoporosis and sarcopenic obesity are commonly associated the development of a frailty syndrome. As the number of elderly people is increasing, by early identifying the risk of frailty and treating and/or preventing its damages, developing interventions we can promote a successful aging.

### *Recommendations*

Large scale, multicentre clinical trial study should be under taken.

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*Ethical approval: The study was approved by the Institutional Ethics Committee*

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