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Original

Risk factors and prevalence of osteopenia and osteoporosis in postmenopausal women diagnosed by bone densitometry

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Abstract

Aim: To determine the prevalence of osteoporosis in postmenopausal Costa-Rican women who attended the Hospital San Juan de Dios of the Caja Costarricense del Seguro Social and to relate it to clinical and lifestyle characteristics.

Methods: Cross-sectional study. A total of 923 bone densitometry studies of postmenopausal women aged between 45 and 80 years were analyzed. A *T-score* value obtained by bone densitometry for lumbar spine and hip was recorded. Age, body mass index, smoking, and other recognized risk factors for osteopenia/osteoporosis were documented. The prevalence of osteopenia and osteoporosis was estimated and the relationship with the factors was analyzed.

Results. Risk factors significantly associated with the disease were: older age ($p<0.001$), earlier age at menarche ($p=0.001$), number of years since menopause ($p<0.001$), and family history of hip fracture ($p=0.01$). Other risk factors were not significant.

Conclusions. The prevalence of osteopenia and osteoporosis in postmenopausal women were 47% and 39% respectively. No relationship was established for lifestyle variables such as smoking, alcoholism, physical activity, and dairy consumption. Further research is required with greater control over these variables to establish their risk related to the disease.

Keywords: osteoporosis, metabolic bone disease, postmenopausal osteoporosis, densitometry, bone density.

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Abbreviations:
BMI, body mass index.
WHO, World Health Organization.

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Conflict of interest:
We have no conflicts of interest to declare.
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According to the World Health Organization (WHO), osteoporosis is a metabolic, systemic, and degenerative bone disease suffered by more than 75 million people worldwide. It consists of a decrease in bone mass and an alteration of bone microarchitecture that leaves the bone susceptible to fractures.[1] In women in the post-menopausal stage, and due to the hormonal changes that occur, there is an increase in osteoclastic resorption activity and a decrease in osteoblastic activity. These changes render postmenopausal women more vulnerable to suffer from this disease.[2] Therefore, they are also at increased risk for bone fragility fractures (most common clinical presentation), mostly accompanied by poor adherence to preventive treatments.[3]

The diagnosis of osteoporosis is made by bone densitometry in the categories created by the WHO. From each anatomical area studied, a value called *T-score* is obtained. Based on the T score, a diagnosis of a normal condition is established (⩾ -1), one of osteopenia (if the value is between < -1 and > -2.5), one of osteoporosis (if ⩽ -2.5) or one of severe or established osteoporosis (if the value is <-2.5 and is accompanied by a fragility fracture).[4]

The standard densitometric study should be composed of a dual analysis of the proximal femur and the lumbar spine since these are the regions with a greater reduction in bone density [5,6] and epidemiologically more relevant in the incidence of fractures due to bone weakness.[6,7]

Bone densitometry and a set of thorough clinical studies of risk factors are essential combinations to obtain a diagnosis and establish an adequate therapeutic approach.[8] Although several studies point out the genetic[5,6] ethnics[2], and lifestyle[7,8] differences related to the development of the disease, no previous studies have been carried out in Costa Rica allowing to identify the risk factors of interest in the diagnosis of the condition in our population. The *International Osteoporosis Foundation* (*IOF*) called for more epidemiological research on osteoporosis in Costa Rica to improve the approach to the disease.[9] The only similar study carried out in Costa Rica was developed by the Costa Rican Association of Climacteric, Menopause, and Osteoporosis (ACCMYO).[9]

The objective of the present investigation is to determine the prevalence of osteoporosis in postmenopausal Costa Rican women treated as patients of the Hospital San Juan de Dios (HSJD) of the Caja Costarricense del Seguro Social (CCSS) and to analyze its relationship with clinical and lifestyle characteristics, such as age, body mass index (BMI) and other recognized risk factors.

Materials and Methods

Population and study design: A retrospective descriptive and cross-sectional study was conducted. Information was documented on all postmenopausal women who underwent bone densitometry indicated by their age, family history, fractures, or for screening or follow-up between the months of July and September 2018, was reviewed. A total of 1572 studies were available.

The following inclusion criteria were used: postmenopausal Costa Rican female between 45 and 80 years of age and having a T-score value obtained by bone densitometry for the lumbar spine and hip. The age range was established because with the equipment used, the reference values for calculating the T-score value are not defined for a population over 80 years of age.

All patients whose bone densitometry had been performed with a protocol other than that for the lumbar spine and hip were excluded, as well as patients with findings of osteophytes or scoliosis in the lumbar spine which could cast doubt on the densitometry results. Variables related to risk factors for the disease such as chronological age, age at menarche and onset of menopause, years since menopause, body mass index (BMI), family history of hip fracture, smoking, alcohol use, physical activity, and consumption of dairy products were collected. These factors were collected to determine whether they modify the risk of developing osteopenia and osteoporosis.

This research protocol was approved by the Scientific Ethical Committee of the University of Costa Rica (CEC-514-2019) and the San Juan de Dios Hospital (HSJD-026-CEC-2020).

Bone densitometry data acquisition: All the data required for the development of the research were obtained from the database of the densitometer Hologic® brand, Discovery™ DXA System software (Hologic, Inc. Marlborough, Massachusetts). A questionnaire completed by the patient and the nursing staff before the study is stored in digital form, indicating personal data, risk factors, clinical history, and other general information. From this same database, the data corresponding to the *T-score* values for each anatomical area scanned were extracted.

Data analysis: Based on their global diagnosis results by bone densitometry, patients were grouped into a group of osteopenia, osteoporosis and *unaffected (or healthy)* women. The postmenopausal years were calculated from difference between age at menopause and age at menarchy. The categories of body mass index were those of the WHO classification (normal, overweight, obese,

and extremely obese). The quantitative variables (chronological age, postmenopausal years, and BMI) were subjected to a normality test (Kolmogorov-Smirnov). Since the assumption of normality was not met, the Wilcoxon rank-sum test (Mann-Whitney test) was used to establish a difference between affected and unaffected women. In the case of BMI, a 4x2 ANOVA on ranks was performed.

For the qualitative dichotomous variables, a contingency test of 3x2 with chi-squared (χ^2) was used to determine the differences between healthy and sick patients (with osteopenia or osteoporosis). All statistical tests were performed with Stata/SE 12 (StataCorp, Texas), and the graphs were made with Prism 8 (GraphPad Software Inc., California). A value of $p < 0.05$ was considered statistically significant. Data in the text are shown as mean (95% confidence interval).

Results

Given the inclusion criteria, 923 women were included in the analysis. The mean age was 62.86 years (62.36 - 63.36). According to the *T-score* results, most women showed osteopenia in either of the two study regions: 55% with osteopenia in the femoral neck or 44% in the lumbar spine. Thus, overall, 47% of the women had osteopenia. Osteoporosis was diagnosed in 39% of the women, and only 14% had a normal record in the global index (Table 1).

Table 1. Distribution of densitometry results distributed by diagnostic category and study region, n=923, July-September 2018, Hospital San Juan de Dios, Caja Costarricense del Seguro Social, Costa Rica

Diagnosis, according to WHO categories	Lumbar spine n (%)	Hip n (%)	Global* n (%)
Normal	210 (23%)	235 (25%)	134 (14%)
Osteopenia	411 (44%)	507 (55%)	433 (47%)
Osteoporosis	302 (33%)	181 (20%)	356 (39%)

*The global category refers to the general diagnosis of the patient given by the result of the bone densitometry.

The average age of the patients at the time of the study was significantly higher in those with a diagnosis of osteoporosis (64.4 years) than those with osteopenia (62.6 years) or with normal diagnosis (59.6 years) (p<0.001). The number of postmenopausal years was significantly higher in women with a diagnosis of osteoporosis (18.4 years) than those with osteopenia (16.3 years) or with normal diagnosis (12.4 years) (p<0.001) (Table 2). Furthermore, in the same sense, the variables of age at menarche (p=0.001) and BMI (p<0.001) were significantly differentiated (Table 3). The different classifications described, and their statistical differences calculated between the groups of unaffected patients and affected patients (osteopenia or osteoporosis result) are shown in Figure 1.

Table 2. Distribution of mean age, age at menopause, and age at menarche at the time of densitometry and years postmenopause according to the diagnostic category, n= 923, July-September 2018, Hospital San Juan de Dios, Caja Costarricense del Seguro Social, Costa Rica

Age (years)	Normal	Osteopenia	Osteoporosis
Age	59.6 (58.3 - 60.9)	62.6 (61.9 - 63.4)	64.4 (63.6 - 65.2)
Age at menopause	47.3 (46.2- 48.4)	46.3 (45.7 - 46.9)	45.9 (45.3 46.6)
Age at menarchy	12.8 (12.5 - 13.2)	13.3 (13.1 - 13.5)	13.6 (13.4 - 13.8)
Postmenopausal years	12.4 (11.4 - 13.3)	16.3 (15.4 - 17.2)	18.4 (17.4 -19.4)

Data are shown as mean (95% confidence interval).

Table 3. Relationship of variables with statistical analysis according to the diagnosis of healthy or sick obtained by bone densitometry, n= 923, July-September 2018, Hospital San Juan de Dios, Caja Costarricense del Seguro Social, Costa Rica

Variable	Total (n=923)	Unaffected (n=134)	Affected (n=789)	p-value
Age	923	59.62 (58.31, 6093)	63,41 (62.87, 63.95)	<0.001
Age at menarchy	923	12.85 (12.53, 13.17)	13,44 (12.93, 13.07)	0.001
Age at menopause	923	47.26 (46.17, 48.35)	46,17 (45.72, 46.62)	0.083
Postmenopausal years	923	12.56 (11.10, 14.02)	17,26 (16.58, 17.94)	<0.001
BMI (kg/m^2)	923	32 (31,15-32,85	28 (27,65-28,35)	<0.001
Low weight	2 (0,2%)	0 (0,00)	2 (0,2%)	
Normal	236 (26%)	9 (0,07)	227 (29%)	0.01
Overweight	382 (41%)	52 (0,38)	330 (42%)	0.18
Obesity	277 (30%)	63 (0,47)	214 (27%)	0.005
Extreme obesity	26 (3%)	10 (0,08)	16 (2%)	0.002

Data are presented as n (%) and as mean (95% confidence interval), as appropriate.

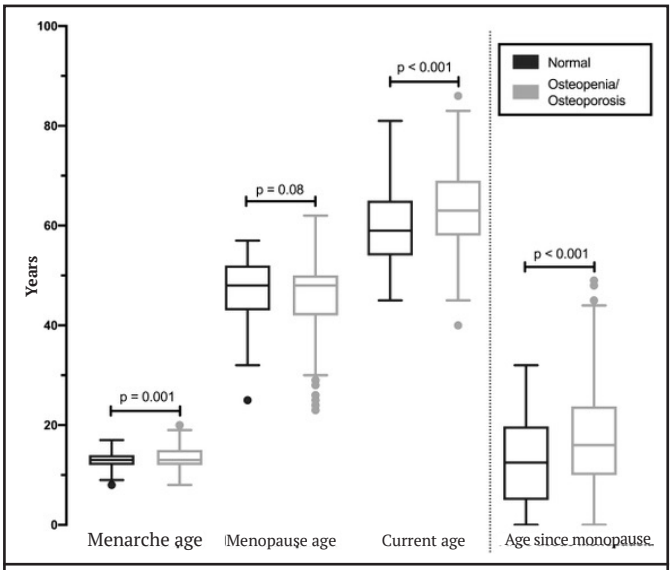

Figure 1. Distribution of ages of individuals at menarche, at menopause, and age at study time according to densitometry result as normal (healthy) and with osteopenia or osteoporosis (diseased), n= 923, July-September 2018, Hospital San Juan de Dios, Caja Costarricense del Seguro Social, Costa Rica.

When analyzing the population in a dichotomous fashion, healthy patients had a mean BMI of 32 (31.15 - 32.85) whereas affected patients had a mean BMI of 28 (27.65 - 28.35). it Women with extreme obesity (BMI > 35 kg/m2) with osteopenia or osteoporosis have a lower BMI than women with a normal diagnosis within this same classification (p = 0.002*)*. This pattern is also repeated in people with normal BMI (p=0.01) and obesity BMI (p=0.005)

The BMI of women with a diagnosis of osteopenia or osteoporosis is lower than the BMI of unaffected women (Figure 2).

In regard to variables related to family history and lifestyles a statistically significant difference was only found in the family history of hip fracture, which was higher in the affected groups (p=0.01) (Table 4).

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Table 4. Analysis of the family history of hip fracture and lifestyles					
Variable	**Total (n=923)**	**Normal (n=134)**	**Osteopenia (n=433)**	**Osteoporosis (n=356)**	**p-value**
Family history of hip fracture		134 (14%)	033 (47%)	356 (39%)	0,01
Yes	161 (17%)	13 (8%)	85 (53%)	63 (39%)	
No	762 (83%)	121 (16%)	348 (46%)	293 (38%)	
Smoking		134 (14%)	433 (47%)	356 (39%)	0,89
Yes	126 (14%)	17 (14)%	60 (48%)	49 (38%)	
No	797 (86%)	117 (15%)	373 (47%)	307 (38%)	
Alcohol use		134 (14%)	433 (47%)	356 (39%)	0,61
Yes	8 (1%)	0 (0%)	6 (75%)	2 (25%)	
No	915 (99%)	134 (14%)	427 (47%)	354 (39%)	
Physical activity		134 (14%)	433 (47%)	356 (39%)	0,85
Yes	349 (38%)	49 (14%)	176 (50%)	124 (36%)	
No	574 (62%)	85 (15%)	257 (45%)	232 (40%)	
Dairy consumption		134 (14%)	433 (47%)	356 (39%)	0,24
Yes	680 (74%)	104 (15%)	318 (47%)	258 (38%)	
No	243 (26%)	30 (13%)	115 (47%)	98 (40%)	

Data are presented as n (%).

Discussion

Of a total of 923 women included in the study, 47% were diagnosed with osteopenia, 39% with osteoporosis and only 14% had normal densitometric studies. In addition, some of the risk factors studied proved to be statistically significant and, therefore, can be associated with the development of osteopenia or osteoporosis.

Osteoporosis has however, different origins, making it very difficult to estimate the influence of the risk factors studied, without taking into account others such as genetic factors [5] and the use of certain drugs.[10] Age is known to be an important risk factor for osteoporosis due to the chronic degenerative nature of the disease.[11] This fact is supported by the findings of this study. When analyzing the relative frequency of affected patients (osteopenia or osteoporosis) by age, patients under 50 years of age had a relative frequency of 0.66, while older women (over 76 years of age) had a relative frequency of 0.96 (data not presented). The occurrence of osteopenia and osteoporosis analyzed by age groups reflected a significant increase in older patients.

The age at menarchy also stood out as a significant risk factor in this study. This means that the later the menarchy occurred, the higher the prevalence of the disease.

Theoretically, late menarche is known to be a risk factor for osteoporosis because of the decreased time of exposure to sex hormones at late menarche and is also related to low calcium intake during growth. [12] It has already been reported that estrogen deficiency is one of the main causes of osteoporosis and that it can be reversed with the use of hormone replacement therapy. [13] In this investigation, all women with menarche at 18 years of age or older were affected (RR:1). In contrast, those who had menarche before the age of 10 years were less frequently affected, for whom the relative risk was 0.76.

The number of years since menopause was also a significant risk factor. As this value represents the number of years a woman has been without exposure to sex hormones due to cessation of menstruation, whether naturally, secondary to hysterectomy, or some other cause, a net loss of bone is generated because of the complex systems of formation and resorption that are affected by the influence of estrogens.[14] The time

since menopause is important because there may be young women who are many years postmenopausal due to early-onset or induced menopause, which increases their risk of developing osteoporosis.

As the genetic factor was studied through the family history of hip fracture in the father or mother and statistically significant differences were found. The presence of first-line relatives who have suffered from fragility fractures may cause an increase in the probability of developing the disease.[15]

On the other hand, given that the analysis of BMI was higher in healthy patients than in affected patients, it has been suggested that a low BMI favors the development of osteopenia or osteoporosis, because it alters body composition, generates a decrease in muscular mass responsible for supporting the bone and could be accompanied by a nutritional deficit. In the other hand a higher BMI could be a protective factor due to the increase in the ratio between lean mass and fat mass and the mechanisms of action of a hormone of the adipose tissue called leptin, which has estrogen-like functions.[17,18]

According to the analysis by BMI category (Figures 2 and 3), it can be recognized that as the BMI category increases, the proportion of patients with a normal diagnosis increases. These findings suggest that nutrition could play an important role in the development of the disease, an aspect that deserves further research.

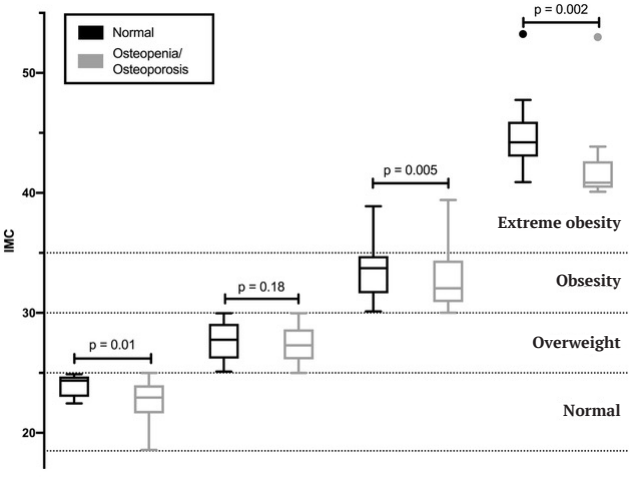

Figure 2. Distribution of BMI results of individuals according to densitometry result as normal (healthy) and with osteopenia or osteoporosis (affected), n= 923, July-September 2018, Hospital San Juan de Dios, Caja Costarricense del Seguro Social, Costa Rica.

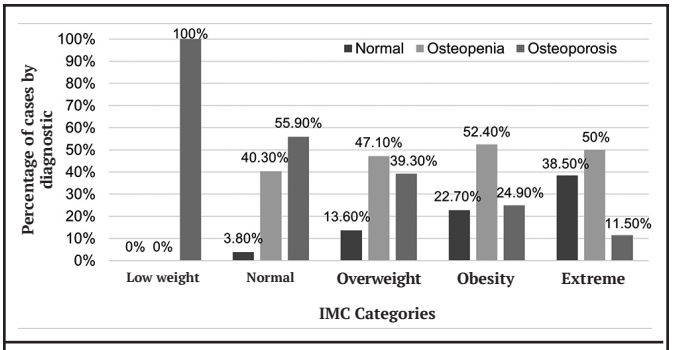

Figura 3. Percentages of patients for each diagnostic category by bone densitometry, according to BMI categories.

Lastly, the variables of age at menopause, consumption of dairy products, physical activity, alcoholism, and smoking did not reach statistical significance. This is despite being known as a risk factor. It is known that smoking can negatively affect bone by reducing exposure to estrogen, which accelerates bone loss.[19] However, due to the limited control over these variables in our population, it would be better to establish the relationship based on controlled studies and not rule them out altogether as risk factors in our population at this time.

Finally, a prevalence of 47% for osteopenia and 39% for osteoporosis was demonstrated in the studied population. As the age of the patients increased, the prevalence by age group also increased. Likewise, the age at menarche, the number of years after menopause, low BMI, and a family history of hip fracture were all significant risk factors associated with the development of osteopenia and osteoporosis. All patients who had a late menarchy (at an age ⩾ 16 years) in the population studied were affected by osteopenia or osteoporosis. Thus, the more years that have elapsed since menopause, the higher the prevalence of osteopenia and osteoporosis.

In addition, having a very high BMI (obesity and extreme obesity) was a protective factor for osteoporosis in the population under study. In this study it was not possible to establish a relationship between the lifestyle variables: smoking, alcoholism, physical activity, and consumption of dairy products.

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