Prevalence of Vitamin D Insufficiency and Clinical Associations among Veiled East African Women in Washington State

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ABSTRACT

Aims: Cultural and biological factors place immigrant women from equatorial Africa at increased risk of vitamin D insufficiency. This could in part explain the high prevalence of fatigue, musculoskeletal complaints, and depressive symptoms in this population.

Methods: In a cross-sectional study of East African immigrant women in Washington State, 25-hydroxyvitamin D (25(OH)D) serum concentrations and multiple measures of physical and psychological symptoms were assessed. Mean serum 25(OH)D serum concentrations and chi-square were used to assess differences between groups. Multiple logistic regression was used to explore differences in the symptoms of subjects with varying degrees of vitamin D deficiency/insufficiency.

Results: Of the 75 women interviewed and who completed surveys, 25(OH)D serum samples were available in 71 subjects. All were found to have low 25(OH)D; 9 (12.3%) had ≤8 ng/mL, 29 (40.9%) had 8.1–15 ng/mL, and 33 (44.9%) had 15.1–30 ng/mL. After controlling for age, women with 25(OH)D ≥ 15 ng/mL were 66% less likely to drink milk than women with 25(OH)D < 15 ng/mL (adjusted odds ratio [aOR] = 0.33, 95% confidence interval [CI] 0.11–0.99). Musculoskeletal complaints, depressive symptoms, and fatigue did not correlate with the severity of 25(OH)D insufficiency.

Conclusions: Vitamin D insufficiency, as reflected by low 25(OH)D serum concentrations, was a universal finding in this group of women, suggesting the need for widespread education and intervention in this and other immigrant groups at northern latitudes.

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INTRODUCTION

Vitamin D is of critical importance in maintaining calcium homeostasis. Symptomatic vitamin D deficiency is associated with musculoskeletal problems, such as bone pain, muscle weakness, and osteomalacia-related bone fragility, as well as mood disturbances and impaired neuropsychiatric function.

Sunlight on the skin (specifically solar UV-B irradiation) induces the formation of pre-vitamin D₃ from 7-dehydrocholesterol in the epidermis, a critical step in the synthesis of metabolically active forms of the vitamin. In the absence of adequate sunlight, ingestion of fatty fish or vitamin D-fortified food, such as milk, is necessary to improve vitamin D intake. Persons at risk of developing vitamin D deficiency include persons living at northern latitudes, the homebound or institutionalized, dark-skinned individuals, and those who avoid direct sunlight exposure for cultural or health reasons.

Studies of Asian and Middle Eastern immigrants residing in Northern European countries (British Isles, Scandinavia, and Norway) have revealed varying degrees of vitamin D deficiency. These countries are located at latitudes above 50° N, and some have diminished UV-B irradiation for many months of the year. Plotnikoff and Quigley studied both immigrants and nonimmigrants who had persistent symptoms of nonspecific musculoskeletal complaints in an outpatient clinic in Minneapolis, Minnesota (latitude 44° N). In this case series, 93% of patients demonstrated vitamin D insufficiency.

Somali families from Eastern Africa immigrated to the Seattle area of Washington State during the 1990s, fleeing civil war and related violence that was widespread after the fall of the government and withdrawal of foreign troops. It is common for Somali women to come to our community clinics with musculoskeletal aches and pains, fatigue, and depressive symptoms. These symptoms are often considered physical manifestations of psychosocial stressors or psychiatric illness related to dislocation and past trauma. However, it is recognized that these women are also at risk for vitamin D deficiency/insufficiency. Women from this predominantly Muslim country wear long robes or dresses and head coverings, called hijab or hejab, which also serve as protection from the equatorial sun. In the Seattle area (latitude 47–48° N) UV-B irradiation is diminished for many months of the year, and in the absence of adequate dietary vitamin D, this traditional form of dress may place Somali women at increased risk for insufficient vitamin D.

We sought to determine the prevalence of vitamin D deficiency/insufficiency among Somali women living in our community and evaluate a possible association of low serum concentrations of 25-hydroxyvitamin D (25(OH)D) with musculoskeletal symptoms, fatigue, pain, and depression. We also explored whether 25(OH)D levels were related to sun exposure or milk or vitamin consumption. As part of our study protocol, we planned to provide all deficient women with 2 months of vitamin D supplementation and a letter with 25(OH)D results to be taken to their healthcare provider at completion of the study.

MATERIALS AND METHODS

The Institutional Review Board of the Fred Hutchinson Cancer Research Institute with reciprocity with the University of Washington approved this cross-sectional study. This pilot project was a collaborative effort between the University of Washington’s Center of Excellence in Women’s Health and a local community organization, the Refugee Women’s Alliance (ReWA). Somali women were recruited by ReWA through fliers and phone calls to women who had received services in the past year at this organization. ReWA provides services to approximately 67% of Somali immigrant women in the Seattle area, assisting in legal, immigration, housing, social, and health services referrals. They provide on-site English literacy and nutrition classes. Approximately 300 Somali women seek services per year. When attempting to recruit women for this project, the original contact information given to ReWA was no longer accurate in almost 50% at study recruitment. The majority had moved and were difficult to trace (original phone number was that of a friend with whom they were living only temporarily). We were able to contact a convenience sample of approximately 130 women, and 100 agreed to participate.

Women were seen at the ReWA facilities on four weekends in March and April of 2005. These dates were chosen because of the known association of temporal deficiencies in vitamin D following winter months. Seventy-five of the 100 women (75%) who agreed to participate came for
the blood draw and administration of a four-page survey that included questions about demographics; joint, back, or bone pain; and muscle weakness, using a simple visual analog scale with anchors of “none” and “severe.” Women were also queried about time spent outdoors, prior fractures, and vitamin, calcium, and milk intake. The survey contained measures for depressive symptoms (Patient’s Health Questionnaire [PHQ9]) and posttraumatic stress disorder (Primary Care Posttraumatic Stress Disorder screen [PC-PTSD]). The survey was first piloted among Somali women from the community, and adjustments were made to increase readability and understanding. Surveys were forward and back-translated in Somali and were administered in Somali by bilingual staff. Blood (3 mL) was drawn by trained phlebotomists and taken on ice to the University of Washington Research Laboratory. Specimens were spun immediately on arrival in the laboratory, and all analyses were run together.

All specimens were run using the DiaSorin (Stillwater, MN) 25(OH)D equilibrium radioimmunoassay (RIA). First, a rapid extraction of 25(OH)D and other hydroxylated metabolites from serum or plasma with acetonitrile was performed. Next, the specimen, antibody, and tracer were incubated for 90 minutes at 20–25°C. Phase separation was accomplished after a 20-minute incubation at 20–25°C with a second antibody-precipitating complex. An additional buffer (phosphate gelatin buffer containing 0.1% sodium azide) was added after this incubation and prior to centrifugation to aid in reducing nonspecific binding.

Serum concentrations of 25(OH)D (ng/mL) were grouped as mildly (15.1–30), moderately (8.1–15), or severely insufficient/deficient (<8.0). These concentrations are equivalent to 38–75, 20–37, and <20 nmol/L, respectively. Controversy exists as to the appropriate definitions of vitamin D insufficiency or deficiency. In predominantly Caucasian populations, parathyroid hormone (PTH) normalization has been reported to occur at 25(OH)D concentrations of 30 ng/mL, bone mineral density (BMD) to plateau at approximately 36 ng/mL, and optimal fracture prevention to be achieved at approximately 40 ng/mL. These norms have not been established for Somali immigrant women, although a lower threshold may be appropriate for African American women. As vitamin D insufficiency has been defined as 21–30 ng/mL, we chose 30 ng/mL as the lower bound of normal. Severe 25(OH)D in our research laboratory was defined as ≤8 ng/mL. Because of the small numbers of Somali women in the study and the current unknown appropriate designations for vitamin D insufficiency/deficiency for this population, we chose to establish fairly equal numbers in the moderate and mildly insufficient/deficient categories and retain our research laboratory’s definition of severe deficiency. We allowed dichotomization of 25(OH)D at 15 ng/mL for some analyses.

All women were invited back to receive their results in sealed envelopes and attend a nutrition class within 2 months after having their blood drawn. The class emphasized the importance of vitamin D supplementation. All women with vitamin D deficiency/insufficiency were given a 2-month supply of cholecalciferol, with doses adjusted for the 25(OH)D result (1, 2, or 3 tablets of 400 IU for mild, moderate, or severe deficiency/insufficiency, respectively). Investigators were present with bilingual interpreters to give the results. Women were asked to take the written results of vitamin D screening to their primary care providers along with recommendations for therapy within the next month.

Mean serum concentrations of 25(OH)D were determined by age, years of schooling, employment, health status, and clinical symptoms. Prevalence of vitamin D deficiency/insufficiency was calculated. Demographic, muscle and bone health characteristics, depressive symptoms, fatigue, nutrition related to vitamin D consumption, and surrogates of sun exposure were evaluated among the three groups (mild, moderate, and severely deficient/insufficient) to assess a possible association with the severity of deficiency. Potential confounding by the presence of PTSD was evaluated.

Multiple logistic regression, with key variables decided a priori to be of import or to show significance on univariate analyses, compared mildly deficient/insufficient to the moderate and severely deficient women, and chi-square analyses compared differences among the three groups (mild, moderate, and severely deficient/insufficient) (p < 0.05). Confidence intervals (CI) with 95% limits were generated. Statistical analyses were performed using StataSE software version 8.2 for personal computer (College Station, TX).
RESULTS

Characteristics of the women are shown in Table 1. Of the 75 women who were interviewed and completed surveys, vitamin D serum samples were available in 71 women, and all were found to have at least vitamin D insufficiency. Nine (12.3%) had serum concentrations ≤8 ng/mL (severe deficiency), 29 (40.9%) had serum concentrations >8 ng/mL but ≤15 ng/mL (moderate deficiency), and 33 (44.9%) had serum concentrations >15 ng/mL but <30 ng/mL (mild deficiency/insufficiency). Overall mean serum concentration was 14.4 ng/mL (95% CI 13.0–15.9).

The mean age of participants was 44.1, with a range of 18–75 years. Most women who were severely deficient were at the extremes of the age range, 18–21 or ≥51. The majority of women had not completed high school (85.5%), and this was particularly true of women with severe 25(OH)D deficiency (100%). Less than 10% of the women were employed outside of the home. Most, 94%, considered themselves to be in good, very good, or excellent health, and self-proclaimed health status did not correlate with serum 25(OH)D concentration. None of the women were smokers, and none reported thyroid dysfunction, or renal or hepatic disease. Four women had diabetes, but none of the 4 had severe 25(OH)D deficiency. Mean serum concentrations did not vary by age, schooling, employment, or self-proclaimed health status.

Table 2 summarizes findings from an analysis of the association of clinical symptoms with severity of 25(OH)D deficiency. The presence of joint, back, and bone pain, muscle weakness, falling, fatigue, or depression was not associated with lower mean 25(OH)D serum concentrations. Over 40% of women had at least mild joint, back, or bone pain. Muscle weakness in the prior 3 months was reported by 24.9% of women. Women with severe 25(OH)D deficiency were more likely to have fallen in the prior 3 months, but this was not statistically significant (22.2%, p = 0.18). At least moderate fatigue in the previous week was reported in 26.8% of women. Minor to moderate depressive symptoms were noted in 14 (19.7%). These findings did not change when controlled for the presence of PTSD (15.5% of women).

Prior fractures, vitamin use, and calcium use were uncommon in all women, 5.5%, 12.7% and 5.5% respectively.
10.0%, respectively. None of these factors was associated with the serum 25(OH)D concentration (data not shown). Most women (56.3%) walked outside at least 10 minutes per day every day. The 9 women who were never or rarely outside for at least 10 minutes per day had mean serum concentrations of 25(OH)D of 11.2 ng/mL (95% CI 7.0–15.4) compared with all other women who were outside for 10 minutes at least one day per week, with 25(OH)D of 14.9 ng/mL (95% CI 13.4–16.4).

The factor that tended to correlate best with severity of vitamin D deficiency was milk intake, although this was not significant in univariate analysis ($p = 0.07$) (data not shown). The mean 25(OH)D serum concentration of women who did not drink milk was 12.9 ng/mL (95% CI 9.4–14.7) compared with women who drank one to two glasses of milk per day (15.5 ng/mL, 95% CI 13.8–17.1). Not one woman drank more than two glasses of milk per day. Because milk intake was a key factor identified 

**DISCUSSION**

Recent studies suggest consumption of at least 700–800 IU of vitamin D per day is needed for optimal prevention of both fractures and falls, presumably from musculoskeletal weakness and pain. A target serum concentration over 30 ng/mL of 25(OH)D has been recommended. Not one Somali immigrant woman evaluated in our study met these recommended standards. Mean 25(OH)D serum concentration for the entire population was 14.4 ng/mL, lower than the 17.7 ng/mL observed in African American women and the 33.1 ng/mL observed in white women.

**FIG. 1.** The association of milk consumption with mean serum 25(OH)D serum concentrations. Low milk consumption was associated with low 25(OH)D.

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**TABLE 2.** Mean Serum 25(OH)D Concentrations in Women with Symptoms of Pain, Muscle Weakness, History of Falling, Fatigue, and Depression Compared with Women Without

<table>
<thead>
<tr>
<th>Symptoms present</th>
<th>Symptoms absent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean serum concentration (ng/mL)</strong></td>
<td><strong>(95% CI)</strong></td>
</tr>
<tr>
<td>Pain(^a)</td>
<td>14.8</td>
</tr>
<tr>
<td>Joint</td>
<td>14.7</td>
</tr>
<tr>
<td>Back</td>
<td>14.4</td>
</tr>
<tr>
<td>Bone</td>
<td>16.4</td>
</tr>
<tr>
<td>Muscle weakness(^a)</td>
<td>14.5</td>
</tr>
<tr>
<td>Falling(^a)</td>
<td>14.5</td>
</tr>
<tr>
<td>Fatigue(^b)</td>
<td>15.5</td>
</tr>
</tbody>
</table>

\(^a\)Bothered by in the past 3 months.
\(^b\)Rated \(\geq 5/10\) in past week.
\(^c\)Mild to moderate by PHQ9 survey.\(^13\)
men participating in the National Health and Nutrition Examination Survey (NHANES III).19

In our study, the lowest serum concentrations of 25(OH)D were observed in women who did not drink milk. Women with serum concentrations <15 ng/mL were 66% less likely to drink milk than women with concentrations of at least 15 ng/mL (aOR 0.33, 95% CI 0.11–0.99). A similar association was observed in NHANES III among adults19 and in a study of adolescents in Boston,21 but not in a Canadian study.22 Our findings were similar to those of the NHANES analysis by Nesby-O’Dell et al.19 African American women who consumed milk at least three times per week were half as likely to have serum vitamin D concentrations <15 ng/mL, as were those women who drank no milk. Similar findings were observed among Caucasian women.

Although we had anticipated that serum 25(OH)D concentrations would correlate with musculoskeletal pain, weakness, fatigue, and depressive symptoms, this small pilot study did not corroborate that assumption. We had presumed that some women in the study would have normal 25(OH)D concentrations. However, of 71 women, there were none who met the criteria for vitamin D sufficiency, and, therefore, the comparison of vitamin D deficient/insufficient women with women found to be vitamin D sufficient could not be made. The nonspecific musculoskeletal complaints reported in other immigrant populations attributed to severe vitamin D deficiency12,23–30 may well have been appreciated in our population if we had had normal controls and a greater number of women with severe vitamin D deficiency. All the studies cited, however, lacked controls or were case reports, with the exception of the study by Erkal et al.30 They found that Turkish immigrants in Germany with low 25(OH)D were more apt to complain of prolonged bone and muscle aches and pains than German men and women living in Germany or Turkish men and women living in Turkey (statistical analysis not shown). The theory that musculoskeletal pain is associated with vitamin D deficiency is also corroborated by a report of patients with chronic low back pain in Saudi Arabia. Al Faraj et al.31 showed that oral therapy with 5,000–10,000 IU/day of vitamin D ameliorated back pain in all 299 (100%) individuals who were found to have 25(OH)D concentrations of ≤9 ng/mL as compared with only 42 (68.9%) individuals with 25(OH)D concentrations >9 ng/mL (p < 0.001).

Others have investigated whether traditional dress or nutrition was more important in determining vitamin D deficiency. In Tunisian women, nutrition and multiparity were more important than wearing a veil.32 In a group of veiled and unveiled Turkish7 and Kuwaiti women8 with presumed similar dietary habits, women who were veiled were more likely to be vitamin D deficient, a finding similar to that of Erkal et al.30 among Turkish women living in Turkey as well as Turkish women who immigrated to Germany. Another study from Turkey evaluated severity of vitamin D deficiency by the degree of veiling and found that women with minimal sun exposure due to clothing were more deficient than others with non-traditional Muslim dress.9 Holvik et al.33 evaluated the prevalence and predictors of vitamin D deficiency among Pakistani, Vietnamese, Turkish, Sri Lankan, and Iranians living in Norway and found that a diet rich in vitamin D (fatty fish and cod liver oil supplements) was strongly associated with greater concentrations of 25(OH)D. NHANES III analyses showed profound differences in vitamin D serum concentration between U.S. African American women and U.S. Caucasian women. Forty-two percent of African American women, compared with 4.2% of white women, had 25(OH)D concentrations <15 ng/mL.19 Thus, it appears likely that the combination of traditional dress, diet low in vitamin D, and dark skin may play an important role in affecting serum concentrations of 25(OH)D.

Our study had several limitations. The analysis was based on a convenience sample of immigrant women who visited a community organization and had stable contact information over 1 year. It is possible that immigrants with poorer health or fewer resources are more likely to seek services, but one could also argue that among those who initially sought services who could not be reached because they had no home or phone at follow-up had even fewer resources. Thus, our results may be biased. Our sample was small, which limited the study’s power to detect differences between groups. We were unable to evaluate parathyroid, thyroid-stimulating hormone (to rule out fatigue due to hypothyroidism), sedimentation rate (to assess other etiologies of musculoskeletal pain), or urinary calcium in this pilot study, but it is doubtful that having these data
would have changed our results overall. Lastly, we had limited dietary and medical information and did no physical assessments.

The strength of this study was apparent in the collaborative efforts of a community organization and an academic team. This study is one of only two\(^\text{12}\) to report on vitamin D deficiency/insufficiency among immigrants to North America and the only one to show universally low 25(OH)D serum concentrations. Quality data collection with culturally sensitive tools was essential. The ability to reach this immigrant population through grassroots recruitment efforts resulted in excellent participation rates that are rarely achieved by academic groups working in isolation, without community partners.

**CONCLUSIONS**

The profound finding of 100% hypovitaminosis D in this population of Somali immigrant women deserves additional study in order to assess the associated important health ramifications for immigrant Muslim women who live in northern climates, have dark skin, and wear traditional dress. Further team efforts that can assess important health disparities for underserved minority populations and improve health outcomes are needed. Interventions that assess supplementation through the Women, Infants and Children (WIC) nutrition programs and enhance our understanding of immigrant dietary habits will be important areas to incorporate into future translational projects.\(^\text{34}\)

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