

Vitamin D Deficiency: Risk Factor for Osteoporosis in A Country Right Under the Path of the Sun

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Abstract

Objective: To determine risk factors and co-morbidities associated with osteoporosis in a non-white population.

Methods: Data was collected from the files of patients that attended the Primary Care Outpatient Clinic at Hospital General de la Plaza de la Salud during the years 2013 and 2014. An observational, retrospective, case control study was executed which included both descriptive and analytical statistical tests as part of the analysis.

Results: Differences were found between the age ($p<0.001$), body mass index ($p<0.001$) and vitamin D blood levels ($p=0.003$) of both groups. Hypertension ($OR=2.15$, $p=0.04$) and dyslipidemia ($OR=3.82$, $p=0.02$) were more prevalent in the group of patients with osteoporosis.

Conclusion: Age and body mass index are important risk factors for osteoporosis across various population groups. Vitamin D deficiency acquires an important role as a risk factor for black Latin-American populations. Further investigations should be made into the relationship between osteoporosis and cardiovascular disease.

Introduction

Osteoporosis is a disease characterized by a deterioration of the bone architecture caused by a metabolic alteration and related to the presence of fractures and increased morbimortality in older adults. It is nowadays the most common bone metabolism disorder in this population group. Although it has a strong connection with the decrease in estrogen levels after menopause, it has been historically associated with other risk factors such as age, weight, parental history of hip fracture, personal history of hip fracture, smoking, and others [1]. These associations have been thoroughly evaluated in white women, but an important question arises in whether these correlations hold for other populations.

This study aims to throw light into this question by analyzing different risk factors and associations with osteoporosis in a sample consisting of Dominican women of black race. The variables that will be examined include previous known risk factors as well as

other proposed ones.

Materials and methods

Our target population was Dominican women of black race between the ages of 55 and 90. The study sample consisted of all patients that attended the Primary Care Outpatient Clinic at Hospital General de la Plaza de la Salud during the years 2013 and 2014 that met the established inclusion criteria.

Subjects included in the sample had to meet the following criteria: 1) 55 - 90 years of age, 2) Dominican, 3) available dual-energy X-ray absorptiometry (DEXA) report, 4) vitamin D blood levels within $+- 30$ days from DEXA, 5) signed release form allowing the hospital to use their information for research purposes. Patients were not included in the study if they had previously used bisphosphonates, ant seizure medications, glucocorticoids, or had the following co-morbidities: parathyroid disease, neoplasia's,

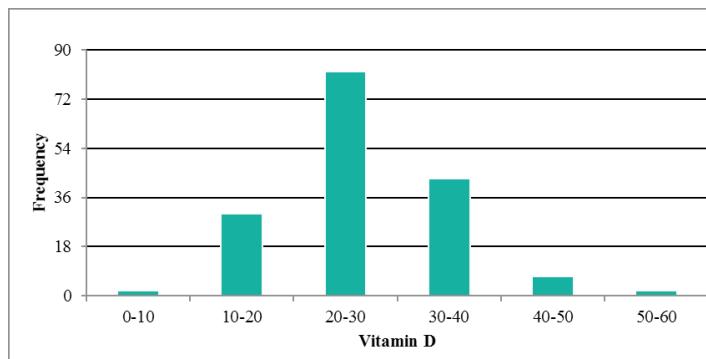
chronic renal insufficiency, inflammatory bowel disease, or hepatic failure.

With the selected sample, an observational, retrospective, case control study was executed. The subjects' files were explored, and data was collected regarding their age, height, weight, comorbidities, as well as laboratory findings and other risk factors. Descriptive analysis was performed in order to describe general state of the sample, followed by a statistical analysis to verify if there is an association between the different variables and the development of osteoporosis in this particular population. The main statistical tests used were Chi-square and Fisher Exact Test for categorical variables and Unequal Two Sample T Test for quantitative variables.

Results

The sample analyzed consisted of 190 patients between the ages of 59 and 88 ($\bar{X}=73.21$, $\sigma=7.00$), 54.21% of which had osteoporosis. The criteria used for the diagnosis of osteoporosis was either a femoral neck or total hip T score below -2.5 on DEXA scan. The remaining 45.79% of the sample had T scores above -2.5, and were therefore assigned to the control group. The mean femoral neck and total hip T score were -2.40 ($\sigma=0.66$) and -2.26 ($\sigma=0.80$) respectively for the complete sample. For patients with osteoporosis specifically, mean T scores were -2.82 ($\sigma=0.40$) for femoral neck and -2.77 ($\sigma=0.55$) for total hip.

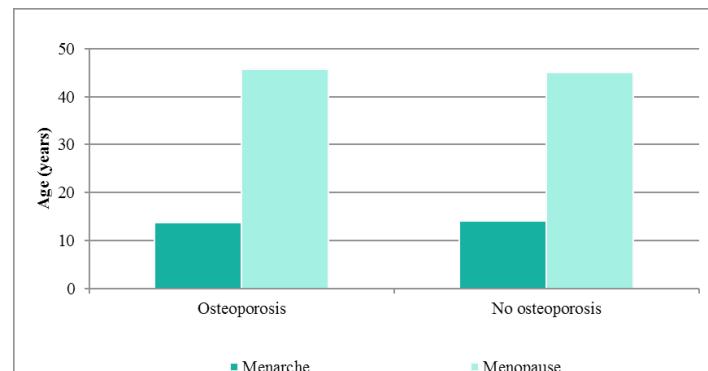
Height for this sample was between 128 and 168 centimeters ($\bar{X}=149.94$, $\sigma=6.49$), while the mean body mass index was 26.79 kg/m² ($\sigma=5.25$). Vitamin D values for the whole sample (including cases and controls) ranged from 6.40 to 56.00 mg/mL, averaging 26.75 mg/mL with a standard deviation of 8.36 mg/mL (Graph 1).



Graph 1: Vitamin D level frequency histogram.

As we moved into the analytical phase of the results evaluation, a correlation was observed between certain expected factors, such as age and body mass index, and the development of osteoporosis. Mean age for patients with osteoporosis was 75 compared to 71 in subjects without osteoporosis ($p<0.001$). Regarding body mass index, an average of 25.57 kg/m² was observed in osteoporotic subjects, in contrast with the 28.23 kg/m² average observed in non-osteoporotic participants ($p<0.001$).

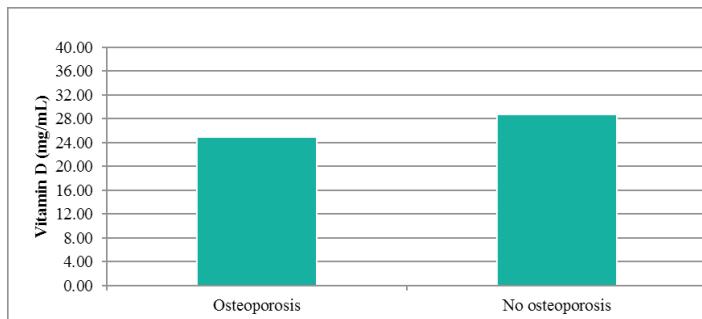
On the other hand, other factors such as smoking, history of hip fracture in family and menarche and menopause age did not show a statistically significant relationship for the sample in question. It was observed 2.91% and 2.33% of the cases and controls respectively had a family history of hip fracture ($p=0.80$). Mean menarche and menopause age for patients that developed osteoporosis was 14 and 46 years compared to 14 and 45 years for patients that did not develop the condition ($p=0.53$ and $p=0.56$ respectively) (Graph 2).



Graph 2: Mean menarche and menopause age and osteoporosis.

Daily calcium intake and corrected blood calcium levels were evaluated but did not show a statistically significant difference between the groups ($p=0.62$ and 0.50 respectively).

When analyzing the association between vitamin D blood levels and osteoporosis development, subjects that had received vitamin D supplementation in the six months prior to measurement of vitamin D blood levels were eliminated, which left us with a subset of 167 subjects. This allowed for control of the confounding effect of vitamin D supplementation on blood levels of the compound. Participants with osteoporosis had a mean vitamin D blood level of 24.85 mg/mL, versus 28.65 mg/mL found in participants belonging to the control group ($p=0.003$) (Graph 3).



Graph 3: Vitamin D blood levels and osteoporosis.

Common co-morbidities in both groups were also evaluated (Table 1). It was found that 86.41% of patients with osteoporosis also had hypertension, while 74.71% of patients without osteoporosis had the condition (OR=2.15, p=0.04). Likewise, 15.53% of patients with osteoporosis had laboratory findings associated with dyslipidemia, compared to the 4.60% found in patients without osteoporosis (OR=3.82, p=0.02).

	Odds ratio	p
Hypertension	2.1516	0.04
Dyslipidemia	3.8161	0.02
Diabetes mellitus	0.9589	0.92
Hypothyroidism	2.4810	0.18

Table 1: Co-morbidites and osteoporosis.

Discussion and Conclusion

Through the present study, age and body mass index were once again determined to be important risk factors for the development of osteoporosis across different populations. Increased age is associated with an increased risk of developing osteoporosis, while the inverse happens with body mass index: decreased body mass index is associated with an increased loss of bone mass.

For the present cohort consisting of a black Latin-American sample, vitamin D deficiency proved a significant relationship with the development of osteoporosis. This holds a possible strong clinical implication for osteoporosis in similar populations due to the widespread elevated prevalence of vitamin D deficiency, such as the one evidenced in this sample.

Since there are few foods that contain significant amount of vitamin D (either naturally or fortified), the main source of vitamin D continues to be exposure to natural sunlight [2]. Vitamin D

deficiency, a condition historically linked to high latitude regions where UV exposure is limited, has been now shown to affect areas all around the world [3]. This is mainly due to lifestyle changes regarding sun exposure and protection, dressing, as well as the protective role of melanin against UV light in dark skinned populations such as the Dominican Republic.

Another interesting finding regarding the epidemiology of osteoporosis in our population was found regarding co-morbidities for these patients, for which both hypertension and dyslipidemia had a higher prevalence in osteoporotic patients. This relationship has been described in previous literature and is suggested to be associated with a shared underlying pathway between osteoporosis and metabolic syndrome involving calcium homeostasis, inflammatory responses and oxidative stress [4]. Moreover, previous associations between vitamin D deficiency and hypertension [5] in light of the present findings might suggest vitamin D deficiency as a common risk factor for both hypertension and osteoporosis, explaining the association between the two diseases.

It is recommended that further studies be done looking into the relationship between these co-morbidities and osteoporosis.

Recognizing that sunlight is the main source of vitamin D and conscious of the limited time we are exposed to this source due to the transcendental lifestyle changes society has had throughout history, vitamin D supplementation and screening should be globally standardized, with disregard of the latitude where the subject lives. This carries a heightened significance when observing the plausible relationship between vitamin D deficiency and certain diseases, not only involving bone structure, but also other organ systems.

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