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Serum Calcium, Vitamin D_3 and Parathyroid Hormone Level in Dark Skin (Type V Skin Color) Adult Sudanese in Khartoum State, Sudan 2017

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Abstract: In Sudan the average level of serum calcium, vitamin D***3*** and parathyroid hormone (PTH) level have not been studied and the only available data and reference range is that of international normal one, most Sudanese have Fitzpatrick skin type V (FST V),which is known to have more melanin that interfere with vitamin D***3*** skin synthesis leading to vitaminD3 hypovitaminosis , in Khartoum state which has the same climate as the whole part of Sudan which is sunny for 6moth annually,but people has different life styles, work environment, dietary habits and ethnic origin. The main aim of this study is to assess normal serum calcium , vitaminD3 level and PTH hormone level in adult Sudanese with skin color type V and type IVand in pregnant ladies and compare male to female, and compare it to type 5 skin color group exposed to sun for longer time (more than five hours per day). cross sectional community based study was conducted in Sudan, Khartoum state during August 2017 to October 2017 among heathy adult Sudanese age more than 18 year, not suffering renal disease or past hypovitaminosis D3 or on oral vitamin D3 therapy or following dietary regime, Forty volunteers were involved in a pilot study, thirteen were type V skin color, eight were pregnant type V skin color, thirteen were type V skin color with maximum sun exposure more than six hours per day(civil construction workers),six were type IV skin color, after taking a written consent they were assessed via interview sheet covering their gender ,age ,residence, pregnancy status for married female ,nature of work ,dietary habits covering fish meals specifically ,daily sun exposure duration ,a blood tests were determined for serum calcium ,serum vitamin D3 and serum parathyroid hormone levels for all volunteers , , mean value for serum calcium, vitamin D3 and PTH hormone level for targeted groups were calculated, correlation between variables were estimated and P value less or equal to< 0.5 was considered statistically significant. for type V skin Sudanese adults the mean serum calcium was(9.12+0.17mg/dl)and vitamin D3 mean value was(28.45+3.21ng/ml),when compared to international values found that 60% were suffering hypovitaminosis D3(normal range:30-70ng/ml)predominantly affecting female>(70%) compared to male (22%) and 45% D3 more than 30ng/ml,38% (20-29.9)and 15% D3 less than 20ng/ml, the mean parathyroid hormone level was 34.93+3.16pg/ml,those of type IV skin color serum Ca mean value was(8.93+0.32mg/dl) and vitamin D3 mean(28.96+2.83ng/ml)which was slightly higher than those of type V skin color and in 50% of them vitamin D3 was more than 30ng/ml,32%(20-29.9ng/ml)and 12% D3 less than 20ng/ml , and the mean parathyroid hormone was 45.86+8.52ng/ml.In pregnant ladies mean Ca level was (8.98+0.21mg/dl),and vitamin D3 mean(26.1+3.51ng/ml)38%of them(>30ng/ml) ,38%(20-29.9ng/ml),24%(<20ng/ml) and the mean PTH value was 33.39+5.52 pg./ml. Those of type V skin color exposed to sun more than 6hours per day showed mean Ca level of (9.05+0.22mg/dl)and vitaminD3 mean (28.53+2.24ng/ml)45%of them(>30ng/ml),38%(20-29.9ng/ml),12%(<20ng/ml), the mean PTH level was 37.63+5.52pg/ml.There was no significant correlation between variables according to this study serum Ca among type V, IV skin color was found within normal international range value and no effect of skin color, but vitamin D3 among type V FST was found low and lower than those of type IV skin type except for type V exposed for more than six hours to sun. Pregnant ladies showed marked hypovitaminosis D3 value, normal PTH level compared to international reference value.

Keywords: Ca, PTH, type V skin (dark), type IV skin color, pregnant type V skin color

INTRODUCTION

According to World Health Organization the sun's rays provide warmth and light that enhance the general feeling of well-being and stimulate blood circulation. Some UV radiation is essential to the body as it stimulates the production of vitamin D. Vitamin D has an important function in increasing calcium and phosphorus absorption from food and plays a crucial role in skeletal development, immune function and blood cell formation, five to 15 minutes of casual sun exposure of hands, face and arms two to three times a week during the summer months is sufficient to keep

vitamin D levels high. Closer to the equator, where UV levels are higher, even shorter periods of exposure suffice. Hence, for most people, vitamin D deficiency is unlikely. Possible exceptions are those who have very limited sun exposure such as the housebound elderly, or those with heavily pigmented skin who live in high-latitude countries where UV levels are relatively low. Recognizing the need for vitamin D, many countries have introduced supplements into common food like flour, cereals and milk. Naturally occurring vitamin D is very rare in our diet, it is present mainly in fatty fish and cod liver oil[1].

In Sudan there is no data about the prevalence of hypovitaminosis D and mean serum Ca ,vitamin D3 and PTH hormone mean value ,however in USA the national health and nutrition examination survey(NHNES) defined Vitamin D3 deficiency as serum hydroxyvitamin D concentrations ≤20 ng/mL (50nmol/L). The overall prevalence rate of vitamin D deficiency was 41.6%, with the highest rate seen in blacks (82.1%), and followed by Hispanics (69.2%). more common among those who had no college education, obese, with a poor health status, hypertension, low high-density lipoprotein cholesterol level, or not consuming milk daily, The lower 25(OH) D of blacks and other groups with dark skin results primarily from the fact that pigmentation reduces vitamin D production in the skin. Individuals with dark skin can produce high 25(OH)D levels given sufficient UV exposure but, under normal conditions at most latitudes in North America, even young, healthy blacks do not achieve optimal 25(OH)D concentrations at any time of year. The black women had much lower 25(OH) D levels all year long and smaller increases in 25(OH) D between winter and summer, Despite their low 25(OH)D levels, blacks have lower rates of osteoporotic fractures, This may result in part from bone-protective adaptations, However, these mechanisms may not fully mitigate the harmful skeletal effects of low 25(OH)D and elevated PTH in blacks, at least among older individuals. Furthermore, it is becoming increasingly apparent that vitamin D protects against other chronic conditions, including cardiovascular disease, diabetes, and some cancers, all of which are as prevalent as or more prevalent among blacks than whites. Clinicians and educators should be encouraged to promote improved vitamin D status among blacks (and others) because of the low risk and low cost of vitamin D supplementation and its potentially broad health benefits[2].

Parent vitamin D is obtained from Sun exposure, Diet, and is converted in the liver to 25(OH) D, the primary storage form of the vitamin and the best clinical indicator of vitamin D status,Milk and cheese are the main sources of Ca (23 and 19 % contribution to overall Ca intake, respectively). Fish products are the main VitD source (30 % contribution to overall VitD intake)[3]. Vitamin D deficiency is a leading cause of osteoporosis although in young and old adults of all races, low 25(OH)D is accompanied by secondary hyperparathyroidism , which may stimulate renal synthesis of the active form of vitamin D. As a group, blacks are observed to have higher circulating levels of PTH and, as in other groups with low 25(OH)D, they tend to have relatively high $1,25(OH)_2D$,However, there is some evidence that blacks may have an intestinal resistance to the actions of $1,25(OH)_2D$. Such an adaptation could benefit the skeleton because 1, $25(OH)_2D$ may have favorable effects on bone formation that are independent of the promotion of intestinal calcium absorption. More limited calcium absorption with normal renal function would theoretically protect against hypercalcemia, prevent down-regulation of $1,25(OH)_2D$ by increased serum calcium, and thereby facilitate the higher $1,25(OH)_2D$ levels that may be necessary for direct beneficial effects on bone[2,3].

Vitamin D also protects against other chronic conditions like inflammatory and autoimmune conditions, including periodontal disease, Sjogren's syndrome, type 1 and type 2 diabetes, multiple sclerosis, and rheumatoid arthritis by targeting lymphocytes, pancreatic islet cells, aortic endothelial cells, and arterial plaque macrophages**,** cardiovascular disease through its anti-inflammatory or other effects and may reduce the risk for colorectal cancer, breast cancer, and prostate cancer by promoting cell differentiation and down-regulating hyperproliferative cell growth[2], Factors influencing endogenous vitamin D synthesis are seasons, time of day, latitude and skin phototypes. Due to the contribution of sun exposure in maintaining vitamin D levels, it would be expected that this deficiency would be more prevalent in countries at high latitude; it has been shown, however, that hypovitaminosis D is commonly found in tropical regions such as Brazil. In high latitude regions in which extreme skin phototypes have been compared, the prevalence of vitamin D deficiency was more common in people with originally darker skin[4].

Association between skin color and vitamin D3 status is strong, as most fair skin individual of FST IV found to have higher vitamin d compared to dark skin FST V[4].

Dark skinned pregnant ladies suffer severe vitamin D deficiency because of increased demand and prevalence of vitamin D deficiency (<20 ng/mL) in women in early pregnancy in Switzerland and evaluated the association of skin color with vitamin D Deficiency,204 pregnant women included, 63% were vitamin D deficient. The mean serum 25-hydroxyvitamin D concentration was 26.1 ng, women with dark skin color were statistically significant more often vitamin D deficient compared to women with light skin color[5,6].

There are many methods of skin color typing, but the most commonly used is Fitzpatrick skin color typing (FST).

Fitzpatrick skin typing

Skin type	Typical Features
I	Pale white skin, blue/green eyes, blond/red hair
II	Fair skin, blue eyes
III	Darker white skin
IV	Light brown skin
V	Brown skin
VI	Dark brown or black skin

Objectively skin color typing can be by melanin index[7], Medsun skin check device using ultraviolet light[13]. Nutritional causes of low vitamin D due to low fatty fish meals was observed in Africa and middle east immigrants to Europe, strikingly association with was the cause behind their low vitamin d levels rather than their dark color[8],other causes of hypovitaminosis D are Clothes and Excess sunscreen use.

Global hypovitaminosis D and its consequences is well recognized as pandemic and the major cause of vitamin D deficiency is the lack of appreciation that sun exposure in moderation is the major source of vitamin D for most humans. Very few foods naturally contain vitamin D, and foods that are fortified with vitamin D are often inadequate to satisfy either a child's or an adult's vitamin D requirement. Vitamin D deficiency causes rickets in children and will precipitate and exacerbate osteopenia, osteoporosis, and fractures in adults. Vitamin D deficiency has been associated with increased risk of common cancers, autoimmune diseases, hypertension, and infectious diseases. A circulating level of 25-hydroxyvitamin D of >75 nmol/L, or 30 ng/mL, is required to maximize vitamin D's beneficial effects for health. In the absence of adequate sun exposure, at least 800–1000 IU vitamin D_3/d may be needed to achieve this in children and adults. Vitamin D_2 may be equally effective for maintaining circulating concentrations of 25-hydroxyvitamin D when given in physiologic concentrations[9].Vitamin Which is directly involved in regulation of serum Ca concentration age, sex, physiological state (eg, pregnancy), and even season (owing to the seasonal variation of[11].

In Sweden study 2015 Immigrants, Vitamin D status was insufficient or deficient in 73% of the participants, 12% had vitamin D deficiency, and only 3.7% had optimal vitamin D status Mean D3 level was 41.0 nmol/l (±16.6) Levels of 25(OH)D3 were lower and vitamin D deficiency was twice as common in immigrants from Africa compared with those from the Middle East. vitamin D deficiency was also significantly associated with low fatty fish intake, not travelling abroad and wearing long-sleeved clothes in summer[10]. The concentration of serum calcium is tightly regulated by parathyroid hormone (PTH), calcitonin, and 1, 25-hydroxy vitamin D Calcium concentration, both total and free, is characterized by a high physiological variation.

METHODS

Across sectional analytic community based study performed in Khartoum state capital of Sudan during(August 2017 to October 2017)among thirty healthy adult Sudanese were more than 18 year of brown skin color type V (FST) and ten Syrians living in Sudan of white skin color type IV FST. All are not suffering any medical condition specifically renal disease or past hypovitaminosis D3 or on oral vitamin D3 supplement, not following dietary regime. Ethical approval of this study was obtained from the national Ribat University NRU, informed consent from each volunteer after clear explanation about the study was taken. Participants were assessed by interview covering skin color type, age , gender, residence, pregnancy status for females, work environment, dietary habits and contents in the last three days and sun exposure hours per day, then three ml of blood was taken and transferred to plain blood container then centrifuged and plasma was separated, *Tosoh AIA Test unit dose test cup reagent system* was used to test for vitamin D3 and PTH, serum Ca level was measured using *Mindray BA-88A power single reagent*. All the data collected in this study was analyzed using the SPSS version 20, (t-test for mean and P value for significance).Correlations between the variables were estimated by the correlations coefficient of determination (*Value*). P value ≤ 0.05 was considered statistically significant, P >0.05 is insignificant.

RESULTS

A total of 40 eligible people from Khartoum state were studied, thirteen of them were of type V skin color ,six were of type IV skin color, thirteen of type V with high exposure to sun >6hours per day and eight of type V skin color pregnant ladies. Participants were healthy and have no chronic medical condition or renal disease, or suffered past vitamin D deficiency and not on oral supplements.

- Type V skin: mean serum Ca was 9.12±0.16mg/dl, mean vitamin D3 level was 28.45±3.21ng/ml and 71% showed D3 levels <30ng/ml, PTH mean level is 34.93±3.16pg/ml (table 1).
- Type IV skin: mean serum Ca 8.93±0.32mg/dl, mean D3 level was 28.97±2.83ng/ml and 50%showed D3 levels less than 30ng/ml, PTH mean level was 45.86±8.52pg/ml (table1).

- Type V with high exposure to sun mean serum Ca level was 9.05±0.22mg/dl, D3 mean level was 28.54± 2.24ng/ml and 53% showed D3 levels<30ng/ml, PTH level 37.63± 5.52pg/ml (table 1).
- Type V pregnant: mean serum Ca 8.98±0.21mg/dl, D3 mean was 26.10± 3.51ng/ml and 62% showed D3 levels<30ng/ml, PTH level 33.39± 5.52pg/ml (table 1).

No significant correlation was found between all variables.

Correlation of excess sun exposure and vitamin D3 level:

Type IV skin is insignificant .P value was P=0.704, Type V skin P value is insignificant: 0 .270

Table-1: Serum calcium, vitamin D3 and PTH level in type V and type IV (FST) and type V with high sun exposure and type V pregnant ladies

Variable	serum Ca mg/dl mean±SE reference value 8-10mg/dl	Serum Ca Range	vitamin D3 level-ng/ml mean±SE reference value 30-70ng/ml	vitamin D3 level Range	PTH level mean±SE reference value 10-65pg/ml	PTH Range
Type V skin	9.12±0.16	8.00-10.20	28.45±3.21	12.40-46.90	34.94±3.16	21.60-61.90
Type IV skin	8.9±0.32	8.10-10.40	28.97±2.83	18.90-38.40	45.8±8.52	11.00-63.00
Type V skin with high sun exposure	9.05±0.22	7.80-10.20	28.54±2.24	15.00-43.00	37.63±5.52	13.50-67.90
Type V pregnant	8.98±0.21	8.10-9.90	26.10±3.51	10.80-39.70	33.39±5.52	15.00-53.90

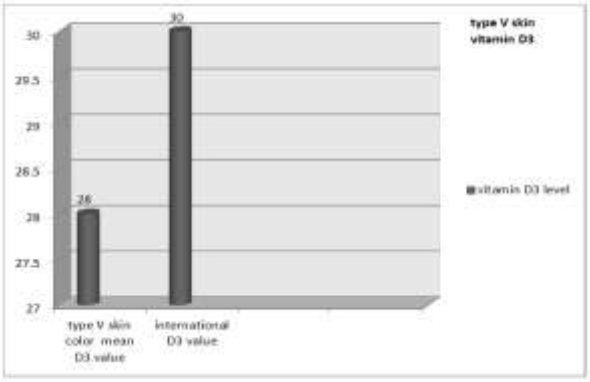

Fig-1: Mean serum vitamin D3 level on type V skin color compared to international reference mean value

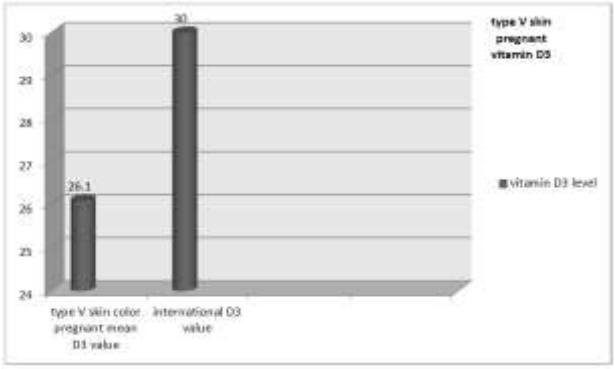

Fig-2: Mean serum vitamin D3 level on type V skin color pregnant compared to international reference mean value

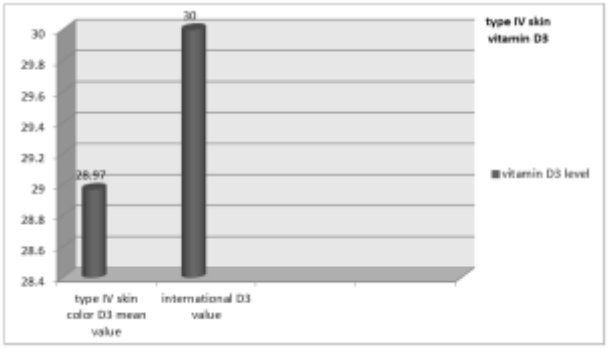

Fig-3: Mean serum vitamin D3 level on type IV skin color compared to international reference mean value

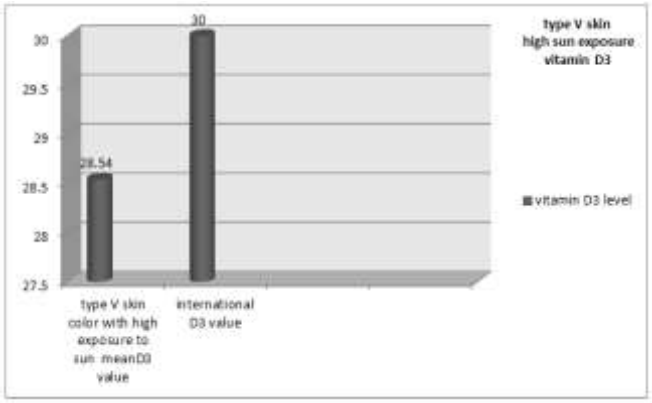

Fig-4: **Mean serum vitamin D3 level on type V skin color highly exposed to sun compared to international reference mean value**

DISCUSSION

According to this study adult Sudanese of dark skin color (type V FST) living in Khartoum state showed clearly normal mean serum calcium levels similar to that of the international records is 9.12mg/dl, but mean vitamin D3 level of 28.45ng/ml is lower than intrernational records(figure1) despite adequate sun exposure and more broaden among females who has lower exposure duration to sun partly because of their life style, when assessing type V skin ladies who pregnancy make additional need and consumption of vitamin D3,mean serum Ca among type V pregnant is 8.98mg/dl which is normal, vitamin D3 among pregnant is lower than non-pregnant and showed mean value of D3 mean is 26.1ng/ml(figure 2) and 62% showed D3 levels<30ng/ml(figure 3) and higher PTH level37.91pg/ml as most international records of low vitamin D 3 during pregnancy but here in Sudan severe deficiency is noted in this study, When vitamin D3 levels compared to slightly fair skin color groups of type IV skin color their mean serum calcium level 8.93mg/dl which is normal according to international normal reference range partly because homeostatic mechanisms are compensating for low vitamin D3 by higher PTH level which showed mean value 45.86pg/ml ,vitamin D3 mean value28.96ng/ml(figure 3) and 50%showed D3 levels less than 30ng/ml is and 51% has normal level so type IV skin has better D3 status in compare to type V skin, even if compared to type V skin with higher exposure to sun more than 6 hours per day who showed mean serum is Ca (9.05mg/dl),and vitamin D3 mean 28.53ng/ml(figure 4) and 53% showed D3 levels<30ng/ml it remain clear fact not only sun exposure is main determinant of vitamin D3 level and color difference has an effect as most of international studies done showed clear association of skin color and serum vitamin D3 and hypovitaminosis D is commoner among dark skin color individuals.

CONCLUSION AND RECOMMENDATIONS

Hypovitaminosis D3 is very common among adult Sudanese with mean vitamin D3 level of (28.45ng/ml) and 71% showed D3 levels <30ng/ml,specially pregnant ladies who has mean vitamin D3 level is 26.1ng/ml and 62% showed D3 levels<30ng/, it is highly recommended to screen all patients of type V skin color attending clinics for vitamin D3 level as vitamin D deficiency even before symptoms appear (because of their high risk)to avoid future complications. Future studies in Sudan with large sample size and different geographical areas may show accurate prevalence of hypovitaminosis D3 which is a major health concern need to be addressed because of community need as almost people are dark color skin.

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