ABSTRACT

Background: Vitamin D deficiency is common in dark-skinned persons living in northern countries. Vitamin D deficiency during pregnancy may have serious consequences for both mother and child.

Objective: The objective was to ascertain the prevalence of vitamin D deficiency in pregnant women of several ethnic backgrounds who were living in The Hague, a large city in the Netherlands.

Design: Midwives whose practice was visited by a large number of non-Western immigrants added the assessment of serum 25-hydroxyvitamin D [25(OH)D] to the standard blood test given to women who visited the practice during week 12 of pregnancy. Subsequently, the Municipal Health Service collected additional data from the midwives’ files (June 2002 through March 2004): background variables, use of tobacco or alcohol or drugs, and infectious diseases. The women were grouped ethnically as Western, Turkish, Moroccan, and other non-Western.

Results: The vitamin D concentrations of 358 women were found in the midwives’ files. Of these women, 29% were Western, 22% were Turkish, and 19% were Moroccan. Mean serum 25(OH)D concentrations in Turkish (15.2 ± 12.1 nmol/L), Moroccan (20.1 ± 13.5 nmol/L), and other non-Western women (26.3 ± 25.9 nmol/L) were significantly (P ≤ 0.001) lower than those in Western women (52.7 ± 21.6 nmol/L). Serum 25(OH)D was below the detection limit in 22% of the Turkish women. The differences between ethnic groups were not confounded by other determinants such as age, socioeconomic status, or parity.

Conclusions: The prevalence of vitamin D deficiency in pregnant non-Western women in the Netherlands is very high, and screening should be recommended.

KEY WORDS: Hypovitaminosis D, vitamin D deficiency, serum 25-hydroxyvitamin D, pregnancy, ethnic groups, prevalence, women

INTRODUCTION

Vitamin D deficiency is common in dark-skinned persons living in northern countries. Vitamin D₃ is produced in the skin after exposure to sunlight or to artificial ultraviolet light. Sunlight is less effective in producing vitamin D₃ in persons with darker skin because the ultraviolet light is absorbed by the skin pigment (1, 2). Low sunlight exposure, covering of the skin, and a diet low in vitamin D and calcium may also contribute to lower vitamin D concentrations in non-Western immigrants to northern countries (3–5). These risk factors affect both males and females of all ages.

Vitamin D deficiency in pregnant women may affect the women as well as their unborn children. The deficiency could lead to a high bone turnover, bone loss, osteomalacia, and hypovitaminosis D myopathy in the mother (6, 7). Most studies of vitamin D deficiency during pregnancy have shown negative effects on calcium homeostasis and skeletal mineralization of the (unborn) child, eg, the occurrence of congenital rickets, craniotubes, and lower bone mineral content (8–10). Effects on maternal weight gain, fetal growth, and birth weight are conflicting and inconclusive (11). Some researchers hypothesize that low prenatal and perinatal vitamin D concentrations affect the functional characteristics of various tissues of the body (12, 13), which leads to a greater risk in later life of multiple sclerosis, cancer, insulin-dependent diabetes mellitus, and schizophrenia.

To ensure adequate absorption of calcium by the fetus, the Health Council of the Netherlands recommends a higher vitamin D intake for pregnant than for nonpregnant women (14). However, several Dutch organizations (ie, those for midwives, gynecologists, and general practitioners) state that there is insufficient evidence of a greater need in pregnant than in nonpregnant women (15). Many of the studies of vitamin D deficiency in pregnant women over the past 25 y found a high prevalence in pregnant non-Western women in countries in various parts of the world (16–22). Information on the prevalence in pregnant women in the Netherlands is scarce but highly relevant, because the group at risk is large and growing: 43% of babies born in the 4 largest Dutch cities in 2002 were of non-Western ethnicity. The aim of our study was to ascertain the prevalence of vitamin D...
deficiency in an early stage of pregnancy in women of different ethnic groups in The Hague.

SUBJECTS AND METHODS

Subjects

In June 2002, midwives whose practice was in a socioeconomically deprived neighborhood in The Hague decided to add the assessment of serum 25-hydroxyvitamin D [25(OH)D] to the standard blood tests given to pregnant women (with health insurance) at their first antenatal visit. Serum 25(OH)D was measured with a radioimmunoassay (Diasorin, Stillwater, MN) by a laboratory accredited by CCKL, the Dutch agency for laboratory accreditation. This test assesses 25-hydroxyvitamin D$_2$ and 25-hydroxyvitamin D$_3$ together, and, because the former is absent in accreditation. This test assesses 25-hydroxyvitamin D$_2$ and 25-hydroxyvitamin D$_3$ together, and, because the former is absent in

The mean serum 25(OH)D concentrations did not differ significantly between the seasons. We did not find a significant seasonal variation even in the Western women, who had the lightest skin

RESULTS

In the period from June 2002 through March 2004, 762 women came to the midwives’ practice in their 12th week of pregnancy. Of these women, vitamin D concentrations for 358 (47%) were found in the files.

Of these 358 women, 29% were of Western (including indigenous Dutch), 22% were of Turkish, and 19% were of Moroccan origin (Table 1). Ages ranged from 17 to 42 y ($\bar{x}$: 26.8 y). Thirty-one percent and 45% of the women lived in neighborhoods with a very high and a high deprivation score, respectively. Forty-five percent of the women were primigravidae, and 29% were in their second pregnancy. Compared with the non-Western women, the Western women were significantly older, significantly fewer lived in a neighborhood with a very high deprivation score, and a greater proportion were primigravidae (the last item resulted in almost identical means. In all non-Western groups, most of the subjects (Turkish, 84%; Moroccan, 81%; other non-Western women, 59%) had a vitamin D deficiency. Serum 25(OH)D concentrations were log transformed because of lack of fit with the normal curve. Because of unequal cell variances, this analysis was weighted by the inverse variances of the subgroups (23). Differences in percentages were tested by using logistic regression. All analyses were performed by using SPSS software (version 12.0.1, SPSS Inc, Chicago, IL).

Means compared by using ANOVA and Dunnett’s test.
2 Means compared by using logistic regression.
3 $\bar{x}$ ± SD (all such values).
4 $P \leq 0.001$.
5 $P \leq 0.05$.
6 $P \leq 0.01$.
July–September, 4%; October–December, 12%). The relation between vitamin D and ethnicity was not confounded by age, season, deprivation score of the neighborhood, parity, smoking or alcohol or drug use, or infectious diseases.

**DISCUSSION**

Mean serum 25(OH)D concentrations in women of Turkish, Moroccan, and other non-Western groups were significantly lower than those in the Western women. In all non-Western groups, most of the women had a vitamin D deficiency—ie, serum 25(OH)D concentrations < 25 nmol/L. This threshold is the reference concentration of the analyzing laboratory and has been debated in the literature (7). However, there is no consensus about the appropriate threshold; higher thresholds have been suggested (24–26). These differences in 25(OH)D concentrations between ethnic groups may be caused by differences in skin type, skin covering (clothes), and the avoidance of direct sun exposure. However, information on these variables was not available.

The season of the blood sampling did not show a clear trend in vitamin D concentrations. In the Netherlands (52° N), vitamin D production in the skin takes place from April through September (27). We would therefore presume the serum 25(OH)D concentrations in the July–September span to be the highest and those in the January–March span to be the lowest. However, our results do not support this presumption, even in the Western women—ie, those with the lightest skin.

Vitamin D concentrations were available for 47% of 762 eligible women. Possible reasons for this relatively low percentage are that the midwives did not 1) add the vitamin D test to the standard blood test, 2) receive the results from the laboratory, or 3) record the serum 25(OH)D concentration in the medical files. We assume that this omission may have resulted in an underestimation of mean values. Even if, in a hypothetical situation, none of the women with an unknown serum concentration of 25(OH)D had a vitamin D deficiency, 25% of the total population would still be vitamin D deficient, and such a situation would be a major problem.

Some women came to the midwives’ practice during a late stage of their pregnancy, had already undergone the standard blood test given in another health-care setting, or both. These women probably are at higher risk of a vitamin D deficiency because most of them are non-Western. The inevitable exclusion of these women will have caused selection bias that is opposite to the 3 above-mentioned possible reasons. In total, 260 pregnant women came later than the 12th wk of pregnancy, partly because they came from a midwife or physician outside the participating practice.

Some other studies have been conducted at a similar latitude (20, 28–30) and thus in a region with an intensity of sunlight similar to that in the area in the current study. The overall conclusion in these studies was comparable: vitamin D deficiency is common among ethnic minorities in the cities studied (ie, Cardiff and London, United Kingdom), even early in pregnancy. Although the first of these studies was published in 1981, the current study indicates that the problem still has not been solved.

Dietary supplements may prevent vitamin D deficiency during pregnancy. The Health Council of the Netherlands recommends a higher amount of vitamin D for pregnant than for nonpregnant women. Because of a lack of evidence, this recommendation is not generally accepted (11, 15, 31). The current study shows, irrespective of this discussion, that special attention should be paid to non-Western pregnant women in the Netherlands. This recommendation is supported by recent case histories of convulsions in the newborns of non-Western mothers in the Netherlands (32). These convulsions were due to a vitamin D deficiency in the mother during pregnancy.

If the pregnancy itself is not the cause of the vitamin D deficiency, it can be said that (preventive) campaigns should aim at all non-Western women, not only pregnant women. However, pregnant women are more easily reachable because of their regular antenatal visits. In addition, the deficiency affects not only the mother, because the vitamin D status of the (unborn) child is dependent on the mother (33). There is no consensus about the adequate amount of vitamin D supplementation to prevent or cure a vitamin D deficiency (31, 34). A study by Cockburn et al (35) found that a dose of 400 IU/d for 4 mo resulted in 25(OH)D concentrations that were 3.8 nmol/L higher than baseline. However, the baseline concentrations in the population in the current study were lower than those of subjects in the study by Cockburn et al, and therefore a higher dose should be considered for our subjects.

Our estimation of the percentage of vitamin D-deficient pregnant non-Western women is conservative. With thresholds > 25 nmol/L, the percentage may rise to almost 100%. Although not

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<th>25(OH)D concentration</th>
<th>25(OH)D deficiency</th>
<th>25(OH)D under the detection limit</th>
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<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
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<tr>
<td>Western (reference) (n = 105)</td>
<td>52.7 ± 21.6</td>
<td>8 (8)</td>
<td>1 (1)</td>
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<tr>
<td>Turkish (n = 79)</td>
<td>15.2 ± 12.1</td>
<td>66 (84)</td>
<td>17 (22)</td>
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<tr>
<td>Moroccan (n = 69)</td>
<td>20.1 ± 13.5</td>
<td>56 (81)</td>
<td>3 (4)</td>
</tr>
<tr>
<td>Other non-Western (n = 105)</td>
<td>26.3 ± 25.9</td>
<td>62 (59)</td>
<td>9 (9)</td>
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1 Means compared by using ANOVA and Dunnett’s test; vitamin D data were log transformed and weighted by inverse cell variances.
2 Deficiency = < 25 nmol 25(OH)D/L.
3 Means compared by using logistic regression.
4 Under the detection limit = <7 nmol 25(OH)D/L.
5 ± SD (all such values).
6 P ≤ 0.001.
7 P ≤ 0.05.
all effects mentioned above are the proven result of a vitamin D deficiency, enough evidence exists for us to consider a vitamin D concentration < 25 nmol/L as a deficiency. These deficiencies should be diagnosed and cured, and therefore we recommend the screening of all pregnant non-Western women for vitamin D deficiency. The high prevalences found in this study, the size of the population groups at risk, and the consequences of inaction make this screening and treatment necessary.

We gratefully acknowledge the statistical assistance of DL Knol. IMM, NSK, BJCM, IV, and JDW designed the study; IMM, NSK, and IV collected the data; IMM and NSK analyzed the data; BJCM supervised the analysis of the data; and all authors were involved in writing the manuscript. None of the authors had a personal or financial conflict of interest.

REFERENCES