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Report

Higher vitamin D levels in Nigerian albinos compared with pigmented controls

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Abstract

Background Several studies have suggested that the lower vitamin D levels in blacks is attributable to the effect of increased pigmentation in blocking cutaneous ultraviolet (UV)-mediated production of vitamin D. Albinos are devoid of melanin and should invariably have higher vitamin D levels when compared with their pigmented counterparts. However, strict photoprotection required in their medical management has been shown to reduce UV-dependent vitamin D production. Associations between low vitamin D and several diseases suggest that the pattern of vitamin D in the black African albino be investigated.

Objective To compare the vitamin D levels between albinos and normal pigmented controls in Anambra State, Nigeria, and thus highlight the impact of skin pigmentation and sun protection practices on vitamin D levels.

Methodology This was a cross-sectional study of a consecutive series of albinos from the Albino Foundation, Anambra State. The vitamin D levels of 61 albinos and 58 matched pigmented controls were analyzed. The sun exposures of the participants were calculated using validated sun exposure questionnaires.

Results The albinos had significantly higher vitamin D levels (median 95.9 [50.1–177.4] ng/ml) than the controls (78.2 [12.1–250] ng/ml). None of the albinos had low vitamin D levels. None of the sun protection practices had significant effects on vitamin D levels.

Conclusion This study contests the claim that black Africans including albinos have low vitamin D levels. Albinos living in South East Nigeria have significantly higher vitamin D levels than their pigmented counterparts.

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Introduction

There has been a rising global interest in vitamin D attributable to the mounting evidence pointing to its role in the physiologic functions of nearly all the tissues and systems of the body including cardiovascular, immunological, neurological, and the skin.[1–3]

Vitamin D is a fat-soluble vitamin obtained chiefly from endogenous cutaneous production and to a lesser extent from diet and supplementation. Levels of 25(OH) D are relatively stable and can be measured to determine vitamin D status.[4] The two important forms of vitamin D are cholecalciferol (vitamin D3), obtained chiefly from sunlight, diet, and supplements, and ergocalciferol (vitamin D2) which is mostly derived from diet and supplements. Several factors influence the levels of vitamin D in humans, including nutrition and cutaneous production. Levels also vary by factors affecting UV exposure such as season of the year, latitude, time of the day, and weather conditions and by individual factors such as age, skin type/tone, clothing habits, lifestyle, and sun exposure habits.

The higher melanin content of black skin is known to filter out ultraviolet radiation (UVR) more efficiently than lighter skin does,[5] thus the heavy pigmentation in the dark skin should lead to a reduction in the level of vitamin D3. Lighter skin types have also been noted to produce up to sixfold the amount of vitamin D produced by the dark skin phenotype.[6] Individuals with oculocutaneous albinism (OCA), a genetic abnormality characterized by reduced or absent melanin, are required to practice sun protection/sun avoidance due to the harmful effect of ultraviolet radiation (UVR) on their skin. This serves to prevent the development of photodermatoses and sun-induced cutaneous malignancies.

The effect of these practices on vitamin D levels remains controversial. In OCA, it is believed that there should be an

increased efficiency of dermal vitamin D production because of the reduced or absent melanin in skin. The black African albino is expected to have higher levels of vitamin D when compared with their non-albino pigmented counterparts even if the influence of sun protection/avoidance is considered. However, limited sun exposure is considered to be a risk factor for the development of vitamin D deficiency.[7]

This study was therefore carried out to determine the impact of skin pigmentation and sun exposure behavior on the vitamin D levels of albinos and their normal pigmented counterparts in a tropical environment.

Materials and methods

This was a community-based analytical cross sectional study conducted at the Nnamdi Azikiwe University Teaching Hospital, Nnewi and Holy Rosary Catholic Hospital, Onitsha, both in South East Nigeria. Study participants were recruited from consecutive members of the Albino Foundation (TAF) and normal pigmented individuals from the general population living within the same locality who presented to the study institutions in response to the general announcements and SMS ("text") messages sent to the members of TAF and the general public.

The ethical approval was obtained from the Nnamdi Azikiwe University Teaching Hospital Ethical Review Board. All study participants gave informed consent before enrollment.

A total of 90 individuals living with OCA and 64 normal pigmented controls were recruited into the study. Vitamin D was measured in 61 albinos and 58 controls. The study was carried out during the dry season (November 2015 to January 2016) when the UV intensity peaks, with a presumed corresponding seasonal peak in vitamin D levels due to increased cutaneous production.

Participants were interviewed with sun exposure questionnaires adapted from a Pakistani study.[8] The sun exposure questionnaires were used to calculate the total sun exposure time of the participants in all domains that affect sun exposure at an individual level – minutes of sun exposure, different domains of sun protection practice – and were taken into consideration as follows: a score was developed by giving different weights (ranging from 0 to 1) according to sun exposure in all domains listed in the questionnaire: an individual who was not protected at all (with respect to various sun protection measures e.g., hat use, shade seeking, sunscreen use, etc.) was given a weight of 100% UVB, and a proportion of 1 was used, whereas if they were unexposed or partially exposed, they received varying degrees of UVB, the proportion of which was calculated based on the sun protection factor (SPF) of each of the sun protection methods used.[8–10] The final scoring algorithm was created by multiplying the time (minutes) spent in the sun by the proportions of different domains.[8–10]

Weight for each item was extrapolated by seeking the SPF of those items and calculating how much sunlight would be blocked. The total minutes spent in the sun was adjusted for sun protection practices (by multiplying the minutes with the average score of sun protection practice) and the value obtained for each hour was multiplied by the hour's fractional equivalent of peak hour UVB to achieve standardized total minutes spent in the sun.

Dietary intake of vitamin D was assessed using a validated food frequency questionnaire for vitamin D.[11]

Five milliliters of venous blood was collected from the antecubital vein of participants following an overnight fast and separated immediately for vitamin D analysis. Separated samples were stored at −20°C using refrigerators and monitored with Fisherbrand thermometer and Eurolab ST9269B multi-thermometer until analysis. Levels of total 25-hydroxyvitamin D were measured with an enzyme-linked immunosorbent assay (ELISA) manufactured by Calbiotech, Inc., Spring Valley, CA, USA.

All data were extracted from the questionnaires and input into SPSS analytical software package version 22 after data cleaning. The results were summarized as proportions for categorical variables and mean (SD) for continuous variables after test of normality was carried out using Shapiro–Wilk test. Mean (standard deviation) vitamin D of albinos and controls was also presented. Differences between persons with OCA and controls were assessed using the Pearson Chi Square test for categorical variables and the independent Student's *t* test for continuous variables with 95% confidence intervals. Statistical significance was defined as when the *P*-value <0.05.

Results

The two groups of participants had similar age distributions, the mean ages being 29.1 (7.0) and 29.8 (9.3) years for albinos and controls, respectively (*P*: 0.311). Although there were more females in the albino group, the difference was not statistically significant (*P*: 0.100). There was no difference in marital status, educational status, and religion between the albinos and controls. There was no statistically significant difference in the occupational sunlight exposure between the albinos and the controls (*P*: 0.281). Most of the participants were involved in low UV exposure occupations (66.7% persons with OCA, 68.4% controls), while 28.1% persons with OCA and 19.3% controls were in high UV exposure occupations.

The median (range) vitamin D levels among the albinos was 95.9 ng/ml (50.1–177.4), which was significantly higher than that of the controls, 78.2 ng/ml (12.1–250), *P*: 0.022. (Fig. 1, Table 1). Forty (67.8%) of the albinos had normal 25 OH vitamin D levels, 19 (32.2%) had hyper-25 OH vitamin D levels, and none of the albinos had low vitamin D. Only two (3.5%) controls had low vitamin D levels (one was deficient and one was insufficient).

Discussion

In this study, the median vitamin D levels for albinos was significantly higher than in the controls (see Table 1, Fig. 1),

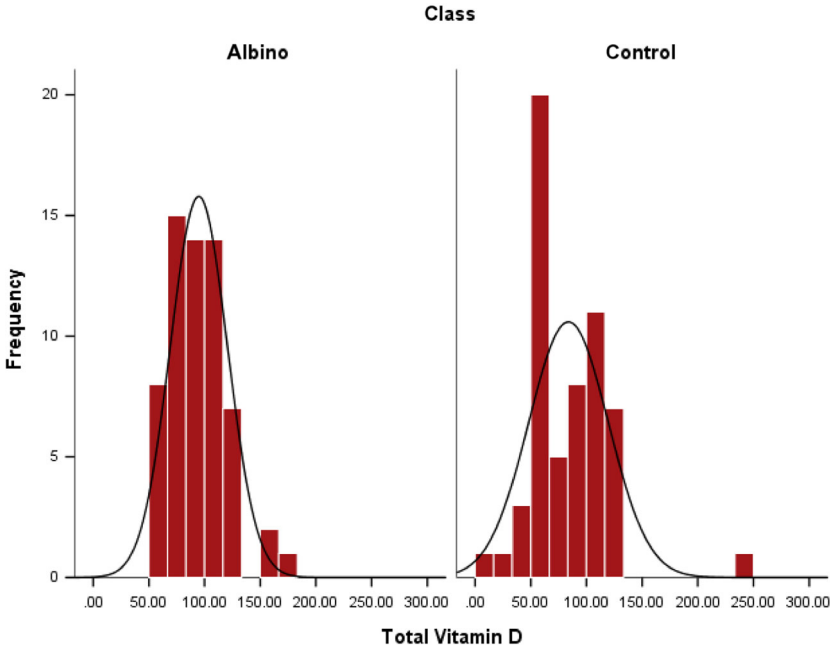

Figure 1 Comparison of the 25-hydroxyvitamin D levels of the albinos and the controls

Table 1 25 Hydroxyvitamin D levels of albinos and controls

	Albinos	Controls	*P*-value
Median serum vitamin D	95.9 (50.1–177.4)	78.2 (12.1–250)	0.022
Males (median, IQR)	105.6 (96.8–111.6)	72.7 (57.8–109.6)	0.021
Females (median, IQR)	83.3 (68.6–99.5)	91.8 (61.7–103.4)	0.485
Low vitamin D levels	–	2 (3.5)	0.345
Normal vitamin D levels	40 (67.8%)	37 (63.2%)	
Hypervitaminosis D	19 (32.2%)	19 (33.3%)	

Table 2 Variables associated with vitamin D levels among albinos

	Albinos with normal vitamin D	Albinos with Hypervitaminosis D	*P*-value
Age (mean, SD)	34.6 (10.2)	34.6 (11.3)	0.996
Gender (*N*, %)			
Male	10 (25.0)	12 (63.2)	0.004
Female	30 (75.0)	7 (36.8)	
Occupation (*N*, %)			
High exposure	9	8	0.255
Moderate exposure	2	1	
Low exposure	29	10	
Sun sensitivity (*N*, %)	35 (87.5)	17 (89.5)	0.975
Sun time (mean, SD)	12.6 (0.5–45.6)	10.2 (0.4–64.8)	0.935

highlighting the role of skin pigmentation in cutaneous vitamin D production despite photoprotection. This finding is similar to that of Cornish et al. and Sinclair et al.[12,13] This is not surprising as the reduced skin pigmentation in albinos increases cutaneous vitamin D production especially as most of the albino participants were found not to practice strict sun protection and sun avoidance.

Available data regarding the differences in the vitamin D levels between albinos and normal pigmented controls are controversial, and there is no general agreement in the available reports. Although some studies show that the vitamin D levels between albinos and pigmented controls varied significantly,[12] another study conducted in South Africa found no statistically significant difference in the median serum 25(OH) D levels between persons with OCA and matched pigmented control subjects. They, however, noted that the normal pigmented controls tended to have lower 25 (OH) D levels (median: 18.4 ng/ml) than the OCA group members (21.8 ng/ml),[13] a finding that reflects the observation in the present study.

The overall vitamin D levels in this study were relatively high in both groups studied, the median values being higher than previously documented,[11,12] suggesting that black Africans (albinos and non-albino blacks alike) living in sub-Saharan Africa have higher vitamin D levels than previously documented.

Contrary to expectations (possibly due to presumed strict photoprotection), black African albinos are not necessarily at risk of low vitamin D levels, as the albino group demonstrated overall normal levels to high vitamin D levels (Table 1, Fig. 1). Although two (3.5%) controls had low vitamin D, none of the individuals with OCA had low vitamin D. Albinism, therefore, may not be a risk factor for hyper/hypovitaminosis D as the effect of reduced or

Variables associated with vitamin D levels among controls

	Controls with normal vitamin D	Controls with hypervitaminosis D	Controls with low vitamin D	*P*-value
Age (mean, SD) years	30.1 (9.5)	29.8 (9.7)	23	0.938
Gender (*N*, %)				
Male	20 (54.1)	10 (52.6)	1	0.992
Female	17 (45.9)	9 (47.4)	1	
Occupational exposure (*N*, %)				
High exposure	7 (18.9)	4 (21.1)	1	0.621
Moderate exposure	5 (12.8)	1 (5.3)	1	
Low exposure	25 (67.6)	1 (73.7)		
Sun exposure Time (week) (mean, SD)	30.4 (24.3–36.5)	35.0 (2.0–69.5)	–	0.593
Skin tone				
IV	3 (8.1)	4 (21.0)	–	0.400
V	20 (54.0)	9 (47.4)	–	
VI	14 (37.8)	6 (31.6)	2	
Sunscreen use (*N*, %)				
No	16 (43.2)	10	2	0.285
Yes	20 (56.8)	8		
I don't know		1 (5.3)		

absent melanin is counteracted by the relatively lower sun exposure found in persons with albinism (Tables 2 and 3). Therefore, the effect of sun exposure behavior blurs the real relationship between albinism and vitamin D.

Previous studies found relatively lower vitamin D levels when compared to the findings in the present study. A probable explanation could be that those studies were carried out in geographical locations with lower sun intensity. The climatic conditions in the two study populations differ – Free State, South Africa, being a temperate region with UV index getting to as low as 0 in the winter period and the present study done in Onitsha and Nnewi both in Anambra state, a tropical region in Nigeria with peak UV index reaching 10 in the dry season during which this study was done.

Secondly, the current study was done during the period of peak sun intensity while one of the reported studies[13] was done in the winter. Vitamin D status among people who practiced photoprotection is reported to be better observed during the warm than in the cold seasons by one study.[14] During the winter, there are shorter days with less sun exposure and most people are inclined to stay indoors. Therefore, the sun exposure behavior of albinos and controls is presumed to vary greatly with seasons and depends on the degree of sun sensitivity and overall adjusted sun exposure time of the different groups as some studies show significant interaction between sun exposure habits, season, and vitamin D.[15,16] In addition, the effect of skin tone on sun sensitivity and vitamin D levels was not considered in the previous studies.[12,13]

Although Cornish et al.[12] collected the samples within 2 days to ensure uniformity, partially sighted albino children and visually impaired/blind controls were used, which can explain the lower vitamin D levels when compared with the present study as visual impairment is likely to severely limit movement and thus sun exposure. The stringent exclusion criteria employed may have also contributed to higher vitamin D levels found in the present study as children, individuals with obesity[17], pregnant women, individuals with liver disease, chronic kidney disease, and those on vitamin D-reducing drugs were excluded.

In conclusion, the findings in this study do not support the hypothesis that black Africans including albinos have low vitamin D levels, as the overall vitamin D levels in all the participants were of normal to high levels. None of the sunlight variables accounted for the vitamin D levels; however, lower skin tone was noted to be associated with decreased sun exposure time. None of the sun protection/avoidance practices had significant effects on vitamin D levels.

This study highlights the fact that albinos do not need vitamin D supplementation routinely. Therefore, vitamin D supplementation in albinos should be based on individual vitamin D testing.

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