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Living in Low-Latitude Regions in the United States Does Not Prevent Poor Vitamin D Status

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Vitamin D deficiency may occur throughout the life cycle, and is described as an unrecognized epidemic. The risk of deficiency may be increased by darker skin color, overweight and obesity, and low vitamin D intakes, while living in low latitudes and not using protective measures against the sun may decrease risk. However, a recent study reported that Hispanic adults living in the high-sun-exposure area of Miami have a high prevalence of poor vitamin D status in the winter, suggesting that living at low latitudes alone does not protect against vitamin D deficiency. The vitamin D status of Hispanics needs further investigation, given the large number of Hispanics living in southern regions of the United States and the emerging role of vitamin D in numerous health disorders.

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INTRODUCTION

Two recently published symposia highlight the role of vitamin D in chronic diseases and the need to establish a recommended dietary allowance.[1,2] Poor vitamin D status has been associated with certain cancers, diabetes, bone disorders, impaired activities of daily living, falling, poor physical function, chronic pain, and depression.[3-9] The 2005 Dietary Guidelines for Americans recommend consuming extra vitamin D (1000 IU or 25 μg/d) in populations at high risk of vitamin D deficiency. Such high-risk populations include older adults, people with darker skin, and those exposed to insufficient ultraviolet radiation.[10] This is an increase above the adequate intake levels, which are 5 μg from birth to age 50, 10 μg from ages 51 to 70, and 15 μg after age 70.[11]

There is an ongoing, and much needed, debate about the concentration of 25-hydroxyvitamin D, 25(OH)D, that should be used to describe vitamin D deficiency, inadequacy, and adequacy. Although there is evidence that 25(OH)D concentrations of approximately 80 nmol/L or more may decrease the risk of bone fractures in older adults,[12] for the purposes of this review, vitamin D inadequacy will be defined as 25(OH)D concentrations of less than 50 nmol/L. The rationale for this cutoff is based on the lack of increase in serum parathyroid hormone levels and normal bone turnover observed after serum 25(OH)D concentrations reach 50 nmol/L.[13] Comparisons of vitamin D status in different studies are complicated by differences in assays.[12,14,15] Therefore, this review will make comparisons primarily among studies that use the same assay method: a radioimmunoassay called DiaSorin (formerly called the INCSTAR test kit, INCSTAR Corp., Stillwater, MN).

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LATITUDE AND VITAMIN D STATUS

Latitude is often assumed to be one of the most important factors influencing vitamin D status. Even though the relative photosynthesis of vitamin D in the skin throughout the year in low-latitude regions is higher than in high-latitude regions due to more UV irradiation, living in sunny climates does not ensure vitamin D sufficiency.[16] However, populations residing at higher latitudes in North America and northern Europe, for example, are believed to be particularly vulnerable to poor vitamin D status.[1] Lips et al.[17] compared the serum 25(OH)D of 7564 postmenopausal women with osteoporosis (based on their bone mineral density) from 25 countries on five continents. The mean concentrations of 25(OH)D (in nmol/L) were 84.7 in northern Europe, 65.9 in central Europe, 61.1 in southern Europe, 76.3 in Canada, 68.4 in the United States, 61.5 in Argentina, 66.8 in Mexico, and 80.4 in Singapore. The prevalence of vitamin D inadequacy and the latitudes of these countries are shown in Figure 1.

Although this study cannot be generalized to all adults, the data do suggest that vitamin D status is not simple matter of latitude of residence. Lips et al.[17]

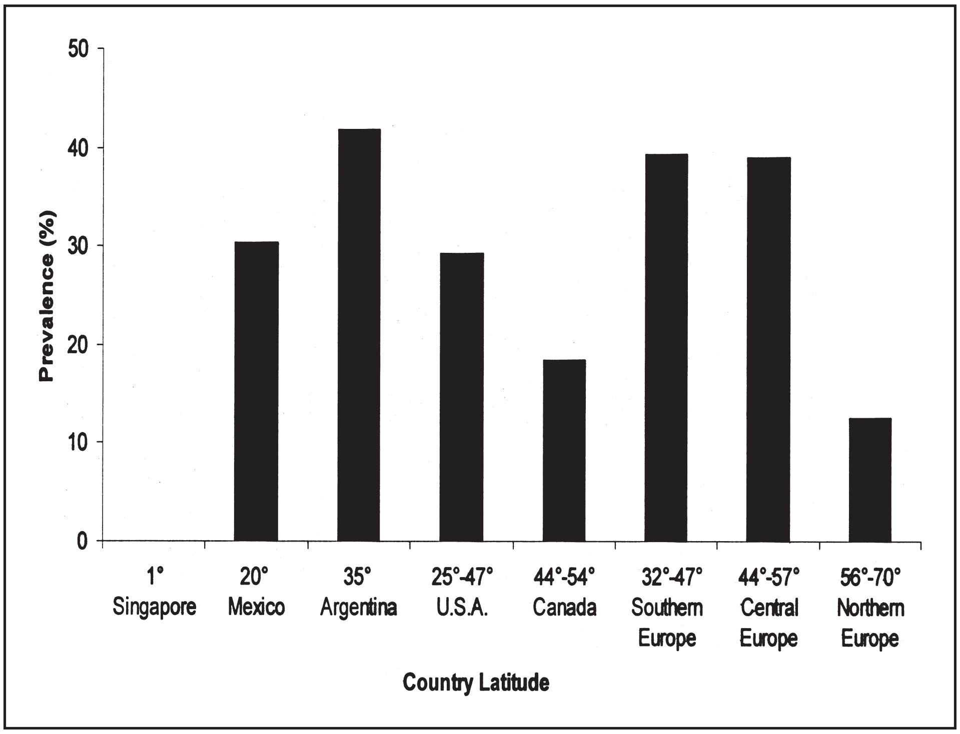

Figure 1. The prevalence of vitamin D inadequacy, which is defined here as a serum 25(OH)D of ≤50 nmol/L, is presented by country and latitude in postmenopausal women with osteoporosis. None of the participants in Singapore had vitamin D inadequacy. Data are from Lips et al., 2001.[17]

suggested that the high consumption of fish in northern Europe may have contributed to their overall good vitamin D status, while the sun-protective habits of southern Europeans may have contributed to their lower vitamin D status. Other factors such as food fortification practices, use of dietary supplements, time outside, clothing habits, and skin pigmentation, also contribute to the differences in vitamin D status among countries.

VITAMIN D STATUS OF HISPANIC AND BLACK POPULATIONS IN MIAMI

Hispanics are the predominant minority group in the United States. In 2002, there were 37.4 million Hispanics that comprised 13.3% of the civilian non-institutionalized population.[18] The most recent census allowed people of Hispanic origin to report their origin as Mexican, Puerto Rican, Cuban, Central and South American, or some other origin. The origin of the US Hispanic population is 66.9% Mexican, 14.3% Central and South American, 8.6% Puerto Rican, 3.7% Cuban, and 6.5% other. Most Hispanics live in the west (44.2%) and south (34.8%), with fewer living in the northeast (13.3%) and midwest (7.7%). Generally, US Hispanics are younger and have lower incomes than non-Hispanic whites.

Despite the large and rapidly growing Hispanic population in the United States, little is known about their vitamin D status and factors that might influence it. Recently, Levis et al.[19] examined vitamin D status at the end of winter (March) and summer (September) in 212 ambulatory adults aged 18 to 88 years residing in Miami, Florida (25.46° N). Participants were recruited in the outpatient internal medicine clinic at a local hospital, where patients tend to be indigent or have poor socioeconomic status. Exclusion criteria were pregnancy and medications or diseases known to influence vitamin D, calcium, or bone metabolism. Participants were assessed for vitamin D and calcium intake (using food frequency and supplement use questionnaires), sunlight exposure (using a questionnaire), current medications, serum 25(OH)D (using a radioassay), and intact parathyroid hormone (PTH) (Immulite®, Diagnostic Products Corp., Los Angeles, CA).

Of the participants in the winter study, 64% were women, 74.1% white Hispanic, 21.2% black, 3.8% white non-Hispanic, and 0.9% other. Mean age was 54.6 years. Sun exposure was categorized as mild (55.2%), moderate (14.2%), or extensive (30.6%). Most participants (97.6%) were taking some type of vitamin supplement. Vitamin D intake averaged 326 IU (8.15 μg) per day, and calcium intake averaged 1152 mg/d. Mean serum 25(OH)D was 55.8, 59.0, and 56.0 nmol/L in the white, Hispanic, and black participants, respectively, and the overall concentration was 58.3 nmol/L. Serum 25(OH)D was 8.3% higher in those with extensive compared with mild sun exposure, 8.3% higher in those over 60 years of age compared with those under 45 years, 11.2% higher in men than women, and 17% higher in those consuming more than 800 IU/d compared with those consuming less than 400 IU/d. As expected, PTH was negatively associated with serum 25(OH)D (r was approximately -0.4, extrapolated from a graph). In multivariate adaptive regression analyses, with age and gender as covariates, an inflection point in PTH was found at serum 25(OH)D concentrations of 50 nmol/L, which was used as the cutoff for hypovitaminosis D. The prevalence of poor vitamin D status at the end of winter is shown in Figure 2.

A subset of the winter participants returned for a second visit in September (n = 99). The participants in this study were similar to those in the winter group, except for a somewhat higher proportion of older females. The prevalence of poor vitamin D status at the end of summer is shown in Figure 2. The seasonal increase in serum 25(OH)D was 14.8% in men and 13% in women, which is somewhat smaller than that reported in higher-latitude regions.[12] Seasonal changes in serum 25(OH)D were not reported separately for the white, Hispanic, and black groups. The prevalence of poor vitamin D status was very similar in Mexican Americans in NHANES III in winter in the south[20] and in Hispanics at the end of winter in Miami (Figure 2, 40% and 36%, respectively). Among blacks, the prevalence of poor vitamin D status was somewhat higher in NHANES III in winter in the south than at the end of winter in Miami (Figure 2, 68.5% and 47%, respectively).[19] Perhaps the lower latitude of 25.46°N and the higher UVB availability in Miami offered some protection against vitamin D inadequacy compared with the southern populations studied in NHANES III at latitudes of 25°N to 34.9°N.

The authors noted that this was the first published report of vitamin D status in south Florida. Their findings raise concern about the vitamin D status of Hispanic and black individuals residing in the southern United States. The relatively small sample size limited the ability to determine the vitamin D status of all of the subgroup populations, such as older Hispanic or black women. Also, the origin of the Hispanic individuals was not reported. Participants were described as being of low socioeconomic status and may not represent the general population of Hispanics or blacks in Miami. Renal function was not assessed, so the renal contribution to poor vitamin D status and high PTH could not be established. The information on sunlight exposure and dietary intake of vitamin D was collected by self-report, and it is not entirely clear that these questionnaires were validated in Hispanic populations. Thus, future studies are needed to further clarify the extent of and risk factors for vitamin D

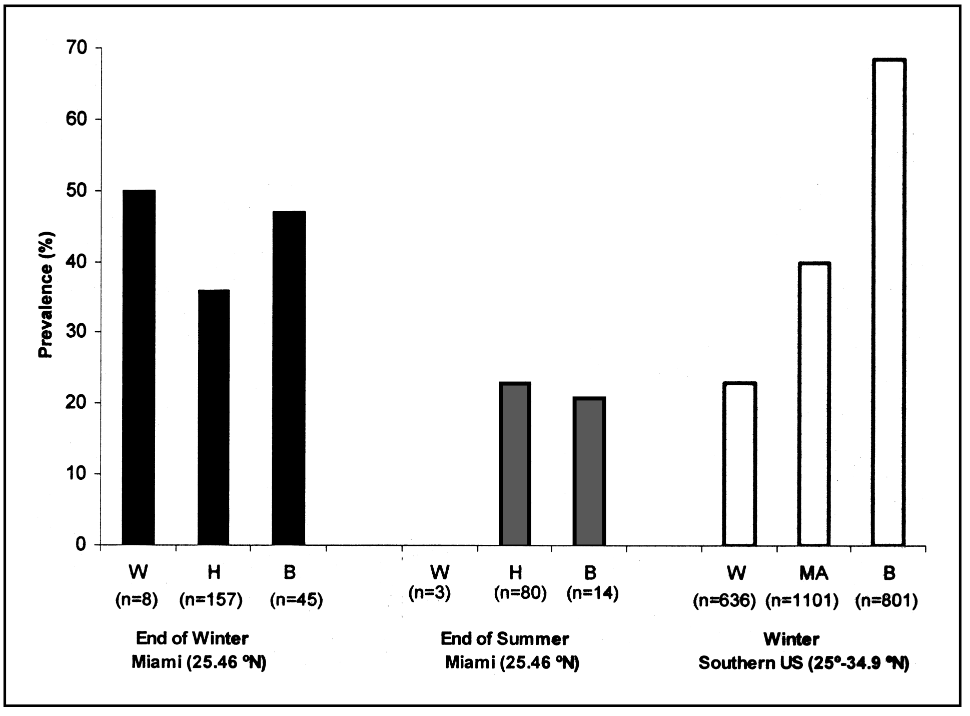

Figure 2. Prevalence of vitamin D insufficiency, which is defined here as a serum 25(OH)D concentration of ≤50 nmol/L. N indicates the total sample size. Black bars are the end of winter in Miami (March) and gray bars are the end of summer in Miami (September, age 18 to 88 years); W = non-Hispanic white; H = Hispanic white; B = black (Levis et al., 2005).[19] White bars are the southern United States during winter in NHANES III (November through March, age 30 to 59 years); W = non-Hispanic white; MA = Mexican American; B = non-Hispanic black. Data are from Looker et al., 2002.[20]

deficiency in various subgroups of the Hispanic population.

RISK FACTORS FOR POOR VITAMIN D STATUS IN HISPANICS

The high prevalence of poor vitamin D status in Hispanics living in high-sunlight areas such as Miami and other parts of the United States can be explained by several factors. Although it is difficult to generalize about variability in vitamin D status among Hispanics, it seems reasonable that skin color, race and ethnic origin, latitude, sun-protective behaviors, sun exposure through occupation, vitamin D intake from fortified foods such as milk, fish intake, use of vitamin D-containing supplements, overweight and obesity, and age could all play a role.

LATITUDE AND SKIN PIGMENTATION

In response to UVB radiation, darker skin makes less vitamin D precursors compared with lighter skin.[21] Variability in racial origin contributes to variability in skin color among Hispanics.[22] Nearly 80% of Hispanics live in the western and southern regions of the United States.[18] As a result of intense heat, sunlight, and skin cancer risk, people may stay indoors in the southern regions. Among adults aged 18 to 41 years in San Antonio, Texas (latitude 29.46° N), Mexican Americans (n = 16) had 47% lower serum 25(OH)D than Caucasians (n = 15) during April through May.[23] Reports from Argentina in middle-aged and older adults indicate a high prevalence of vitamin D deficiency, with the prevalence increasing at lower latitudes.[24,25]

In NHANES III, serum 25(OH)D concentration was obtained from 18,857 individuals aged 12 years and older. Assessments were made in summer in the higher latitudes and in winter in the lower latitudes, making comparisons of the prevalence of poor vitamin D status between latitudes problematic. However, ethnic/race comparisons can be made within a season and latitude. The mean serum 25(OH)D in winter (November through March) in the south (latitudes 25° to 34.9° N) in non-Hispanic whites, Mexican Americans, and non-Hispanic blacks between the ages of 30 and 59 was 75.0, 63.5, and 48.8 nmol/L in men and 66.0, 53.5, and 41.8 nmol/L in women, respectively.[20] The prevalence of poor vitamin D status in these subgroups is shown in Figure 2. Compared with non-Hispanic whites, the prevalence of poor vitamin D status was 1.6 to 2 times higher in Mexican Americans and 2.4 to 4 times higher in non-Hispanic blacks. Clearly, living in low latitudes does not protect darker-skinned populations from poor vitamin D status in the United States.

SUN-PROTECTIVE BEHAVIORS

Darker skin is less sensitive to sunburn, and there are differences in sun-protective behaviors among various ethnic and racial groups. Saraiya et al.[26] examined the prevalence of sunburn in the past year among adults aged 18 years and older in the 2000 National Health Interview Survey Cancer Control Module. About 44.1% of white, non-Hispanic males and 35.3% of white, non-Hispanic females had at least one sunburn experience. In contrast, about 21.5% of white, Hispanic males and 17.2% of white, Hispanic females reported at least one sunburn experience.[26] There is evidence that some Hispanic populations may be less likely to use sunscreen. Among US high school students (9th to 12th grades) in the 1999 Youth Risk Behavior Survey, 25% of whites, 74.1% of blacks, and 43.2% of Hispanics or Latinos never used sunscreen. Only 32.5% of whites, 13.7% of blacks, and 28.4% of Hispanics or Latinos rarely used sunscreen. Assessment of sun-protective behaviors will be important in future studies of vitamin D status in Hispanics.[27]

SUN EXPOSURE THROUGH OCCUPATION

There is variability in occupation among different ethnic and racial groups. According to US Census Bureau Current Population Survey 2002,[28] 14.2% of Hispanics and 35.1% of non-Hispanic whites were working at managerial and professional occupations. Hispanics were twice as likely as non-Hispanic whites (20.8% vs. 10.9%) to work as operators, fabricators, and laborers. Hispanics were also more likely to work in the farming, forestry, and fishing industries (4.6% vs. 2.2%). Hispanics may be more likely to have increased sun exposure and less likely to use sunscreen compared with whites.

DIETARY VITAMIN D INTAKE

In NHANES III (1988–1994), vitamin D intake from food alone and food with supplements was estimated for people age 6 and over among different races and ethnicities. Among women of age 12 and over and among men of age 12 to 19 years, whites had the highest intake and African Americans had the lowest intake of vitamin D both from food alone and from food with supplements. Mexican Americans had an intermediate intake among the three groups. Among men 20 to 49 years of age, whites had the highest and Mexican Americans had the lowest intake of vitamin D both from food alone and food with supplements. African Americans had an intermediate intake among the three groups. Among women 20 to 49 years of age, whites had the highest intake and African Americans had the lowest intake of vitamin D both from food alone and from food with supplements. Mexican Americans had an intermediate intake among the three groups. Among men age 50 and over, whites had the highest and Mexican Americans had the lowest vitamin D intake from food alone. In this group, whites had the highest and African Americans had the lowest vitamin D intake from both food and supplements.[29]

Frequency of dairy food intake among 101 first-generation Mexican Americans was examined; 91% consumed cheese and 85% drank milk on 2 to 7 days/week. However, this study did not monitor the daily intake of dairy foods, so it is difficult to estimate overall dairy food intake.[30] Calcium intake was estimated from the Hispanic Health and Nutrition Examination Survey and NHANES II among non-Hispanic whites, non-Hispanic blacks, Mexican Americans, Cubans, and Puerto Ricans 11 to 74 years of age. Overall results indicated that non-Hispanic blacks had the lowest calcium intake compared with non-Hispanic whites and other Hispanic populations. Non-Hispanic whites had a higher calcium intake compared with Hispanic groups. Milk made the highest contribution to calcium intake in all Hispanic population groups, and these groups tended to drink whole milk rather than low fat (2%) milk.[31] There is evidence that non-Hispanic blacks and Hispanics over 9 years of age have a high prevalence of lactose maldigestion, which is estimated at 75% in non-Hispanic blacks, 60% of Hispanics, and 20% of whites.[32] Overall, Hispanic and black populations appear to have lower vitamin D intake than the white population in the United States.

VITAMIN D INTAKE FROM SUPPLEMENTS

The prevalence of dietary supplement use varies among different race and ethnic groups.[33] In NHANES 1999–2000, the lowest prevalence of taking any supplement among adults was observed in Mexican Americans (33.3%) compared with non-Hispanic blacks (36%) and non-Hispanic whites (58.2%). Approximately 39.8% of non-Hispanic whites, 23% of non-Hispanic blacks, and 20.5% of Mexican Americans were taking dietary multivitamin/multimineral supplements. The prevalence of taking calcium supplements was 12.4% in non-Hispanic whites, 3.2% in non-Hispanic blacks, and 5.6% in Mexican Americans.[33] Additional information on the intake of vitamin D-containing supplements in Hispanic populations is needed.

OVERWEIGHT AND OBESITY

Obesity has been associated with poor vitamin D status, and the strength of the relationship may be stronger in whites than in blacks and in younger than in older people.[34-36] According to NHANES 1999–2000, the prevalence of obesity in non-Hispanic white, Mexican-American, and non-Hispanic black men is 27.3%, 28.9%, and 28.1%, and in women is 30.1%, 39.7%, and 49.7%, respectively.[37] Looker[36] reviewed several mechanisms by which obesity may impair vitamin D status, such as through avoidance of the sun and/or sequestration of vitamin D in the fat mass. The influence of obesity on vitamin D status of all populations including Hispanic populations warrants further investigation.

AGE

Advancing age is associated with a decreased ability of the skin to synthesize precursors of vitamin D.[38] Although most of the information is from whites and blacks,[39-41] there appears to be no reason to expect that darker-skinned individuals from various ethnic and racial groups would be protected from the effects of aging on vitamin D synthesis in the skin. Further research on the effect of age on cutaneous synthesis of vitamin D is needed in Hispanic populations, as well as other racial and ethnic groups.

CONCLUSIONS

Hispanic and black populations do not appear to be protected from seasonal variations in vitamin D status and poor vitamin D status in the lower latitude regions of the United States.[19,20] A variety of factors may influence vitamin D status among Hispanic and black populations, but elucidating the primary risk factors for vitamin D deficiency in these populations will require more research involving studies of skin color, body composition, dietary and supplement use patterns, sun-protective behaviors, and direct measures of UVB exposure during leisure and occupational activities.

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