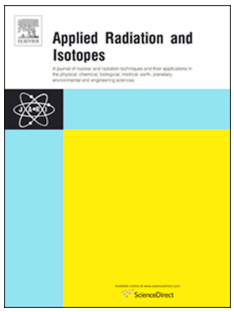

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PII: S0969-8043(22)00509-7

DOI: https://doi.org/10.1016/j.apradiso.2022.110624

Reference: ARI 110624

To appear in: *Applied Radiation and Isotopes*

Received Date: 28 February 2022

Revised Date: 18 December 2022

Accepted Date: 20 December 2022

Please cite this article as: Al-Bogami, M.M., Akanle, O.A., Aldawood, S., Alkhorayef, M., Sulieman, A., Jawad, A.S., Mageed, R.A., Comparison of bone mineral density changes between male and female osteoporosis patients using dual energy X-ray absorptiometry scan, *Applied Radiation and Isotopes* (2023), doi: https://doi.org/10.1016/j.apradiso.2022.110624.

Comparison of bone mineral density changes between male and female osteoporosis patients using dual energy X-ray absorptiometry scan

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Abstract

The goal of the current research was to define the impact of individual characteristics on the response of osteoporosis patients to bisphosphonate medication, as well as the influence of gender on changes in the bone mineral density (BMD).The DXA scan was used to assess a group of 647 osteoporosis patients (533 females and 114 males) who visited the St Bartholomew's Hospitals and Royal London osteoporosis clinics. All male subjects received statistically substantial increases in BMD relative to baseline values after two years of therapy. When compared to prior therapy, men's BMD of the lumbar spine (LS) and hip joint (HJ) rose by 0.057g/cm^2 (6.9%, p0.001) and 0.021g/cm^2 (2.48 percent, p0.001), respectively.. Female patients had BMD changes of 0.028g/cm^2 (3.58 percent, p0.001 vs. prior therapy) and -0.006g/cm^2 (-0.78 percent, p0.001 vs. before treatment) in the lumbar spine and hip, respectively. Male patients exhibited a greater increase in BMD than female patients due to ovarian failure and significant oestrogen loss, which speeds up bone resorption by 90% following menopause, according the research findings

Keywords*: DXA scan; Osteoporosis; BMD; Radiation dosimetry*

1. Introduction

Bone remodels itself on a regular basis to maintain its ideal mass and mend minor and major injuries such as fractures. Bone metabolism and mass are affected by a variety of variables, including a lack of calcium (Ca-20) and vitamin D, smoking, living an unhealthy lifestyle, and drinking too much alcohol (Harinarayan et al., 2021; Moyad et al., 2003). Ethnicity and genetic variables have an impact on bone mass. African-American women, for example, are more likely than Caucasian women to reach a greater topmost bone mass. Additionally, there is proof that Japanese women experience the same frequency of vertebral fractures as Caucasian women, and that Afro-Caribbean women experience fewer vertebral fractures than Caucasian women (Bover et al., 2018; Eskridge et al., 2010; Wagner et al., 2000). However, this observation's scientific basis is unknown.

Aging, menopause, food, medicines, stress, traumas, and chronic inflammatory disorders like rheumatoid arthritis (RA) all increase the risk of bone loss (Harinarayan et al., 2021; Moyad et al., 2003). Oestrogen levels are vital in the remodelling process in menopausal women. By activating osteoblasts to produce new bone, oestrogen is crucial for maintaining bone density. Before menopause, the ovaries produce the hormone. The ovaries halt making oestrogen hormone during menopause, but the adrenal gland releases modest quantities of androgens, which are transformed to oestrogen by the aromatase enzyme. Osteoblasts (bone forming cells) become less active consequently of lower oestrogen amounts in postmenopausal female, resulting in decreased bone mass (Mackey et al., 2005). Furthermore, long-term use of drugs like corticosteroids induces bone loss through a variety of methods.

Calcium-regulating hormones such parathyroid hormone (PTH), calcitonin, and 1,25-dihydroxy vitamin D control bone metabolism. PTH has a significant effect on both bone production and bone resorption. Furthermore, PTH levels tend to grow as people become older,

which could lead to escalation in bone resorption and impairment. On the other hand, calcitonin is a potent inhibitor of osteoclastogenesis and bone turnover (made by the thyroid). Vitamin D 1,25-dihydroxy is required for the discrepancy of osteoblasts and osteoclasts, as well as for bone resorption and creation. Furthermore, growth hormones that operate systemically, as well as the activation of local insulin-like growth factor (IGF) synthesis, can drive bone development and resorption (Raisz, 1999).

As a result of increased bone growth and lengthening, bone creation is most rapid in children. Ninety percent of bone development occurs before the age of twenty. Between the ages of 20 and 30, bones grow their final 10%, but they thicken rather than lengthen. Bones achieve their greatest and strongest sizes between the ages of 30 and 35.

Pathological changes in bone structure and density are frequently monitored using a variety of clinical and laboratory methods. To prevent bone loss and effectively treat disorders like osteoporosis, early detection of pathological alterations is criticalA measurement of the amount of bone minerals (calcium hydroxyapatite) per volume of bone tissue is known as bone mineral density (BMD). It may be measured in grammes per square centimeter of bone tissue using dual energy X-ray absorptiometry (DXA) and proximal dual energy X-ray absorptiometry, respectively. In lab testing for changes in bone conditions, serum levels of osteocalcin, deoxypyridinoline, and carboxyterminal cross-linking telopeptide of bone collagen (CTX), as well as bone-specific alkaline phosphatase, are assessed (Mackey, 2005; Zaidi, 2007).

Bone mineral content (BMC) and BMD are the typical elements of quantity. Total bone mineral mass (calcium hydroxyapatite) per unit area (g/cm2) of bone is referred to as BMD, whereas total bone mineral mass at a specific place of the bone is referred to as BMC. A value for the prediction of fracture incidence is provided by BMD assessment at any bone site. Nevertheless, measurements taken at the

skeletal region of concern are typically the utmost accurate predictors of fractures at that location. Additionally, the best method for anticipating osteoporotic fractures is to evaluate the axial skeletal locations of the spine and femur (McClune et al., 2010; El Maghraoui & Roux, 2010).

DXA is now the most widely used method for assessing BMD in the diagnosis and follow-up of patients with osteoporosis because of its precision, accuracy, and low radiation exposure. DXA is used in the World Health Organization's (WHO) criteria for diagnosing osteoporosis diseases. As a result, DXA has become the gold standard for central and peripheral skeletal BMD measures in clinical practise (McClune et al., 2010; , El Maghraoui & Roux, 2008). DXA uses two different energy levels of X-ray beams that are absorbed in a different way by soft tissue and bone minerals. The technique is based on the quantity of X-ray transmission through various tissues in the body with high and low photon energy. The approach is based on the observation that X-ray absorption in any material, including soft tissue (fat and muscle) and bone mineral, is affected by both the X-ray energy and the elemental makeup of the attenuating substance. DXA can precisely measure bone within soft tissue by separating transmission attenuation caused by bone from that caused by soft tissue. As a result, DXA values provide a g/cm2 composite assessment of both cortical and trabecular bones (Yu et al., 2021; El Maghraoui & Roux, 2008; Midgley et al., 2011). Anteroposterior (AP) spine testing, which includes assesses the posterior portions of the vertebrae, such as the pedicles, articulation, and spinous processes, might result in measurement errors. DXA scan of the lateral spine analyzes the vertebral body in great detail while avoiding these issues (Berry et al., 2018).

Despite the importance of the task and its impact on a wide range of groups, there are little studies available in comparison to the frequency of the procedures (Booz et al., 2020; Cossio-Bolanos et al., 2022). The WHO recommended using sex-related standard deviation criteria for osteoporosis diagnosis because of considerable differences in BMD between males and females, especially given the importance of postmenopausal osteoporosis. The goal of the current research was to define the influence of individual characteristics on the response of osteoporosis patients to bisphosphonate medication, as well as the influence of gender on changes in the BMD.

2. Materials and Methods

2.1 Dual energy X-ray absorptiometry (DXA)

At the Royal London Hospital in Whitechapel, a Hologic Discovery QDR series Dual Energy X-ray Absorptiometry (DXA) scanner was used to calculate the BMD of the lumbar spine and hip. T and Z scores work as typical units for calculating and monitoring changes in bone density together with BMD. The The number of SDs above or below the average BMD value for young, healthy people (ages 20–35), adjusted for sex and race, is known as the T-score.

2.2 Patients

To identify important variables that affect BMD and how well patients respond to treatment, researchers looked at the effects of age, sex, family origin, and some lifestyle choices in a group of 647 primary osteoporosis patients who attended the osteoporosis clinics at the Royal London and St. Bartholomew's Hospitals. Patients are up of 533 women and 114 men, with an average age (SD) of 68.311.16 years (51-87 years). The majority of the patients

smoked, with 121 of the cohort admitting they were smokers, therefore their smoking behaviors were known.

2.3 Statistical Methods

To evaluate the effects of gender, age, ethnic background, and environment on the responsiveness of osteoporosis patients to therapy, differences between groups were examined using the t-test for continuous variables and the chi squared test for categorical data. Subgroup analysis was used to look at the different differences in hip and spine BMD among different groups. The Mann-Whitney U test or an independent Student's t-test, as appropriate, was used to analyze BMD differences across these groups. In a multivariate linear regression model that was modified for age, gender, ancestry, and style of life, associations between changes in BMD and risk variables were also examined.

2.4 Precision assessment

Because bone densitometry uses radiation dose, the effort is constantly made to guarantee that readings are consistently repeatable to offer maximal benefits for patients with little radiation exposure. When repeat measurements are taken of the same patient, the DXA system is considered precise if the BMD readings are consistently obtained. When this result is compared to data from a reference population, accuracy, which is a measurement of the actual BMD value, is crucial. The percentage difference between measurements and a measure's real (genuine) value is accuracy, which is given in percentages (Khan et al., 2022).

Over the course of 28 months, the DXA scanner's in vitro long-term precision was tested. For short-term precision, BMD measurements were taken from a spine phantom, and errors in accuracy were reported as CV. The spine phantom's mean BMD was 0.997g/cm^2, its SD was

0.005g/cm^2, and its CV was 0.5%. All BMD readings were within 1.5% of the mean, as shown in Figure (1).

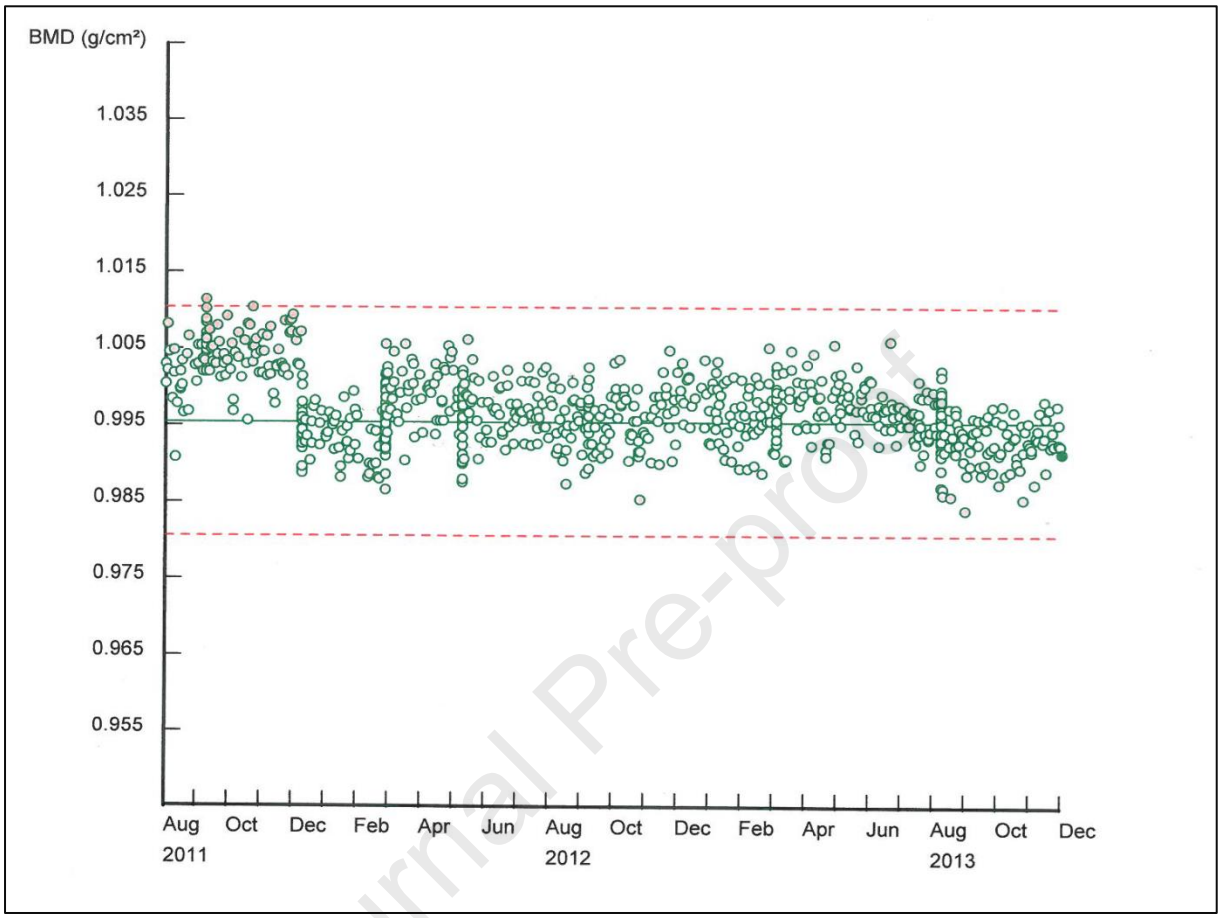

Figure 1: BMD assessments with long-term in vitro precision. The spine phantom was used to do daily regular BMD precise measurement in order to confirm the scanner's quality control. For 28 months, these measures were made.

Short-term and long-term precision tests were performed in order to confirm the DEXA machine's accuracy. Repositioning the phantom was done to assess the potential influence of operator positioning on the accuracy of BMD readings for short-term precision. On the scanning table, the phantom was left in place so that measurements of the accuracy over time could be taken. As anticipated, there was a 0.01% difference between the 0.33% in the first position and the 0.32% in the second position, showing that operator location had only a little

effect on the machine's accuracy. The variances, however, were not statistically noteworthy (p=0.8) with a 99% confidence range.

Overall, the Hologic QDR series DXA machine utilized in the trials had short-term accuracy values that were compatible with the manufacturer's claims of less than 1% precision.

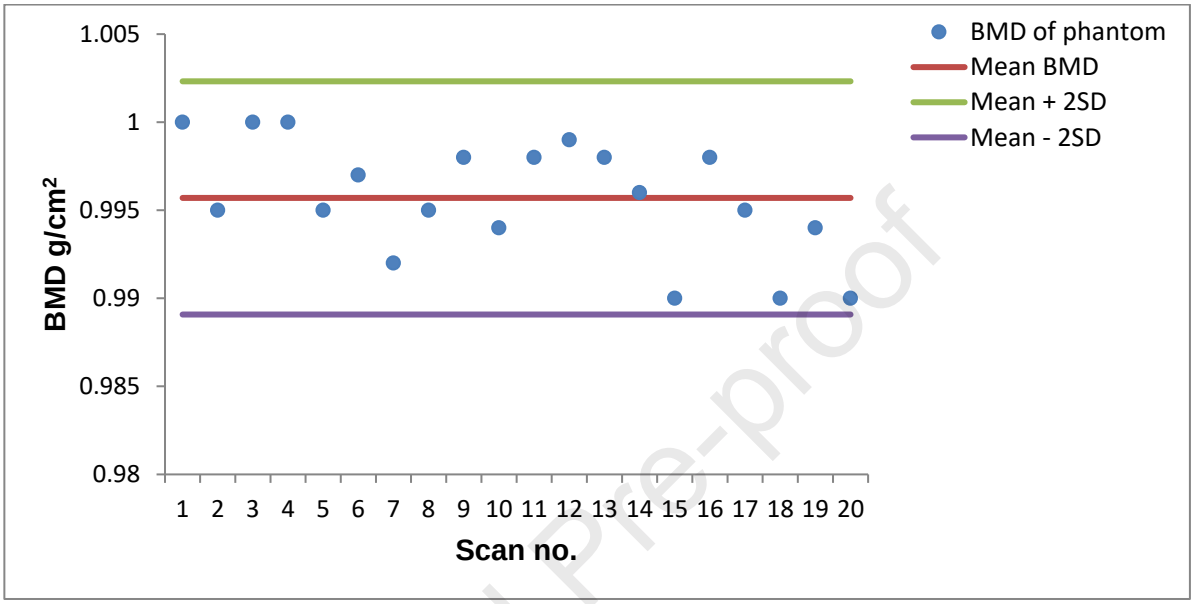

Figure 3.2: BMD measurements with immediate accuracy. A spine phantom was subjected to twenty DXA scans, with the phantom being moved about in between each scan.

3. Results and Discussion

3.1 Patient admission

The osteoporosis clinics at the Royal London and St. Bartholomew's Hospitals investigated 647 individuals with primary osteoporosis (mean age 68.311.6 years). In this study, individuals using bisphosphonates were evaluated for changes in BMD (hip and spine) during two years of treatment. In this research, the effects of age, sex, ancestry, and smoking on bone tissues were examined. Numerous factors led to the selection of patients with osteoporosis, including the sheer volume of individuals available and the fact that the majority received anti-osteoporotic medications primarily for their bone condition (bisphosphonates). Ineligible patients included those who were bedridden, on steroids or anti-epileptic medications, and suffering from renal disorders, diabetes mellitus, thyroid hyper activity, or cancer. The lumbar spine (L1-L4) and hip were evaluated using DXA images (Hologic Discovery QDR series). The progress of their replies was monitored yearly, and both places were examined simultaneously. 1.95 years were spent on bisphosphonate therapy (mean SD). In this study, a BMD "nonresponse" was defined as a decline in BMD from baseline two years into therapy at two of the examined sites. BMD "response" was defined at two years post-therapy as either no change or an increase from baseline at the examined locations. When tested using a nearby spine phantom, the DXA scan's coefficient of variation (CV) was acceptable. Every day, 1000 mg of calcium and vitamin D were given to each patient (800IU). A questionnaire presented by an interviewer was used to gather demographic and clinical data before therapy, during DXA scan sessions, and after 1 and 2 years. Age, lifestyle (smoking, consuming more than two drinks per day, and physical activity), a family history of fractures, a personal history of fractures, and a list of current medicines were all gathered.

3.2 Variations in BMD

In the hip joint and lumbar spine , the mean BMD gains were 0.017g/cm2 (2.14 percent, p0.001 vs. baseline) and 0.006g/cm2 (0.5 percent, p0.001 vs. baseline), respectively, after a year.

Additionally, after two years of therapy, the lumbar spine's BMD changed by 0.032 g/cm2 (4.1 percent, p0.001 vs. baseline), and the hip's BMD changed by -0.002 g/cm2 (-0.25 percent, p0.001 vs. baseline), respectively (Figure 2).

In this experiment, 172 of the 647 participants did not react to the bisphosphonate drug, while 475 did. In responder patients, the BMD of the hip and the lumbar spine increased by 0.004g/cm2 and 0.056g/cm2, respectively, increasing by 7.1% and 0.001% from baseline. Non-responders' BMD decreased in the lumbar spine and hip, respectively, by -0.018g/cm2 (-2.3 percent) and -0.031g/cm2 (-3.9 percent, p0.001 vs. baseline). Tables 1 and 2 provide an epidemiological summary of the patient under investigation, including demographic information, lifestyle choices, and baseline BMD. Age, gender, risk factors, and baseline BMD did not differ statistically significantly between respondents and non-responders.

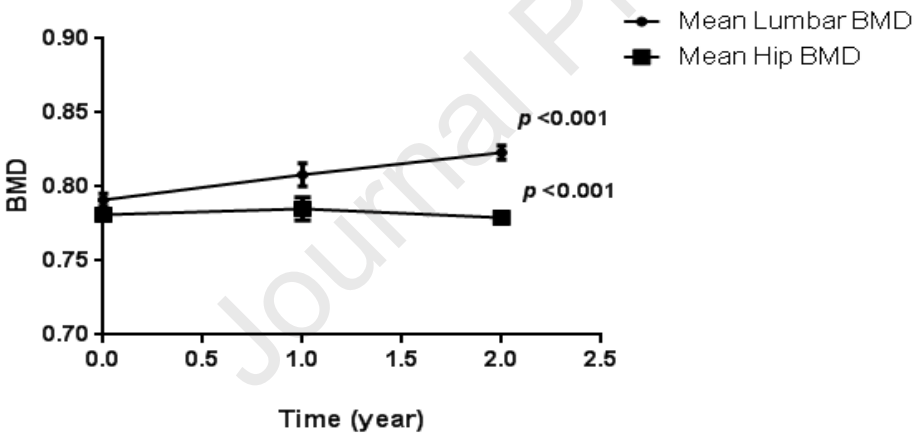

Figure 2: BMD changes in osteoporosis patients treated with bisphosphonates. This study included 647 subjects who were taking bisphosphonates in total. Mean lumbar spine and hip BMD were assessed at baseline (time 0), 1 and 2 years following therapy using DXA images. A standard deviation of +/- 2 standard deviations is shown by the error bars (SD) (Figure 2).

Table 1: Baseline BMD for responder and non-responder osteoporosis patients prior to therapy initiation.

Characteristics	Respondent n=475	Non-respondent n=172	All cohort n=647
Lumbar spine(LS)			
BMD (g/cm^2)	0.79 (0.11)	0.78 (0.1)	0.79 (0.1)
t-score	-2.88(1.0)	-2.87 (0.9)	-2.88 (0.96)
Femoral bone			
BMD (g/cm^2)	0.78 (0.12)	0.77 (0.11)	0.78 (0.11)
t-score	-2.43(0.85)	-2.46 (0.84)	-2.44 (0.85)

BMD values [mean (SD)] were calculated using a DXA scan. According to WHO recommendations, a patient is deemed to have primary osteoporosis if they have a t-score of -2.5 at any bone site.

Table 2: Data on osteoporosis patients studied.

Characteristics		**Respondent n=475**	**Non Respondent n= 172**	**overall 647**
Age	Mean (St. Diviation)	68.6 (11.8)	67.5 (11)	68.3 (11.6)
Sex				
(woman)	no. (Percentage)	382 (80.4)	151 (87.8)	533
Post-menopausal	no. (Percentage)	366 (96)	144 (95)	510
Ancestral background				
Caucasians	no. (Percentage)	383 (81)	135 (79)	520
Asians	no.(Percentage)	68 (14)	28 (16)	97
Afro-Caribbean	no.(Percentage)	21 (5)	9 (5)	30
Calcium Intake (mg/day),	Mean (St. Diviation)	586 (370)	600 (360)	590 (367)
Vit. D (µg)	Mean (St. Diviation)	5.6 (3.7)	5.7 (3.6)	5.6 (3.7)
Age group				
50's	no.(Percentage)	89 (19)	30 (17)	119
60's	no.(Percentage)	139 (29)	75 (44)	214
70's	no. (Percentage)	159 (33)	39 (23)	198
80's	no.(Percentage)	88 (19)	28 (16)	116
Fracture history	no.(Percentage)	79 (17)	38 (22)	117
Familial fracture	no.(Percentage)	60 (13)	27 (16)	87
Hormone Replacement Therapy, no.(Percentage)		51 (11)		73
Low Body Mass	no.(Percentage)	42 (8)	22 (13) 25 (15)	67
Osteoporosis Treatment				
Alendronate	no.(Percentage)	278 (58)	89 (52)	367
Zolendronate	no.(Percentage)	133 (28)	46 (27)	179
Risendronate	no.(Percentage)	37 (8)	31 (18)	68
Pamidronate	no.(Percentage)	27 (6)	6 (3)	36
Behaviour (**history**)				
Smoker	no.(Percentage)	86* (18)	35 (20)	121
Non-smoker	no.(Percentage)	266 (56)	94 (55)	360
Alcohol drinks	no.(Percentage)	38 (8)	6 (3)	44
Physical and sport exercises	no.(Percentage)	117 (25)	39 (23)	156

The study examined the effects of age, gender, ancestry, and smoking habits on the reaction to bisphosphonate medication in a total of 647 participants. Only 481 of the patients had data on their smoking habits.

3.3 Factors that influence BMD alterations in bisphosphonate-treated patients

To estimate the effect of personal traits on how responsively osteoporosis patients respond to bisphosphonate medication, the role of gender on changes in BMD was initially investigated. After two years of therapy, there was statistically significant improvement in BMD among all male patients in comparison to baseline measurements (3). Males' BMD of the lumbar spine and hip increased in comparison to pretreatment by 0.057g/cm2 (6.9%, p0.001) and 0.021g/cm2 (2.48%, p0.001, respectively). BMD changes in the lumbar spine and hip of female patients were 0.028g/cm2 (3.58 percent, p0.001 vs. prior to therapy) and -0.006g/cm2 (-0.78 percent, p0.001 vs. prior to therapy), respectively (Figure 3).

Table 3. Change in BMD in male and female osteoporosis patients treated with bisphosphonates.

	N	BMD values prior to therapy (mean SD)	Mean % BMD difference	Std. Error of Mean
BMD changes in Lumbar spine				
Man	114	0.82(0.11)	6.90	0.8
Woman	533	0.78(0.11)	3.58	0.3
BMD changes in Femoral bone				
Man	114	0.84(0.13)	2.48	0.57
Woman	533	0.76(0.11)	-0.78	0.22

Group statistics and independent sample tests are offered as the verage, and data is analyzed in accordance with the instructions in the methodology section.

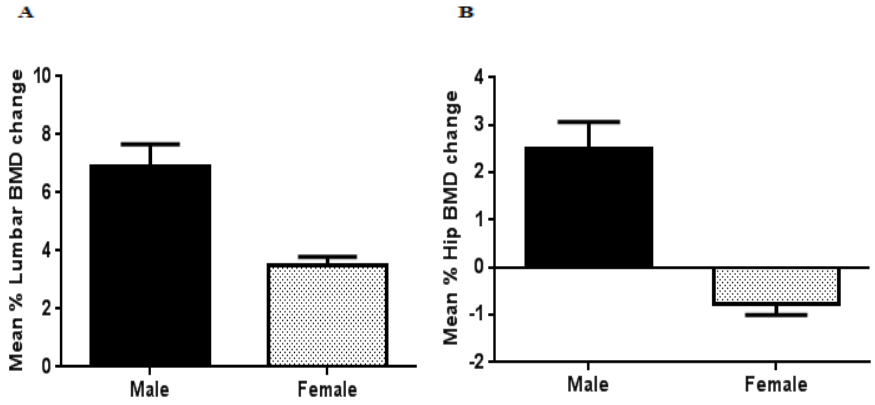

Figure 3: BMD variations in male and female osteoporosis patients after two years of bisphosphonate therapy at the hip (A) and lumbar spine (B).

Results of 533 female and 114 male patients were analyzed. The standard error of the mean is used to describe BMD data as a mean. An examination of the effect of gender within the same age groups revealed that male patients improved their BMD more than female patients in the same age group (Table 4). However, because of the limited number of male patients in this age group (10 male patients only), care should be used when extrapolating these results from the fact that the change in BMD of male patients in the 80 age group was less than that of female patients (Figure 4).

Table 4: Change in BMD in male and female osteoporosis patients according to age treated with bisphosphonates.

Change in lumbar BMD	N	Mean % BMD change	Std. Error of Mean (SEM)
Male			
50's	25	6.66	1.4
60's	33	9.14	1.9
70's	46	7.9	1.3
80's	10	3.9	1.7
Female			
50's	94	3.1	1
60's	181	2.95	0.6
70's	152	1.7	0.5
80's	106	4.7	0.5

Group statistics and independent sample tests are provided as the mean for changes in BMD in osteoporosis patients broken down by gender and age categories, and data is analyzed as described in the Materials and Methods section.

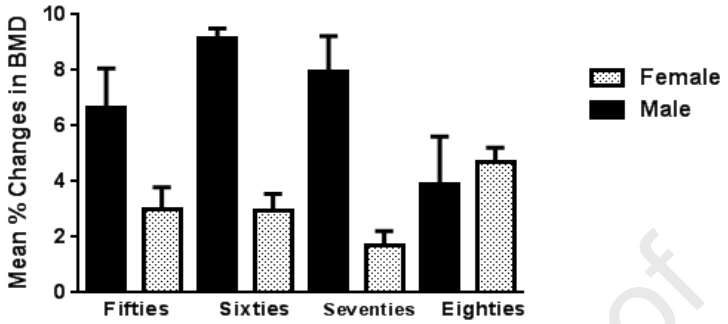

Figure 4: BMD varies in males and females with osteoporosis as a function of age.

In order to examine the impact of age on changes in lumbar BMD following bisphosphonate therapy in males and females, the 647 patients with osteoporosis were divided into subgroups based on their age range. To examine the variations in BMD between age groups, ANOVA was utilized (Table 5). After two years of therapy, older patients' hip BMD decreased statistically significantly compared to younger ones. On the other hand, significant differences in lumbar spine BMD between age groups could not be substantiated. Additionally, people in their sixties responded at a rate that was lower than that of other groups (Figure 5).

Table 5: Age-related changes in BMD in response to bisphosphonates.

Age	N	Mean % BMD change	Std. Error of Mean (SEM)
lumbar BMD changes			
50's	119	4.54	0.72
60's	214	2.86	0.52
70's	198	4.6	0.65
80's	116	5.1	0.87
Femoral BMD changes			
50's	119	1.1	0.5
60's	214	0.4	0.4
70's	198	-0.54	0.3
80's	116	-2.44	0.6

Data is analyzed as described in the Materials and Methods section for changes in BMD in osteoporosis patients split by age. Group statistics and independent sample tests are provided as the mean.

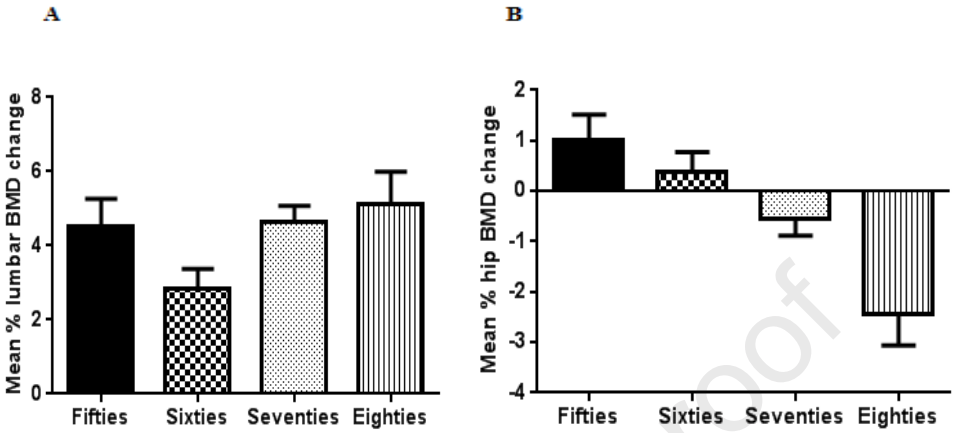

Figure 5: BMD variations in osteoporosis patients according to age groups. The research comprised 119 patients in their fifties, 214 in their sixties, 198 in their seventies, and 116 in their eighties.

Patients from various ethnic origins did not have significantly different BMD in the lumbar spine and hip (Table 6). Asian and Afro-Caribbean patients' BMD improved less than that of Caucasian ones. The small number of Afro-Caribbean patients that could be included in the research impeded the statistical analysis. In comparison to Caucasian (0.796 and 0.773g/cm2) and Asian (0.746 and 0.783g/cm2) individuals, Afro-Caribbean patients had higher BMD prior therapy for the lumbar spine and hip, correspondingly (0.855 and 0.914 g/cm2) (Figure 6).

Table 6: Changes in BMD of osteoporosis patients in response to bisphosphonates, broken down by ethnic origin.

Background origin	N	Baseline BMD mean SD	Mean% BMD change	Std. Error (SEM)
Lumbar BMD change				
Caucasias	520	0.795 (0.1)	4.24	0.32
Asians	97	0.748 (0.1)	3.3	0.69
Afro-Caribbean	30	0.855 (0.1)	3.4	0.92
Hip BMD change				
Caucasias	520	0.773 (0.1)	-0.4	0.3
Asians	97	0.783 (0.1)	0.96	0.7
Afro-Caribbean	30	0.914 (0.1)	-0.2	0.9

Group statistics and independent sample tests were employed to analyze changes in BMD among osteoporosis patients segmented by ethnic origin. The data is analyzed as described in the Materials and Methods section, and it is presented as a mean and standard deviation (SEM).

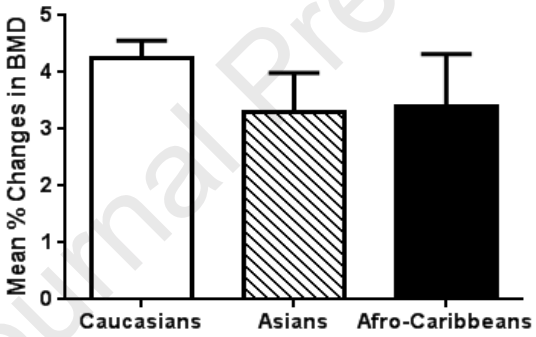

Figure 6: Alterations in individuals' lumbar spine BMD dependent on their racial or cultural heritage. Patients with osteoporosis who received bisphosphonates in this research included 520 Caucasian, 97 Asian, and 30 Afro-Caribbean individuals. No matter whether a patient responded to therapy or not, all patients are subject to the information.

Smokers considerably underperformed non-smokers in terms of improvement in lumbar spine and hip BMD when it came to the effect of smoking on BMD alterations (p=0.001) (Table 7). Smokers' hip and lumbar spine BMD decreased by 0.01g/cm2 (1.61%) and 0.017g/cm2, respectively, while non-smokers' BMD increased by 0.04g/cm2 (4.96%) and 0.006g/cm2 (0.7%). (Figure 7).

Table 7: BMD changes in smokers and non-smokers with osteoporosis.

BMD change	N	Baseline BMD mean SD	Mean BMD change	Std. Error (SEM)
Lumbar BMD change				
Smoker	121	0.781(0.1)	2.18	0.5
Non smoker	360	0.80(0.1)	4.96	0.4
Femoral BMD change				
Smoker	121	0.761(0.11)	-1.61	0.4
Non smoker	360	0.787(0.11)	0.7	0.3

Group statistics and independent sample tests were utilized to examine changes in BMD in osteoporosis patients divided into smokers and non-smokers.

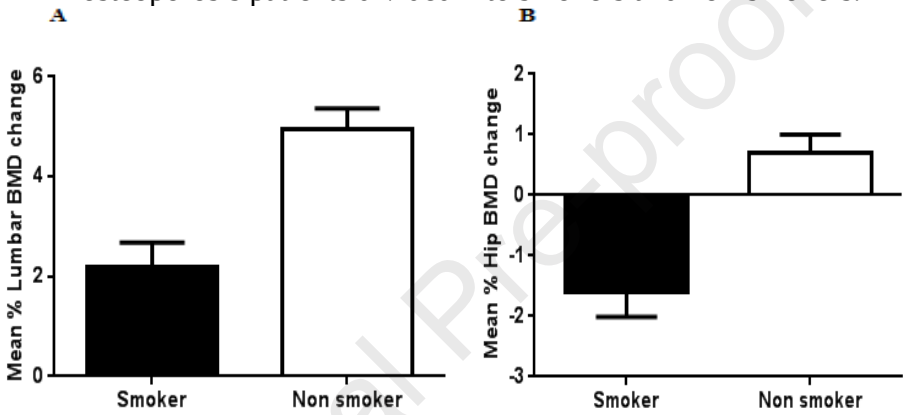

Figure 7 . The effect of smoking on variations in lumbar and hip BMD in osteoporosis patients receiving bisphosphonates. A study was done on the BMD of 360 non-smokers and 121 smokers who had osteoporosis and were taking bisphosphonates. After two years of therapy, BMD levels were compared to baseline (before treatment). with SEM error bars

Additionally, the relationship between patient variables (age, gender, ancestry, and smoking) and modifications in BMD at the lumbar spine and hip was examined using Spearman's correlation coefficient analysis (Table 8). Smoking and female gender both contributed to a lessened increase in BMD in the hip and lumbar spine (p0.001). The alterations in BMD at the hip were much greater in younger people. Ethnic background had no significant impact on changes in BMD levels. The alterations in lumbar spine and hip BMD did not significantly correlate with other clinical characteristics such HRT usage, medically induced menopause, or low body mass ($p>0.05$).

Table 8. Demographics, gender, race, smoking, and lumbar spine and hip BMD in osteoporosis patients using bisphosphonates are all related. (Analysis of relationships using Spearman's correlation coefficient)

Patient Parameters	**Femoral BMD Changes**		**Lumbar spine BMD changes**	
	r	***p*-value**	***r***	***p*-value**
Age	-0.20	<0.001	0.05	0.22
Gender (female)	-0.46	<0.001	-0.36	<0.001
Background origin	0.06	0.11	0.05	0.24
Smoking	-0.26	<0.001	- 0.34	<0.001

Bisphosphonate-treated osteoporosis patients were split into two groups: non-responders, who showed signs of a decline in BMD at the measured sites two years after beginning therapy, and responders, who showed signs of a rise in BMD at the measured sites two years after beginning treatment. (73% versus 27%, respectively)

After receiving treatment for two years, the average BMD increases in the lumbar spine and hip were 0.032g/cm2 (+4.1%, p0.001 vs. baseline) and -0.002g/cm2 (-0.25%, p0.001 vs. baseline), respectively. Since cancellous bones are more common in the lumbar spine than cortical bones, which are more common in hips, the discrepancy between the BMD values of the hip and lumbar spine is most likely due to the quicker rate of bone remodeling in cancellous bones (Jiang, et al., 2012). The findings of this study on how bisphosphonates affect BMD are consistent with those of prior investigations (Eastell et al., 2003; Wasnich & Miller, 2000; Hejdova et al., 2005; Wells et al., 2008).

The study found that the increase in BMD was greater in male patients than in female ones. This result can be explained by the fact that postmenopausal women between the ages of 50

and 60 are more prone to develop osteoporosis due to ovarian failure and significant oestrogen reduction, which causes bone resorption to accelerate by 90% after menopause. These findings have been supported by biomarkers, which show that signs of bone production have increased by only 45%, with a lesser increase in BMD in females as a result of the imbalance between bone resorption and bone formation (Jiang et al., 2012; Khosla & Riggs , 2008). Contrarily, male testosterone influences BMD improvement with medicine in a favorable manner (Khosla & Riggs , 2008).

The smoking research was fascinating since it showed a connection between smoking and a decline in BMD improvement. Smoking and changes to BMD have previously been linked, according to research ((Oncken et al., 2006; Yoon et al., 2012; Shu-guang et al., 2011). Due to this, both treated and untreated individuals' smoking behaviors have been linked to decreased BMD improvement after therapy ((Oncken et al., 2006; Yoon et al., 2012; Shu-guang et al., 2011). The study's findings are generally consistent with those of other studies (George et al., 2003; Wasnich et al., 1999; Cummings et al., 2000)

Eventually, despite the fact that these conceptual analyses and modifications have highlighted important benchmarks to take into account when analyzing the influence of individual characteristics on how well patients with osteoporosis respond to bisphosphonate treatment, the data still have limitations. First off, the limited sample number of patients who were Afro-Caribbean is probably what impacted the analyses of ethnicity in terms of bisphosphonate response. The analysis of the association between changes in BMD and fractures, the main outcome of relevance to physicians, also took sample size into account. Second, the results may have been strengthened by include sex hormone levels as well as blood and urine indicators of bone production and resorption. The study's third drawback is the gap in BMD measurements, since we had to wait 1-2 years to assess a patient's response to bisphosphonates (Wasnich et al., 1999; Cummings et al., 2000). This may be noteworthy since,

according to some research, using bisphosphonates for a few days to a few months can significantly reduce blood levels of markers for bone turnover (Cummings et al., 2000, Delmas et al., 2000).

4. Conclusions

Based on the research, male patients saw a greater increase in BMD than female patients because of ovarian failure and significant oestrogen loss, which increases bone resorption by 90% following menopause. Results showing that Afro-Caribbean individuals have greater baseline BMD in the lumbar spine and hip than Caucasian and Asian patients are therefore consistent with past observations. Nevertheless, the current investigation lacked a sizable cohort of Afro-Caribbean patients to produce complete and insightful data. Interestingly, studies on BMD enhancement in individuals with osteoporosis found that the drug's method of administration and, consequently, probable compliance with the agent, might affect therapy response. The research reveals, however, that patients' responses to osteoporosis medication, in this case bisphosphonate, depend on their age, gender, ancestry, and smoking habits.

Acknowledgments

The authors would like to extend their sincere appreciation to the Researcher supporting program at King Saud University, Riyadh, for funding this work under the project number (RSP-2021/328).

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Highlights

- Bone mineral density (BMD) in the diagnosis and follow-up of patients with osteoporosis was investigated
- The DEXA scan was used to assess a group of 647 osteoporosis patients
- Afro-Caribbean patients have higher baseline BMD in the lumbar spine and hip than Caucasian
- Age, gender, ancestral origin, and smoking behaviours all affect osteoporosis treatment

Declaration of competing interest

All authors declare that there is no conflict of Interest.