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Original Research

Vitamin D status is inversely associated with obesity in a clinic-based sample in Puerto Rico

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ABSTRACT

Studies show that vitamin D status is associated to obesity but data in Hispanic individuals is scarce. The aim of this study was to assess the association between vitamin D status and obesity in a clinic-based sample in Puerto Rico. We hypothesized that subjects with a higher adiposity would have a lower vitamin D status. We extracted the following data from medical records of a private clinic: age, gender, serum 25(OH)D levels, weight, height, and waist circumference. Body mass index (BMI) (kg/m^2) and waist-to-height ratio were calculated and categorized according to standard guidelines. Statistical analyses included analysis of covariance, Pearson correlations and χ^2 test. From 797 individuals (mean age 53.7 ± 15.4 years; 63.5% females), 35.6% were overweight and 43.7% obese. Mean 25(OH)D levels were 24.7 ± 8.7 ng/mL; 5.3% had levels <12 ng/mL, 30.6% had levels 12 to 20 ng/mL, and 43.5% had levels 21 to 30 ng/mL. Mean 25(OH)D levels were significantly higher in normal weight and overweight males compared to obese males ($P < .05$) and in overweight females compared to obese females ($P < .05$). Levels were also higher in those with low risk compared to high risk of waist circumference and waist-to-height ratio ($P < .001$). BMI, waist circumference, and waist-to-height ratio were inversely correlated to 25(OH)D levels ($P < .001$). A greater proportion of obese individuals (41.4%) were vitamin D deficient or insufficient compared to the normal weight (33.9%) and overweight individuals (30.3%) ($P < .05$). In conclusion, in this clinic-based sample of Puerto Rican adults, those with higher BMI, waist circumference, and waist-to-height ratio had a significantly lower vitamin D status.

1. Introduction

Vitamin D is a liposoluble molecule that can be synthesized in the skin as a result of sun exposure or can be obtained from foods containing this nutrient naturally (eg, cod liver oil and fatty fishes), vitamin D fortified products, and supplements [1]. Serum vitamin D or 25(OH)D levels are widely accepted as a biomarker to estimate the vitamin D status [2]; it reflects the

Abbreviations: 25(OH)D, 25-hydroxyvitamin D or vitamin D; BMI, body mass index; WC, waist circumference; WHtR, waist-to-height ratio; IOM, Institute of Medicine.

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vitamin D synthesized in the skin and the vitamin D obtained from foods or supplements. Although there are no universally accepted cutoff points for the optimal serum 25(OH)D levels, the Institute of Medicine (IOM) established that levels above 20 ng/mL (>50 nmol/L) are adequate. However, the Endocrinology Society considers that levels 30 ng/mL (≥75 nmol/L) and above are optimal [3].

Vitamin D deficiency is a public health concern around the world [4,5]. There is a high prevalence of vitamin D deficiency and insufficiency worldwide [6]. In the United States, 32% of the total population and 43% of the Hispanics had vitamin D levels below 20 ng/mL [7]. Moreover, in a large sample of Puerto Ricans (n = 4090), 65.8% had vitamin D levels below 30 ng/mL and 24.9% had levels below 20 ng/mL [8].

Several studies have shown a consistent association between adiposity and vitamin D status, in which an increase in adiposity results in lower serum 25(OH)D levels [9–12]. Hence, obese subjects are more likely to have suboptimal vitamin D levels. This association was also found in Hispanics and African Americans in the United States [13]. In Puerto Rico, the only study that has addressed this association among 94 overweight and obese adults found a significant inverse correlation of 25(OH)D levels with percent body fat [14]. Further research is needed, particularly in Hispanic populations, to understand the factors that contribute to the high prevalence of vitamin D deficiency, such as obesity [8]. This is important as obesity is now recognized as one of the leading health threats worldwide [15], which is highly prevalent in Hispanics. In the US, 35% of adults (≥20 years) are obese [16]. Similarly, Behavioral Risk Factor Surveillance System data collected in 2013 showed that 28% of adults were obese and 39% were overweight [17]. However, a study conducted in a representative sample of Puerto Ricans living in the San Juan metropolitan area of Puerto Rico showed an even higher prevalence of overweight and obesity (40.8% obesity and 36.7% overweight) [18].

To start addressing this gap in knowledge, we sought to assess the association of vitamin D status with obesity in a clinic-based sample from Puerto Rico. Our specific objectives were to (1) assess the correlations of serum 25(OH)D with body composition measures, (2) evaluate the associations of vitamin D status with obesity status, and (3) compare serum 25(OH)D levels across obesity status. Based on prior research, it was hypothesized that subjects with higher adiposity would have a lower vitamin D status. To test our hypothesis, we analyzed a large data set of medical records of individuals attending a private endocrinology clinic with information on vitamin D status and obesity.

2. Methods and materials

2.1. Study population

A retrospective medical record review of all patients who attended the *Endocrinology, Diabetes, and Metabolism Clinic* located in Utuado, Puerto Rico was performed between 2005 and 2013. Those medical records that had complete information on body composition measures and laboratory test results for serum 25(OH)D levels were included in the study. The institutional review board of the Medical Sciences Campus of the University of Puerto Rico approved this study.

2.2. Demographic, body composition, and clinical data

A data collection form was used to extract demographic information, body composition measures, and medical history from the medical records. Demographic data included age and sex, and body composition data included weight, height, and waist circumference (WC). Weight (pounds) and height (inches) were measured by the clinic staff using a physician scale (Detecto, Model 338; Webb City, MO, USA) with height rod and WC (inches) was measured using a measurement tape. These were converted to kg, m and cm, respectively.

Obesity was assessed using the body mass index (BMI), WC, and waist-to-height ratio (WHtR). BMI, calculated as weight in kilograms (kg) divided by height in meters squared (m^2), was used as an index of general obesity [19]. Subjects were classified using the World Health Organization (WHO) cutoff points: normal <25.0 kg/m^2; overweight 25.0–29.9 kg/m^2; and obese ≥30 kg/m^2[20]. The WHtR and WC were used as central or abdominal obesity indices [19]. WHtR was calculated by dividing the WC (cm) by height (cm). High WHtR was defined as values greater than 0.5 [21], whereas elevated WC was defined as ≥102 cm (40 in) in men and ≥88 cm (35 in) in women [22]. In addition, co-morbidities including hypertension, diabetes, and hyperlipidemia were collected.

2.3. Circulating 25(OH)D

Blood test results for serum 25(OH)D levels in nanograms per milliliter (ng/mL) were extracted from the records. We also extracted the method used to measure vitamin D levels. Most of the serum vitamin D tests in our sample (96.9%) were performed using immunoassays (92.9% immunochemiluminometric assay; 0.9% chemiluminescence immunoassay; and 3.1% IDS enzymeimmunoassay). The remaining tests (3.1%) were performed with liquid chromatography–mass spectrometry.

There is an ongoing debate on the cutoff values for vitamin D status. The IOM established that a person with levels below 12 ng/mL (<30 nmol/L) is at risk for deficiency, levels between 12 and 20 ng/mL (30 – 50 nmol/L) are inadequate, and levels of 20 ng/mL and above (≥50 nmol/L) are adequate [2]. However, the Endocrine Society classifies the vitamin D status as deficient if serum 25(OH)D levels are 20 ng/mL or below (≤50 nmol/L), insufficient if levels are between 21 and 29 ng/mL (52–72 nmol/L), and sufficient if levels are 30 ng/mL and above (≥75 nmol/L) [3]. For the present study, the cutoff values used to describe the vitamin D status were: <12 ng/mL for deficiency, 12–20 ng/mL for inadequacy, >20 ng/mL for adequacy (subclassified as insufficiency if levels were 21–29 ng/mL and optimal if levels were ≥30 ng/mL).

2.4. Statistical analyses

We conducted sex-specific analyses given the sex differences in vitamin D levels and obesity observed in previous studies. Baseline characteristics of patients were summarized by age-