# Association of Osteoporosis with Radiologic Grading of the Hip Among Older Filipino Patients with Suspected Hip Osteoarthritis

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## ABSTRACT

***Introduction:***

*Among older populations, osteoarthritis (OA) is one of the most common chronic joint disorders and is a leading cause of disability, while osteoporosis is the most common metabolic bone disease, conferring fragility and significant risk of fracture. The relationship between OA and osteoporosis remains controversial. Although earlier studies reported an inverse association between the two diseases, more recent literature found a complex relationship mediated by various factors.*

***Objective:***

*The investigators sought to determine the association of osteoporosis with radiologic grading of the hip among older Filipino patients with suspected hip osteoarthritis.*

***Methodology:***

*A cross-sectional analytical study was conducted involving 256 patients with suspected hip OA who underwent radiography of the hips and central dual energy x-ray absorptiometry (DXA). Radiographs of the hips were evaluated by a radiologist using the Kellgren-Lawrence (KL) grading scale, while central DXA images were processed and evaluated by a nuclear medicine physician using the World Health Organization criteria for the diagnosis of osteoporosis and the 2019 International Society for Clinical Densitometry guidelines. The primary outcome measures were the prevalence of osteoporosis in patients with suspected hip OA, and the association of osteoporosis with radiologic KL grading of the hips. The secondary outcome measure was the association of osteoporosis with sex and BMI.*

***Results:***

*The study found that osteoporosis was present in 136 (53.1%) of the 256 patients who all presented with radiologic evidence of hip OA. There was a positive association between the presence of osteoporosis and the radiologic grade of hip OA (p-value: 0.006 on the right hip and 0.036 on the left). Osteoporosis was more prevalent in women compared to men (p-value: 0.031). Likewise, osteoporosis had a direct relationship with BMI (p-value: <0.001).*

***Conclusion:***

*Osteoporosis was prevalent in a significant proportion of older Filipino patients with clinical and radiologic evidence of hip OA, particularly among women, and was positively associated with increasing severity of OA. The study suggests that obesity may not necessarily protect against osteoporosis in this population, possibly relating to increased adiposity and decreased lean muscle mass.*

***Keywords:*** *osteoporosis, osteoarthritis, hip osteoarthritis, DXA scan*

# INTRODUCTION

Osteoarthritis (OA) is one of the most common chronic joint disorders of the elderly and one of the leading causes of disability, affecting approximately 7% of the global population, disproportionately affecting women [1,2]. A similar demographic profile is noted in patients diagnosed with osteoporosis, which is regarded as the most common metabolic bone disease [3]. These two diseases constitute major health problems that confer substantial long-term economic burden on afflicted individuals [4].

Although traditional perspectives propose an inverse association between the two diseases with implications that OA and osteoporosis rarely coexist clinically, contemporary investigations now suggest that there exists a multifaceted relationship between the two musculoskeletal diseases that is influenced by various convergent and divergent factors [5,6,7,8]. Despite the continued global discourse on the relationship of OA and osteoporosis, there is a dearth of published literature concerning the two conditions in Filipino populations.

The present study investigated hip OA and its relation to osteoporosis using established measures for the two diseases – hip radiography with the Kellgren-Lawrence (KL) grading classification for OA and dual energy x-ray absorptiometry (DXA) using the 2019 guidelines from the International Society for Clinical Densitometry (ISCD) and the World Health Organization (WHO) criteria for osteoporosis. This investigation sought to supplement existing literature to further clarify the association between hip OA and osteoporosis among older Filipinos.

## *Relationship between osteoarthritis and osteoporosis*

A negative association between OA and osteoporosis was first suggested half a century ago by Foss and Byers who found increased bone density in patients undergoing hip surgery due to OA [9]. This assertion was supported by cross-sectional studies which found that OA is associated with increased bone mass and density [6]. Sowers and colleagues found higher metacarpal bone mass in patients who were diagnosed with OA of the wrist and hands; however, bone mass was derived using radiographs as opposed to bone mineral densitometry. Cooper and colleagues likewise relied on radiographs of the hips in their study and reported a negative association between osteoporosis and OA [10,11]. As part of the large cross-sectional Study of Osteoporotic Fractures, Nevitt and colleagues used single photon absorptiometry and DXA to evaluate bone density at various sites, and found that elderly Caucasian women with moderate to severe radiographic hip OA had higher bone density in the hip, spine, and appendicular skeleton compared to women without hip OA [12]. Meanwhile, the Chingford study utilized central DXA to evaluate lumbar spine and femoral neck bone density, and reported small increases in the mean bone density of middle-aged women with early radiographic evidence of OA in the hands, knees, and lumbar spine; however, on follow-up, the same investigators interestingly found that low bone density at the femoral neck may be weakly associated with progression of the degree of OA [5,13]. The Rotterdam study also found that radiographic evidence of OA in the knees and hips was directly associated with higher femoral bone density, but follow-up DXA revealed a greater rate of bone loss over time among patients with OA compared to those without OA [14]. Chaganti and colleagues used both DXA and quantitative computed tomography (QCT) to assess for osteoporosis, and found higher bone density in older men with moderate to severe hip OA compared to those without hip OA [15]. More recently, Hardcastle and colleagues found that high bone mass, as defined by DXA bone density Z-scores, was directly associated to OA in the knees and osteophytosis, concluding that high bone mass confers a predisposition to a subtype of OA characterized by increased bone formation [16]. The Framingham study, on the other hand, found that while bone density at the proximal femur is higher among patients with grade 1 to 3 knee OA, no such association is seen in patients with grade 4 or more severe knee OA [17]. Data from the Baltimore Longitudinal Study of Aging showed that measures of appendicular bone mass using single photon absorptiometry had no significant association with the KL grade of hand OA, and on follow-up, observed that women with radiographic evidence of hand OA also experienced a greater rate of bone loss at the radius than women with normal hand radiographs similar to observations from the Rotterdam study [18]. This is supported by a recent study by Ding and colleagues, which found that older patients with hip and knee OA had a greater rate of total hip bone loss over time [19]. Small observational studies also found that a significant proportion of patients scheduled for total arthroplasty of the hip or knee also had osteoporosis [20, 21]. Histologic case reports likewise showed that sudden onset of knee

OA may be due to collapse of subchondral bone secondary to decreasing bone density [22]. The conflicting findings in literature may arise from the heterogeneity of OA across different joints, the variety of methods used for evaluating the diseases in question, as well as other mediating factors that may alter the relationship between osteoporosis and OA. As can be garnered from the abovementioned studies, OA may have different presentations in different joints with varying evidence for a negative association between OA and osteoporosis in the wrists, lumbar spine, hips, and knees. Sambrook and colleagues surmise that the association may even vary for bilateral hip OA and unilateral hip OA due to possible differences in their underlying causes [6]. The degree and severity of OA may also be a contributing factor, as data from the Framingham study suggests that the mere presence or absence of radiologic OA is insufficient to fully characterize its association with osteoporosis [17].

## *Measurements for osteoarthritis and osteoporosis*

In interpreting existing literature on OA and osteoporosis, the tools being used for the assessment must also be considered. KL grading classification has largely been the method of choice to evaluate OA for the past six decades [23]. Bone density measurement, in contrast, has undergone various iterations over the years, as reflected in several of the studies that were discussed earlier. Nonetheless, the 2019 guidelines from the ISCD has reaffirmed the status of central DXA as the standard for the diagnosis of osteoporosis using the WHO criteria [24,25]. Reflective of these guidelines, current practice in clinical densitometry does not prescribe a cut-off bone density value, typically measured in $g/cm^2$, in the diagnosis of osteoporosis and instead utilizes T-scores for post-menopausal women and older men as the basis for bone density classifications as defined by the WHO.

## *Body mass index, obesity, and other mediating factors*

Body mass index (BMI) and obesity are considered as important mediators between OA and osteoporosis [16]. Classic clinical experience characterized women with OA as obese with more fat, muscle mass, and strength, while women with osteoporosis were seen as generally slender with less fat, muscle girth, and strength [26].

Obesity is widely recognized as an important risk factor for the development and progression OA – initially attributed to biomechanical factors alone but in recent years has been found to involve complex mechanisms involving inflammatory and endocrine factors [27]. Obesity is also frequently linked to diabetes mellitus, which is understood to affect the risk of developing OA. Dubey and colleagues noted that the hyperglycemic state in diabetes can cause detrimental changes to the metabolism of normal articular cartilage, predisposing an individual to OA [28].

On the other hand, high BMI and obesity were traditionally associated with increased bone density and were largely believed to be protective against osteoporotic fractures [29]. Increased physical loading and strain were deemed favorable for bone geometry and modelling, while the adiposity associated with obesity was thought to preserve estrogen, which plays a key role in promoting bone formation while reducing bone resorption [30,31]. This was supported by literature showing that obese post-menopausal women have higher serum concentrations of estrogens compared to non-obese controls [32]. More recent studies, however, found that obesity may have adverse effects on bone mass and density due to its links with other metabolic changes, such as increased levels of pro-inflammatory cytokines TNF-α and IL-6 that are implicated in accelerated bone loss [31]. Moreover, obesity, diabetes mellitus, and insulin resistance are inversely associated with the concentration of adiponectin in the plasma, which is believed to have a favorable effect on bone mass and density [33,34]. Additionally, there is growing pre-clinical evidence in mice that obesity induced by a high-fat diet not only increases bone resorption but also facilitates fat infiltration of the bone marrow, which then facilitates osteoclastogenesis in the bone microenvironment [35,36]. These findings are supported by a recent cross-sectional study among elderly populations in Greece wherein osteoporosis was found to coexist with osteosarcopenic obesity, characterized by excess fat and low lean muscle mass [37].

## *Osteoarthritis and osteoporosis among Filipino patients*

Considering the emergent literature for these complex relationships between OA, osteoporosis, obesity, and diabetes mellitus, further investigation appears to be warranted across different populations. Among Filipinos,

there is a paucity of data delving into such associations. A large cross-sectional study across the Philippines was done to identify risk factors for osteoporosis among Filipino adults and interestingly linked large body builds to increased prevalence of fractures; however, the data largely relied on self-reports rather than actual measurements of bone density [38]. Conversely, Miura and colleagues found low body weight as a predisposing factor for osteoporosis among post-menopausal Filipino women [39]. It must be noted, however, that this study used the non-conventional method of calcaneal measurements for the diagnosis of osteoporosis. Nevertheless, Mendoza and colleagues utilized DXA in their study involving adult Filipino males, and reached a similar conclusion regarding low BMI as a risk factor for osteoporosis [40]. To date, however, there have been no published studies investigating the relationship of OA and osteoporosis among Filipino populations.

## OBJECTIVES:

*General objective*: To determine the association between osteoporosis and radiologic grading of the hip among older Filipino patients with suspected hip OA

*Specific objectives:*

1. To determine the prevalence of osteoporosis among older Filipino patients with suspected hip OA
2. To examine the relationship of osteoporosis with the radiologic grading of the hips among older Filipino patients with suspected hip OA

# MATERIALS AND METHODS

### *Study design, population, and setting*

This is a retrospective cross-sectional study involved adult patients, aged 50 and older, who presented with chronic hip pain, and had undergone central DXA and plain radiography of both hips in a period of six months, at St. Luke's Medical Center - Quezon City from January 1, 2018 to December 31, 2020 .

### *Exclusion criteria*

1. Patients with previous hip injury or hip arthroplasty
2. Patients who were diagnosed with or suspected to have other rheumatologic diseases, and/or malignant lesions in the hips, apart from hip OA
3. Patients who have congenital abnormalities of the hips (e.g. developmental hip dysplasia)
4. Patients with incomplete data

### *Study procedure*

Patients presenting with chronic hip pain and suspected to have hip OA had radiography of the hips using one of the three available stationary x-ray machines, namely: Siemens Aristos VX Plus S/N 1118, Siemens Multix Fusion VA20 S/N 1027, and Shimadzu Radspeed Pro DR S/N 3M5249A 64001. The radiographs were then reviewed and evaluated by a radiologist who was blinded from the bone mineral densitometry results. Grading of OA for each hip was done using the KL radiologic scale (see Table 1).

For central DXA, the patients were asked to avoid calcium-containing products (dairy products, calcium supplements, etc.) for 24 hours prior to the procedure. The patients were advised to avoid barium studies of the upper and lower gastrointestinal tract, intravenous pyelogram, or CT scan with contrast a week before the procedure. Patients were asked to change into a hospital gown and to remove their shoes and accessories. The patient's height and weight were measured and recorded prior to scanning. The DXA technologist assisted the patients in lying supine on the DXA machine. Scanning of the lumbar spine and hips was performed in Thick Mode, as determined by GE's Lunar software enCORE, lasting approximately 13 minutes. The

**TABLE 1:** Kellgren-Lawrence radiologic grading for hip osteoarthritis

| **Grade** | **0** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|---|
| **Description** | No joint space narrowing (JSN) or reactive changes | Doubtful JSN, possible osteophytic lipping | Definite osteophytes, possible JSN | Moderate osteophytes, definite JSN, some sclerosis, possible bone-end deformity | Large osteophytes, marked JSN, severe sclerosis, definite bone ends deformity |

| **TABLE 2:** WHO criteria for osteoporosis | |
|---|---|
| Normal | T-score at or above –1.0 SD |
| Low bone mineral density (osteopenia) | T-score between –1.0 and –2.5 SD |
| Osteoporosis | T-score at or below –2.5 SD |
| Severe osteoporosis | T-score at or below –2.5 SD and fragility fracture/s |

machines were calibrated each day by using a standardized phantom to ensure consistency of the data collected. To evaluate for osteoporosis, the images were reviewed and evaluated by a nuclear medicine physician who was blinded from the hip radiography results. The images were processed and evaluated using the ISCD 2019 guidelines for adults based on the WHO criteria for the diagnosis of osteoporosis (see Table 2). Additionally, BMI was derived from the retrieved height and weight data that was routinely obtained as part of central DXA.

### *Outcome measures*

*1*. Primary outcomes:

a) Prevalence of osteoporosis in patients with suspected hip OA
b) Association of osteoporosis with radiologic KL grading of the hips

2. Secondary outcome:

Association of osteoporosis with sex and BMI.

### *Sample Size*

Based on the study of Ding and colleagues, a two-sided α of 90%, power of 10% was deemed significant [19]. Computing with a standard deviation of 0.34, the estimated sample size was 125 participants. Adjusting for 2 more variables (sex, BMI) in the analysis with an additional 20% for each control variable, the final sample size was 200 subjects.

### *Statistical Analysis*

Data was encoded and tallied in SPSS version 10 for windows. Descriptive statistics were generated for all variables. For nominal data, frequencies and percentages were computed. For numerical data, mean ± SD were generated. Analysis of the different variables was done using the Chi-square test for nominal (categorical) data, while ANOVA was used to compare more than two groups with numerical data.

## RESULTS

The study included a total of 256 patients of which 22 (9.0%) were male and 234 (91.0%) were female. Table 3 shows the quantitative characteristics of the patients in the study, detailing their mean ages, BMI, height, and weight. Between males and females, only height and weight were shown to have a significant difference (p-value <0.001).

Table 4 shows the clinical and radiologic profiles of the patients involved in the study. Osteoporosis was present in 136 (53.1%) patients, of which 15 (5.9%) were severe. All 256 (100%) patients had radiologic evidence of OA in both hips. Most patients were found to have KL grade 3 joint disease, as seen in the right hip of 174 (68%) patients and in the left hip of 160 (62.5%) patients.

Table 5 shows the association of sex to BMI classification, KL grade of hip OA, and bone mineral densitometry classifications. Females had significantly lower bone mineral densitometry classifications, i.e., more osteoporotic, compared to males (p-value of 0.031). No significant difference is seen between females and males in terms of BMI classification and KL grade of hip OA.

Table 6 shows that osteoporotic patients had significantly higher BMI than non-osteoporotic patients (p-value <0.001). It also shows that when grouped into BMI classifications, there was a significantly higher number of osteoporotic patients that were classified as obese compared to non-osteoporotic patients (p-value <0.001).

Meanwhile, Table 7 shows that that patients with osteoporosis had higher KL grade, i.e., more severe OA, in both hips compared to patients without osteoporosis (p-values of 0.006 for the right hip and 0.036 for the left hip). In a sub-group analysis of male patients, osteoporosis had no significant association with BMI. Likewise, no significant association was seen between osteoporosis and KL grading of hip OA among males (see Tables 8 and 9).

| **TABLE 3:** Quantitative characteristics | | | | |
|---|---|---|---|---|
| | **Total**<br><br>**MEAN ± SD** | **Male**<br><br>**MEAN ± SD** | **Female**<br><br>**MEAN ± SD** | **p-value** |
| **Age** | 67.9 ± 10.19 | 68.7 ± 10.15 | 67.8 ± 10.21 | 0.703 |
| **BMI** | 25.9 ± 4.83 | 26.1 ± 3.32 | 25.9 ± 4.95 | 0.799 |
| **Height (m)** | 1.5 ± 0.07 | 1.7 ± 0.06 | 1.5 ± 0.06 | **<0.001** |
| **Weight (kg)** | 61.1 ± 13.08 | 73.4 ± 11.50 | 60.0 ± 12.64 | **<0.001** |

| **TABLE 4:** Clinical and radiologic profiles | |
|---|---|
| | **n (%)** |
| **Prevalence of Osteoporosis** | |
| Present (Osteoporosis + Severe osteoporosis) | 136 (53.1) |
| Absent (Normal + Osteopenia) | 120 (46.9) |
| **Bone Mineral Densitometry Classification** | |
| Normal | 25 (9.8) |
| Osteopenia | 95 (37.1) |
| Osteoporosis | 121 (47.3) |
| Severe osteoporosis | 15 (5.9) |
| **Prevalence of Osteoarthritis** | |
| Present (KL 1 + KL 2 + KL 3 + KL 4) | 256 (100) |
| Absent (KL 0) | 0 (0) |
| **Kellgren-Lawrence Grade** | |
| **Right Hip** | |
| KL 0 | 0 (0) |
| KL 1 | 5 (2.0) |
| KL 2 | 56 (21.9) |
| KL 3 | 174 (68.0) |
| KL 4 | 21 (8.2) |
| **Left Hip** | |
| KL 0 | 0 (0) |
| KL 1 | 6 (2.3) |
| KL 2 | 76 (29.7) |
| KL 3 | 160 (62.5) |
| KL 4 | 14 (5.5) |

Meanwhile, among female patients, the data in Table 10 shows significantly higher BMI among osteoporotic patients versus non-osteoporotic patients (p-value of <0.001). It also demonstrates a significantly higher number of female patients that were classified as obese in the osteoporotic group than in the non-osteoporotic group (p-value <0.001). Table 11 shows that there was significantly higher KL grading of the right hip in osteoporotic patients compared to non-osteoporotic patients (p-value of 0.004). No such significance is observed for the KL grading of the left hip.

| **TABLE 5:** Association of sex to body mass index classification, Kellgren-Lawrence grade and bone mineral | | | | | |
|---|---|---|---|---|---|
| | | | **Male: n (%)** | **Female: n (%)** | **p-value** |
| **BMI Classification** | | Underweight | 0 (0.0) | 10 (4.3) | 0.701 |
| | | Normal | 8 (36.4) | 92 (39.3) | |
| | | Overweight | 11 (50.0) | 95 (40.6) | |
| | | Obese I | 3 (13.6) | 29 (12.4) | |
| | | Obese II | 0 (0.0) | 8 (3.4) | |
| **Kellgren-Lawrence Grade** | **Right Hip** | KL 0 | 0 (0.0) | 0 (0.0) | 0.247 |
| | | KL 1 | 0 (0.0) | 5 (2.1) | |
| | | KL 2 | 3 (13.6) | 53 (22.6) | |
| | | KL 3 | 15 (68.2) | 159 (67.9) | |
| | | KL 4 | 4 (18.2) | 17 (7.3) | |
| | **Left Hip** | KL 0 | 0 (0.0) | 0 (0.0) | 0.518 |
| | | KL 1 | 1 (4.5) | 5 (2.1) | |
| | | KL 2 | 4 (18.2) | 72 (30.8) | |
| | | KL 3 | 15 (68.2) | 145 (62.0) | |
| | | KL 4 | 2 (9.1) | 12 (5.1) | |
| **Bone Mineral Densitometry Classification** | | Normal | 6 (27.3) | 19 (8.1) | **0.031** |
| | | Osteopenia | 8 (36.4) | 87 (37.2) | |
| | | Osteoporosis | 7 (31.8) | 114 (48.7) | |
| | | Severe Osteoporosis | 1 (4.5) | 14 (6.0) | |

| **TABLE 6:** Association of osteoporosis to body mass index | | | | |
|---|---|---|---|---|
| | | **OSTEOPOROSIS** | | **p-value** |
| | | **Present** | **Absent** | |
| | | **MEAN ± SD** | **MEAN ± SD** | |
| **BMI** | | 27.6 ± 4.98 | 24.4 ± 4.16 | **<0.001** |
| | | **N (%)** | **N (%)** | |
| **BMI Classification** | Underweight | 0 (0.0) | 10 (7.4) | **<0.001** |
| | Normal | 36 (30.0) | 64 (47.1) | |
| | Overweight | 55 (45.8) | 51 (37.5) | |
| | Obese I | 21 (17.5) | 11 (8.1) | |
| | Obese II | 8 (6.7) | 0 (0.0) | |

# DISCUSSION

Osteoporosis and OA are among the most prevalent musculoskeletal diseases across the globe, accounting for substantial fragility, disability, and healthcare utilization [1,2,3,4]. In the present study, females were found to be more osteoporotic compared to males, consistent with global trends of the disease [3].

Osteoporosis and OA were previously assumed to rarely

| **TABLE 7:** Association of osteoporosis to Kellgren-Lawrence grade | | | | | |
|---|---|---|---|---|---|
| | | | **OSTEOPOROSIS** | | **p-value** |
| | | | **Present** | **Absent** | |
| | | | **n (%)** | **n (%)** | |
| **Kellgren-Lawrence Grade** | **Right Hip** | KL 0 | 0 (0.0) | 0 (0.0) | **0.006** |
| | | KL 1 | 1 (0.8) | 4 (2.9) | |
| | | KL 2 | 16 (13.3) | 40 (29.4) | |
| | | KL 3 | 90 (75.0) | 84 (61.8) | |
| | | KL 4 | 13 (10.8) | 8 (5.9) | |
| | **Left Hip** | KL 0 | 0 (0.0) | 0 (0.0) | **0.036** |
| | | KL 1 | 1 (0.8) | 5 (3.7) | |
| | | KL 2 | 29 (24.2) | 47 (34.6) | |
| | | KL 3 | 80 (66.7) | 80 (58.8) | |
| | | KL 4 | 10 (8.3) | 4 (2.9) | |

| **Table 8:** Association of osteoporosis to body mass index among males | | | | |
|---|---|---|---|---|
| | | **OSTEOPOROSIS** | | **p-value** |
| | | **Present** | **Absent** | |
| | | **MEAN ± SD** | **MEAN ± SD** | |
| **BMI** | | 26.5 ± 3.14 | 25.5 ± 3.74 | 0.536 |
| | | **n (%)** | **n (%)** | |
| **BMI Classification** | Underweight | 0 (0.0) | 0 (0.0) | 0.592 |
| | Normal | 4 (50.0) | 4 (50.0) | |
| | Overweight | 8 (72.7) | 3 (27.3) | |
| | Obese I | 2 (66.7) | 1 (33.3) | |
| | Obese II | 0 (0.0) | 0 (0.0) | |

| **TABLE 9:** Association of osteoporosis to Kellgren-Lawrence grade among males | | | | | |
|---|---|---|---|---|---|
| | | | **OSTEOPOROSIS** | | **p-value** |
| | | | **Present: n (%)** | **Absent: n (%)** | |
| **Kellgren-Lawrence Grade** | **Right Hip** | KL 0 | 0 (0.0) | 0 (0.0) | 0.822 |
| | | KL 1 | 0 (0.0) | 0 (0.0) | |
| | | KL 2 | 2 (66.7) | 1 (33.3) | |
| | | KL 3 | 10 (66.7) | 5 (33.3) | |
| | | KL 4 | 2 (50.0) | 2 (50.0) | |
| | **Left Hip** | KL 0 | 0 (0.0) | 0 (0.0) | 0.337 |
| | | KL 1 | 0 (0.0) | 1 (100.0) | |
| | | KL 2 | 2 (50.0) | 2 (50.0) | |
| | | KL 3 | 10 (66.7) | 5 (33.3) | |
| | | KL 4 | 2 (100.0) | 0 (0.0) | |

coexist clinically [5,6]. The present study showed that among older Filipino patients presenting with chronic hip pain – for which OA was the suspected cause – approximately half were found to have osteoporosis. Meanwhile, the hip radiographs show that all the patients in the study have varying degrees of OA in the hips. These findings appear to contradict earlier literature regarding osteoporosis and OA and support contemporary perspectives concerning the possibility of concomitant disease [7,8]. Ding and colleagues did not evaluate for the presence or absence of osteoporosis in their study but found an increased rate of total hip bone loss over time in patients with knee and hip OA [19]. The results of the current study are compatible with their observations and may imply that the loss of bone density experienced by such patients is clinically significant enough to warrant the diagnosis of osteoporosis based on the WHO criteria. These results are similar to the findings of small observational studies involving patients scheduled for total arthroplasty of the hip and knee secondary to OA; however, the current study osteoporosis at 53.1% as opposed to the previously reported 20–23%, probably owing to the differences in the populations involved [20,21]. Nevertheless, the diagnosis of osteoporosis is quite significant because it necessitates not only increased vigilance against potential fragility fractures but also the need for appropriate therapeutic interventions [24]. Additionally, in the context of providing surgical management for hip OA, the concurrent presence of osteoporosis may affect a higher proportion of individuals diagnosed with bone quality and may significantly compromise the stability of

**TABLE 10:** Association of osteoporosis to body mass index among females

| | | OSTEOPOROSIS | | p-value |
|---|---|---|---|---|
| | | Present | Absent | |
| | | MEAN ± SD | MEAN ± SD | |
| **BMI** | | 27.8 ± 5.17 | 24.4 ± 4.19 | **<0.001** |
| | | **n (%)** | **n (%)** | |
| **BMI Classification** | Underweight | 0 (0.0) | 10 (100.0) | **<0.001** |
| | Normal | 32 (34.8) | 60 (65.2) | |
| | Overweight | 47 (49.5) | 48 (50.5) | |
| | Obese I | 19 (65.5) | 10 (34.5) | |
| | Obese II | 8 (100.0) | 0 (0.0) | |

**TABLE 11:** Association of osteoporosis to Kellgren-Lawrence grade among females

| | | | OSTEOPOROSIS | | p-value |
|---|---|---|---|---|---|
| | | | Present: n (%) | Absent: n (%) | |
| **Kellgren-Lawrence Grade** | **Right Hip** | KL 0 | 0 (0.0) | 0 (0.0) | **0.004** |
| | | KL 1 | 1 (20.0) | 4 (80.0) | |
| | | KL 2 | 14 (26.4) | 39 (73.6) | |
| | | KL 3 | 80 (50.3) | 79 (49.7) | |
| | | KL 4 | 11 (64.7) | 6 (35.3) | |
| | **Left Hip** | KL 0 | 0 (0.0) | 0 (0.0) | 0.122 |
| | | KL 1 | 1 (20.0) | 4 (80.0) | |
| | | KL 2 | 27 (37.5) | 45 (62.5) | |
| | | KL 3 | 70 (48.3) | 75 (51.7) | |
| | | KL 4 | 8 (66.7) | 4 (33.3) | |

the implant [21]. In light of these findings, it is thereby pertinent to screen for osteoporosis in older patients with suspected or confirmed hip OA, as the presence of osteoporosis may significantly alter their clinical outcomes.

Interestingly, the current investigation also showed that osteoporotic patients presented with higher KL grading in the hips compared to their non-osteoporotic counterparts, particularly among female patients. Among males alone, no such correlation was identified. There is the belief that lower bone density in the subchondral region may be seen in earlier OA prior to the onset of sclerotic changes that are observed in severe OA [1]. The results of the current study may seem to run contrary to this assertion, but given the nature of osteoporosis as a systemic condition as opposed to a largely localized pathology like OA, it is likely that while there is sclerosis in the subchondral region of the joint in severe OA as reflected in the KL grading scale, significant bone loss can still be observed in the bone regions being evaluated by central DXA (i.e., lumbar spine, femoral neck, total proximal femur); hence, the observations in the present study. These results are clinically pertinent given how patients with KL grades 3 and 4 – that is, more severe hip OA – are more likely to require surgical interventions such as total hip arthroplasty and, as mentioned earlier, may have worse clinical outcomes in the setting of concomitant osteoporosis.

Data from the current study suggests a direct association of high BMI to the presence of osteoporosis, which is again more significant among female patients. These results challenge the notion of obesity being protective against osteoporosis, providing further evidence for the growing literature concerning the unfavorable effects of obesity on bone density [29,31]. The data from the study appears to reflect the conclusions of Tanchoco and colleagues associating large body builds to osteoporosis among Filipino adults [38]. It must be emphasized, however, that BMI calculations only consider weight and height as factors, without characterizing distributions of body fat and muscle mass. There is growing pre-clinical and clinical evidence to suggest that excess adiposity and low lean muscle mass can contribute to decreased bone density and predispose an individual to osteoporosis [35,36,37]. The findings of the present study may be reflective of this process given how the patients involved are older with chronic hip pain secondary to OA, which may predispose them to sedentary lifestyles and osteosarcopenic obesity, characterized by high fat with concurrent loss of skeletal muscle [37]. This is further supported by sub-group analysis of the present data showing that significance is only observed among women who generally present with higher adiposity compared to men.

Certain limitations of the current study must be acknowledged. Whereas older studies have relied on measurements of bone density – quantified in $g/cm^2$ – to investigate the relationship of osteoporosis to OA, the investigators opted to dichotomize patients into either osteoporotic or non-osteoporotic categories in order to focus on clinically pertinent disease. Nevertheless, monitoring trends of bone loss over time is still best accomplished using changes in bone density values over the course of several years [24]. Such trends may provide further insight concerning the relationship of osteoporosis and OA; however, these lie beyond the scope of this cross-sectional study.

Another limitation is the relatively small sample population of male patients, which may have affected some of the results on sub-group analysis. Although both osteoporosis and OA disproportionately affect women, investigations involving older men may still provide insight regarding the two diseases.

Finally, the retrospective nature of the study is its most significant limitation, which restricted the extent of clinical data that could be examined. Apart from advanced age, there is limited information as to why central DXA was performed in this population. The hip radiographs would typically suffice for the primary complaint of chronic hip pain among the patients in the study, but the presence of other symptoms, if there are any, were not investigated. These unidentified factors may have contributed to the unexpectedly large number

of patients who had both osteoporosis and OA in this population. Although the study delved into the potential role of BMI in mediating the relationship between osteoporosis and OA, other conditions and metabolic states that could have affected both bone density and the hip joints were not investigated. Moreover, it must be acknowledged that the interval of several months between the hip radiographs and central DXA studies of some patients may have allowed extraneous variables to affect the findings. A prospective study, in contrast, may allow for a shorter time interval between the diagnostic studies, leading to stronger conclusions regarding the relationship of the two bone-related diseases.

# CONCLUSIONS

In summary, osteoporosis may be found in a sizable proportion of older Filipino patients with hip OA, particularly among women. Furthermore, the presence of osteoporosis was positively associated with higher radiologic KL grading of the hips. The coexistence of both diseases may be mediated by obesity, a risk factor for OA that was previously thought to be protective against osteoporosis. The study found a positive association between osteoporosis and BMI, which suggests that obesity may not necessarily protect against osteoporosis in this particular population, possibly due to increased adiposity and decreased lean muscle mass.

# RECOMMENDATIONS

Screening for osteoporosis using bone mineral densitometry may be warranted in older Filipinos with suspected or known hip OA given the substantial likelihood of an individual having both conditions. Further studies regarding the relationship of osteoporosis and hip OA are recommended, involving a larger sample population that would ideally include more male participants. Moreover, longitudinal studies involving serial central DXA scanning and hip radiographs can provide insights concerning the changes in radiologic KL grading and bone density over the course of several years. In view of the current study's findings regarding the relationship of obesity and osteoporosis, evaluating fat and lean muscle mass distribution among patients with concomitant OA and osteoporosis is recommended. Conveniently, the same DXA scanners used for bone mineral densitometry are capable of total body composition studies, which would provide a wealth of information for future investigators.

## *CONFLICTS OF INTEREST*

The authors have no conflicts of interest to declare.

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