DOI: 10.38103/jcmhch.17.2.12

Original research

# EVALUATING THE RELATIONSHIP BETWEEN BONE DENSITY, OSTEOPOROSIS, AND SOME RISK FACTORS

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**ABSTRACT**

***Objectives:*** *Evaluate the relationship between bone mineral density, osteoporosis, and certain risk factors such as age, body mass index, lifestyle, glucocorticoid use in the study subjects.*

***Methods:*** *A cross-sectional descriptive study was conducted on 142 elderly men who attended health check-ups at Hue Central Hospital from April 2023 to August 2024. Bone density was measured using Dual Energy X-ray Absorptiometry (DEXA) at three sites: lumbar spine, femoral neck, and total femur.*

***Results:*** *The prevalence of osteoporosis and osteopenia was 32.4% and 38.0%, respectively. Multivariate logistic regression analysis identified several factors significantly associated with osteoporosis. At the lumbar spine, increasing age (OR = 1.06), smoking (OR = 5.81), physical inactivity (OR = 3.42), and glucocorticoid use (OR = 29.10) were associated with a higher risk of osteoporosis. At the femoral neck, lower BMI (OR = 0.84 per 1 kg/m² increase) and smoking (OR = 3.48) were significantly associated with increased osteoporosis risk.*

***Conclusions:*** *Age, smoking, physical activity, BMI, and glucocorticoid use significantly affect bone density and osteoporosis in elderly men. Older age, smoking, lack of physical activity, and glucocorticoid use are linked to low bone density, especially at the lumbar spine. Higher BMI helps protect against osteoporosis, particularly at the femoral neck. Early screening, lifestyle changes, and proper medication management are essential to improving bone health and reducing fracture risk in elderly men.*

***Keywords:*** *Bone density, osteoporosis, elderly men, risk factors.*

## I. INTRODUCTION

Osteoporosis is a musculoskeletal disease characterized by decreased bone density and an increased risk of fractures. Osteoporosis is a serious health problem, affecting more than 200 million people worldwide [1]. Numerous studies conducted over the past 30 years show that approximately 20% of women aged 60 and older are affected by osteoporosis, while in men of the same age, the rate is around 10%. Osteoporosis progresses silently without symptoms until fractures occur. Bone fractures are the most serious consequence of osteoporosis and one of the leading causes of reduced lifespan. For patients who are fortunate enough to survive a fracture, they often face multiple complications, and their quality of life is significantly reduced. Some patients lose the ability to work, or their mobility is impaired, affecting labor productivity and the economy of a nation. It can be said that fractures due to osteoporosis increase mortality rates, decrease lifespan, reduce quality of life, and become a burden on healthcare systems and national finances [2].

Men have a lower rate of osteoporosis than women due to larger bone mass and a slower rate of bone loss. It is estimated that for every five

**Received:** 10/01/2025. **Revised:** 05/03/2025. **Accepted:** 19/3/2025.

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men over the age of 50, one will suffer a fracture due to osteoporosis in their lifetime. In the Dubbo Osteoporosis Epidemiology Study, the ratio of hip fractures between men and women was 1:4.5 in the 60 - 69 age group, 1:1.5 in the 70 - 79 age group, and 1:1.9 in those aged 80 and older. Although the rate of osteoporosis and fractures in men is lower than in women, when fractures do occur, the mortality rate for men is significantly higher than for women. This difference is attributed to comorbidities and infection. The mortality rate after a hip fracture is 10.2% in men compared to 4.7% in women, and the 1 - year mortality rate is 37.5% in men compared to 28.2% in women. This risk can persist for over 10 years [3]. Elderly men are at high risk for osteoporosis and also have many dangerous underlying health conditions. The combination of these diseases increases the risk of disability, decreases quality of life, and reduces lifespan, making understanding osteoporosis in elderly men a critical issue. This is the reason we conducted this study titled: "Evaluating the relationship between bone density, osteoporosis, and certain risk factors" with the objective to evaluate the relationship between bone density, osteoporosis, and risk factors such as age, body mass index, lifestyle, and glucocorticoid use in elderly men undergoing health checks at Hue Central Hospital.

## II. MATERIALS AND METHODS

### 2.1. Study Subjects

The study was conducted on 142 elderly male patients who came for health check-ups at Hue Central Hospital from April 2023 to August 2024.

Inclusion Criteria: Subjects must meet the following conditions: Age ≥ 60 years. Male.

Exclusion Criteria: Subjects who do not agree to participate in the study or do not have the cognitive ability to participate. Subjects who have been or are currently receiving treatment for osteoporosis. Subjects who cannot measure bone density at the femoral neck due to hip joint replacement or bilateral femoral neck fractures, or one side has had a hip joint replacement and the other side has a fracture. Subjects who cannot measure bone density at the L1-L4 vertebrae.

### 2.2. Research Methodology

This is a cross-sectional descriptive study using a convenient sampling method.

- All patients underwent collection of the following data: age, smoking history, alcohol consumption, physical activity, medical history, glucocorticoid use history, weight, height, blood pressure, and BMI.

- Bone density was measured using the DEXA method at the femoral neck, total femur, and lumbar spine.

**Table 1:** Diagnostic Criteria for Osteoporosis as Recommended by the WHO (1994) [4]

| Diagnosis | Criteria |
|---|---|
| Normal | T-score ≥ -1 |
| Osteopenia | -2.5 < T-score < -1 |
| Osteoporosis | T-score ≤ -2.5 |
| Severe Osteoporosis | Osteoporosis + recent history of fractures |

## III. RESULTS

### 3.1. Osteoporosis Prevalence in the Study Subjects

According to the WHO diagnostic criteria for osteoporosis, when the T-score ≤ -2.5 at one of the three measurement sites (either the lumbar spine, femoral neck, or total femur), among the 142 study subjects, 46 patients were diagnosed with osteoporosis, accounting for 32.4% (table2).

**Table 2:** Osteoporosis Prevalence According to WHO Criteria

| Bone Condition | Number (n) | Percentage (%) |
|---|---|---|
| Normal | 42 | 29.6 |
| Osteopenia | 54 | 38.0 |
| Osteoporosis | 46 | 32.4 |
| Total | 142 | 100 |

### 3.2. Relationship Between Bone Density and Some Risk Factors

A significant negative correlation was observed between age and bone mineral density (BMD) at the femoral neck ($r = -0.175$; $p < 0.05$) (Table 3). BMI showed a significant positive correlation with BMD at the lumbar spine ($r = 0.227$; $p < 0.05$) (Table 4). The mean BMD in the smoking group was significantly lower than in the non-smoking group at both the femoral neck and lumbar spine ($p < 0.05$) (Table 5).

**Table 3:** Correlation Between Bone Density and Age

| **Characteristics (n=142)** | | **BMI** |
|---|---|---|
| Bone Density at Femoral Neck (g/cm$^2$) | r | 0.164 |
| | p | > 0.05 |
| Bone Density at Lumbar Spine (g/cm$^2$) | r | 0.227 |
| | p | < 0.05 |

**Table 5:** Relationship Between Bone Density and Smoking

| **Characteristics (n=142)** | **Smoking** | | **p** |
|---|---|---|---|
| | **Yes (n=61)** | **No (n=81)** | |
| Bone Density at Femoral Neck (g/cm$^2$) | 0.819 ± 0.139 | 0.900 ± 0.150 | < 0.05 |
| Bone Density at Lumbar Spine (g/cm$^2$) | 0.904 ± 0.181 | 1.064 ± 0.180 | < 0.05 |

No significant difference in mean BMD was found between alcohol users and non-users at the femoral neck and lumbar spine. In contrast, glucocorticoid users had significantly lower BMD, while physically active individuals had significantly higher BMD at both sites compared to their counterparts ($p < 0.05$; Tables 6 and 7).

**Table 6:** Relationship Between Bone Density and Glucocorticoid Use

| **Characteristics (n=142)** | **Glucocorticoid Use** | | **p** |
|---|---|---|---|
| | **Yes (n=25)** | **No (n=117)** | |
| Bone Density at Femoral Neck (g/cm$^2$) | 0.793 ± 0.148 | 0.881 ± 0.147 | < 0.05 |
| Bone Density at Lumbar Spine (g/cm$^2$) | 0.864 ± 0.185 | 1.023 ± 0.189 | < 0.05 |

**Table 7:** Relationship Between Bone Density and Physical Activity

| **Characteristics (n=142)** | **Physical activity** | | **p** |
|---|---|---|---|
| | **Yes (n=54)** | **No (n=88)** | |
| Bone Density at Femoral Neck (g/cm$^2$) | 0.910 ± 0.146 | 0.838 ± 0.147 | < 0.05 |
| Bone Density at Lumbar Spine (g/cm$^2$) | 1.071 ± 0.159 | 0.950 ± 0.204 | < 0.05 |

Multivariate logistic regression analysis identified two significant factors associated with osteopenia and osteoporosis at the femoral neck: higher BMI was protective (OR = 0.84; 95% CI: 0.73 - 0.97), while smoking increased the risk (OR = 3.48; 95% CI: 1.39 - 7.68), both with $p < 0.05$ (Table 8).

**Table 8:** Multivariate Logistic Regression Model Identifying Some Factors Associated with Osteopenia and Osteoporosis at the Femoral Neck

| Factor | | OR | 95%CI | p |
|---|---|---|---|---|
| Age | | 1.01 | 0.96 - 1.06 | > 0.05 |
| BMI | | 0.84 | 0.73 - 0.97 | < 0.05 |
| Smoking | Yes | 3.48 | 1.39 - 7.68 | < 0.05 |
| | No | 1 | - | - |
| Alcohol Consumption | Yes | 0.87 | 0.42 - 3.52 | > 0.05 |
| | No | 1 | - | - |
| Physical activity | Yes | 1 | - | - |
| | No | 1.52 | 0.63 - 3.67 | > 0.05 |
| Glucocorticoid Use | Yes | 1.82 | 0.58 - 5.73 | > 0.05 |
| | No | 1 | - | - |

**Table 9:** Multivariate Logistic Regression Model Identifying Some Factors Associated with Osteopenia and Osteoporosis at the Lumbar Spine

| Factor | | OR | 95%CI | p |
|---|---|---|---|---|
| Age | | 1.06 | 1.01 - 1.22 | < 0.05 |
| BMI | | 0.90 | 0.77 - 1.04 | > 0.05 |
| Smoking | Yes | 5.81 | 1.73 - 19.45 | < 0.05 |
| | No | 1 | - | - |
| Alcohol Consumption | Yes | 0.79 | 0.19 - 3.25 | > 0.05 |
| | No | 1 | - | - |
| Physical activity | Yes | 1 | - | - |
| | No | 3.42 | 1.28 - 9.14 | < 0.05 |
| Glucocorticoid Use | Yes | 29.10 | 3.18 - 266.35 | < 0.05 |
| | No | 1 | - | - |

After multivariate logistic regression analysis, four significant factors were associated with increased risk of lumbar spine osteopenia and osteoporosis: age (OR = 1.06; 95% CI: 1.01 - 1.22), smoking (OR = 5.81; 95% CI: 1.73 - 19.45), physical inactivity (OR = 3.42; 95% CI: 1.28 - 9.14), and glucocorticoid use (OR = 29.10; 95% CI: 3.18 - 266.35), all with $p < 0.05$ (Table 9).

## IV. DISCUSSION

From the analysis of 142 men aged ≥ 60 years undergoing DEXA at Hue Central Hospital (April 2023 - August 2024), 32.4% (46/142) were diagnosed with osteoporosis according to WHO criteria (T-score ≤ -2.5 at any site). Age was a significant factor; each additional year increased the risk of osteopenia and osteoporosis at the lumbar spine by 1.06 times (OR = 1.06; 95% CI: 1.01 - 1.22; $p < 0.05$). This aligns with the Dubbo study, which reported an exponential increase in hip fracture incidence from age 75, with higher post-

fracture mortality in men (twice that of women). The MrOS study (2009) found that BMD loss at the femoral neck in 85 - year - old men (0.021 g/cm²) was 2.5 times greater than in 65 - year - olds (0.008 g/cm²), increasing fracture risk by 25% over 4.6 years. Men with lower baseline BMD experienced the greatest loss during follow-up. Similarly, Yao Fan et al. (2024) observed an age-related increase in osteopenia and osteoporosis prevalence in men, from 0% at age 18 to 5.43% at age 75 [5].

BMI was positively correlated with lumbar spine BMD ($r = 0.227$; $p < 0.05$). Multivariate analysis showed that each 1 kg/m² increase in BMI reduced the risk of femoral neck osteopenia/osteoporosis by 0.84 times (OR = 0.84; 95% CI: 0.73 - 0.97; $p < 0.05$). These findings are consistent with previous studies. According to Nguyen Van Tuan và Nguyen Dinh Nguyen, individuals with taller stature, lower body weight, and lower fat percentage had higher fracture risk due to longer femoral necks and reduced fat padding [6].

A study by Meyer et al. (2008) found BMI positively associated with BMD 30 years later, where weight loss increased osteoporosis risk, while weight gain was protective. Wu (2022) also showed underweight individuals had a 6.5 - fold higher osteoporosis risk, and overweight/obesity had protective effects [7]. In summary, low BMI is a risk factor, while higher BMI may offer protection via mechanical loading and estrogen from fat tissue, though it should not be seen as a standalone protective factor due to associated health risks in older adults. Smoking was significantly associated with lower BMD at both the femoral neck and lumbar spine ($p < 0.05$). Smokers had a 5.81 - fold increased risk of lumbar spine osteopenia/osteoporosis (OR = 5.81; 95% CI: 1.73 - 19.45; $p < 0.05$) and a 3.48 - fold increased risk at the femoral neck (OR = 3.48; 95% CI: 1.39 - 7.68; $p < 0.05$). Similar results were reported by In Young Cho et al. (2020), where long-term quitters and non-smokers had lower fracture risks (aHR = 0.83 and 0.84, respectively) [8]. Min Fang et al. (2024) also linked smoking to higher risks of osteoporosis (OR = 1.21) and osteoporotic fractures: hip (OR = 1.47), wrist (OR = 1.33), and spine (OR = 1.43) [8].

No significant association between alcohol consumption and BMD or osteoporosis was found in this study. However, previous literature indicates a complex relationship. Kaptoge et al. (2003) found that moderate alcohol consumption (1 - 2 drinks/day) may protect bone health via increased estrogen and reduced stress, especially in younger/middle-aged men. In contrast, excessive alcohol intake impairs calcium absorption, vitamin D metabolism, and bone formation. Clarke et al. (2004) observed reduced BMD in men > 60 with heavy alcohol use. The MrOS Study (2009) confirmed higher BMD in moderate drinkers and lower BMD in heavy drinkers. Karina M. Berg et al. (2008) also found a dose-response relationship: reduced hip fracture risk at 0.5 - 1.0 drinks/day (RR = 0.80), but increased risk at > 2 drinks/day (RR = 1.39) [9].

In conclusion, while moderate alcohol consumption may not negatively affect bone health - and may even be protective - excessive intake is detrimental, especially in older men. Maintaining moderate and balanced consumption is important for bone protection with age. Glucocorticoid-induced osteoporosis (GIOP) is the most common secondary form of osteoporosis. Around 3% of people over 50 and 5.2% of those over 80 have used glucocorticoids (GC). Among long - term users (≥ 6 months), 30% develop osteoporosis. Bone loss mainly occurs in trabecular bone, particularly in the spine and ribs. Fracture risk increases with dosage but may improve after stopping GC use [10].

Our findings showed significantly lower BMD in GC users and a 29.10-fold increased risk of lumbar spine osteoporosis (OR = 29.10; 95% CI: 3.18 - 266.35; $p < 0.05$). Ji Weon Koh et al. (2020) also found increased fracture risks with GC use: vertebral fractures rose from 1.39 to 2.43 times, and hip fractures from 1.72 to 3.28 times across increasing GC dose levels [11]. Similarly, A study by Ho Thi Le et al. (2023) reported a 4.92 - fold higher lumbar spine osteoporosis risk in GC-using rheumatoid arthritis patients.

Bone mass decreases by ~0.5% annually after age 40, regardless of sex or ethnicity. Although most osteoporosis studies focus on women, the growing elderly male population highlights the need to investigate physical activity's role in male

bone health [12]. Our results showed a significantly higher rate of lumbar spine osteopenia/osteoporosis in inactive men, with a 3.42 - fold increased risk (OR = 3.42; 95% CI: 1.28 - 9.14; $p < 0.05$). A study by Daly et al. (2021) found that exercise frequency and impact volume predicted changes in hip and spine BMD, with impact count more important than lifted weight [13]. A study by Min - Chen Wu et al. (2024) further confirmed that exercise benefits bone health across all stages - from normal BMD to osteoporosis [14].

## V. CONCLUSIONS

This study highlights the significant impact of age, smoking, physical activity, BMI, and glucocorticoid use on bone mineral density (BMD) and osteoporosis in elderly men. Increased age, smoking, lack of physical activity, and glucocorticoid use were associated with a higher risk of lower BMD, particularly at the lumbar spine. On the other hand, higher BMI was found to offer some protective effects against osteoporosis, especially at the femoral neck. These findings underscore the importance of addressing modifiable risk factors, such as smoking cessation, regular physical activity, and careful management of glucocorticoid use, to prevent bone density loss. Early screening, lifestyle modifications, and appropriate medication management are essential strategies for enhancing bone health and reducing the risk of fractures in elderly men.

### Disclosure

The authors report no other conflicts of interest in this work.

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