Racial/ethnic considerations in making recommendations for vitamin D for adult and elderly men and women

Bess Dawson-Hughes

ABSTRACT
Vitamin D is acquired through diet and skin exposure to ultraviolet B light. Skin production is determined by length of exposure, latitude, season, and degree of skin pigmentation. Blacks produce less vitamin D3 than do whites in response to usual levels of sun exposure and have lower 25-hydroxyvitamin D [25(OH)D] concentrations in winter and summer. Blacks in the United States also use dietary supplements less frequently than do whites. However, blacks and whites appear to have similar capacities to absorb vitamin D and to produce vitamin D after repeated high doses of ultraviolet B light. There is a growing consensus that serum 25(OH)D concentrations of at least 75-80 nmol/L are needed for optimal bone health, on the basis of studies of older white subjects living in Europe and the United States. The studies show that increasing serum 25(OH)D concentrations to this level decreases parathyroid hormone (PTH) concentrations, decreases rates of bone loss, and reduces rates of fractures. Among US blacks, low 25(OH)D concentrations are associated with higher concentrations of PTH, which are associated with lower bone mineral density. Vitamin D supplements decrease PTH and bone turnover marker concentrations among blacks. These findings suggest that improving vitamin D status would benefit blacks as well as whites. On the basis of studies conducted in the temperate zone, the intake of vitamin D3 needed to maintain a group average 25(OH)D value of at least 75-80 nmol/L are needed for optimal bone health, on the basis of studies of older white subjects living in Europe and the United States. The studies show that increasing serum 25(OH)D concentrations to this level decreases parathyroid hormone (PTH) concentrations, decreases rates of bone loss, and reduces rates of fractures. Among US blacks, low 25(OH)D concentrations are associated with higher concentrations of PTH, which are associated with lower bone mineral density. Vitamin D supplements decrease PTH and bone turnover marker concentrations among blacks. These findings suggest that improving vitamin D status would benefit blacks as well as whites. On the basis of studies conducted in the temperate zone, the intake of vitamin D3 needed to maintain a group average 25(OH)D concentration of 80 nmol/L in winter is ~1000 IU/d. Broad-based vitamin D supplementation is needed to remove vitamin D insufficiency as a contributing cause of osteoporosis.

KEY WORDS Vitamin D, bone mineral density, fractures, dietary requirement

INTRODUCTION
Osteoporosis is a common problem in the United States and elsewhere. In its recent prevalence report, the National Osteoporosis Foundation indicated that, among those ≥ 50 y of age, 20% of white women and 5% of black women have osteoporosis and 52% of white women and 35% of black women have low bone mass, defined as 1-2.5 SD below the young reference mean (1). Seven percent of white men and 3% of black men have osteoporosis, and 35% of white men and 19% of black men have low bone mass. These values are in accord with recent estimates of fracture rates for the 2 race groups. Barrett et al (2) reported that the actuarial risks of hip fractures by age 85 y are 11.2% for white women, 3.6% for black women, 4.1% for white men, and 2.0% for black men. Vitamin D is known to be essential for bone health. It is also well recognized that blacks have lower vitamin D concentrations than do whites. The fact that blacks have higher bone mass and lower fracture rates than do whites has led some to assign less importance to defining the role of vitamin D in bone health for blacks. The objectives of this report are to compare, for blacks and whites, vitamin D physiologic processes, observational studies of vitamin D, and vitamin D intervention studies related to bone health. The issues of optimal 25-hydroxyvitamin D [25(OH)D] concentrations and the vitamin D intake needed to reach such concentrations are also addressed.

COMPARATIVE PHYSIOLOGIC FINDINGS
In addition to having higher bone mass than whites, blacks have been reported to have higher circulating concentrations of parathyroid hormone (PTH) (3, 4) and 1,25-dihydroxyvitamin D [1,25(OH)2D] (3, 4), although these findings have not been observed consistently (5). With dynamic testing involving citrate infusions among black and white women, Fuleihan et al (6) observed a mild degree of PTH elevation among black subjects. A consistent finding is that blacks have lower urinary calcium concentrations than do whites, when the 2 groups are studied with the same calcium intakes (3, 5, 7). Black women were shown to have similar levels of calcium absorption, compared with white women; however, their circulating concentrations of 1,25(OH)2D were higher, which suggests that blacks may have gut resistance to the actions of 1,25(OH)2D (8). Consistent with this suggestion, a subsequent investigation revealed that the increase in fractional calcium absorption in response to oral administration of 1,25(OH)2D was reduced among blacks, compared with whites (7).

Racial/ethnic differences in bone turnover have also been reported. In a large observational study among premenopausal and postmenopausal women; however, their circulating concentrations of 1,25(OH)2D were higher, which suggests that blacks may have gut resistance to the actions of 1,25(OH)2D (8). Consistent with this suggestion, a subsequent investigation revealed that the increase in fractional calcium absorption in response to oral administration of 1,25(OH)2D was reduced among blacks, compared with whites (7).

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1763S
perimenopausal women, Finkelstein et al (9) observed that serum osteocalcin concentrations were 11–24% higher among white women than among black, Chinese, and Japanese women in the United States. In that study, urinary N-telopeptide concentrations were similar for the black and white women, being 9–18% higher than values for the Chinese and Japanese women. In other studies, blacks exhibited lower turnover rates than did whites (3, 4, 10). During dynamic testing involving PTH(1–34) infusions, black and white women exhibited similar increases in the markers of bone formation but the white subjects demonstrated significantly greater increases in biochemical markers of bone resorption than did the black subjects (11). This resistance to the bone-resorbing action of PTH may contribute to the higher bone mass among black adults.

SERUM 25(OH)D CONCENTRATIONS AMONG BLACKS AND WHITES

Serum 25(OH)D concentrations are generally lower among blacks than among whites. This was observed in the third National Health and Nutrition Examination Survey sample of >18,000 men and women (12). It was also noted in a study of 90 black and white women, 20–40 y of age, who were evaluated 4 times each in the course of 1 year in the Boston area, at latitude 42° N (13). Figure 1 displays serum 25(OH)D concentrations for the 90 women according to season. Not only were 25(OH)D concentrations generally lower among blacks but also the changes in 25(OH)D concentrations with the seasons were attenuated. This is consistent with the observation of Loomis (14) that blacks produce less vitamin D than do whites at usual levels of sun exposure. In that study, intakes of vitamin D were similar among blacks (207 IU/d) and whites (232 IU/d).

Is there any evidence to suggest that blacks and whites have different capacities to absorb or synthesize vitamin D? Matsuoka et al (15) administered a single dose of 50,000 IU of vitamin D3 to young blacks and whites and measured their serum 25(OH)D responses in the subsequent 24 h. For the black and white subjects, peak responses (observed at 10 h after the dose) decreased along the same regression line, which suggests that absorption characteristics were similar for the 2 groups. In both groups, the percentage changes in serum 25(OH)D concentrations were inversely related to the starting 25(OH)D concentrations. Supporting evidence for this finding was found in an observational study in which blacks and whites demonstrated similar positive associations between self-reported intakes of vitamin D and serum 25(OH)D concentrations (16). Brazerol et al (17) defined and compared the skin vitamin D synthetic capacity for black and white subjects who were exposed to total-body, suberythemal, ultraviolet B rays (280-315 nm) twice weekly for 6 wk. As shown in Figure 2, the black subjects had lower starting 25(OH)D concentrations than did the white subjects, but their increases in response to ultraviolet B light exposure were similar to those of the white subjects. Concentrations of the 25(OH)D metabolite 24,25-dihydroxyvitamin D also increased in parallel for the black and white subjects (Figure 2). These studies suggest that blacks and whites have similar capacities to absorb and synthesize vitamin D.

OBSERVATIONAL STUDIES OF THE CONSEQUENCES OF LOW 25(OH)D CONCENTRATIONS

In a study of 246 elderly, black and white, low-income subjects in Boston, serum PTH concentrations were somewhat higher among the black subjects, but the associations of 25(OH)D concentrations with PTH concentrations were similar for the 2 groups (16). In this study population, there was a high prevalence of secondary hyperparathyroidism, defined as fasting serum
TABLE 1

Serum 25(OH)D and PTH concentrations and nonvertebral fracture rates in response to supplementation with vitamin D3

<table>
<thead>
<tr>
<th>Study</th>
<th>Sex</th>
<th>Dose of vitamin D3</th>
<th>Published serum 25(OH)D concentrations (nmol/L)</th>
<th>Standardized* serum 25(OH)D concentrations (nmol/L)</th>
<th>Effect on serum PTH concentrations</th>
<th>Preventive effect on fractures (hip and others)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chapuy et al (21, 24)</td>
<td>F</td>
<td>800</td>
<td>100</td>
<td>71</td>
<td>~47</td>
<td>+</td>
</tr>
<tr>
<td>Chapuy et al (23)</td>
<td>F</td>
<td>800</td>
<td>100</td>
<td>71</td>
<td>~33</td>
<td>+</td>
</tr>
<tr>
<td>Dawson-Hughes et al (22)</td>
<td>M, F</td>
<td>700</td>
<td>112</td>
<td>99</td>
<td>F: ~33; M: ~23</td>
<td>+</td>
</tr>
<tr>
<td>Trivedi et al (20)</td>
<td>M, F</td>
<td>820</td>
<td>74</td>
<td>—</td>
<td>—</td>
<td>+</td>
</tr>
<tr>
<td>Lips et al (19)</td>
<td>M, F</td>
<td>400</td>
<td>54</td>
<td>54</td>
<td>~6</td>
<td>NS</td>
</tr>
</tbody>
</table>

* Serum 25(OH)D concentrations were standardized to DiaSorin equivalent values (ie. HPLC, followed by a competitive protein-binding assay), on the basis of a cross-calibration study (25). Reprinted from Nutritional Aspects of Osteoporosis, Burckhardt P, Dawson-Hughes B, Heaney R, eds., copyright 2004, with permission from Elsevier.

VITAMIN D INTERVENTION STUDIES

Vitamin D intervention studies with fracture outcomes have been conducted predominantly among European and American whites. In 1996, Lips et al (19) reported that supplementation with 400 IU/d vitamin D had no effect on the risk of hip fractures among elderly men and women living in the Netherlands. Supplementation with 100 000 IU of vitamin D every 4 mo (equivalent to 833 IU/d) for a large group of community-dwelling elderly men and women in the United Kingdom decreased the risk of any first fracture by ~30% (20). Three other studies of the effects of combined calcium and vitamin D supplementation showed reductions in rates of hip fractures (21) and all nonvertebral fractures (21–23), compared with placebo. The results of those studies are summarized in Table 1. The published 25(OH)D concentrations in Table 1 refer to the concentrations achieved with the vitamin D supplements. The standardized 25(OH)D values were adjusted to DiSorin equivalent values with the use of data from a cross-calibration study by Lips et al (25). The assay used by Trivedi et al (20) was not included in the cross-calibration study but was reported by the authors (KT Khaw, personal communication, 18 August 2003) to be an HPLC method; therefore, values may be similar to the standardized values. From the available fracture studies, it can be observed that vitamin D doses of ≥700 IU/d reduced fracture rates but a dose of 400 IU/d was not effective. As expected, the serum 25(OH)D concentration achieved with 400 IU/d was lower (only 54 nmol/L) than the concentrations achieved with the higher doses studied (71-99 nmol/L). The reductions in serum PTH concentrations also appeared to be dose related. The reduction was minimal with the dose of 400 IU/d and was substantial with the higher doses. From these findings, it appears that 25(OH)D3 concentrations of 71-99 nmol/L are needed to decrease risks of fractures and that 700-800 IU/d vitamin D3 brings the group mean 25(OH)D concentration into this range. A higher intake would be needed to ensure concentrations of 70-99 nmol/L similar for the black and white subjects with normal PTH concentrations.

Finally, among those subjects, heel bone mineral densities were significantly lower among the black women with secondary hyperparathyroidism than among the black women with normal PTH concentrations (18). From these findings, we can conclude that low 25(OH)D concentrations are associated with untoward skeletal effects among blacks and whites.
Vitamin D is required to bring the group mean 25(OH)D concentration to 80 nmol/L. The specific benefit to be gained from increasing vitamin D intake remains to be defined for black subjects.

CONCLUSIONS

Vitamin D is important for optimal bone health among blacks and whites. Utilization of oral vitamin D appears to be similar for blacks and whites. Blacks and whites appear to have similar capacities to synthesize vitamin D in the skin but, at usual levels of sun exposure, vitamin D synthesis is less efficient among blacks because of their greater skin pigmentation. For white subjects, although direct evidence is needed.

REFERENCES