

Association between vitamin D levels and central adiposity in an eastern Africa outpatient clinical population

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Background: Eastern Africa is a vast area straddling the Equator at roughly between latitude 18° North and 25° South of the Equator. This region enjoys overhead or near overhead sunshine throughout the year receiving an estimated 200–275 W/M² of UVB annually. It is a region undergoing rapid socio-economic changes and thus impacting change in work habits and environment from the outdoors to the indoors. There however exists a dearth of vitamin D₃ data on people in this region despite the recognition of vitamin D₃ deficiency being a global epidemic. The purpose of this study was to examine the status of vitamin D₃ and central obesity in this clinical population and their relationship if any.

Results: Vitamin D deficiency and insufficiency in this clinical population in Eastern Africa, females had lower serum concentration, with the younger population having lower serum concentrations than the elderly. There was also a significant difference in serum levels when data was analyzed by ethnicity. Similarly central obesity was also highly prevalent in this population. The odds of being Vitamin D deficient was 3.3 times ($p = 0.022$) higher among individuals with elevated waist circumference than those with normal waist circumferences. Among the males, the odds of being Vitamin D deficient and having an elevated waist circumference was 6.8 times ($p = 0.011$) higher than for males with normal waist circumferences. This was however not observed among the females.

Methods: Serum 25(OH)D, Waist circumference (WC) and Waist to Hip ratio (WHR) data on 182 outpatients attending a Therapeutic Lifestyle Changes was retrospectively analyzed by gender, age category and ethnicity.

Conclusion: Living on or close to the equator and having overhead or near overhead sunshine throughout the year in and of itself is not a guarantee of adequate serum 25(OH)D concentrations. It may therefore be prudent for clinicians in this region to risk stratify their patients based on work location, age category and ethnicity.

Introduction

Eastern Africa (EA) is the region in Africa as defined by the United Nations scheme of geographic regions and comprises of 19 regions.¹ It is a vast area straddling the Equator at roughly between latitude 18° North and 25° South of the Equator and ensconced between latitude 31° and 50° east of the Prime Meridian. Eastern Africa is home to almost 280 million people² of different ethnicities, cultural practices and religions. This region enjoys overhead or near overhead sunshine throughout the year receiving an estimated 200–275 W/M² of UVB annually.³

Rapid socio-economic changes are sweeping through this region, whose current rate of urbanization is estimated at 4%, however, this is likely to increase with the recent discovery of oil, natural gas and other natural resources in this region further altering the rural ways of life. Urbanization or previously rural areas and increased rural–urban migration result in change in work habits and environment from the outdoors to the indoors.

Deficiencies of Vitamin D₃ are widely recognized in populations living beyond latitudes 35° North and South of the equator

due to seasonal sun exposure and are increasingly being recognized as a global epidemic.^{4,5} However, there appears to be a dearth of 25(OH)D data on Africans. Perhaps because it straddles the equator, it may be mistakenly assumed that serum 25(OH)D concentrations are optimal in people living in this region. The purpose of this study was to examine the vitamin D status of adults living in equatorial latitude and to explore the relationship between 25(OH)D and surrogate measures of central adiposity.

Results

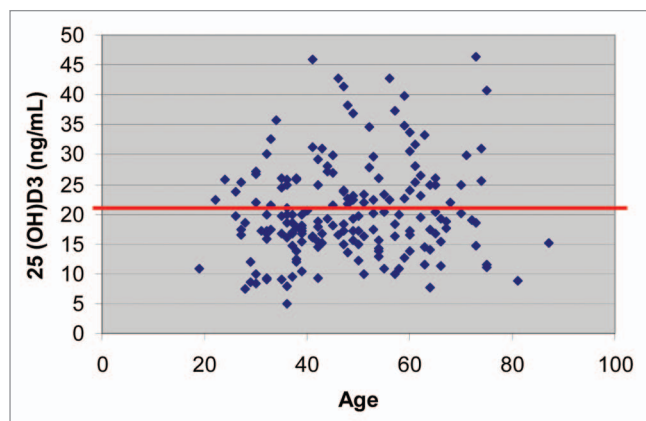
Data from 182 patients met the inclusion criteria for this retrospective study, of these 28% were males and 72% were female. A summary of the characteristics of this clinical population is shown below in **Table 1**.

Mean age was 47.98 ± 13.84 yrs, mean 25(OH)D was 20.51 ± 8.01 ng/mL. Prevalence of 25(OH)D deficiency and insufficiency overall in this clinical population in EA was 8% and 82% respectively. Overall prevalence of central obesity using Waist Circumference (WC) and Waist to Hip ratio (WHR) was

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Table 1. Characteristics of the clinical population

Parameter	Population (N-182)	Male (n-51)	Female (n-131)
Age –years SD	47.98 (13.84)	51.98 (13.96)	46.43 (13.52)
Waist Circumference (cm)	99.75 (14.92)	103.51 (14.29)	98.29 (14.95)
Waist to hip ratio	0.89 (0.87)	0.95 (0.06)	0.87 (0.08)
25 (OH)D3 ng/mL	20.51 (8.05)	21.88 (8.92)	19.98 (7.67)

**Figure 1.** Distribution and mean serum 25(OH)D by age.

67% and 49.5% respectively. The distribution and mean serum 25(OH)D by age in this clinical population is shown in **Figure 1**.

An independent T-Test analysis by gender showed mean age was significantly higher ($p < 0.015$) among the males than the females. An ANOVA of the data by age category showed significant differences in 25(OH)D. Post Hoc analysis showed the age category 41–50 had significantly higher levels ($p = 0.047$) than those under age 40 ($p < 0.001$). Young males in the age category 19–30 had lower mean serum 25(OH)D concentrations than those above age 30 ($p = 0.089$), while they also had significantly

higher waist circumferences ($p = 0.05$). The odds, unadjusted for ethnicity, of being 25(OH)D deficient were 3.3 times ($p = 0.022$) higher among individuals with elevated waist circumferences than those with normal waist circumferences. Among the males, the odds of being 25(OH)D deficient and having an elevated waist circumference was 6.8 times ($p = 0.011$) higher than for men with normal waist circumference. This was however not observed among the females.

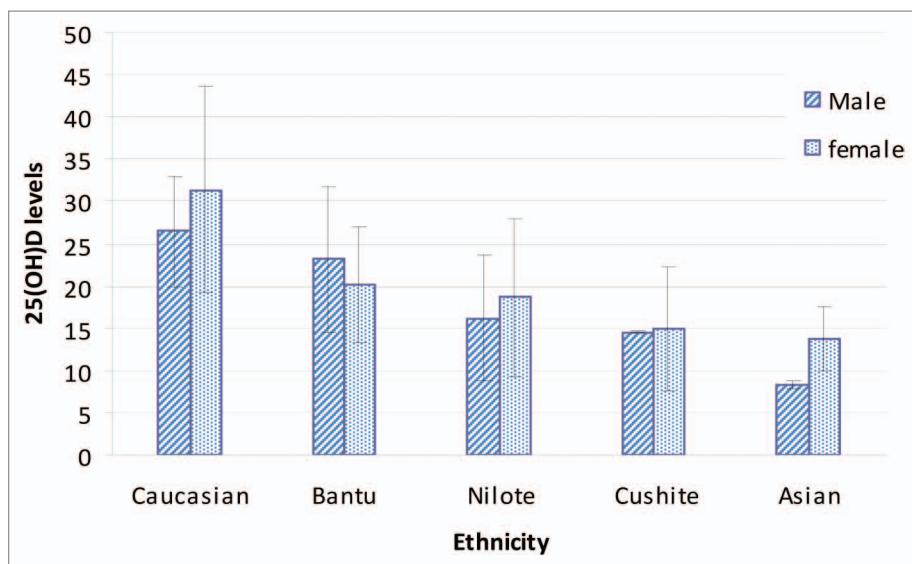
An ANOVA of the overall data by ethnicity showed significant differences in their 25(OH)D levels with Caucasians having significantly higher ($p < 0.001$) mean concentrations. A Chi-square analysis of gender for linear relationships showed that there was significant linear relationship between gender and 25(OH)D at $p < 0.049$ ($\chi^2 6.19$, $df = 2$) and waist circumference at $p < 0.001$ ($\chi^2 14.74$, $df = 2$). It was also found that there was a significant linear relationship between age categories and Waist-to-Hip ratio ($p < 0.001$, $\chi^2 17.938$, $df = 4$).

Analysis of data for correlations showed a positive correlation between waist to hip ratio and age ($r = 0.392$, $p < 0.001$). In the males, WC and 25(OH)D showed a negative correlation ($r = -0.347$, $p = 0.013$). However, in females WHR and Age ($r = 0.432$, $p < 0.001$) were positively correlated (**Fig. 2**).

The mean vitamin D3 levels differed significantly between the patients from different ethnicities. It is noted that Caucasians had significantly higher mean Vitamin D levels than other ethnicities. Asians were found to have the lowest vitamin D levels. Mean 25(OH)D levels by ethnicity are shown below in **Figure 3**.

Discussion

The high prevalence of 25(OH)D insufficiency in this urbanized clinical population in Eastern Africa was surprising given the presence of overhead or near overhead sunshine throughout the year. Their mean serum 25(OH)D concentrations were in stark contrast to those of outdoor living (hunter gatherers or pastoralists) Hadzabe and Masaai of Tanzania who had mean serum 25(OH)D concentrations of 43.6–47.6 ng/mL⁶ which were very similar to those of five traditionally living communities in Tanzania whose mean serum concentration was 42.4 ng/mL.⁷ The stark difference between this urbanized clinical population and the outdoor or traditionally living people in EA, is their way of life with the former

**Figure 2.** Mean 25(OH)D in the various Ethnic groups by gender.

tending to work more indoors and dressing more formally (less skin exposed to casual UVB) than the latter who work outdoors and or wear loose clothing thus exposing arms, part shoulder, legs and head/face to casual UVB, enabling synthesis of 25(OH) D. Analysis of serum Vitamin D by ethnicity showed Caucasians having the highest mean levels followed by the Bantu; these two tend to have lighter skin complexions than the Nilotes. However, Cushites and Asians, who generally have lighter complexions than the Bantus, had significantly lower vitamin D concentrations than the Bantus, suggesting the influence of other factors hindering UVB exposure. It is important to note that the Cushites, mainly Somalis in this study, and Asians tend to dress very conservatively due to social and religions customs. In addition, females in these two ethnic groups tend to play more traditional roles such as performing household chores further minimizing casual UVB exposure.

Despite the high prevalence of central obesity (measured by WC and WHR) alongside a high prevalence of 25(OH)D insufficiency in this clinical population, there was no significant correlation between these two variables, except in the males, which showed a significant negative correlation, the postulated decreased bioavailability of 25(OH)D from cutaneous stores due to deposition in body fat stores⁸ was not evident in this clinical population in EA. Furthermore, given that females had a higher proportion of central obesity than males, it is interesting that this correlation was not observed.

Material and Methods

Data on outpatients, who had done 25(OH)D tests as part of routine blood tests during intensive therapeutic lifestyle changes, was retrospectively analyzed. Data on minors, those on vitamin D3 supplements or non-resident in this region for less than six months was excluded from analysis.

A total of 182 (51 male, 131 female) outpatients were included in the study. Central obesity was determined by measurement of waist circumference at the narrowest point above the umbilicus and below the ribs using a standard measuring tape over light clothing. Waist to hip ratio was also determined by computing the ratio of the waist circumference to the hip circumference also assessed using a standard measuring tape on the widest part of the gluteus maximus. Serum 25(OH)D levels were determined using the chemiluminescent LIAISON 25OH Vitamin D total assay from DioSorin Inc. 25(OH)D cut-offs used were deficiency < 10 ng/mL, insufficiency 10–30 ng/mL, sufficiency 30–100 ng/ml, while the International Diabetes Federation's waist circumference cut-offs used were 80 cm for women and 94 cm in males. Waist to hip ratios cut-offs used were 0.85 for females and 0.95 for males. These variables were analyzed by gender, age-category (19–30, 31–40, 41–50, 51–60 and 60+) and ethnicity.

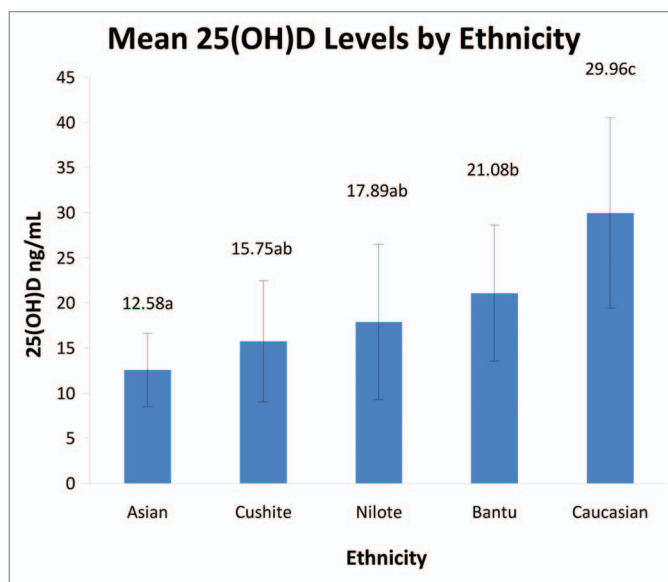


Figure 3. 25(OH)D levels by Ethnicity. Means with the same letter are not significantly different ($p < 0.001$).

Conclusion

The high prevalence of Vitamin D deficiency and insufficiency in this population is suggestive that the global Vitamin D deficiency epidemic is likely much greater than previously postulated and worrying in view of the health implications. It is also important to note that living on or close to the equator and having overhead or near overhead sunshine throughout the year in and of itself is not a guarantee of adequate serum Vitamin D concentrations. It is therefore important for clinicians with patients from this region to pay close attention to their (patients') mode of dress (conservative or not conservative), ethnicity and complexion of skin. Patient history take should include work location (indoor or outdoor), the weekly amount of time spent in the sun and degree of skin exposure during this time, as an initial 25(OH)D deficiency risk assessment. This could then be followed up with actual serum 25(OH)D work up with a view of supplementing for optimization of serum levels.

Finally fortification of foods and beverages with Vitamin D3 in this region may be desirable, while the question of how much may only be answered after larger population studies to determine serum 25(OH)D levels.

Disclosure of Potential Conflicts of Interest

No potential conflict of interest was disclosed.

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