Prevalence of Vitamin D Insufficiency and Deficiency among Young Physicians at University District Hospital in San Juan, Puerto Rico

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Vitamin D has been attracting increased attention because of higher prevalences of vitamin D insufficiency and deficiency than expected in areas with sufficient sun exposure. Even though sunlight exposure and diet are the main determinants of vitamin D status, other factors, such as age, race, the use (or not) of sunscreen, medications, and malabsorptive conditions, also affect vitamin D levels.

Recent studies have found high prevalences of vitamin D deficiency and insufficiency in different populations. However, there are limited data regarding the prevalence of vitamin D deficiency and insufficiency in Puerto Rico. To shed more light on the subject, we evaluated a sample of 51 internal medicine residents and research fellows, aged from 25 to 39 years at the University District Hospital in San Juan, Puerto Rico, doing so by means of a questionnaire that explored basic socio-demographic and lifestyle characteristics and collected anthropometric data; in addition, we obtained blood samples in order to determine 25-hydroxyvitamin D levels.

The median 25-hydroxyvitamin D level was 21 ng/mL (range, 7-38 ng/mL). Forty-five participants (88.2%) had 25-hydroxyvitamin D concentrations of lower than 30 ng/mL. We found vitamin D deficiencies in 43.1% of the population and insufficiencies in 45.1%.

Contributory factors to our findings include limited exposure to sunlight during periods of high sun intensity, increased body mass index, and a limited area of the body being exposed to sunlight. A relationship between reduced physical activity levels and hypovitaminosis D was also found. Both calcium intake and vitamin D intake, which were markedly below recommended daily allowances, were positively correlated with 25-hydroxy vitamin D levels, but with a weak association. [*P R Health Sci J 2015;34:83-88*]

Key words: 25-Hydroxyvitamin D/calcium, Dietary/vitamin D, Dietary/sunlight exposure/physical activity

Cholecalciferol is a prohormone that is mainly produced in the human by being synthesized in the skin after ultraviolet radiation exposure, and to a lesser extent obtained by dietary sources. This prohormone is metabolized in the liver to 25-hydroxyvitamin D, and then further metabolized in the kidneys to 1, 25-dihydroxyvitamin D which is the metabolically active form of vitamin D. Even though sunlight exposure and diet are the main determinants of vitamin D status, other factors, such as age, race, the use of sunscreen, medications, and malabsorptive conditions, also affect vitamin D levels.

In recent years, vitamin D has been attracting increased attention because of higher prevalences of vitamin D insufficiency and deficiency than expected in areas with sufficient sun exposure (1-7). Vitamin D, an essential vitamin and hormone, has a variety of functions, including regulating both calcium and phosphate levels and promoting bone mineralization. This hormone has also been found to be related to the increased risks of metabolic syndrome, obesity, insulin sensitivity, diabetic retinopathy, adverse obstetric and newborn outcomes, cardiovascular health, and all-cause mortality (8-16). The current literature has suggested that vitamin D supplementation may have a role in improving several chronic conditions, aside from its proven effects on bone mineral density and fracture

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reduction (17-22). However, other studies have not been able to prove this therapeutic effect (23).

Many studies have evaluated the prevalence of hypovitaminosis D in different populations (1-7). According to the third National Health and Nutrition Examination Survey (NHANES), the prevalence of vitamin D deficiency in adults in the United States has been reported to be 25 to 75% (24). While, of those healthy adults living in Puerto Rico, there is scant information regarding the prevalence of vitamin D deficiency or insufficiency. It is important to evaluate the prevalence of hypovitaminosis D in this population, since a higher-than-expected prevalence of low vitamin D levels has been found in areas with abundant sunlight.

Young physicians, during their training years, would be expected to be especially vulnerable to vitamin D insufficiency, because they spend so many hours working indoors. Vitamin D levels were determined for 5 residents at University District Hospital as part of their annual physical examination, and all of them had low vitamin D levels (L. Hernández, personal communication, May 2010). This finding and the lack of data on vitamin D status in Puerto Rican young physicians raised the question as to whether vitamin D insufficiency might be more common than expected in this population, despite living in a tropical area. To answer that question, we designed a research study to estimate the prevalence of vitamin D insufficiency and deficiency in residents and research fellows at University District Hospital in San Juan, Puerto Rico. The aims of this study were to: 1) assess the prevalence of vitamin D deficiency or insufficiency among residents and research fellows of different specialties at University District Hospital in San Juan, Puerto Rico; 2) investigate the different factors that could influence the prevalence of hypovitaminosis D among said population.

Material and Methods

Target population

The target population was composed of residents and research fellows from the internal medicine program and subspecialties at University District Hospital. Per the study's exclusion criteria, individuals suffering from chronic renal insufficiency (creatinine levels >1.5 mg/dL) or chronic liver disease (bilirubin levels >2 mg/dL) as well as those having any kind of malignancy were excluded from participation. A total of 100 individuals were invited to participate in this study: residents of the internal medicine program (49), residents in any of the internal medicine subspecialties at University District Hospital (47) and 4 research fellows. The participation rate was 51% (51/100).

Data collection

The participants were invited to fill out the study questionnaire and undergo blood sampling for analysis. We were interested in 25-hydroxyvitamin D levels as well as other biochemical parameters. Blood samples were obtained through the hospital-based laboratory, Laboratorio Intensivo Cooperativo, of University District Hospital. Previous laboratory results (no more than 6 months old) were considered in this study, as well. These procedures took place on the date determined either by the program director or the chief resident of each program. Blood samples for 25(OH)vitamin D levels were taken mainly in 2 seasons of the year, spring (March-May) and winter (November-January). Both interventions were done after obtaining oral informed consent from all participants. Study procedures were approved by the Institutional Review Board of the University of Puerto Rico, Medical Sciences Campus.

Questionnaire information

The questionnaire explored basic socio-demographic characteristics, collected anthropometric data, and enquired about physical activity, diet, sun exposure, and working hours. Each participant's body mass index (BMI) was calculated. Using the definitions of the World Health Organization, we categorized those participants whose BMI ranged from 18.5 to 24.9 as being of normal weight, while those whose BMI was 25 or higher were categorized as being overweight. Daily dietary intake of calcium and vitamin D were calculated from the data obtained from a food frequency questionnaire (FFQ) containing 24 questions focusing on both calcium- and vitamin D- containing foods that were been consumed regularly at the time of the study. This FFQ was developed for the Latin American Vertebral Osteoporosis Study (25) and validated for the Puerto Rican population by Suárez E and Pérez C, 2009. An open-ended question regarding current vitamin and/or mineral supplementation was included and used to calculate mean total intake. To assess the frequency of each food item, there were 8 choices that ranged from ''3 or more servings per day'' to "rarely or never." Total intakes of vitamin D and calcium were determined by adding a given food item's calcium and vitamin D content (according to the United States Department of Agriculture's National Nutrient Database for Standard Reference, 2011). Each individual's physical activity level was categorized in one of the following ways: (1) no physical activity, (2) fewer than 2.5 hours of activity per day, and (3) 2.5 or more hours of activity per day. Sun exposure was expressed as (1) low (not at all between 10:00 a.m. and 4:00 p.m.) or (2) high (occurring between 10:00 a.m. and 4:00 p.m.). Working hours were reported by participants in answer to a question asking the number of hours worked per day. The two possible answers provided were (1) <9 hours per day and (2) >9 hours per day. In order to estimate the percentage of body surface area exposed to the sun, a total body surface-area calculator diagram was used (Wallace, 1951, Rules of Nine Chart).

Biochemical analysis

Serum 25-hydroxyvitamin D levels were determined using liquid chromatography–tandem mass spectrometry at a reference laboratory (Quest Diagnostics, Tampa, FL). According to the US Institute of Medicine, (26) a 25-hydroxyvitamin D level above 20 ng/mL can be considered sufficient, at least for skeletal health. And, in recent years, several authors have considered a value above 30 ng/mL to be optimal for the prevention of many extra-skeletal conditions. Therefore, in our study, 25-hydroxyvitamin D levels were categorized as being (1) deficient (<20 ng/mL, <50 nmol/L), (2) insufficient (20-29 ng/mL, 50-74 nmol/L), or (3) sufficient (≥ 30 ng/mL, ≥75 nmol/L).

Statistical analysis

Normally distributed data were summarized as means with respective standard deviations, and non-normally distributed data were presented as medians, with their respective percentiles (P25, P75). Comparisons of proportions and means between circulating levels of serum 25-hydroxyvitamin D [25(OH)D] groups were made using Fisher's exact test/Pearson's Chi-square test and ANOVA, respectively; medians were compared using the Kruskal–Wallis equality-of-populations rank test. Analysis using Spearman's rank correlations were performed to assess the association between total daily vitamin D and calcium consumption and 25-hydroxyvitamin D levels. For all tests a p-value lower than 0.05 was considered statistically significant. Statistical analysis was performed using the STATA software, v. 11.2.

Results

Characteristics of the study group

A total of 51 Hispanic residents and research fellows participated in this study (Table 1). The study sample consisted of 23 women (45.1%) and 28 men (54.9%), with the members of both groups being evenly distributed among the postgraduate training programs (49.0% being PGY1–PGY2 and 51.0% being PGY3 or higher). The participating women had a median age of 30 years (range, 26-39) and average BMI of 23.7 kg/m^2. The participating men had a median age of 28 years (range, 25-34) and an average BMI of 27.0 kg/m^2. Seventy-eight percent of the men (versus 26% of the women) were in the overweight category. Thirty (59%) of the participants considered themselves to be of mixed race, while 16 (31%) said that they were white, 4 (8%) said they were black, and 1 (2%) self-identified as Asian.

Health behaviors

More than half of the participants (51.0%) performed fewer than 2.5 hours per week of physical activity. Only 13.7% of the participants reported being exposed to the sun between 10:00 am and 4:00 pm. The median percentage of body area exposed to the sun was 13.5%. The total daily calcium consumption and vitamin D medians were 303.7 mg (P25 = 148.13 mg; P75 = 652 mg) and 133.3 units (P25 = 49.5 units; P75 = 241.6 units), respectively (Table 2).

Table 2. Lifestyle characteristics of a sample of 51 young physicians at University District Hospital, San Juan, Puerto Rico, according to circulating levels of 25(OH) vitamin D.

Characteristic	Overall sample (n = 51)	Deficient or <20 ng/mL (n = 22)	Insufficient or 20-29 ng/mL (n = 23)	Sufficient or ≥30 ng/mL (n = 6)	P-value
Tobacco use (%)					
None	72.0	81.8	60.9	80.0	0.27
Former and Current Smokers	28.0	18.2	39.1	20.0	
Physical Activity (%)					
None	19.6	36.4	4.4	16.7	0.03***
Fewer than 2.5 hours/week	51.0	27.3	69.6	66.7	
2.5 or more hours/ week	29.4	36.4	26.1	16.7	
Dietary habits††					
Total daily calcium consumption (mg)	303.1 (148.1, 652.0)	234.5 (122.4, 280.5)	515.2 (323.2, 722.1)	255.1 (68.1, 409.9)	0.01***
Total Vitamin D consumption (Units)	133.3 (49.5, 241.6)	103.9 (42.5, 145.5)	159.3 (68.2, 261.1)	78.2 (16.0, 274.5)	0.33

††Non-normally distributed data reported as median (P25, P75), ***P-value < 0.05

Table 1. Anthropometric characteristics of a sample of 51 young physicians at University District Hospital, San Juan, Puerto Rico, according to circulating 25(OH) vitamin D levels.

	Overall sample (n = 51)	Deficient or lower than 20 ng/mL (n = 22, 43%)	Insufficient or 20-29 ng/mL (n = 23, 45%)	Sufficient or ≥30 ng/mL (n = 6, 11%)	P-value
Sex (%)					
Female	45.1	54.6	34.8	50.0	0.42
Male	54.9	45.5	65.2	50.0	
Mean Age (yrs.)†	29.1 (±2.9)	28.9 (±2.2)	29.6 (±3.6)	28.3(±2.3)	0.58
Mean BMI (kg/m^2)†	25.5 (±3.9)	25.3 (±4.0)	26.5 (±3.7)	22.3 (±2.3)	0.05***

†Normally distributed data reported as mean (± SD), ***P-value < 0.05

Serum values

The median 25-hydroxyvitamin D level was 21 ng/mL (range, 7-38 ng/mL). Forty-five participants (88.2%) had 25-hydroxyvitamin D concentrations of lower than 30 ng/mL, 22 (43%) were deficient (< 20 ng/ml), and 23 (45%) had insufficient levels (20-29 ng/ml).

Bivariate analysis

Twenty-five-hydroxyvitamin D concentration was significantly associated with physical activity (p-value <0.05) and BMI (p-value<0.05). Mean values of BMI were significantly (p-value<0.05) higher among individuals with insufficient and deficient levels of 25-hydroxyvitamin D concentration (Table 1). Individuals in our study with normal BMIs (21.7%) were more likely to have sufficient levels of 25-hydroxyvitamin D than were those whose BMIs indicated that they were overweight (3.6%). Vitamin D deficiency was more common among those of our participants who did not dedicate time for physical activity than it was among those who did. Participants who did not report being exposed to sunlight in the period between 10:00 a.m. and 4:00 p.m. were more likely to have deficient levels of 25-hydroxyvitamin D (<20 ng/mL), than were those who reported receiving such exposure (47.7% vs. 14.3%, respectively).

Mean values of total daily calcium consumption were significantly ($p<0.05$) lower among individuals with deficient levels of 25-hydroxyvitamin D. (Table 2). A significant positive, but weak correlation was found between 25-hydroxyvitamin D concentration and total daily calcium consumption. As total daily calcium consumption increased, 25-hydroxyvitamin D concentration increased (Spearman's coefficient of correlation = 0.28). There was a positive but weak correlation between 25-hydroxyvitamin D concentration and total daily vitamin D consumption. As total daily vitamin D consumption increased, 25-hydroxyvitamin D concentration increased as well (Spearman's coefficient of correlation = 0.05). Of the few members of the study population (n = 7) taking vitamin supplements that included vitamin D, only 43% had sufficient levels of 25-hydroxyvitamin D.

Although a high percentage of women had a vitamin D deficiency, this was not significant. Self-reported race was not associated with vitamin D status (p-value = 0.17) nor was the season (p-value = 0.85) in which the blood of the participants was sampled (data not shown). Age, working hours, having 24-hr on-call duty, smoking, and years of residency were not found to be factors that affect 25-hydroxyvitamin D concentrations.

Discussion

The purpose of the present study was to estimate the prevalence of 25-hydroxyvitamin D deficiency and insufficiency in a group of Hispanic young physicians living in a tropical region. We found that 88.2% of the participants had hypovitaminosis D (43.1% had a deficiency and 45.1% had an insufficiency). The median 25-hydroxyvitamin D level for the sample was 21 ng/mL (P25 = 15 ng/mL, P75 = 27 ng/mL).

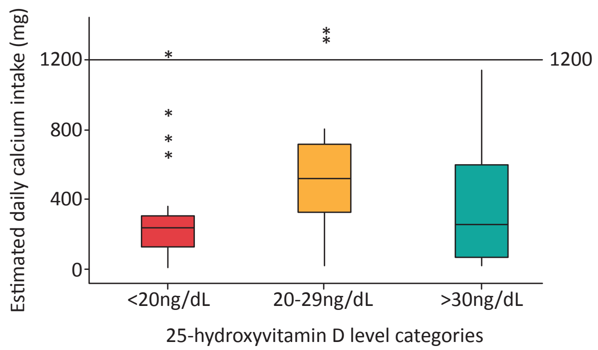
To our knowledge there is scarce research on vitamin D status in this particular population, though our findings are consistent with other studies on young physicians. Mendoza et al. studied a similar population and found a 75% prevalence of vitamin D deficiency compared to a 45% prevalence of same in a matched control group (27). In a group of medical residents living in a tropical region of India, Singh et al. found a 98% prevalence of hypovitaminosis D (28). Our group of young physicians compares with these similar populations in this respect.

Moreover, concerning other populations in Puerto Rico, Suárez-Martínez EB et al. found (in over 4,000 Puerto Ricans, island-wide) hypovitaminosis D (<30 ng/mL) in 68.5% of the subjects (29), while Palacios C et al. found (in a sample of overweight/obese adults in Puerto Rico) a 45% prevalence of vitamin D insufficiency and a median serum 25-hydroxyvitamin D level of 30.7 ng/mL (30). Furthermore, among Hispanics living in the United States, NHANES III data showed a mean 25-hydroxyvitamin D level of 27.4 ng/dL for men and 22.71 ng/dL for women (31). The higher prevalence of hypovitaminosis D found in our sample could be explained by reduced exposure to sunlight during periods of high sun intensity and by the limited physical activity commonly seen during the residency years of young physicians.

Participants with relatively higher BMIs were more likely to have either a vitamin D deficiency or an insufficiency. An inverse association of adiposity and vitamin D levels has been previously described (10, 32-33). It is interesting to note that the individuals in our group with sufficient 25-hydroxyvitamin D levels, representing only 11.8% of our population (n = 6), had significantly lower BMIs compared to the individuals in groups with low vitamin D levels (22.3 vs. 25.9 kg/m2), and this despite their having poor calcium and vitamin D intake. This unexpected finding could be due to the reporting errors that are often made when recalling food intake or to there being too small a number of people in the sample to arrive at any valid conclusion. It is of interest that in this particular sample of young physicians, mean BMI among the female sample members was normal, while the male population mean was in the overweight range, although no significant difference in vitamin D status per gender was found.

Calcium intake and vitamin D intake were markedly below the recommended daily allowances (Figures 1 and 2) for the population as a whole. Both calcium intake and vitamin D intake were positively correlated with 25-hydroxy vitamin D levels, but with a weak association. Vitamin D intake and calcium intake were higher in individuals with insufficient serum 25-hydroxyvitamin D levels compared to individuals with deficient levels. However, this association was not found in individuals with sufficient levels, which lack is likely because of the very small number of participants in this group. Excluding the group with sufficient vitamin D levels from the analysis makes it even more evident that individuals with insufficient 25-hydroxyvitamin D levels have significantly better calcium and vitamin D consumption and receive more exposure to the sun in peak solar radiation hours than do individuals with deficient levels. Low calcium and vitamin D intake in the US population has been consistently reported in the literature (6-7, 34-35). But, in this case, both the possibility of there being some degree of recall bias and the characteristics of the questionnaire may have had an impact on our results.

Our study's small sample size (which size resulted from its being a convenience sample) limits the generalizability of our findings. Moreover, serum PTH levels and other biomarkers associated with vitamin D metabolism were not measured in our study because our population of apparently healthy young physicians was not expected to have abnormalities in this respect. Another limitation is the use of self-reported race which is not necessarily an accurate measure of skin color.

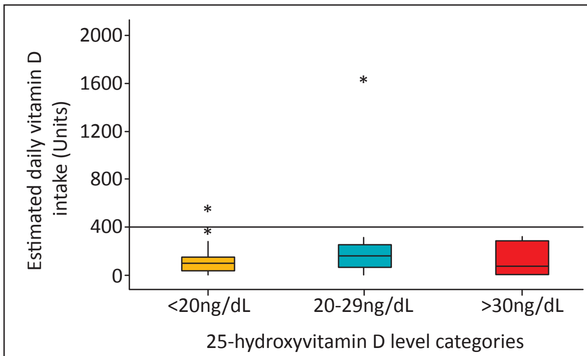


Reference line at 1200 mg represents the USDA recommended daily allowance
Categories: <20ng/dL (n = 23), 20-29 ng/dL (n = 22), >30 ng/dL (n = 6)

Figure 1. Daily calcium intake according to 25-hydroxyvitamin D levels

However, our findings reinforce the possibility of there being a higher prevalence of hypovitaminosis D than expected in the population under study. Such findings raise the question of how dietary and lifestyle aspects contribute to low 25-hydroxyvitamin D levels in an educated cohort. The high demands placed on young physicians often lead to their acquiring unhealthy eating habits. That fact coupled with our findings prompts our suggestion that counseling be implemented and healthier lifestyles actively promoted in this population.

Further studies with a larger sample should be done to determine the prevalence of hypovitaminosis D in other groups of professionals working indoors and living in Puerto Rico, which professionals might have unsuspected low levels of vitamin D and would almost certainly benefit from supplementation. The long term implications of low vitamin D levels and the benefits of vitamin D replacement in otherwise healthy persons have yet to be determined.



The reference line at 400 units represents the USDA recommended daily allowance. Categories: <20ng/dL (n = 23), 20-29 ng/dL (n = 22), >30 ng/dL (n = 6)

Figure 2. Daily vitamin D intake according to 25-hydroxyvitamin D levels

Conclusion

We found a high prevalence of hypovitaminosis D in a convenience sample of physicians living in Puerto Rico, a tropical region. Significant determinants of vitamin D status for our population included calcium and vitamin D intake, physical activity, body mass index, and sun exposure between 10:00 a.m. and 4:00 p.m.

Resumen

La vitamina D ha cobrado un mayor interés en los últimos años debido a que se ha encontrado prevalencias más altas que lo esperado en áreas con suficiente disponibilidad de luz solar. A pesar de que la luz solar y la dieta son los principales determinantes de los niveles de vitamina D séricos, otros factores como la edad, la raza, utilización de bloqueadores solares, medicamentos y condiciones de malabsorción pueden afectar los niveles de vitamina D. Estudios recientes han encontrado altas prevalencias de deficiencia e insuficiencia de 25-hidroxyvitamina D en diferentes poblaciones. Sin embargo, no hay suficiente información en la literatura sobre esta condición en nuestra población. Por lo tanto, decidimos evaluar una muestra de 51 residentes de medicina interna del Hospital Universitario en San Juan, Puerto Rico, entre 25 a 39 años de edad. Se realizó un cuestionario sobre características sociodemográficas, datos antropométricos, y estilos de vida y se obtuvieron resultados de laboratorio para niveles de 25-hidroxivitamina D. La mediana para el nivel de 25-hidroxivitamina D fue de 21 ng/mL (rango 7-38 ng/mL). Cuarenta y cinco participantes (88.2%) tenían concentraciones de vitamina D menor a 30 ng/mL. De los mismos el 43.1% fueron clasificados como deficientes de vitamina D y el 45.1% como insuficientes. Los factores contribuyentes a nuestros hallazgos incluyen una exposición limitada a la luz solar durante las horas pico de intensidad solar, un mayor índice de masa corporal y una superficie corporal limitada expuesta a la luz solar. Se encontró además una relación entre un menor nivel de actividad física e hipovitaminosis D. Se encontró una asociación débil entre el consumo de calcio y vitamina D y los niveles de 25-hidroxivitamina D. El consumo de ambos nutrientes fue muy por debajo de las recomendaciones nutricionales en la población estudiada.

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