Evaluation of Lifestyle and Some Biochemical Parameters Involved in Bone Health in Pre and Postmenopausal Cameroonian Women

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ABSTRACT

Aims: A healthy skeletal system with strong bones is essential to overall health. This study aimed to assess lifestyle and bone's biomarkers of women.
Study Design: This was a cross-sectional study.
Place and Duration of Study: The enrollment took place at the Yaounde Military Hospital from November 2016 to July 2017.
Methodology: A set of 105 postmenopausal and 127 premenopausal participants were enrolled from November 2016 to July 2017 in Yaounde. Their physical activities level was evaluated using a

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questionnaire. Sunlight exposure between 10:00AM and 4:00PM was assessed. Colorimetric methods were used to evaluate calcium, albumin, and alkaline phosphatase activity in plasma. These parameters were then compared within year since menopause (YSM) and osteoporosis risk assessment instrument (ORAI) sub-groups.

Results: 13.4% participants were moderately active. Only 22.8% participants had at least 30 minutes sun exposure daily. A multivariable analysis of demographic, lifestyle, biochemical characteristic revealed age, BMI, albumin and calcium were the main factors that influenced bone health among our participants. A significant difference of calcium concentration was found between the two groups whereas albumin was significantly higher in premenopausal than postmenopausal. Albumin was the only variable with a significant difference in the YSM sub-groups while only calcium was non-significantly higher among the ORAI sub-groups.

Conclusion: Elevated plasma level of calcium, albumin and alkaline phosphatase could be indicators of high bone turnover.

1. INTRODUCTION

Bone health is critically important to the overall health and quality of life [1]. Healthy bones provide the body with a frame that allows for mobility and protection against injury. Risk of developing serious bone problem is greater in postmenopausal and physically inactive women who are elderly, thin and small framed. This risk is also important in women who have a deficient calcium intake [2]. In postmenopausal women, the drop of estrogen causes a negative remodeling balance with a high osteoclastic resorption not compensated by increased osteoblast functions. This concept tends to be supported by reports of cytokine mediated inhibition of bone resorption by estrogens *in vitro* [3]. There is also evidence of reduce renal tubular reabsorption of calcium in both normal and osteoporotic postmenopausal women [4].

Research and development over the past decade have identified several blood and urinary molecules as markers of bone metabolic activity, providing estimations of the rates and direction of the biological activities governing bone turnover [5]. Bone turnover markers are generally subdivided into two categories: biochemical markers of bone formation and biomarkers of bone resorption. Because of the cost, the availability and the specificity of some of these biochemical markers, there are some worries in their routine use for diagnosis in clinical application. Adverse changes in plasma calcium, phosphate, alkaline phosphatase, albumin due to estrogen deficiency have been implicated in the increased incidence of osteoporosis in postmenopausal women [6]. Besides, these markers are generally available, have better sensitivity and specificity for osteoporosis diagnosis but they are rarely used routinely in

clinical laboratories in Cameroon to diagnose osteoporosis. In bone disease, it is crucial to identify individuals, who need intervention, or monitor those on treatment. Interestingly, biochemical bone turnover markers reflect changes in bone metabolism more rapidly than changes in other clinical test such as bone mineral density and could potentially be used as indicator in the diagnosis and monitoring of metabolic bone diseases [7].

As with many conditions, physical activity is promoted as a potentially beneficial activity for bone health. It has been related to a higher risk of osteoporotic fracture; may postpone the age-related decline in bone mineral density (BMD), and by that reduce the risk of fracture [8]. Previous studies showed significant continuing increase in bone mass in exercising premenopausal young women compared to non-exercising controls [9].

Sunlight exposure can reverse bone loss caused by osteoporosis. In a cohort study in Japan, Sato, et al. [10] reported that sunlight exposed women had an increased bone mass by an average of 3.1% as compared to 3.3% decreased in the non-sunlight-exposed group and more importantly, this latter group had a fracture rate 6 times higher than the sunlight exposed women. Vitamin D plays an important role in calcium homeostasis and bone metabolism. Its synthesis in the skin is dependent on sun exposure (specifically UVB radiation) which is an important major natural source.

Even though bone disease often strikes late in life, the importance of beginning prevention at a very young age and continuing it throughout life is now well understood [1]. The Cameroonian

population is predominantly female and this population could be facing serious bone disease in the coming decades. Data on prevention of bone disease especially relationship between lifestyle (physical activity, sunlight exposure) biochemical bone markers in central Africa and particularly in Cameroon are non-existent. Our study hypothesizes: plasma concentration of some specific biochemical markers of bone formation could lead to high risk of osteoporosis in women; secondly lifestyle may improve plasma calcium concentration, thirdly menopausal duration and osteoporosis risk assessment instrument could affect the selected biochemical markers of bone. Thus, this cross-sectional study was aimed at assessing the physical activity level and bare skin sunlight exposure and also determining the plasma concentration of calcium, phosphate, alkaline phosphatase activity, and albumin of pre- and postmenopausal women in Yaounde, Cameroon.

2. MATERIALS AND METHODS

2.1 Study Area and Population

Participants were Cameroonian women living in Yaounde aged 18 years and older, not pregnant and having consented voluntarily. The menopausal status was considered here as the permanent cessation of menstruation resulting from loss of ovarian follicular activity. This was a retrospective definition since it was based on a 12 months consecutive amenorrhea period with no obvious physiological or pathological cause. The enrollment took place at the Yaounde Military Hospital from November 2016 to July 2017. The aim of the study was first explained to prospective participants. This process was done in markets, schools; offices, churches, gatherings and the hospital. Volunteers were invited to the Yaounde Military Hospital for enrollment. Three hundred and six (306) volunteers were assessed for eligibility criteria and we had 249 eligible for the study. We finally recruited 232 participants and this gave a respond rate of 93.2%. The attrition rate of 6.8% was due to non-respect of appointment and inability to obtain consent. During the enrollment, according to their menopausal status, the enrolled participants were grouped into postmenopausal (105) and premenopausal (127) apparently normal women. All women under any medication interfering with bone metabolism were excluded. Participants with known pathology of bone or calcium and phosphorus metabolism or major heart, liver or kidney diseases or malignancies were also excluded.

2.2 Data and Samples Collection

Information on socioeconomic status, occupation, educational level, and weight-bearing exercises was collected using a well-structured-questionnaire developed for this study. Anthropometric parameters (height, weight) were measured and the body mass index (BMI) was calculated as mass (Kg) / height $(m)^2$. The participants attended the laboratory in the morning after an overnight fast. From each woman enrolled in this study, 5ml of venous blood sample were collected in heparinized coated tubes under fasting conditions. Plasma was separated by centrifugation at 3000 rpm for 10 minutes and aliquots were stored at -70ºC until analysis.

2.3 Physical Activity Assessment

Physical activity was assessed through self-reporting with question adapted from the International Physical Activity Questionnaire (IPAQ) [11]. Each participant indicated its level of activity on average during each week over the last 2 months. Activities were defined as either "intensive" (carrying heavy load, digging holes or playing football), "moderate" (jogging, riding a normal bike not including walking) or non-stop walk for at least 10 minutes. Those who did not carry out one of the physical activities mentioned in the questionnaires were declared inactive. For each level of activity, participants indicated how long and how many days during the last 7 days each specific activity was performed. Participants were also asked to only mention physical activities that they did for at least 10 minutes. Categories of activity were not mutually exclusive since participants would have taken part in intense and moderate activities or non-stop walk for at least 10 minutes during the past 7 days. The total activity of each participant was gotten by summing up the time spent practicing each activity.

2.4 Sun Exposure

Sunlight exposure of each participant during each week was estimated by evaluating, the average daily bare skin (arms, legs or the hands, arms, and face) exposure to sun between 10:00 AM and 4:00 PM. The selection criteria ranged from less than 5 minutes to more than 30 minutes a day. Sun exposure was considered acceptable if it was more than 30 minutes daily.

2.5 Biochemical Analysis

Biochemical analysis were performed on the plasma sample of each enrolled participant in order to determine the concentrations of calcium, phosphate, magnesium, albumin and creatinine as well as the activity of alkaline phosphatase (ALP). The kits and reagents used for these analyses were from BIOLABO. Each of these biochemical parameters was measured with a semi-automated analyzer (Kenza Max Biochemistry from BIOLABO) following the manufacturer instructions.

Total calcium concentration was determined with the method described by Moorehead and Briggs [12]. In alkaline solution, O-Cresol PhtaleinComplexone (CPC) reacted with calcium to form a dark-red coloured complex which absorbance was measured at 570 nm.

Inorganic phosphorus was measured as described by Daly and Ertingshausen and modified by Gamst and Try [13,14]. In an acid medium, phosphate ions formed a phosphomolybdic complex with ammonium molybdate. Its absorbance measured at 340 nm was proportional to the concentration of phosphate ions in the specimen.

Magnesium was determined by Gindler and Heth [15] and Khayam-Bashi, Liu and Walter [16] methods. Calmagite, a metallochromic indicator formed a coloured complex with magnesium in basic medium. The absorbance, measured at 510-550 nm, was proportional to the magnesium concentration in the specimen.

The activity of alkaline phosphatase was evaluated following the recommendations of the German Society of Clinical Chemistry [17] and the Scandinavian Society of Clinical Chemistry [18]. In alkaline solution, ALP catalyzed the hydrolysis of p-nitrophenylphosphate in p-nitrophenol and phosphate. The activity was measured at 405 nm.

The kinetic method based on the Jaffe reaction was used to test creatinine [19]. The colorimetric reaction of creatinine with picrate was measured kinetically at 490 nm.

Bromocresol green method was used to test albumin. In buffered solution at pH 4.2, bromocresol green bonded to albumin to form a coloured compound which absorbance was measured at 630 nm.

2.6 Osteoporosis Risk Assessment

It was evaluated by the osteoporosis risk assessment instrument (ORAI) as described by Cadarette, et al. [20]. The ORAI calculates the risk scores according to age, weight and current estrogen use of postmenopausal women. According to ORAI scores, postmenopausal participants were subdivided into two sets. The first set contained women with an ORAI score below 9 while the second set was constituted of women with ORAI scores of 9 or greater. Be-side this subdivision, participants were also subdivided into 4 groups according to the duration of their menopausal state. Each of these groups contained women respectively in menopause for 1-5 years, 6-10 years, 11-15 years and more than 15 years.

2.7 Data Analysis

Data was cleaned, coded and entered using Microsoft excel and exported to EPI info 7 for statistical analysis. Data were presented as mean ± SD for continuous variables and percentages and frequencies for categorical variables. The Pearson's Chi-square was used because the dependent (menopausal status) or independent (demographic, lifestyles and biochemical) variables had two or more categories. Variables were analyzed using logistic regression analysis. Variables that reached a likelihood ratio P-value < 0.05 in univariable analysis were included in the multivariable models. In addition, other variables that have been scientifically confirmed to influence bone health were also included in these multivariable analysis and a manual forward stepwise method was used to select most significant independent variables. We made sure at no point of our analysis did the number of independent variables exceeded 10 variables as recommendations by Altman [21]. All the variables were included in Table 2. The relationship between biochemical markers and menopausal duration (YSM) and osteoporosis assessment (ORAI) was also done using linear regression analysis (Table 3). The overall accepted level of statistical significance was set at P < 0.05.

3. RESULTS AND DISCUSSION

3.1 Participant Characteristics

A total of 232 participants including 127 (54.7%) premenopausal and 105 (45.3%) postmenopausal apparently normal women were

enrolled in this study. The age of premenopausal women ranged between 18 and 61 with a mean age of 31.9±10.0 years. Their mean BMI was 27.3±6.2 Kg/m^2. Among the 127 premenopausal women, 47 (37%) were 25 years old or less while 15 (11.8%) had more than 45 years. Three participants (2.9%) (one woman of 61 years and two others of 53 years) were experiencing a late menopause since they declared being in a premenopausal state. The age of postmenopausal women was between 45 and 81 years with a mean age of 57.8±7.4 years. The mean of their BMI was 30.4±6.4 Kg/m^2. Among the postmenopausal women, 25 (23.8%) were below 52 years. Among the 232 participants enrolled in this study, 143 (61.6%) answered no when asked if they knew that bone metabolism was altered after menopause.

3.2 Lifestyle Assessment

Overall, 53 women (22.8%) were inactive while 179 (77.2%) were performing some physical activities. The period spent practicing ranged from 0.5 to 14 hours per week (Table 1). Only one (0.4%) premenopausal woman aged 18 years had intense activity while overall, 31 (13.4%) performed moderate activity. Non-stop walk for at least 10 minutes was practiced by 175 (75.4%) women. Less than half of them (47.4%) were postmenopausal. Among postmenopausal, 40 (38.1%) women walk daily for at least 30 minutes on average whereas it was only 20 (15.7%) among premenopausal women. In this

latter group the number of woman with moderate activity was about the same 21 (15.9%).

Out of the 232 women, only 53 (22.8%) had more than 30 minutes daily sunlight exposure. Over two-thirds (67.9%) of them were postmenopausal. More than half (51.7%) of all the participants reported having 15 minutes or less sun exposure.

Overall, about 77.2% participants had insufficient sun exposure or low physical activity (Fig. 1). Detail analysis revealed that about 21.9% postmenopausal women had acceptable behavior: More than 30 minutes sunlight exposure and at least 30 minutes non-stop walk daily.

3.3 Biochemical Characteristics

To analyze the biochemical variables, the covariates controlled were age, BMI and physical activity. The mean concentration of plasma calcium was 8.2±0.9 mg/dl in premenopausal participants and 8.3±1.4 mg/dl in postmenopausal women (Table 2). When the variables were adjusted, a statistically significant difference was found between the mean calcium concentrations for the two groups. The alkaline phosphatase activity in plasma was higher in postmenopausal participants (154.3±49.6 IU/l) than in premenopausal (121.1±43.5 IU/l). However, no significant difference was found between these two groups (P = .05). Albumin

Table 1. Number of participants by level of activity in hour per week

	Premenopausal			Postmenopausal		
Time (hour)	0.5-4.5	5-9.5	10-14	0.5-4.5	5-9.5	10-14
Intense activity (n (%))	1 (100)	n/r	n/r	n/r	n/r	n/r
Moderate activity (n (%))	17 (54.8)	4 (12.9)	n/r	10 (32.3)	n/r	n/r
>10mins nonstop walk (n (%))	82 (47.7)	7 (4.1)	1 (0.6)	61 (35.5)	15 (8.7)	6 (3.5)
n/r = no respondents						

Table 2. Multivariable analysis of biochemical characteristics and menopausal status of participants (N=232)

Variables	Premenopausal	Postmenopausal	*P* value (unadjusted)	*P* value (adjusted)
Albumin (g/l)	41.4 ± 6.7	40.8 ± 6.7	.47	.03*
Creatinine (mg/dl)	0.8 ± 0.2	0.8 ± 0.3	.34	.43
Calcium (mg/dl)	8.2 ± 0.9	8.3 ± 1.4	.45	.00*
Phosphate (mg/dl)	3.1 ± 2.9	3.4 ± 0.9	.44	.42
Magnesium (mg/dl)	2.0 ± 0.2	1.9 ± 0.3	.32	.35
Alkaline phosphatase (IU/l)	121.1 ± 43.5	154.3 ± 49.6	.00*	.05

Data are presented as mean ±SD, the covariates controlled were age, BMI and Physical activity (hour), * statistically significant
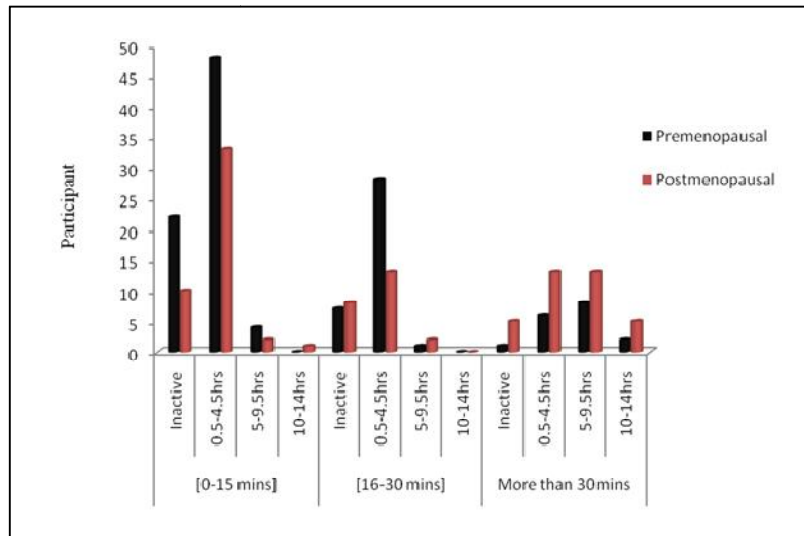
Fig. 1. Number of participant according to lifestyle (physical activity and sun exposure)
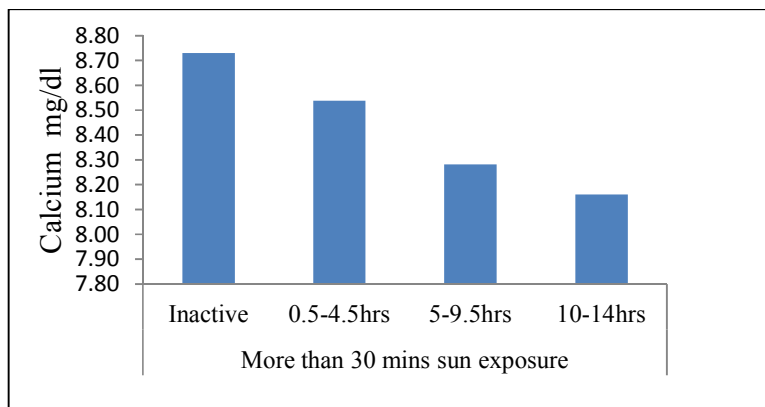

Fig. 2. Calcium concentration of postmenopausal participants according to lifestyle (physical activity and sun exposure)

level was statistically higher (P=.03) in premenopausal women (41.4±6.7 g/l) than postmenopausal (40.8±6.7 g/l). Creatinine, phosphate and magnesium levels did not differ between the two groups (Table 2).

A clear variation of plasma calcium concentration was only observed within the sub-group of postmenopausal participants with more than 30 minutes sun exposure. As shown on Fig. 2, the mean calcium concentrations slightly decreased as women of this sub-group became more physically active.

The mean ORAI score of the postmenopausal women was 9.3±0.5 with 30 (28.6%) of them having a score of 9 or greater. Their mean year since menopause was 8.3±7.5 years. As

highlighted on Table 3, there was a significantly higher (P=.00) plasma albumin level (51.7±7.9 g/l) in women who had been in the postmenopausal state since 11 to 15 years. The calcium level was higher (8.7±9.3 mg/dl) in postmenopausal women with an ORAI score of 9 or greater than those with a score lower than 9 (8.2±1.5 mg/dl). However, no significant difference (P=.08) was found between the two groups. Phosphate, magnesium, albumin, creatinine and alkaline phosphatase levels did not change among these two groups (Table 3).

3.4 Discussion

Menopause is a natural physiological phenomenon occurring in women. It is neither a disease nor a dysfunction of the organism even

though there is the arrival of many biological changes such as the deterioration of bone metabolism which can lead to osteoporosis. A reliable analysis of 36 epidemiological studies spanning 35 countries, estimated the mean age of menopause at 48.8 years, with considerable variation by geographical region [22]. In this study, three participants (one 61 and two with 53 years) had late menopause. A woman can experience late-onset menopause if she has both increased BMI and increased sex hormone concentrations [23]. Biological and environmental factors as well as genetic factor are the sources of variation in menopause age [24]. Early menopause aggregates within families and so do late menopause [24]. If a woman's mother experiences late-onset of menopause, she may also experience it.

The mean body mass index (BMI) of postmenopausal participants (30.4±6.4 Kg/m^2) was significantly higher (*P*=.00) than premenopausal (27.3±6.2 Kg/m^2). According to the proposed cut-off points by a World Health Organization expert committee, the above values correspond to obesity and overweight states respectively [25]. At menopause, the drop in estrogen favors abnormal fat accumulation in adipocytes, a decrease in lean body mass as well as basal energy expenditure. It was well established that during the transition from premenopause to postmenopause, there was a marked increase in the amount of visceral adipose tissue [26]. In normal pre- and postmenopausal women, total body fat was positively related to bone mineral density throughout the skeleton [27]. Therefore for our postmenopausal participants with a mean BMI of 30.4±6.4 Kg/m^2, fat mass, which was the most important indices of obesity, could have

beneficial effect on increasing bone mass; and reducing the risk of fracture and osteoporosis.

Participants of this study were 77.2% active and they practiced from a minimum of 0.5 hour to a maximum of 14 hours weekly. This maximum was more than 2 times lower than what was reported by Muir, et al. in postmenopausal women of at least 75 years [28]. Overall, we also had a disappointing 13.4% participant with moderate activity. This was not good news even for young premenopausal since it had been confirmed that active practicing of sports in young ages had a beneficial effect on skeletal health in older time of life [8,29]. Only 10 (9.5%) postmenopausal participants were moderately active, those who were not (90.5%) were more vulnerable to bone disease since estrogen deficiency appeared to reduce the sensing of biomechanical strains by bone cells [30]. About three-quarters (75.4%) of the participants had walking exercise programs. Unfortunately, this does not generate high-intensity loading forces, nor does it represent a stimulus to bone in most individuals. Authors had observed that in healthy postmenopausal women, brisk walking had no effect on bone mineral density [31,32]. These findings do not rule out the possibility that habitual walking for many years helps to preserve bone.

In the current context of modernized world, the population is moving indoors, and even in the areas that are sunny throughout the year, sunlight exposure and vitamin D deficiency is increasing, both in rural and urban populations. Our results on sunlight exposure confirmed this deficiency since only 22.8% of our participants had more than 30 minutes daily bare skin sun exposure while 51.7% had less than

Table 3. Biochemical variables related to menopause duration and osteoporosis assessment

	Calcium (mg/dl)	Phosphate (mg/dl)	Magnesium (mg/dl)	Creatinine (mg/dl)	Albumin (g/l)	ALP (IU/l)
YSM (year)						
1-5 (n=54)	8.2±1.4	3.5±1.0	1.9±0.2	0.8±0.3	40.2±6.4	153.7±54.9
6-10 (n=23)	8.0±1.5	3.3±0.7	1.9±0.5	0.8±0.3	40.4±6.1	147.5±46.3
11-15 (n=5)	9.0±1.1	3.3±0.8	1.9±0.2	0.8±0.2	51.7±7.9	175.4±41.3
>15 (n=23)	8.7±0.9	3.2±0.6	2.1±0.2	0.8±0.1	40.2±6.1	157.9±41.8
P value (unadjusted)	.19	.53	.26	.98	.00*	.69
ORAI						
< 9 (n=75)	8.2±1.5	3.3±0.7	1.9±0.4	0.8±0.3	40.7±6.7	153.8±54.3
≥9 (n=30)	8.7±0.9	3.6±1.1	2.0±0.2	8.41±0.2	40.9±6.8	155.5±35.8
P value (unadjusted)	.08	.23	.38	.88	.88	.87

*Data are presented as mean ±SD, YSM = year since menopause, ORAI = osteoporosis risk assessment instrument, * statistically significant, ALP = Alkaline phosphatase*

15 minutes exposure to the sun. This is a very low rate of sun exposure that could easily lead to weaker bone. A study in Spain has shown that women who were sun seekers had only about one-eleventh the risk of hip fracture as those who stayed indoors [33]. Sunlight exposure plays important role during the synthesis of vitamin D and therefore could affect its plasma level since skin has been reported as the main source of vitamin D in many people. Indeed, vitamin D synthesis occurs when the 7-dehydrocholesterol receives a sufficient dose of solar ultraviolet B radiation (290-315 nm). If our participants do not take a diet rich in vitamin D to compensate the deficiency resulting from the lack of skin photosynthesis of this vitamin, their means serum level in vitamin D will probably be low. This may affect the calcium and phosphorus metabolism which is regulated not only by vitamin D and food intake but also by thyroid and sexual hormone like estrogen.

The significant difference (*P*=.00) observed between the plasma calcium level of premenopausal (8.2±0.9 mg/dl) and postmenopausal participants (8.3±1.4 mg/dl) was in accordance with results of Usoro, et al. [34] and Nordin, et al. [35] in the same groups of women in Nigeria and Australia respectively. At menopause, there is a negative remodeling balance with a high osteoclastic resorption not compensated by increased osteoblast functions. In fact, cytokine might mediate inhibition of bone resorption by estrogens *in vitro* [3]. Loss of estrogen at menopause or by ovariectomy is associated with increased secretion of IL-1, IL-6, and TNF-α from the peripheral blood monocytes, bone marrow stromal cells, or osteoblast and decreased expression of TGF-β in bone [36]. Elevated levels of these factors result in increased osteoclastogenesis. There is also evidence of reduce renal tubular reabsorption of calcium in both normal and osteoporotic postmenopausal women [4].

Even though alkaline phosphatase (ALP) level was higher in postmenopausal participants than in premenopausal, this was not statistically significant. This finding correlated with the results of Usoro, et al. [34] and Bhattarai, et al. [36]. In their study, Mukaiyama, et al. [37] had a significantly higher total ALP and bone ALP levels in postmenopausal women in their 80s than those who were in their 60s. ALP is involved in producing osteoid and mineralization of bones, in the absence of liver disease, its level can provide information about bone turnover [37].

Albumin level was higher (*P*=.03) in premenopausal participants (41.4±6.7 g/l) than postmenopausal (40.8±6.7g/l). These results can be explained by the fact that serum albumin concentration decreases in the course of ageing particularly in the osteoporosis women and inadequate intake of proteins might be the cause of lowered albumin [38].

Regarding postmenopausal women who were subdivided according to year since menopause, a significant (*P* = .00) difference was observed in the plasma concentrations of albumin. However, no significant difference was observed in the plasma concentrations of calcium, phosphate, magnesium and creatinine as well as the ALP activity. The rate of bone loss is most rapid in the early postmenopausal period and subsequently begins to level by 5 years postmenopause [39]. Biochemical markers of bone turnover are poor at categorizing women into fast and slow losers of bone [40].

Calcium was non-significantly (*P* = .08) higher in participant with and ORAI score of 9 or greater. The fact that its renal tubular reabsorption is reduced after menopause could be a possible explanation to this phenomenon since it is suggested that estrogens promote tubular reabsorption of calcium by the kidney [4]. An ORAI score of 9 or greater is the threshold to recommend further testing with bone densitometry [20].

The primary limitation of this study is the characterization of participants at one point in adulthood without knowledge of the sequence of previous bone health risk factors. This cross-sectional study might not provide accurate estimates of relationships between sunlight exposure, physical activity, and other lifestyle and biochemical variables that can change with time. Another issue is the non-representative nature of the sample that could reduce the generalizability of results, the potential for residual confounding and the potential for errors in or bias self-reported data. The dietary minerals intake is lacking due to unpublished data on the nutritional value of foods consumed in Cameroon. Other biomarkers of bone turnover were not analyzed in this study. Despite these limitations, these data generated here have provided a descriptive picture on bone health of Cameroonian women. They could therefore be used as a baseline for subsequent studies. Additional studies with more parameters and bone biomarkers will enable to establish a good

relationship between lifestyle and bone turnover biomarkers in central Africa.

4. CONCLUSION

This study shows that pre- and postmenopausal women had a low level of weight-bearing physical activity that helps either bone building or maintenance. Its shows also that, women of these two groups were less expose to sunlight and therefore, may have low level of vitamin D. The plasma concentrations of calcium differ significantly between pre and postmenopausal women. The years since menopause (YSM) or osteoporosis risk assessment instrument (ORAI), did not seem to affect the plasma concentration of phosphate, magnesium, creatinine and ALP activity. To maintain a good bone health, women must be encouraged to practice moderately and be more exposed to sunlight.

CONSENT AND ETHICAL APPROVAL

This study was approved by the National Ethics Committee for Human Health Research (ethic clearance Nº2016/08/803/CE/CNERSH/SP). All participants provided informed consent.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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