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CORRELATES OF HYPOVITAMINOSIS D AMONG POSTMENOPAUSAL WOMEN IN KIAMBU COUNTY, KENYA: A COMMUNITY SURVEY

Dr. Fred Chuma Sitati, MBChB, M.Med (Ortho), FCS (ECSA), Dip SICOT, Consultant Orthopaedic and Trauma Surgeon, Senior Lecturer, Department of Orthopaedic Surgery, University of Nairobi, P.O Box 895 -00200 Nairobi, Kenya. Prof. Peter Gichangi, BSc (Anatomy), MBChB, MMed (Obs/Gyn), PhD, MPH, Consultant Obstetrician and Gynaecologist and DVC ARE and Professor, Technical University of Mombasa, Kenya, Visiting Professor, Ghent University. Nairobi. P.O.Box 2631-00200 Nairobi. Dr. Moses Madadi Obimbo, MBChB, Dip FELASA C, MSc, M.Med (Obs/Gyn), PhD, Post-doc-Forgaty Global Health Fellow, Consultant Obstetrician and Gynaecologist and Senior Lecturer, Department of Human Anatomy and Reproductive Health, University of Nairobi, Kenya. P.O. Box 30197-00100 Nairobi, Kenya.

Corresponding author: Dr. Fred C. Sitati, MBChB, M.Med (Ortho), FCS (ECSA), Dip SICOT, Consultant Orthopaedic and Trauma Surgeon, Senior Lecturer, Department of Orthopaedic Surgery, University of Nairobi, P.O Box 895 -00200 Nairobi, Kenya. Email: fredsitati@yahoo.com.

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F. C. Sitati, P. Gichangi and M. M. Obimbo

ABSTRACT

Introduction: **Vitamin D deficiency remains a major global health issue yet new research shows it has a role in reducing the risk of communicable and non-communicable diseases. In Kenya, there is scanty information on the prevalence of hypovitaminosis D and its associated factors. The objective of this study was to determine the prevalence and correlates of hypovitaminosis D amongst postmenopausal women in a Kenyan peri urban population.**

Methods: **We carried out a community based cross sectional survey involving 254 post-menopausal women in Kiambu County, Kenya from October 2017 to February 2018. Multi-stage random sampling approach was adopted where households were selected after sampling sub-counties and enumeration areas. A structured questionnaire was administered, and physical examination done on recruited participants by the principal investigator and research assistants. Weight and height of the participants were measured, and bone mineral density was determined using Dual energy X-ray absorptiometry (DXA). All participants had blood samples taken to assay for serum 25-hydroxyvitamin D (25(OH)D) levels. SPSS statistical software version 21.0, SPSS Inc was used for data analysis.**

Results: **The mean age of the women was 64.6 years with a range of between 50 and 95 years. 58.7% (149) of respondents had 25(OH)D serum levels below 30 ng/ml. The prevalence of Vitamin D deficiency was 18.9% (48), Vitamin D insufficiency 39.8% (101) while 41.3% (105) of women had normal Vitamin D levels. There was a positive association between hypovitaminosis D and**

advancing age (p-value=0.042), lower education levels (p=0.006), Body mass Index (BMI) (p-value=0.043) and osteoporosis (p=0.000). Occupation, marital status and wealth status had no association with the serum vitamin D levels

Conclusions: **The prevalence of hypovitaminosis D in Kenya is high and is associated with advancing age, lower education levels, BMI and osteoporosis. Early detection and prevention of hypovitaminosis D may be the key to reduce osteoporosis in postmenopausal women in Kenya.**

INTRODUCTION

Vitamin D is an essential hormone for a healthy skeleton. It not only stimulates the intestinal absorption of calcium but also regulates turnover of bone and muscle function(1). Emerging research has revealed that Vitamin D has beneficial effects to the immune and cardiovascular system as well as being protective against some cancers(2).

Vitamin D3 is mainly produced in the skin when one is exposed to the ultraviolet light of the sun. The serum 25hydroxyvitamin D (25(OH)D) concentration is a measure of an individual's vitamin D status. Vitamin D status is compromised by a diet that is low in vitamin D and calcium, insufficient sunlight exposure, advancing age, covering of the skin and skin pigmentation (3).

Vitamin D deficiency has been described as a pandemic and is estimated to affect 1 billion persons globally across all ages (4). Severe vitamin D deficiency results in rickets in children and osteomalacia in adults. It may also lead to secondary hyperparathyroidism, muscle weakness, mineralization defects, high bone turnover, bone loss, and it predisposes to fractures (3).

According to the US Endocrine Society Vitamin D deficiency is defined as 25(OH)D serum levels below 20 ng/ml, Vitamin D inadequacy at concentrations between 20-30 ng/ml and Vitamin D sufficiency at values above 30 ng/ml (5). It has been suggested that public health interventions should be considered if more than 20% of the population has 25(OH)D below 30 nmol/L(1). Prentice noted the need for more research work on Vitamin D in Africa because low dietary intake of calcium combined with high infectious disease rates in many African countries may increase vitamin D turnover and utilization contributing to a high prevalence of hypovitaminosis D (6).

To our knowledge no studies have been done to document the serum vitamin D status and predictors of low levels in postmenopausal women (PMW) in Kenya. Thus, we conducted this study to determine the prevalence of hypovitaminosis D in postmenopausal women and their risk profiles in Kiambu County, Kenya.

MATERIALS AND METHODS

Study Design and setting: This cross-sectional study was a community-based survey of post-menopausal women undertaken in Kiambu County between October 2017 and February 2018. Kiambu County is semi urban and has a population of 1,623,282 (Kenya National Bureau of Statistics, 2009). It is located 1.0314° S, 36.8681° E and enjoys sunshine year-round. Kiambu county was chosen because of its mixed rural and urban population as well as proximity to the DXA study centre.

Sample size and sampling: To obtain the sample size for participants in this study, the following formulae was adopted.

$$n = \frac{(Z\alpha + Z\beta)^{\wedge}2 \times p \times (1-p) \times NR}{m^2 \times HHD \times Pop} deff$$

Where n was the required sample size,

$Z\alpha$ = 1.96, the critical value for the standard normal distribution corresponding to a significance level of 5% for a two-tailed test,

$Z\beta$= 80% was the statistical power,

p = 32% as the prevalence rate of osteoporosis among post-menopausal women,

NR = 10% is the anticipated non-response rate,

$deff$ = 1 is the design effect,

m = 5.7% as the margin of error corresponding to 95% confidence level,

HHD = 2.4 is the mean household size for households which have the population of interest

pop = 53.2% is the sample proportion of the population of interest

Using this formula, the targeted sample size was 254.

Thus 254 women were recruited into the study. A multistage random sampling was done to limit bias. In the first stage, seven out of 12 sub-counties in Kiambu County were randomly selected. The second stage involved the random selection of enumeration areas in the selected sub-counties taking into consideration population proportional to size. The third and final stage involved the random selection of households which had women who were 50 years old and above. The information used was obtained from the Kenya National Bureau of Statistics (KNBS). All postmenopausal women in Kiambu County who consented to be involved in the study were included. Menopause was defined as a female aged 50 years and above who had not had menses for at least 12 months(7) . Those with mental or physical limitations that would have affected their ability to be tested or answer questions were excluded.

Data collection: A structured, pre-coded and pre-tested questionnaire was administered to all study participants in their households through a face to face interview. The principal researcher and the other two researchers coordinated seven research assistants who each covered a sub county. Information about the participant's socio demographic factors (age, marital status, education, and occupation) was collected.

Wealth status was assessed based on a validated theoretical approach by Po et al., which constructs the measure of household income using physical assets, we were able to estimate household wealth and divided the results in quintiles. This is because of the difficulties encountered in collecting information on income and consumption data in community surveys [8].

In order to assess the level of physical activity, all participants answered about their physical activity in the previous seven days with the validated, long version of the International Physical Activity Questionnaire (IPAQ. The results were processed and analysed according to the guidelines of the IPAQ website [9]. Anthropometric measurements of weight (using an adjustable scale) and height (using a portable stadiometer) were taken using World Health Organisation protocols, with light clothes on and without shoes. Bone mineral density was measured at the hip and lumbar spine using Lunar prodigy DXA system (analysis version 14.0) manufactured by GE Health care. Osteoporosis, Osteopenia and normal bone mineral densities were defined as per the World Health Organisation criteria of Tscores. The Body mass index (BMI) was calculated using the formula: weight in kilograms divided by height in meters squared [weight (kg)/height (m2)]. We utilized the conventional WHO classification for BMI which has 4 categories of: underweight (<18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25–29.9 kg/m^2), and obese (≥30 kg/m^2) [10].All participants had blood samples taken to measure serum Vitamin D levels. All blood samples (2 ml of venous blood) were collected from the participants placed in a plastic tube with clot activator and immediately stored in a laboratory fridge at 2-8°c and analysis done at the close of the day. The serum Vitamin D level was determined using an enzyme immunoassay competition method with a final fluorescent detection (ELFA). The instrument used was VIDAS 25 OH Vitamin D TOTAL (VITD).

In this study, the 25(OH)D level will be considered normal if it is 30-100 ng/mL, insufficient if it is between 20 and 29 ng/mL, and deficient if it is less than 20 ng/mL(5). All participants were educated about osteoporosis and maintaining good bone health in two sessions, after the tests were done and when they were given their results. This was done in groups of approximately twenty women from similar counties.

Data management: The SPSS statistical software version 21.0, SPSS Inc., Chicago, IL, USA) was used to perform all the statistical analysis. Data analysis was conducted where categorical variables were summarized using frequencies and percentages while continuous variables were presented using mean and standard deviations. During bivariate analysis, Student's t-test was used to estimate associations between serum Vitamin D levels and continuous variables while Chi-squared tests were used to estimate associations with categorical variables. Logistic regression analysis was used to determine independent factors associated with serum Vitamin D levels and to estimate the magnitude and significance of these relationships. Associations with $p<0.05$ level were considered statistically significant.

Ethical considerations: All Participants in this study gave a written informed consent and those found to have Vitamin D deficiency or Vitamin D insufficiency were referred with a referral form for treatment at their hospital of choice. The study was approved by Kenyatta National Hospital, Ethics and Research Committee (KNH/UoN-ERC) and Kiambu county government prior to commencing.

RESULTS

Socio demographic characteristics of the study population: 254 postmenopausal women aged 50 years old and above, residing in Kiambu County were recruited into the study. The mean age was 64.6 years with an age ranging between 50 and 95 years and a standard deviation of 10.7. Over a quarter of these women (26.4%) had not attended any formal schooling while just above half (54.3%) had attained primary education. Almost all women (96.9%) did not have formal employment and were taking manual jobs related to gardening, house-chores and seasonal small-scale trading. Just above half were married or living with a partner (54.3%). Majority (51.2%) were in lowest/ lower wealth quintile. More than a third (36.6%) of the study participants were obese, a third (33.5%) were overweight, 26% normal while 3.9% were underweight.

Analysis of the participant’s serum Vitamin D levels revealed that 58.7% (149) of respondents had 25OHD serum levels below 30 ng/ml of whom 18.9% (48) had deficient levels, 39.8% (101) had insufficient levels while the rest had sufficient serum vitamin D levels.

Bivariate analysis was done to determine the relationship between serum vitamin D and the participant characteristics. Taking those who were deficient as the reference group, we found that they are significantly older by 5.0 (p-value=0.022) and 4.5 (p-value=0.042) years when compared to those who were insufficient and sufficient respectively. There was a positive association between those with lower levels of education (no formal school and primary education) and those with deficient or insufficient serum vitamin D levels as shown in Table 1. Body mass index (BMI) had a positive association (p-value=0.043) with those who were deficient. There was a positive association between osteoporosis and those with deficient (p=0.000) or insufficient (p=0.002) serum Vitamin D levels. It is important to note that almost half (46.5%) of postmenopausal women do not have osteoporosis despite having insufficient serum vitamin D levels. Occupation, marital status and wealth status had no association with the serum vitamin D levels (p-value>0.05).

Table 1

Demographic characteristics and Serum vitamin D results among postmenopausal women

Overall		**Deficient (n=48)** 18.9%	**Insufficient (n=101)** 39.8%	**Sufficient (n=105)** 41.3%
Age	Mean	68.4	63.4	63.9
	Standard deviation	11.4	10.3	10.5
Education	No school	45.8%	17.8%	25.7%
	Primary	41.7%	60.4%	54.3%
	Secondary	12.5%	15.8%	20.0%
	College/University	0.0%	5.9%	0.0%
	Chi-square - Exact P-value	0.006**		
Occupation	Formal employment	2.1%	3.0%	3.8%
	Non-formal employment	97.9%	97.0%	96.2%
	Chi-square - Exact P-value	0.639		
Marital status	Living alone/ Single	2.1%	5.9%	5.7%
	Living together/ Married	58.3%	47.5%	59.0%
	Divorced/ Separated	39.6%	5.9%	5.7%
	Widowed	0.0%	40.6%	29.5%
	Chi-square - Exact P-value	0.234		
Wealth status	Lowest quintile	27.1%	14.9%	21.9%
	Lower quintile	27.1%	33.7%	30.5%
	Middle quintile	16.7%	14.9%	12.4%
	Higher quintile	10.4%	17.8%	16.2%
	Highest quintile	18.8%	18.8%	19.0%
	Chi-square P-value	0.544		

BMI	Mean	27.3	29.8	27.2
	Standard deviation	5.6	6.5	5.5

Table 2 shows the results of performing multivariate analysis treating serum vitamin D levels as the dependent variable against other independent variables. From the results, having low serum vitamin D levels significantly increases the risk of osteoporosis by 18% while increased gestation reduces serum vitamin D by 11%.

Table 2

The odds ratio of serum vitamin D levels and respondent characteristics and history

Risk factors	Coefficient	Standard error	Z	P-value	95% confidence interval	
					Lower CI	**Upper CI**
Age	0.03	0.2	0.1	0.893	-0.4	0.4
Schooling	-0.29	0.3	-1.0	0.319	-0.9	0.3
BMI	0.26	0.3	0.8	0.431	-0.4	0.9
Bone DEXA categories	0.82	0.3	3.0	0.002***	0.3	1.3
Osteoporosis	0.04	0.1	0.4	0.672	-0.1	0.2

DISCUSSION

Our study noted a high (58.7%) prevalence of hypovitaminosis D among postmenopausal women in Kiambu County. Kagotho et al. in a tertiary hospital in Kenya using samples of healthy blood donors revealed a hypovitaminosis prevalence of 60%(8).In another retrospective study done in Kenya by Gitahi and Kiplamai, a prevalence of 90% was found in participants attending a clinic(9). This findings are consistent with what has been found in other studies done outside Kenya (2) (11). However it is important to note our results were not in keeping with a study done in Tanzania among the Maasai and Hadzabe which found that none of the participants were Vitamin D deficient and mean serum 25(OH)D was 46.1 ng/ml(12).This may be explained by the fact that the Tanzanian community sampled were hunters and gatherers who spent most of their time outdoors.

Several studies have revealed that with advancing age, there is a statistically significant decrease in serum Vitamin D level(13). We too observed a statistically significant relationship between increasing age and serum Vitamin D It has been noted that the elderly usually adopt a more indoor and sedentary life. The aged also have decreased skin thickness associated with lower 7-dehyrocholesterol production which results in reduced vitamin D levels. A study in East Africa found a positive association between age and vitamin D(12). This could be expected since the population sampled was below 64 years. Our study revealed a positive association between lower levels of education and low serum vitamin D levels which was similar to other studies(14). This could be explained by the greater understanding of dietary requirements by those with a higher level of education

Those participants with Vitamin D Insufficiency had significantly (p-value=0.004) 2.7 BMI units higher than those who were Vitamin D sufficient. This inverse relationship between serum Vitamin D levels and BMI has been demonstrated in several studies and it is postulated that obese individuals have a larger storage capacity for vitamin D in adipose tissue leading to lower serum levels of Vitamin D (15) (16).

In our study population, there was a positive correlation between osteoporosis and those with deficient (p=0.000) or insufficient (p=0.002) serum Vitamin D levels. This is consistent with other studies and is explained by the key role Vitamin D plays in calcium metabolism (5)(17). Low serum vitamin D levels are associated with reduced BMD and increased fracture risk especially in Post-menopausal women (18). However, in sharp contrast to our findings, some studies found no significant association between serum vitamin D levels and presence of osteoporosis (19) (20). These differences may be explained by the differences in race, gender, age, geographical location, climate, hormonal status and cultures in the studies done.

CONCLUSION

The prevalence of hypovitaminosis D in postmenopausal women in Kiambu county, Kenya is high and is associated with advancing age, low socio-economic status, lower education level, increasing BMI and osteoporosis. Early detection and prevention of hypovitaminosis D may be the key to reduce osteoporosis and its complications in postmenopausal women in this region. Counselling postmenopausal women on the benefits of adequate dietary intake as well as Vitamin D supplementation should be considered.

Our study limitations included the inability to accurately identify definite risk factors for hypovitaminosis D due to the cross-sectional nature of our design. Secondly, we did not collect information on dietary vitamin D intake or sun exposure which are both predictors of vitamin D levels. Despite the limitations, to our knowledge, this is the first randomized community survey done in sub-Saharan Africa to document serum Vitamin D levels in post-menopausal women

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