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ORIGINAL ARTICLE

Bone mineral density, metabolic syndrome, and vitamin D in indigenous from south of Brazil

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Abstract
Summary Bone mineral density (BMD), metabolic syndrome (MS), and vitamin D levels were evaluated in 73 indigenous from south of Brazil aged between 40 and 86 years. BMD loss in lumbar spine was detected in 63 %, MS was detected in 76.7 %, and vitamin D levels were altered in 67 % of subjects.
Purpose This study aims to evaluate bone mineral density and its relationship with metabolic syndrome (MS) and vitamin D levels in indigenous from south of Brazil.
Methods Transversal, descriptive, analytical study was developed in Nonoai City between October and December 2011. Seventy-three indigenous people aged between 40 and 86 years were enrolled. MS was defined according to NCEP-III. Serum levels of vitamin D and other parameters were quantified to define metabolic syndrome. Spine and femur bone mineral density was measured by dual-energy X-ray absorptiometry. Bone mineral loss was classified using the World Health Organization criteria.
Results Sixty-three percent of indigenous participants presented bone mineral loss in lumbar spine, and 19 % in femur. Overall frequency of MS was 76.7 % and more prevalent in females. Lower serum levels of vitamin D were observed in 67 % of the participants. Among the risk factors related to MS criteria, only the HDL levels were associated with bone mineral loss. Regarding nutritional habits, there were positive correlations between fat foods and meat intakes, MS, and low levels of vitamin D.
Conclusions The elderly indigenous people present a high incidence of low bone mineral density, mainly in the lumbar spine, low levels of vitamin D, and a high prevalence of metabolic syndrome. Public health policy should also prioritize chronic degenerative diseases prevention and care for indigenous people. Healthier lifestyle in this population should be a focus for health promotion program by the governments.

Keywords Bone mass density · Metabolic syndrome · Vitamin D · Elderly indigenous

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Introduction

Osteoporosis is defined as a progressive systemic disease, characterized by low bone mass and microarchitectural deterioration, leading to bone fragility and increased risk of fractures [1]. Insufficient levels of vitamin D have been implicated in various disorders such as cardiovascular diseases and also may be related with metabolic syndrome (MS) with few inconclusive studies [2]. In a previous work, we found that indigenous people from south of Brazil have a high prevalence of MS, are sedentary, and have unhealthy eating habits with excess of carbohydrates and low vegetable intake [3]. The sedentary life and lower calcium intake

are well-known risk factors for bone mineral loss, while low fish and seafood intake are risk factors for vitamin D deficiency [1, 2, 4]. Thus, we hypothesize that indigenous, in addition to metabolic syndrome, also could present low bone mineral density and altered serum levels of vitamin D. Moreover, little is known about indigenous health problems which could be detected by simple survey methods as the ones applied in the present study. Vitamin D is important for the homeostasis of calcium and phosphorus, which are essential for musculoskeletal health.

Methods

This research is characterized as a cross-sectional descriptive and analytical study with a convenient sampling where all the subjects that lived on the village Pinhalzinho located at Planalto/Nonoai City (Rio Grande do Sul, Brazil), aged 40 or older were enrolled. Seventy-three indigenous belonging to Kaingang ethical group of both sex were included (Table 1).

This research was approved by the Scientific Committee of the Institute of Geriatrics and Gerontology (IGG/PUCRS-12/29/2012), Research Ethical Committee (CEP 05323/11) from the Pontifical Catholic University of Rio Grande do Sul, and by the Research Ethical National Committee (CONEP, 497/2011-REG: 16,470). The research was also approved by FUNAI (Indian National Foundation) responsible for studies and scientific research with indigenous peoples (opinion 08/1918), and by Indigenous Health District Council of Rio Grande do Sul, FUNASA-RS. Sample collection and interviews started only after the subjects have signed their consent.

The questionnaire contained data regarding anthropometric and social habits, food intake, tobacco and alcohol consumption, use of pharmaceutical drugs (such as hypoglycemic, hypolipemic, and anti-hypertensive), physical activities, and past familial diseases related to MS.

Physical activities were considered in accordance with the indigenous habits, such as agricultural work, hunting, football, and walking between villages. We considered active individuals, those who practiced some type of physical activity for at least 30 min a day, every day.

Diet records were used to estimate average daily food intakes and classified according to recommendations of World Health Organization (WHO) global strategy for healthy eating, physical activity, and health.

The MS diagnosis follows the National Cholesterol Education (NCEP-III) criteria [5] and blood glucose levels were determined according to the International Diabetes Federation [6]. Individuals that present three or more of the following criteria were classified as possessing MS: alteration of blood glucose levels ≥100 mg/dL; cholesterol-HDL <40 mg/dL for men and <50 mg/dL for women; triglycerides >150 mg/dL; waist circumference for men >102 cm and for women >88 cm; blood pressure ≥130/85 mmHg.

The venous blood was collected after at least 8 h of fasting. Serum levels of 25(OH)D (25-hydroxyvitamin D) was determined by Chemoluminescence kit (Siemens, São Paulo). The vitamin D levels were classified as follow: deficient, <20.0 ng/mL; insufficient, 21.0 to 29.0 ng/mL; normal, 30 to 100 ng/mL; and toxic, >100 ng/mL [7].

To obtain of anthropometric data, the indigenous remained barefoot and with light clothes. The waist circumference was measured with the participant in the standing up position using a measuring tape positioned between the lower edge of the last rib and the top edge of the iliac crest. Height was measured without shoes using a mobile vertical metal stadiometer. The weight was recorded with a calibrated electronic scale.

Systemic blood pressure was obtained from the right arm, after 5 min of rest, with devices calibrated by INMETRO.

Densitometry scanning was performed in the Laboratory of Clinical Densitometry, LABDENS, located at São Lucas Hospital by dual-energy X-ray absorptiometry with subject in the supine position. Bone densitometry of the lumbar spine (L1–L4) and proximal femur was determined according to the WHO criteria which uses the *T* score and *Z* score. Subjects were defined as having normal bone mineral density (BMD) with *T* score values of −1 or above, *T* scores between −1 and −2.5 as osteopenic. However for individuals who do not fit these criteria, as men under 50 years and premenopausal women, the *Z* score was used, and if the values was <−2.0, the alterations was considered normal for the age [8].

Table 1 Age, anthropometric data, and bone mineral index of Kaingang ethnic group from south of Brazil

	Female (50)	Male (23)	Total (73)	*p* value[a]
Age (years)	53.8±12.93	58.9±13.69	55.5±13.23	0.134
Weight(kg)	75.2±12.88	80.71±13.57	76.6±12.92	0.099
Height (m)	1.47±0.053	1.60±0.058	1.50±0.08	<0.001
BMI (kg/m^2)	34.54±5.16	31.23±5.35	33.4±5.39	0.014

BMI body mass index

[a]Student's *t* test

The data were analyzed using Epi Info, version 3.5.1. The chi-square test was applied for categorical data, and Fisher's exact test was used when sample were too small. p values below 0.05 were considered as statistically significant.

Results

We have included 73 indigenous people aged between 40 and 86 years. The median age was 55.5 (±13.2)years, and 31.5 % were males and 68.5 % females.

Bone mineral density, vitamin D serum levels, and MS frequency within this population are presented in Table 2. Most subjects (63 %) have low bone mass in lumbar spine, but only 19 % had femur alterations. The Z score was significantly lower for males when compared to females both for lumbar spine (p=0.025) and femur (p=0.007).

The vitamin D serum levels did not shown any relation with BMD in this population. Considering all individuals included, 41 (73.2 %) women and 15 (26.8 %) men present the criteria for MS (76.7 %). When these data (MS) were compared with BMD, no significant difference was detected, although 37 (66 %) of those with MS presented low bone mass (data not shown).

When their diet was analyzed (data not shown), it was noticed between the natives who do not use milk (86.3 %), 79 % presented MS.

Vitamin D deficient or insufficient levels were detected in 67.1 % of the indigenous and 40 subjects had MS. When the criteria for MS where analyzed separately (data not shown), only the HDL levels were significantly related to vitamin D altered levels (p=0.016).

Discussion

This work was one of the first to describe data regarding bone mineral density in indigenous peoples from south of Brazil. Our investigation detected a high prevalence of lumbar bone mass loss, with higher incidence in males.

The first study of bone mass was done with Canadian aboriginal women in 2006, where they found values similar to those presented here. The aboriginal have a higher risk of fractures, more comorbidities and low bone mineral density when compared to their non-Aboriginal compatriots. Moreover, they were more obese and have bone mineral density of the calcaneum and forearm, and overall BMD was significantly lower when compared to White women. The authors pointed that several factors may contribute to the

Table 2 Bone mineral density, vitamin D levels, and metabolic syndrome of Kaingang ethnic group from south of Brazil

	Bone mineral density			
	Female (50)	Male (23)	Total (73)	p
Spine (L1–L4)				
BMD (g/cm^2)	0.89±0.16	0.89±0.14	0.9±0,16	0.871
T score	−1.47±1.52	−1.77±1.33	−1.6±1.46	0.425
Z score	−0.46±1.30	−1.26±1.42	−0.70±1.38	*0.025*
Normal	20 (74 %)	7 (26 %)	27 (37 %)	0.432
Altered	30 (65 %)	16 (35 %)	46 (63 %)	
Femur (total)				
BMD (g/cm^2)	0.94±0.12	0.98±0.11	1.0±0.12	0.152
T score	0.00±1.01	0.38±0.73	−0.1±0.94	0.107
Z score	0.71±0.85	0.13±0.66	0.53±0.83	*0.007*
Normal	40 (80 %)	19 (83 %)	59 (81 %)	0.788
Altered	10 (20 %)	4 (17 %)	14 (19 %)	
Overall BMD				
Normal	20 (74 %)	7 (26 %)	27 (37 %)	0.432
Altered	30 (65 %)	16 (35 %)	46 (63 %)	
Vitamin D	29.6±34.60	27.9±27.57	29.1±32.36	0.847
Normal	17 (70.8 %)	7 (29.2 %)	24 (32.9 %)	0.763
Altered	33 (67.3 %)	16 (32.7 %)	49 (67.1 %)	
MS				
Yes	9 (52.9 %)	8 (47.1 %)	17(23.3 %)	0.102
No	41 (73.2 %)	15 (26.8 %)	56 (76.7 %)	

BMD bone mineral density, *MS* metabolic syndrome

ethnic differences observed such as the social vulnerability of Aboriginal population that is associated with nutritional deficiencies, low educational level, and high comorbidity. Indeed, evidence indicates that ethnicity is a factor that can affect the risk of osteoporosis and fractures and racial differences are well described in the literature. American Blacks, for example, have high bone mineral density and low risk of fractures; meanwhile, Asians have low bone density associated with decreased risk of hip fracture, possibly due to differences in skeletal size and femur length [9, 10].

It is known that weight gain is directly related to cardiovascular disease and diabetes, which is dependent of life habits and reduced physical activity. In the present population, men had higher stature and lower BMI than women (p=0.001 and p=0.014, respectively). In contrast to our findings, a study conducted with indigenous from Australia has shown that 25 % of men and 30 % of women had low BMI, and the authors justified their findings by the traditional way of life and normal health condition without presence of comorbidities presented by this population [11, 12].

Indigenous people from Xavante ethnic group (Mato Grosso, Brazil) conducted during the 1960s pointed that they had their lifestyles based on hunting, fishing, and gathering, with high physical activity. At that time, 90 % of the subjects had a BMI within the normal values, and the average of BMI for women was 22.0 kg and for man was 23.8 kg [13]. However, when this population was studied again in the 1990s, the authors notice many changes in their diet and lifestyle, most notably due to industrialization and low physical activity, showing that females BMI increased to 25.2 kg and males increased to 25.8 kg [14].

Natives from Alaska present risk factors for osteoporosis, low calcium intake, are chronic users of oral corticosteroids, and have increased risk of low bone mineral density [15]. Additionally, bone mineral density of postmenopausal indigenous from North America and natives from Alaska compared with non-Hispanic White women has shown that the two groups had similar BMD, suggesting that the natives are extremely obese and have high bone mineral density in some locations compared to extremely obese non-Hispanic White women [16].

The prevalence of MS in the American population is around 35 % and progressively increases according to age group, for example, between 60 and 69 years; 43.5 % of this population has MS, regardless of gender [16, 17]. The indigenous enrolled in the present study was evaluated 3 years ago, and by then, 65.3 % had MS [3]. At present, these indices raised to 76.7 % corroborating data from literature that point to the increasing incidence of MS, regardless the ethnic origin [18].

Changes in diet, sedentary lifestyle with reduced physical activity, high caloric food intake and obesity may have contributed to the transition of the epidemiological profile indigenous people [19].

A study involving healthy non-indigenous individuals has shown that subjects with MS have vitamin D values below normal levels, although with no correlation with HDL, waist circumference, blood pressure, and glucose levels. However, low levels of 25(OH) vitamin D were associated with increased levels of LDL and triglycerides [20]. Additionally, other study described bone loss and metabolic syndrome in 61.7 % of participants, and low levels of vitamin D were found in 90 % of participants [21].

When changes of bone mass were compared with the MS, we notice that the percentage of indigenous people with BMD changes is higher in individuals with MS (80.4 %), although with no statistical significance (p=0.326). The literature reports that the combined effect of risk factors for MS and its relationship with bone health are still controversial. Overweight and obesity protect against excessive bone loss during aging. An analysis that included 60,000 men and women from 12 different ethnic groups showed that low BMI is associated with increased fractures, and bone mass change was associated with central adiposity. Despite that hyperglycemia predict bone loss and osteoporotic fractures, the association between high glucose levels with bone mineral density is not conclusive [22]. The evidence of association between alterations on triglycerides or HDL levels and hypertension with bone mineral density are also contradictory [23].

Experimental studies and epidemiological data demonstrate that obesity itself, as well as other components of the MS, may have negative influence on the bone architecture. Furthermore, the contradiction between low BMD and high risk of fracture in patients with type 2 diabetes has not been clearly explained [24].

In contrast to our study, there was a research about bone mineral density with aborigines from South America where BMD in the femur was higher when compared to a White population. No significant differences were observed in the bone mineral density of the lumbar spine. The authors pointed out that the intense physical activity required by their lifestyle may cause the increased BMD at proximal femur. Additionally, the elevated vitamin D levels, produced by increased sun exposure, can lead to greater absorption, despite the low calcium intake [25].

Conclusion

The Brazilian population is the result of a long miscegenation process, whose intensity has varied over time. A mix of several ethnic groups that includes African, indigenous, and European immigrants produced values, beliefs, and behaviors, unique for Brazil. There are few studies that evaluate the metabolic syndrome and bone mass density in indigenous populations. This study was designed to evaluate the

BMD and its relationship with the MS among middle-aged and elderly indigenous from Kaingang ethic group living in southern rural areas.

We found a high prevalence of MS, mainly in women, alterations on BMD with higher incidence in lumbar spine when compared to femur, and alterations on vitamin D levels. However, we did not detect a correlation between MS and BMD, vitamin D levels, and BMD, but an association between vitamin D levels and HDL levels was found.

Further studies with indigenous populations from other ethnic groups from Brazil and other countries could contribute to determine lifestyle changes due to an increasing contact with urban society and its relationship with the increasing incidence of chronic diseases in native's populations.

Conflicts of interest None.

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