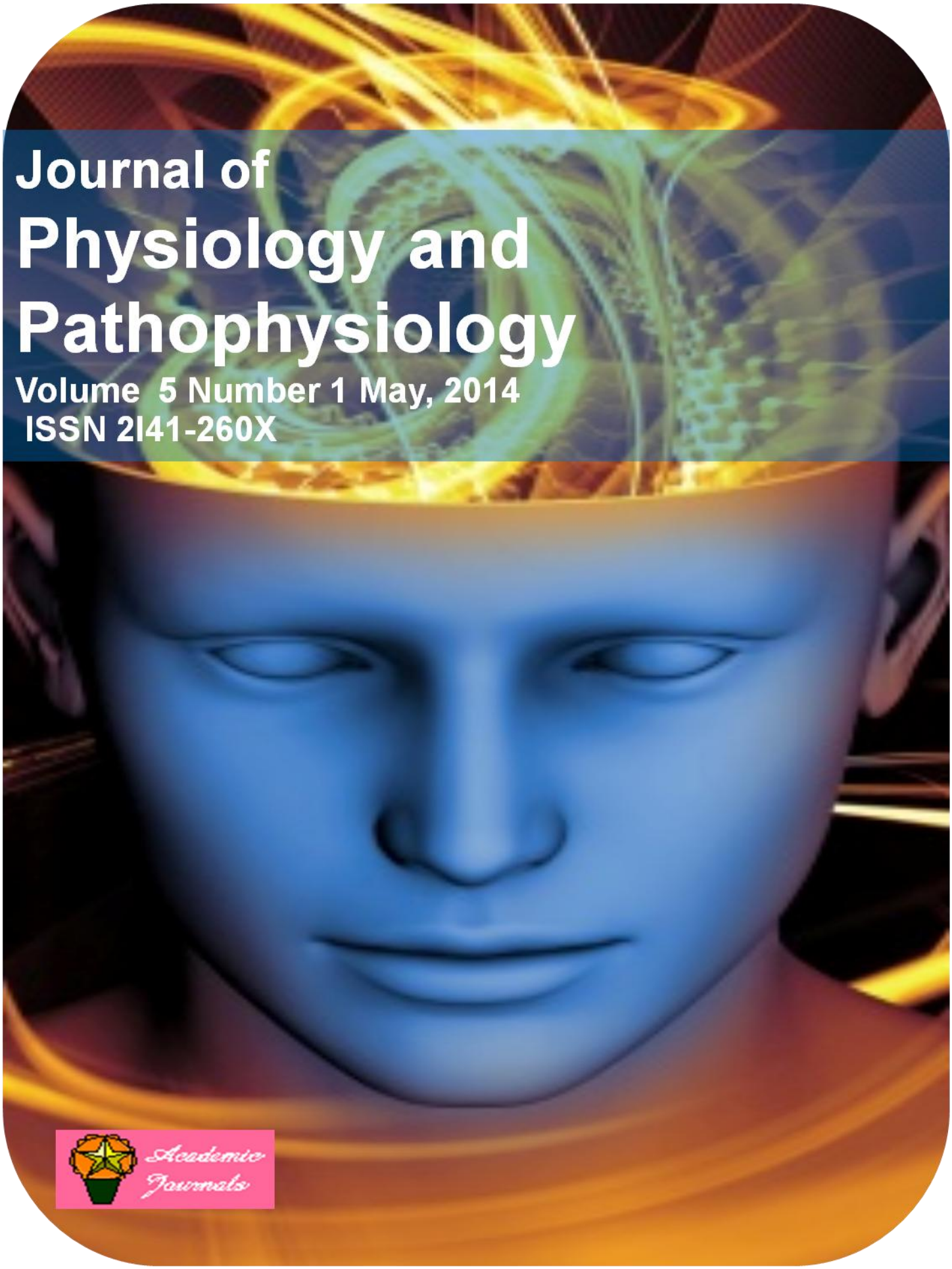

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*Full Length Research Paper*

# Evaluation of the height of premenopausal and postmenopausal women in Zaria, Nigeria

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**Excessive height loss in postmenopausal women (PMW) has been found to reflect low bone mass; an index helpful in predicting vertebral fractures. One hundred and sixty five women were recruited for the cross-sectional study comprising of 77 premenopausal women who served as control and 88 PMW who constituted the study group. The subjects were administered a questionnaire after obtaining informed consent. While their height, weight, waist circumference and serum testosterone levels were determined utilizing standard methods. The results were presented as mean ± SD, while data was analyzed with Student's t-test, one way ANOVA, and correlation for comparing association; $p<0.05$ was considered significant. The postmenopausal women had a significantly lower mean height (158.56 ± 7.02 cm) than the premenopausal women (162.25 ± 6.44 cm), $p<0.001$. There was a decrease in mean postmenopausal height with increasing duration of menopause, however, it was not statistically significant; 158.71 ± 7.32, 158.40 ± 7.34 and 158.41 ± 6.41 cm, respectively for women who were 1-5, 6 - 10 and > 10 years postmenopausal. The age at menopause and the body mass index demonstrated a positive correlation with the height of the menopausal women. While the serum testosterone and the body mass of the postmenopausal women demonstrated a negative correlation with their age at menopause. It is concluded that the postmenopausal women had a significantly lower height than the premenopausal women (mean height difference of 3.69 cm) and were at risk of vertebral fractures; critical levels predictive for vertebral fractures range between 3 – 6 cm losses in height. We recommend longitudinal studies to determine the prospective height loss across the menopause transition in Nigerian women and thus indicate the critical levels predictive for vertebral fractures for Nigerian menopausal women.**

**Key words:** Bone, bone mineral density, height loss, menopause, menopausal height, vertebral fractures, Zaria.

## INTRODUCTION

Height loss is common as people age (Takahashi et al., 2005; Kado et al., 2004). This occurs due to bone loss

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with increasing age. It is a slow process beginning between 30 to 40 years and continues throughout life (Bonjour *et al*., 1994). However it varies greatly among individuals. Causes of height loss include changes in the curvature of the spine, narrowing of the intervetebral discs and vertebral fractures (Briot et al., 2010). Excessive height loss was found to reflect low bone mass, a feature of postmenopausal osteoporosis. Postmenopausal osteoporosis is characterized by an imbalance between increased osteoclast activity and decreased osteoblast function, resulting in increased bone remodeling, bone microarchitectural deterioration, and skeletal fragility (Ebeling, 2010). A previous study indicated that measurement of height loss could be an accurate method for detecting vertebral fractures (Siminoski et al., 2006). The thresholds useful in clinical practice to detect prevalent vertebral fracture range from 3 cm to 6 cm, with the risk of prevalent fracture increasing with the magnitude of the height loss (Krege et al., 2006; Vokes et al., 2006; Siminoski et al., 2006 and Gunnes et al., 1996).

A mean loss of height of 4.5 cm since early adulthood was observed in the study by Briot et al. (2010) in a large population of postmenopausal women in primary care practices. They observed that the risk of an existing vertebral fracture was significantly higher among patients with a height loss of at least 4 cm. The study by Siminoski et al. (2006) recommended spine radiographs to examine for the presence of vertebral fractures in subjects with a historical height loss of > 6.0 cm. Other sites of fractures due to increased bone loss in menopause include fractures of the radius and the femur; bone loss attributed to estrogen deficiency (Albright et al., 1940).

Bone mineral density and fracture risk varies widely across racial and ethnic groups. African-Americans reportedly have higher bone mineral density than their Caucasian counterparts with an associated lower incidence of osteoporotic fractures (Finkelstein et al., 2002). Height loss is contributed partly by vertebral fractures; a common fracture site in postmenopausal osteoporosis (Kado et al., 2003). A study on postmenopausal height loss in Nigerian women has not been carried out despite the beaming number of postmenopausal women; sequelae to increased life expectancy. The increase in postmenopausal population infers a probable increase in the prevalence of postmenopausal health conditions such as osteoporosis with the risk of fractures. This is in a setting where health services and especially specialized health services (menopause clinics) are either inadequate or non-existent. A simplified method of determining thresholds predictive of vertebral fractures and of identifying women requiring radiographic investigation in general clinical practice is thus necessary. We conducted this study to compare the height of postmenopausal women to that of pre-menopausal Nigerian women in Zaria.

## METHODOLOGY

Data was collected with a questionnaire, stadiometer, flexible metric tape and a weighing scale.

### Study site

The study was conducted in Zaria, Kaduna state of Nigeria. Zaria lies within latitude 11°3′N and longitude 7°42′ E (Mortimore, 1970). Zaria is an ancient city that has metamorphosed into an urban setting due to it becoming an educational town. Among the several institutions sited here are the Ahmadu Bello University, National Research Institute of Chemical Technology, National College of Aviation Technology and the National Animal Production Research Institute, Zaria. Thus making the inhabitants cosmopolitan in nature.

### Study subjects

Nine hundred and fifty women were approached and screened for the study out of which 230 women (24.2%) were eligible and interviewed. One hundred and sixty five (165) Nigerian women residing in Zaria, Northern Nigeria eventually participated in the cross-sectional study (the study included blood collection for assays of which some participants declined). Included subjects were representative of the general population. Postmenopausal women were 88 while 77 of the subjects were premenopausal women.

Postmenopausal women included in the study group were at least 1 year amenorrhoeic due to a natural cause according to the guidelines of Research on the menopause (1981) and aged 40 – 65 years. For the control group, women who are regularly menstruating, non-lactating, non-pregnant with no use of hormonal contraception (1 year) and aged 20 – 35 years were included in the study.

Women who had a history of renal disease, malignancy, alcohol ingestion, cigarette smoking, on treatment with steroids, previous fractures or obvious skeletal deformities were excluded. Subjects using hormonal contraceptives or on hormone replacement therapy and women experiencing cessation of periods other than by natural menopause were identified and excluded from the study as described by Crawford et al. (2000). Informed consent was gotten from all participants while approval from the Ethical Committee on Human Research of Ahmadu Bello University, Zaria was obtained.

### Height measurement

Height was measured to the nearest 0.5 cm with a stadiometer. Each patient was measured without shoes, with her heels, buttocks and back to the stadiometer backboard. The patient's head was maintained in the Frank-fort plane, with the lower edge of the left eye socket in the same horizontal plane as the notch superior to the tragus of the left ear. The patient was instructed to stretch to a fully erect position while keeping her feet flat on the floor while the height was recorded during normal respiration (Norton et al., 1996).

### Weight measurement

Their weights were measured while wearing light clothing and bare footed to the nearest 0.2 kg with a calibrated weighing scale. The

body mass index was calculated according to Guyton and Hall (2006) as:

Weight (kg)/ height ($m^2$)

**Waist circumference determination**

With the subject standing, a flexible metric tape was placed at the level midway between the lower rib margin and the iliac crest. The waist circumference was then measured to the nearest 0.5 cm.

**Blood collection**

Blood samples (5 mm) were collected from the subjects between 13.00 – 18.00 h by venepuncture at the cubital fossa and transferred to empty plain sample bottles. The samples were centrifuged using a bench centrifuge at 1,500 rpm for 20 min and the serum was separated and stored at -4°C until assayed.

**Testosterone assay**

Using Microwell testosterone kits, based on the principle of competitive immunoenzymatic colorimetric method for quantitative assay (read by a microplate reader - BIORAD - PW40 and PR5100, Austria) and at an absorbance of 450 nm, serum concentrations of testosterone was determined according to the instruction with commercial kits (Tietz, 1995 and Uotila et al., 1981). The intra- and inter-assay coefficients of variation were 9.3 and 11.2%. The assay was carried out at the Department of Chemical Pathology, Ahmadu Bello University Teaching Hospital, Shika, Zaria.

**Statistical analysis**

Results were presented as mean ± SD. Data was analyzed using student's t-test, one way analysis of variance and correlation (to summarize relationships between the various continuous variables). While a level of significance of $p<0.05$ was selected.

## RESULTS

Out of the total of 165 women recruited for this study, 88 were postmenopausal women while 77 were pre-menopausal women. Significant differences were noted when comparing the, weight (60.86 ± 13.46 kg vs. 65.42± 14.01 kg), waist circumference (78.87 ± 11.37 cm vs. 93.04 ± 13.12 cm) and BMI (23.13 ± 5.03 kg/m² vs. 25.96 ± 4.97 kg/m²) of the two groups of women. The postmenopausal women had significantly higher values. However, the menopausal women had a lower mean height than the pre-menopausal women (158.56 ± 7.02 cm vs. 162.25 ± 6.44 cm; $p<0.001$), as depicted by Table 1.There was an observed decrease in postmenopausal height with increased duration of menopause, 158.71 ± 7.32cm, 158.40 ± 7.34 cm and 158.41 ± 6.41 cm respectively for women who were 1-5, 6 -10 and > 10 years postmenopausal (Table 2). However, it was not statistically significant within the menopausal groups; $p>0.05$. The age at menopause and the BMI demonstrated a positive correlation with the height of the menopausal woman (Table 3). While the serum testosterone and the BMI of the postmenopausal women demonstrated a negative correlation with the age at menopause.

The mean age, height, weight, waist circumference and BMI of the control was significantly lower than that of the postmenopausal women ($p<0.05$). The height of the postmenopausal women was however significantly lower than that of the premenopausal women ($p<0.05$).

The height of the postmenopausal women was lower than that of the premenopausal women. While the BMI and serum testosterone concentration of the postmenopausal women was higher than that of the pre-menopausal women. There were however no significant within group differences among the postmenopausal women.

Serum testosterone levels and the BMI of the post-menopausal women demonstrated a positive correlation with their height. However, the serum testosterone con-centration and the BMI of the postmenopausal women demonstrated a negative correlation with the age at menopause.

## DISCUSSION

Men and women both lose bone with age. The men do not lose an equivalent loss as that found in menopause (Sowers et al., 2010). The lower height in menopausal women (Table 1) is principally due to accelerated bone loss due to menopause induced by estrogen deficiency as reported by the findings of Riggs et al., (2002). The effect of estrogen on bone mineral density is via both a direct effect on bone cell function and an indirect effect on extraskeletal calcium homeostasis. Estrogen recep-tors are found on osteoblasts and osteoclasts (Oursler et al., 1998; Eriksen et al., 1988). Estrogen stimulates osteoprotegerin (OPG) in osteoblasts which exerts anti-resorptive effects on bone (Bord et al., 2003). Estrogen deficiency is associated with decreased OPG production and the up regulation of receptor activator of nuclear factor-κ B ligand (RANKL) with the resultant increased bone resorption (Eghbali-Fatourechi et al., 2003). Effects of estrogen on extraskeletal calcium homeostasis includes its involvement in regulating intestinal calcium absorption (Gennari et al., 1990), modulating renal calcium handling (Mc Kane et al., 1995) and directly inhibiting the increases in PTH (Riggs et al., 1998). The mean difference in height between the premenopausal women (having a higher mean height) and the premenopausal women (PMW) was 3.69 cm. The actual percentage height loss of the PMW could not be ascertained in this study since the study was a cross sectional study.

**Table 1.** Age and anthropometric characteristics of the premenopausal and postmenopausal Nigerian women.

| Characteristic | Premenopausal women (n = 77) | Postmenopausal women (n = 88) | p |
|---|---|---|---|
| Age (years) | 25.51± 5.21 | 53.59 ± 6.11 | <0.001 |
| Age at menopause (Mean ± SD years) | - | 46.16± 3.45 | |
| Height | 162.25 ± 6.44 | 158.56 ± 7.02 | <0.001 |
| Weight | 60.86± 13.46 | 65.42± 14.01 | 0.035 |
| BMI | 23.13± 5.03 | 25.96 ± 4.97 | <0.001 |
| Waist circumference | 78.87 ± 11.3 | 93.04 ± 13.12 | <0.001 |

**Table 2.** The height, BMI and serum testosterone concentration of the postmenopausal women with duration of menopause.

| Variable | Control (n=77) | 1 -5years (n=45) | 6 – 10years (n=20) | >10years (n=23) |
|---|---|---|---|---|
| Height (cm) | 162.25 ± 6.45* | 158.71 ± 7.32 | 158.40 ± 7.34 | 158.41 ± 6.41 |
| BMI (kg/m²) | 23.13 ± 5.03* | 25.34 ± 4.30 | 27.68 ± 6.04 | 25.68 ± 5.07 |
| Serum testosterone (ng/ml) | 1.40 ± 1.0 | 1.69 ± 0.67 | 1.60 ± 0.45 | 1.69 ± 0.44 |

*p<0.05.

**Table 3.** A correlation matrix for menopausal women.

| Variable | Testosterone | BMI | Height | Menopausal age |
|---|---|---|---|---|
| Testosterone | 1 | -0.164 | 0.030 | -0.198 |
| BMI | - | 1 | 0.237 | -0.053 |
| Height | - | - | 1 | 0.066 |
| Menopausal age | - | - | - | 1 |

Estrogen deficiency in menopause is associated with certain changes. The intervetebral disc annulus fibrosis cells have been shown to express the estrogen beta receptor gene and culture of these cells in estradiol showed significantly increased cellular proliferation (Gruber et al., 2002). The flattening of the intervertebral discs contributes to the height loss associated with menopause. Vertebral fractures resulting from osteoporosis also leads to loss of vertebral body height and in other instances kyphosis which in turn causes a decrease in stature. Consequently, excessive decrease in height in postmenopausal women is highly suggestive of the presence of osteoporotic fractures and should serve as an indication for a spinal radiograph (Kaptoge et al., 2004; Gunnes et al., 1996; Spector et al., 1993; Riggs and Melton, 1983).

Estrogen –deficient menopausal bone loss is modulated by factors such as age at attaining menopause, genetics, menopausal status, thinness, lifestyle factors (exercise, smoking, alcohol intake) and low calcium and Vitamin D intake (Position Statement, 2010).

PMW had lower height with increasing duration of menopause which was however not statistically significant (Table 2). The lower height secondary to increased loss in bone mineral density was found to be greatest in the 0-5 years after menopause with a decline in the rate of bone loss subsequently (Forsmo et al., 2007 and Yuichiro et al., 2005).

The body mass index of the PMW demonstrated a positive correlation with the height of the women (Table 3). Studies by Walker et al (2007), Voort et al (2001), and Ooms et al. (1993) revealed a lower bone mineral density and increased fracture risk in women with lower BMI. Thus, women with lower BMI might be more likely to present with significant height losses during menopause.

Testosterone is important for the maintenance of bone mineral density (Davis and Davison, 2012). Low levels of endogenous testosterone have also been implicated in height loss of postmenopausal women (Jassal et al., 1995). In their prospective study, low plasma bioavailable

testosterone predicted a significant risk of vertebral fractures as estimated by height loss in elderly postmenopausal women, implying that testosterone delays bone loss. This is depicted in our study (Table 3) where serum testosterone was observed to demonstrate a positive correlation with the height of PMW. The aromatization of testosterone to estradiol could reflect the relation of testosterone to height loss (Anderson et al., 1997).

Other factors playing a role in bone loss during the menopause transition includes follicle stimulating hormone (FSH) (Cannon et al., 2010). The study by Sowers et al. (2010) revealed an increase in bone loss by 2 years before the final menstrual period despite normal ranges of estrogen at that period. It has been suggested by a study that elevated serum FSH accelerates bone loss directly (Sowers et al., 2006). Other contributors to menopausal bone loss include, low progesterone levels, and decreases in serum inhibin concentrations (Perrien et al., 2006; Prior, 1990).

On the other hand, age related bone loss (late, slow phase) is attributed to, in part, age related increase in bone turnover due to increases in parathyroid hormone levels with aging. Other contributors to age related bone loss include, vitamin D deficiency, impaired metabolism of vitamin D to its active form and a decrease in intestinal vitamin D receptors with a consequent decrease in intestinal calcium absorption (Sipos et al., 2009). Estrogen and testosterone deficiency are also being implicated in age related increase in bone turnover (Khosla et al., 1998).

## Conclusion

Postmenopausal women had a significantly lower mean height than the pre-menopausal women. Critical levels predictive for vertebral fractures from previous studies range between 3 – 6 cm losses in height. Menopausal women with a historical height loss of more than 3 cm may be at risk of vertebral fractures. There was a significant relationship between the BMI, serum testosterone concentration and the height of the PMW which was a positive correlation.

## RECOMMENDATION

We recommend that:

1. Prospective longitudinal studies to determine the critical levels predictive of vertebral fractures for Nigerian women.
2. Height assessment in menopause by physicians to ascertain height loss and fracture risk.
3. Assessment of female African bone mineral density in order to determine normal ranges for objective diagnosis of osteoporosis in postmenopausal women.
4. Further studies on sex hormones (progesterone, inhibin and FSH) modulation of bone loss in Africans.

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## Conflict of Interest

The authors declare that they have no conflict of interests.

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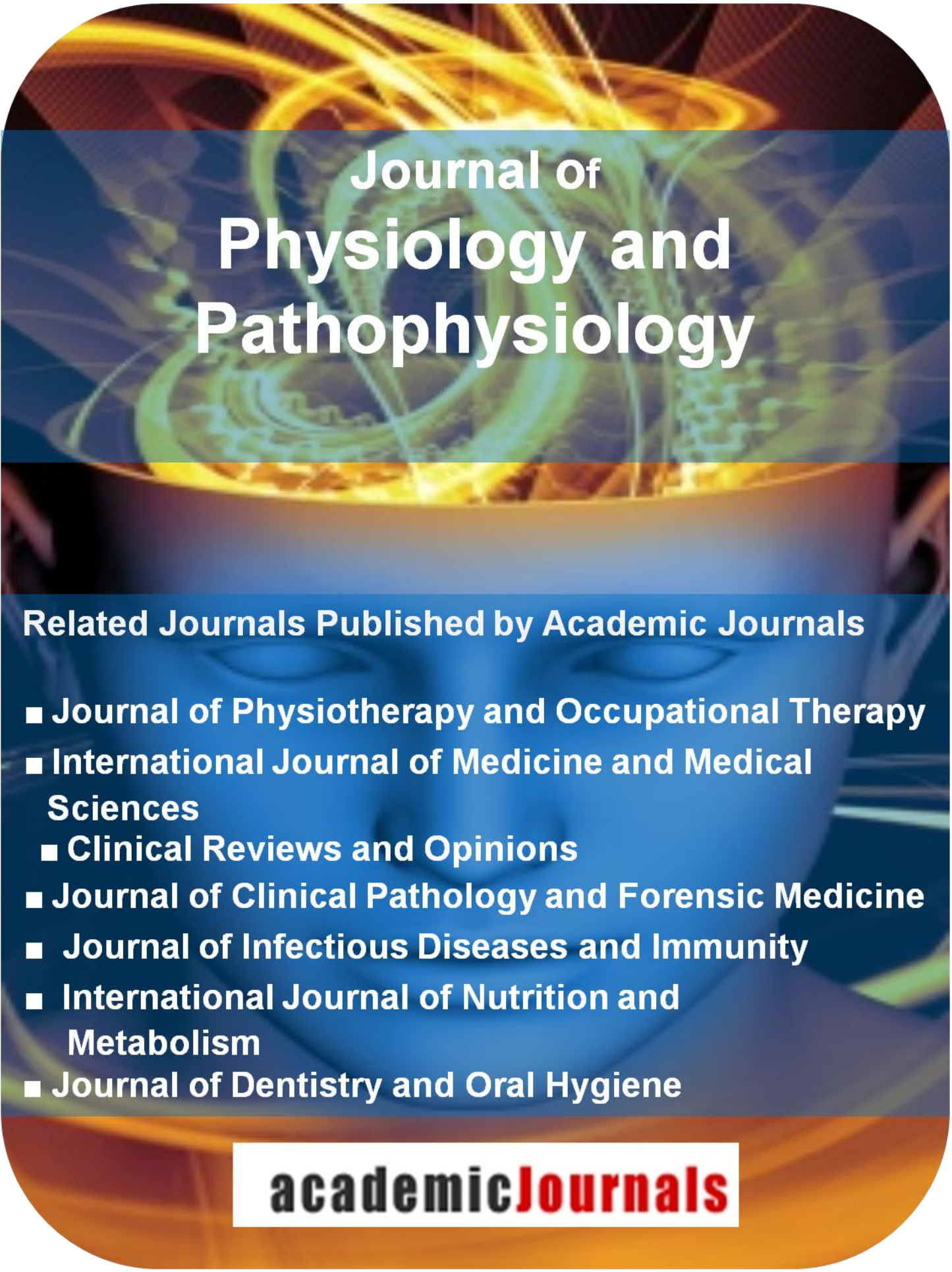
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