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Association Between Age and Body Mass Index on Bone Minerals in Postmenopausal Women

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Abstract

Our recent study shows that postmenopausal women present with lower serum calcium but higher phosphate compared to premenopausal women and that this may contribute to their increased risk for osteoporosis. However, several factors such as genetic, hormonal and environmental factors had been implicated with paucity of information on the effect of age and body mass index. It is the objective of this study to determine the association between age and body mass index on serum calcium and phosphate activities in postmenopausal women. The study was a cross sectional study carried out in a catholic mission hospital in Benin City, Nigeria. A total of 40 pre-menopausal and 280 post postmenopausal women completed the study. Following standard ethical process and laboratory procedures blood sample was obtained from each woman for estimation of serum calcium and phosphate concentrations. Statistical analysis was done using SPSS version 20 at 95% confidence interval. There was a significant different in the age and the findings on BMI implies that postmenopausal women are 8.75 times more likely to be overweight. In the postmenopausal women, serum calcium correlates negatively with age ($r = -0.064$; $p>0.05$) and BMI ($r=-0.055$; $p>0.05$) while serum phosphate correlates positively with age ($r = 0.077$; $p>0.05$) and BMI ($r = 0.131$; $p<0.05$). The implications of these findings are that menopausal women may improve bone health by increase intake of calcium rich diet and increasing effort to reduced excessive weight gain.

Keywords

Menopausal Age, Body Mass Index, Postmenopausal, Bone Minerals

1. Introduction

Osteoporosis is a skeletal condition characterized by deterioration of bone tissue architecture and consequently low bone mass [1]. It is a bone metabolic syndrome whereby the bones turn out to be weak and incompetent in supporting the body weight as a results of both minerals and bone matric loss [2] that lead to bone strength reduction and bone fragility [3]. It is a public health issues for the reason that it is connected with an increased osteoporotic fractures risk and mortality and as such contribute to a large socio-economic burden [4–6]. According to Riggs et al. [7], after the age of 40-50 years, there is slow progression of bone loss in both sexes, but more rapid in women around the menopausal transition; this increases the risk of postmenopausal women to osteoporosis. In a recent study, it was showed that one or two pregnancy might have positive influence on body minerals during the postmenopausal life and that this effect may have some confounding factors.

In support of our assertion, genetic, hormonal and environmental factors have been reported to contribute to osteoporosis development [8–10]. Thus, bone loss as well as its restoration appears to be tie around lifestyle behaviors, as well as physical activity patterns and dietary calcium intake [11]. In this study, the association between age and body mass index on bone minerals (indicated by serum calcium and phosphate activities) in postmenopausal women was investigated.

2. Materials and Methods

2.1. Study Design

The study is a prospective cross sectional study of post-menopausal women attending the Saint Philomena Catholic Hospital in Benin City, Nigeria.

2.2. Ethical Consideration

Ethical approval was gotten from the Health Ethics Review Committee of Saint Philomena Catholic Hospital and from the clinic management approved the study. From the participating post-menopausal women we obtained informed consent after adequate, clear and complete provision of information concerning the study. The study also following the guidelines in the Declaration on the Right of the subject/participant [12] and confidentiality of data was guaranteed.

2.3. Site of the Study

The study was carried out in the Saint Philomena Hospital obstetrics and gynecology department. The Hospital is a catholic hospital positioned at number 23 Dawson Road, Benin City, Edo State and was established in February 1941 as a biblical mustard seed. Over the years, the institution has grown to grant medical services in obstrerics, internal medicine, gynaecology, surgery, dermatology dentistry, ophthalmology, and physiotherapy.

2.4. Study Population and Sample Size Determination

The study is targeted at all post-menopausal receiving clinical carefromthe obstetrics and gynecology department of Saint Catholic Philomena Hospital.

The sample size was determined by the formula according to [13];

$$N = [2(z\alpha + z\beta)^2 / (\delta/\sigma)^2]$$

Where $\alpha = 0.05$, $z\alpha = 1.96$; for $\beta = 0.20$; $z\beta = 0.84$.

Hence $(z\alpha + z\beta)^2 = (1.96 + 0.84)^2 = 7.84 \approx 8 / 0.5^2 = 32$.

However, some subjects who will be enrolled in this study may drop out due to the study protocol and other reasons. To deal with this, the sample size was increased by a factor which will be equal to the "attrition rate". Since 20% of 1/(1–0.2) or 1.25. That is, 25% more subjects than the sample size calculation called for were enrolled. This amounted to 40 subjects in each group and included premenopausal women, nulliparous postmenopausal women, and postmenopausal women with parity ranging from one to six and above.

2.5. Inclusion Criteria

The criteria for participating in the study were all medically diagnosed post-menopausal women within the ages of 49 and 69 who are apparently healthy and currently not undergoing any treatments on chronic illnesses.

2.6. Exclusion Criteria

Post-menopausal women who gave consent but had poor obstetric history, history of pathologically influenced menopause, surgical induced menopause, chemotherapy, assisted reproductive technique, or on hormone replacement therapy as well as women chronically ill or on medications for over four weeks were excluded from the study. In addition, those shown to present other chronic illness and are currently on other drugs were excluded from the study. Subjects less than 49 years and above 70 years were excluded from the study. All patients who fail to give consent to be included in the study were also be excluded from the study.

2.7. Sampling Procedures

Post-menopausal women who met the inclusion criteria were invited to take part in the study by visiting case notes. The convenient sampling method was adopted for recruiting women into the study after confirmation of menopause.

2.8. Sample Collection

Post-menopausal women who gave consent were required to complete a questionnaire that has been pretested. The questionnaire contained their bio-data, medical and obstetric historyand blood samples obtained after completion of the structured questionnaire following standard procedures.

2.9. Sample Analysis

Anthropometric parameters such as height and weight were determined using standio meter (measured in meters; Avery Berked, UK) and weighing scale (measured in kilograms; Avery Berked, UK) respectively and body mass index determined with formula; Weight in Kilogram/Height in meter square (Wt/Ht^2).

Estimation of serum calcium and phosphate: Serum calcium was estimated by using spectrophotometer methods following the procedures previously outline by Tietz [14]. Inorganic phosphorus was estimated following the methods by Daly and Ertingshausen [15] using the spectrophotometer

2.10. Data Analysis

The data obtained were analysis using the Statistical Package for Social Sciences (SPSS) version 20. The data were subjected to descriptive statistic (frequency, percentage and mean) and inferential statistics ("t-test") and statistical difference was determined at a confidence interval of 95% and $p<0.05$ was considered significant.

3. Results

Table 1 shows the age and BMI of the women that participated in the study. Of course there was a significant difference ($p<0.05$) in the mean ages of the premenopausal (31.73±11.45 years) and postmenopausal (57.06±5.57 years) groups of women considering that menopause is a factor of age. Although the mean height between the groups was not

significantly different (1.51±0.37m vs. 1.56±0.11m; p>0.05), post-menopausal women (67.30±15.68 Kg) had statistically significant higher (p<0.05) body weight compared to the premenopausal women (60.49±17.17 Kg). Overall, there was a significantly higher body mass index in the postmenopausal women ((27.60±4.32 Kg/m^2) compared to the premenopausal women (25.42±4.16 Kg/m^2).

Table 1. *Biological profile of the women participating in the study.*

Groups	N	Age (years)	Height (M)	Weight (Kg)	BMI (Kg/m^2)
Premenopausal	40	31.73±11.45	1.51±0.37	60.49±17.17	25.42±4.16
Postmenopausal	280	57.06±5.57*	1.56±0.11	67.30±15.68*	27.60±4.32*

N=320; values are mean ± standard deviation; * indicates significant different at p<0.05.

Table 2 shows the mean serum calcium and phosphate in premenopausal and postmenopausal women and their percentage difference. It was a finding here that serum calcium (11.07±1.53mg/dl vs. 8.20±0.41mg/dl) was significantly lower (p<0.05) in postmenopausal women with a percentage different of 25.93%. On the other hand, serum phosphate (2.39±0.45mg/dl vs. 3.71±0.71mg/dl) was significantly higher (p<0.05) in post menopausal women with a percentage increase of 55.23.

Table 2. *Mean serum calcium and phosphate in pre-menopausal and post-menopausal women and percentage different.*

Group	Ca^{2+} (mg/dl)	PO_4 (mg/dl)
Premenopausal	11.07±1.53	2.39±0.45
Postmenopausal	8.20±0.41*	3.71±0.71*
% difference	25.93	55.23

N=320; values are mean ± standard deviation; * indicates significant different at p<0.05.

Table 3 is a correlative table between age and BMI and serum calcium and phosphates in postmenopausal women. It was observed that serum calcium correlates negatively with age (r = -0.064; p>0.05) and BMI (r=-0.055; p>0.05) in the postmenopausal women. However, serum phosphate was observed to correlates positively with age (r = 0.077; p>0.05) and BMI (r = 0.131; p<0.05) with BMI presenting a significant correlates.

Table 3. *Association between age and BMI on serum calcium and phosphate in postmenopausal women.*

		Ca	PO_4
Age	Coefficient	-0.064	0.077
	P-value	0.282	0.198
BMI	Coefficient	-0.055	0.131*
	P-value	0.356	0.028

* indicates correlation is significant at p< 0.05 level

4. Discussion

The findings of this study showed that postmenopausal women had a 25.93% reduction but a 55.23% excess of serum calcium and phosphate respectively compared to premenopausal women. This opposite relationship between serum calcium and phosphate has also been observed by the study of Shakoor et al. [16]. In fact, a study has showed a progressive significant decrease in serum calcium and a progressive significant increase in serum phosphate from ages 45-50, 51-55 and 56-60 in postmenopausal women [16]. This result implies that postmenopausal women may be exposed to increased risk of Osteoporosis; noted earlier as a public health issues contribute to a large socio-economic burden [4 – 6]. It is known that due to a reduction in hydroxypatite crystal formation, calcium and phosphorus deficient osteoporotic woman may have a decrease rate of bone mineralization [17]. Numerous factors such as age, body weight, physical inactivity, cigarette smoking, excess alcohol intake or concomitant diseases affect bone mass [18]. In this study we investigated the influence of age and BMI on body minerals in postmenopausal women considering their increased risk for osteoporosis.

In the present study, we report that age has a non-significant negative correlates with serum calcium but positive non-significant correlates with serum phosphate. By this it implies that increasing age may inhibit serum calcium while stimulating serum phosphate. Although acquirement of highest bone mass begins in mother womb, and completed by 40 years, the amount of bone that is gained in pubertal period is the main contributor to this process [19]. Bone loss accelerates in the latest years after cessation of ovarian function at menopause and bone mass endures to decline with age [20]. This is in agreement with the observed negative correlation between age and serum calcium level in this study. In addition, the study by Shakoor et al. [16] reported significant negative correlation between age and serum calcium and a significant positive correlation between age and serum phosphate. Also in accordance with the observed negative correlation between age and serum calcium, a study has reported that the level of serum calcium declined significantly in post-menopausal women with respect to their age [21]. This effect between age and serum calcium may be related to poor calcium absorption as age progresses. In agreement with this assertion, Gallagher *et al*. [22] documented that intestinal calcium absorption decreases with aging in postmenopausal women and results in decreased serum calcium level.

In this study we observed body height was not significantly differs between the premenopausal and postmenopausal women but weight was significantly higher in postmenopausal women compared to premenopausal women (table 1). This finding corroborates that of Shakoor et al. [16] who had shown that height of women between the ages of 45-50, 51-55 and 56-60 did not significantly differ by there was significant progressive increase in body weight. The observation in the present study showed that the

premenopausal group was 0.52kg/m^2 slightly above the upper limit of a normal BMI while the postmenopausal group was about 2.70kg/m^2 above the upper limit of a normal BMI. These give a percentage BMI increase of 2.09% for the premenopausal women and 10.84% for the postmenopausal women. In another line of thought, this implies that the postmenopausal women are 8.75 times more likely to be overweight compared to premenopausal women. These results are similar to the results of study of Hannan *et al*. [20] who observed that increase in fat mass is associated with increase in age and the study by Khatak *et al*. [21] found that there was increase in BMI with age in postmenopausal women.

The relationship between BMD and BMI is poorly defined considering some authors reporting positive relationship and others documentations showing BMI as risk factor for osteoporosis [23]. We showed that BMI negatively correlates with serum calcium but positively and significantly correlates with serum phosphate in postmenopausal women (table 3). This implies that the risk of osteoporosis is higher in postmenopausal women with higher BMI. In line with this observation, Hsu *et al.* [24] has reported a negative relationship between fat mass and bone mass. A study conducted on women with osteopenia/ osteoporosis to find out the association between body mass index and bone mineral density, shown that BMI has an inverse relationship with BMD status [25]. In fact, another study has reported that fat mass is inversely correlated with bone mass [26].

5. Conclusion

Based on the findings of this study, it was concluded that age and BMI influence serum minerals necessary for bone density and can have impact on osteoporosis in postmenopausal women. The findings are that age and increased BMI may negatively correlate with serum calcium but positively correlate with serum phosphate. This implies that menopausal women can improve their bone health by increasing intake of calcium rich diet and increased effort to reduced excessive weight gain.

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