CLINICAL STUDY

Low levels of serum calcidiol in an African population compared to a North European population

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Abstract

Objective: To compare vitamin D status in an African population living at 10°N with a Norwegian population living at 60°N.

Design: Serum samples from 30 healthy young Ethiopians and 31 full term pregnant women from Addis Ababa were collected in September, and from 24 healthy Norwegians in March and 23 pregnant women from Oslo in February to June.

Methods: Serum (s) levels of calcidiol and intact parathyroid hormone (iPTH) were measured.

Results: The median values for s-calcidiol were significantly lower in Ethiopians compared with Norwegians (young Ethiopians 23.5 nmol/l vs young Norwegians 81 nmol/l, P < 0.001; pregnant Ethiopians 25 nmol/l vs pregnant Norwegians 36 nmol/l, P < 0.05) while those for s-iPTH were significantly higher (young Ethiopians 5.7 pmol/l vs young Norwegians 2.4 pmol/l, P < 0.001; pregnant Ethiopians 4.8 pmol/l vs pregnant Norwegians 2.8 pmol/l, P < 0.02).

Conclusion: In spite of abundant availability of ultraviolet radiation, the population from Addis Ababa had a high rate of biochemical vitamin D deficiency compared with the Norwegian group.

Introduction

Vitamin D is essential for normal calcium and bone metabolism, and it is derived from oral intake or cutaneous production when the skin is exposed to the ultraviolet B rays contained in sunlight (1). In North America and Europe, the importance of dermal production as a source of cholecalciferol is demonstrated by the seasonal fluctuations in the serum concentration of calcidiol (2). Several studies have shown that people of non-caucasian races moving from a sunny climate to Northern Europe can develop vitamin D deficiency with increased risk of rickets and osteomalacia (3,4). Differences in serum calcidiol have been demonstrated between white and black people living in the USA (5), but there are few studies on vitamin D status in black people living in Africa. M’Buyamba-Kabangu et al. (6) showed that males from Zaïre living in Africa had significantly higher serum (s) calcidiol and non-significantly lower serum intact parathyroid hormone (s-iPTH) than their countrymen who had moved to Belgium. In a study from Nigeria, it was found that pregnant women using veils for religious reasons had significantly lower s-calcidiol levels compared with non-veiled women (7). Addis Ababa is situated at latitude 10°N, 2,700 m above sea-level. We wanted to do a survey on the vitamin D-endocrine system expressed by s-calcidiol and s-iPTH in young, normal Ethiopians and in pregnant Ethiopian women living in Addis Ababa, and compare the values with a Norwegian population living in Oslo at latitude 60°N at sea-level. As differences in the effect of cholecalciferol could be influenced by polymorphisms in the vitamin D receptor alleles (8), a study of the frequency of a common vitamin D receptor allele in the Ethiopian subjects was also carried out.

Subjects and methods

In Addis Ababa, blood samples were obtained from 102 healthy student nurses aged 19–40 years. The samples were drawn in the first week of September after the period of summer rains. The first 30 serum samples from Ethiopia were obtained in the laboratory (24 men and 6 women, aged 21 (range 20–22) years) were selected for the measurement of s-calcidiol and s-iPTH. For the study of pregnant women, blood samples were drawn...
from 31 healthy full term pregnant Ethiopian women (aged 25 (22–28) years) consecutively entering hospital in August and September. After venepuncture, one aliquot was obtained as an EDTA sample and one as a whole blood sample. The samples containing whole blood were allowed to clot at room temperature, were separated by centrifugation, and serum and EDTA blood were stored at $-20^\circ$C. All samples from Addis Ababa were transported by plane frozen on dry ice to the Hormone Laboratory in Oslo for analysis.

In Oslo, blood samples were collected from healthy students and health workers aged 18–35 years in late winter (March) (8 men and 16 women, aged 24 (23–25) years). For the study of pregnant women, blood tests were drawn from 23 full term Norwegian women (aged 25 (22.5–29.5) years) in the period February to June.

The serum concentration of calcidiol was measured using HPLC after extraction and chromatographic separation (9). The intra-assay coefficient of variation (CV) was 10–13%. Serum levels of iPTH were determined in duplicate using a two-site immunoradiometric assay (Allegro intact PTH, Nichols Institute Diagnostics) (9). The intra-assay CV was 6–9%. After extracting DNA from whole blood, a fragment of the vitamin D receptor (VDR) gene was amplified by polymerase chain reaction (PCR) and treated with the endonuclease restriction enzyme BsaMI. VDR alleles were assessed after agarose gel electrophoresis of the digested PCR products and were denoted B to indicate the absence of the restriction site or b in the presence of the restriction site (10).

Results are presented as median and 25 and 75 percentiles. Differences between populations were tested using the Mann–Whitney test. A $P$ value of less than 0.05 was considered statistically significant.

**Results**

Individual serum levels of calcidiol and iPTH are shown in Figs 1 and 2 respectively for normal Ethiopians and normal Norwegians, and pregnant Ethiopians and pregnant Norwegians. The normal Ethiopians had significantly lower serum levels of calcidiol (23.5 (18–29) nmol/l vs 81 (67.5–101.5) nmol/l) and higher serum levels of iPTH (5.7 (4.2–7.4) pmol/l vs 2.4 (2.0–3.2) pmol/l) compared with normal Norwegians ($P < 0.001$ for both). Only 2 (8%) of the Norwegians had s-calcidiol below 50 nmol/l, compared with all except one of the Ethiopians (97%). No Norwegians had s-calcidiol below 30 nmol/l, compared with 23 (77%) of the Ethiopians. Seventeen (60%) of the Ethiopians had s-iPTH above the highest Norwegian iPTH value (4.8 pmol/l). Four (14%) of the Ethiopians had values for s-iPTH above 8.5 pmol/l, which is the upper limit of the reference range.

Among the pregnant women, the Ethiopians had significantly lower serum levels of s-calcidiol than the Norwegians (25 (17–46) nmol/l vs 36 (27–57) nmol/l, $P < 0.02$) and significantly higher iPTH (4.8 (2.7–7.6) pmol/l vs 2.8 (2.2–4.3) pmol/l, $P < 0.01$). S-calcidiol levels below 50 nmol/l were found in 25 (81%) of the Ethiopians and 13 (57%) of the Norwegians, and serum levels below 30 nmol/l were found in 17 (55%) of the Ethiopians and 8 (35%) of the Norwegians. Eight (40%) of the Ethiopians had s-iPTH above the highest Norwegian iPTH value (5.4 pmol/l). Four (20%) of the Ethiopians had values for s-iPTH above the upper limit of the reference range.

In the VDR allele analysis in the 102 normal Ethiopians, bb was found in 37 (36.3%), Bb in 51 (50.0%), and BB in 14 (13.7%). The allelic fractions were $b = 0.61$, $B = 0.39$.

**Discussion**

This study has shown that both normal Ethiopians and full term pregnant Ethiopian women living in Addis Ababa have a significantly decreased vitamin D status compared with Norwegians living in Oslo when both
populations were tested after the season of lowest sun exposure. The low vitamin D status expressed as the serum concentration of calcidiol was accompanied by a significantly higher serum level of iPTH in the Ethiopians. The allelic fractions of VDR were not different between the Ethiopians and previous published values from a Norwegian population (11).

The finding of a low vitamin D status in Ethiopians living at 10°N at an altitude of 2700 m was unexpected. It may be explained by clothing habits in Addis Ababa, leaving little skin open to sun exposure, in addition to a low capacity for exposed skin with high melanin content to produce cholecalciferol (12). In addition, while there is no cholecalciferol supplementation of food in Ethiopia, margarine and butter are supplemented in Norway. We do not know whether our findings are applicable to the total Ethiopian population or are the result of the living conditions specific for Addis Ababa.

Low vitamin D status may have a bearing on calcium metabolism and future bone health. We do not, however, have any knowledge on the epidemiology of metabolic bone disease in Ethiopians. As the finding of a low vitamin D status was also made in the full term pregnant women, this could be of importance for the vitamin D status in their newborn children (13). Rickets has been found in as many as 30% of Ethiopian children below 3 years of age (14–16).

In conclusion, in a population from Africa with abundant availability of ultraviolet radiation, low levels of s-calcidiol and increased levels of s-iPTH were found. This might be of clinical importance for disturbances in calcium and bone metabolism both in newborn children and in adults. We do not know, however, whether these metabolic disturbances constitute an important impact on the general health of the population. Further studies are therefore warranted to see if measures should be taken to prevent the low vitamin D status in this African population.

References


