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VITAMIN D STATUS AND THE RISK OF CARDIOVASCULAR DISEASE AMONG OFFICE WORKERS IN IBADAN, NIGERIA: A CROSS-SECTIONAL STUDY

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ABSTRACT

Introduction: **Cardiovascular diseases (CVDs) are significant global health concern, accounting for an estimated 17.9 million deaths annually. Office workers, live a sedentary lifestyle and often lack exposure to sunlight, thus vulnerable to vitamin D (Vit D) deficiency, which might be associated with increased risk of CVD. This study aims to investigate the relationship between Vit D level and CVD risk among office workers in Ibadan, Nigeria. Methods: This pilot study employed a cross-sectional survey of 80 office workers at two tertiary Institutions based in Ibadan, Nigeria. Vit D levels, lipid profile, apolipoproteins A1 and B-100 were measured by standard laboratory methods while Castelli's Risk indexes I and II (CRI-1 and CRI-2) were calculated.**

Results: **About a quarter of respondents 19 (24%) of the participants had Vit D deficiency, 35 (44%) had insufficiency while the remaining 26 (32%) had sufficient Vit D levels. The Vit D deficient group had the highest risk of CVD with 11% of the group having CRI-1 ratio >4.0 and 5% having CRI-2 ratio >3; none of the Vit D sufficient group were in this range while 4% of Vit D insufficient group had CRI-1 ratio >4. Pearson correlation showed a significant positive relationship between Vit. D level and HDL-cholesterol concentration (r=0.77, p=0.001).**

Conclusion: **The findings of this study shows that Vitamin D deficiency and insufficiency is prevalent among office workers in Ibadan, Nigeria and is closely linked to higher cardiovascular risk and dyslipidemia. Optimizing Vit D levels through exposure to sunlight, dietary sources, or supplementations may be beneficial for maintaining cardiovascular health especially among office workers.**

Key words: Cardiovascular diseases, Vitamin D status, Castelli risk index I & II, Dyslipidemia, Office workers

INTRODUCTION

Cardiovascular diseases (CVD) are leading cause of mortality and morbidity globally which comprises of complication to the circulatory vascular system.[1] With a projected 17.9 million deaths per year, cardiovascular diseases (CVDs) continue to be the leading cause of death globally.[2] CVD is associated with conditions like acute coronary heart disease, stroke and heart failure.[3]

Previous study has shown that physiological functions, such as cardiovascular and bone health, depend heavily on vitamin D.[4] Its relationship to cardiovascular risk factors has been studied, but the results have been inconclusive. Some suggest positive relationship between vitamin D deficiency and risk of developing CVDs, others suggest that while regular vitamin D supplementation for heart health is not always encouraged, maintaining adequate levels may provide cardiovascular protection. However, other research has found no correlation between these two parameters.[5]

In recent times, urbanization, coupled with few outdoor activities has led to decreased exposure to sunlight especially among workers within administrative buildings even in Nigeria.[6] Thus, serum vitamin D status might become inadequate and impact negatively on the cardiovascular health of such workers leading to cardiovascular related conditions like obesity and hypertension. It is difficult to create efficient preventative and intervention plans that are suited to the unique requirements of this group in Nigeria due to the lack of local data on vitamin D level and its effects on cardiovascular health. Moreover, current research frequently ignores seemingly healthy people who could be at risk for CVD, losing chances for early intervention.

Castelli risk Index (CRI) are lipid profile-derived ratios used to evaluate the risk of CVDs. The Castelli Risk Index I (CRI-1), is the total cholesterol (TC) divided

by high-density lipoprotein cholesterol (HDL-c) while low-density lipoprotein cholesterol (LDL-c) divided by HDL-c yields the Castelli Risk Index II (CRI-2).[7] When compared to individual lipid levels, these ratios are thought to be more accurate in predicting the risk of CVD. A CRI-1 value >4 indicates the development of coronary plaques and is regarded as a sign of a higher risk of CVD. An elevated risk of CVD, acute myocardial infarction, and insulin resistance is predicted by a high CRI-II of >3.[8] Hence this study would explore the use of CRI-1 and CRI-2 as markers of cardiovascular risk.

While there is substantial global research on vitamin D and cardiovascular health, specific studies focusing on healthy office workers in South-Western Nigeria may be limited, in fact few research have addressed the link between cardiovascular status and vitamin D status in office workers. Public health initiatives targeted at lessening the overall burden of CVDs in Nigeria may benefit from an understanding of the prevalence and consequences of vitamin D insufficiency in this population. Hence, the need to investigate the influence of vitamin D status on the cardiovascular health of apparently healthy office workers in Ibadan Metropolis, Nigeria.

MATERIALS AND METHODS

Study location/study setting

The University College Hospital is a premier federal tertiary teaching hospital in Ibadan, South West, Nigeria. This study location is embedded within a high-pressure, fast-paced healthcare environment with workforce comprising of clinical professionals and non-clinical workers including administrative staff responsible for managing medical record. They are often engaged in shift work and prolonged sitting hours away from daytime light.

Also, Lead City University, a private tertiary institution in Ibadan, South West Nigeria, comprising of academic, and administrative office workers who often spend long hours sitting indoor with no exposure to daytime sunlight, experiencing low physical activities throughout the day.

Study design

This is an analytical cross-sectional survey of 80 participants between ages 18 and 45years. This study was conducted over a period of twelve months, from May, 2024 to May, 2025.

Study population

The study population were apparently healthy office workers in South-Western Nigeria recruited from University of Ibadan and Lead City University, Ibadan, Nigeria.

Inclusion criteria

Apparently healthy office workers without any underlying disease condition and with average 8 working hours at the office starting from 8am. Residential in Ibadan, South Western Nigeria, in order to give room for similar weather condition exposure (length of day does not vary substantially over the course of the year in Ibadan).

Exclusion criteria

Participants aged 45years and above were excluded because advanced age is a non-modifiable risk factor for cardiovascular diseases, hence can be a confounding variable in this study. Participants with diagnosis of hypertension, chronic kidney disease, diabetes mellitus, and those with BMI greater than 30kg/m^2 (obesity) were excluded because of their possible effect on vitamin D concentrations. These has been suggested to lower vitamin D levels through increased sequestration, reduced synthesis, or loss.[12] Those on vitamin D supplements were also excluded because it might falsely increase the level of measured vitamin D.

Ethical approval

Ethical approval was obtained from the UI/UCH Research Ethics Committee Review Board with an assigned number UI/UCH EC: 24/0215. Informed consent form was issued to them and duly signed by all participants.

Data collection

Information on dietary pattern, socio-demographics, medical history, lifestyle behavior, work stress and duration of daily exposure to sunlight was collected from all participants by using a well-structured questionnaire designed for this study.

The clinical measurements included weight (measured in kilograms to 2 decimal places) and height (measured in meters to 2 decimal places), which were obtained from each participant using the stadiometer and the stadiometer's headpiece, respectively, with each participant wearing clothing without shoes. BMI was calculated as weight/height^2 (kg/m^2 to 2 decimal places). Blood pressure was measured twice, using a standard aneroid sphygmomanometer on the left arm after at least 10 minutes of rest, with the average of the measurements recorded.

The participants were classified into three groups based on the measured vitamin D concentrations. Vitamin D Deficient group (serum Vit. D levels < 20ng/mL),

Vitamin D insufficient group (serum Vit. D levels =20-29 ng/ml) and Vitamin D sufficient group (serum Vit. D levels > 30ng/ml).[9]

Sample size determination

Sample size was determined using the formula Cochran Sample Size Formula for Continuous Data[10] which is as follows:

$n = Z^2\sigma^2 / E^2$

where Z, (Z-score for 95% confidence interval): 1.96

σ (Standard Deviation): 0.5 (A standard assumption when the actual variance of the population is unknown)

E (Margin of Error): 0.11

$n = 1.96^2 \times 0.5^2/0.11^2$

n=79.57, approximately n=80

Participants were recruited using a convenient (non-random) sampling technique.

Sample collection

10mls of venous blood was withdrawn from each participant at the ante cubital fossa, after 10-12 hours overnight fast, and dispensed into gel clot activator tube and left for 30minutes for clot retraction, each specimen tube was then centrifuged at 3000 rpm for 15minutes and serum decanted into a plain bottle for biochemical analysis of lipid profile, Apo A1, Apo B-100 and Vitamin D concentrations. Samples were stored at -20°C prior biochemical analysis within 3 months of specimen collection.

Biochemical analysis

Serum vitamin D level was measured by enzyme-linked immunosorbent assay (ELISA) on a Stat Fax 4000 ELISA reader (Awareness Technology Inc., Ramsey, USA), using the Accubind Vit. D ELISA Kit. Serum Total Cholesterol (TC) was estimated by the cholesterol CHOD-PAP method using Randox diagnostic kit which is an enzymatic end point method. Serum High-Density Lipoprotein Cholesterol (HDL-C) was estimated by precipitation method while serum Triglycerides (TG) was estimated by GPO-PAP method of Randox diagnostic kit. Serum LDL-Cholesterol concentration was calculated using the equation described by Frederickson-Frieldwald; LDL-C = TC - HDL-C - (TG/5).

Castelli Risk Index 1(CRI-1) was estimated as; TC/HDL-c ratio, Castelli Risk Index II (CRI-2) was calculated as; LDL-c/HDL-c ratio. A value of CRI-I >4 is considered an indicator of increased risk of CVD and reflects the formation of coronary plaques. A value of CRI-II >3 predicts an increased risk of CVD, acute myocardial infarction, and insulin resistance[8].

Statistical analysis

Data obtained were subjected to statistical analysis using the Statistical Package for the Social Sciences (SPSS), Version 25.0 (IBM Corp., Armonk, New York, USA). The Kolmogorov-Smirnov test of normality revealed a Gaussian distribution; hence results were expressed as mean ± Standard Deviation for quantitative variables and frequency (%) for qualitative variables. Students T test and Mann-Whitney U test was used for comparison of means between two groups, ANOVA was used to compare means between the three vitamin D groups. While associations between variables was determined using Pearson correlation. Significance was set at $p<0.001$

RESULTS

Classification of Vitamin D status in participants

Nineteen (19) participants (representing 24% of the total) had deficient Vitamin D levels, <20ng/ml, 35 participants (representing 44% of the total) had

Table 1: Baseline sociodemographic characteristics of the office workers

Variables		Study participants (n=80)
Gender, n(%)	Male	59 (73.8)
	Female	21 (26.2)
Age (yrs)		33.29 ± 7.33
Height		1.62± 0.09
Weight (Kg)		67.45 ± 15.14
BMI(kg/m²)		25.83 ± 5.12
SBP (mmHg)		117.4 ± 12.79
DBP (mmHg)		72.8 ± 9.59
History of CVD, n(%)	No	80 (100)
Family History of CVD, n (%)	No	68 (85)
	Yes	12 (15)

BMI: *Body Mass Index* ***SBP:*** *Systolic Blood Pressure* ***DBP:*** *Diastolic Blood Pressure*
Data represented as mean± SD and n (%)

insufficient Vitamin D levels (20-29 ng/ml) while 26 participants (representing 32% of the total) had sufficient levels of Vitamin D, > 30ng/ml

Classification of BMI in participants according to WHO criteria

Underweight (<18.5%): 2 participants (2.5%)
Normal weight (18.5 – 24.9): 28 participants (35%)
Overweight (25.0 – 29.9): 50 participants (62.5%)

Baseline sociodemographic characteristics of Participants

Table 1 shows the Baseline Sociodemographic characteristics of the participants. The mean values for weight, height and body mass index (BMI), systolic blood pressure (SBP) and diastolic blood pressure (DBP) were within normal limits of the reference except for the mean BMI which is in overweight (>25.0kg/m^2) range. Also, 73.8% (59) of the participants were male, while 26.2% (21) were female. 15% of the participants had a family history or relation with cardiovascular diseases and all of them mentioned hypertension as the only CVDs.

Table 2 shows the summary of the lifestyle and habits of the participants. Only 43.75% of the participants are exposed to early morning sunlight once to three times a week, while 30% of the participants are

Table 2: Summary of lifestyle and habits of office workers

Lifestyle and Habits	Parameters	Frequency (%) (n=80)
Stress at work	No	12 (15)
	Yes	68 (85)
Stress Frequency (How often)	Daily	42 (52.5)
	Monthly	4 (5)
	Rarely	11 (13.8)
	Weekly	18 (22.5)
Coping Mechanism	Exercise	22 (27.5)
	Medication	13 (16.3)
	Sleeping	6 (7.5)
	Rest	5 (6.3)
	Social Support	15 (18.8)
	None	19 (23.8)
Experience Chest pain, Shortness of breath, swelling of legs/feet, Dizziness	Chest Pain	19 (23.8)
	Chest pain, Shortness of breath	8 (10)
	Chest pain, swelling of legs/feet	2 (2.5)
	Chest pain, Dizziness	11 (13.8)
	Dizziness	5 (6.3)
	Swelling of legs/feet	2 (2.5)
	None	33 (41.3)
Exposure to early morning sunlight	Yes	60 (75)
	No	20 (25)
Exposure to sunlight (Frequency)	Once	15 (18.75)
	Twice	10 (12.5)
	Thrice	10 (12.5)
	More than thrice	24 (30)
	Rarely	1 (1.25)
	Never	20 (25)
Perform physical exercise	Yes	58 (72.5)
	No	22 (27.5)
Physical exercise (Frequency)	Daily	31 (38.8)
	Weekly	17 (21.4)
	Frequently	1 (1.3)
	Rarely	6 (7.5)
	Occasionally	3 (3.8)
Physical exercise (Types)	Gymnasium	4 (5)
	Jogging	10 (12.5)
	Playing Football	2 (2.5)
	Running	1 (1.3)
	Swimming	1 (1.3)
	Skipping rope	3 (3.8)
	Walking	33 (41.3)
	Weight lifting	2 (2.5)
Fish consumption in week (Frequency)	Once	14 (17.5)
	Twice	15 (18.8)
	Thrice	15 (18.8)
	More than thrice	32 (40)
	Never	4 (5)
Egg consumption in a week (Frequency)	Once	19 (23.8)
	Twice	23 (28.8)
	Thrice	20 (25)
	More than thrice	14 (17.5)
	Never	4 (5)
Mushroom consumption in a week (Frequency)	Once	5 (6.3)
	Thrice	1 (1.3)
	Never	74 (92.4)
Cod liver oil consumption in a week (Frequency)	Once	5 (6.3)
	Thrice	1 (1.3)
	More than thrice	2 (2.5)
	Occasionally	1 (1.3)
	Never	71 (88.6)

exposed to sunlight more than three times a week. The participants diets are moderate in fish and egg intake, while mushrooms and cod liver oil are rarely consumed.

Table 3 shows the summary of anthropometric data of participants based on Vitamin D classification. There is no statistically significant difference (p>0.001) in the age, height, weight, SBP, and DBP of the participants across the three vitamin D groups, however there is a statistically significant difference (p<0.001) in the BMI across the three vitamin D groups, such that as BMI increases as the vitamin D concertation decreases.

With F (2,77) =4.12, and F (2,77) =7.57, p<0.001 for SBP, and BMI respectively, variation between group is statistically significant.

Table 4 shows the serum Lipid profile, apolipoproteins concentration and Castelli Risk Factor according to vitamin D status. The participants with vitamin D deficiency had the highest mean TC concentration (158.32 mg/dL), while those with sufficient vitamin D had the lowest (146.12 mg/dL). The mean serum TG concentration decreases across the groups, from 124.62 mg/dL in the deficient group to 109.68 mg/dL in the sufficient group. The mean serum HDL-c concentration, increases across all the three groups, with the highest mean (58.94 mg/dL) in the vitamin D sufficient group. Apo A1 increases significantly across the groups with the lowest value in the vitamin D deficient group. Apo B and the LDL-c concentrations, decrease significantly across the three groups from deficient group to the sufficient group. Apo B/Apo A ratio decreased slightly across the groups: 0.96 (deficient), 0.90 (insufficient), and 0.84 (sufficient), supporting the trend that higher vitamin D levels are associated with lower cardiovascular risk.

Table 5 shows the assessment of cardiovascular risk factors across the vitamin D groups. The prevalence of low HDL-c (<60mg/dl) is higher in the defficient (67%) and the insufficient (66%) groups compared to the sufficient group (39%) with a statistically significant difference across the 3groups (p<0.001). Also, the

Table 3: Summary of anthropometric data of participants based on vitamin D classification

Variables	Deficient Vit.D <20ng/ml (n=19)	Insufficient Vit.D= 20-29ng/ml (n=35)	Sufficient Vit.D >30ng/ml (n=26)	F value	p-value
Age (yrs)	32.79 ± 7.96	32.37 ± 6.85	34.88 ± 7.50	1.59	0.210
Height (m)	1.62 ± 0.12	1.62 ± 0.09	1.63 ± 0.06	2.02	0.140
Weight (kg)	69.09 ± 15.0	65.3 ± 16.38	69.16 ±13.62	2.61	0.080
BMI (kg/m^2)	27.20 ±5.77	26.88 ± 5.20	25.08 ± 4.41	7.57	0.000*
SBP (mmHg)	125.4 ± 0.44	118.3 ± 0.45	119.2 ± 0.55	4.12	0.020
DBP (mmHg)	90.2 ± 0.25	80.8 ± 1.4	80.6 ± 0.91	2.27	0.110

SBP=*Systolic Blood Pressure*, **DBP**= *Diastolic Blood Pressure*, **BMI**=*Body Mass Index*

Table 4. Serum lipid profile, apolipoproteins and castelli risk factor according to vitamin D status

Variables	Deficient Vit.D <20ng/ml (n=19)	Insufficient Vit.D= 20-29ng/ml (n=35)	Sufficient Vit.D > 30ng/ml (n=26)	F value	p-value
TC (mg/dL)	158.32 ± 2.1	148.93 ± 1.4	146.12 ± 1.8	5.11	0.000*
TG (mg/dL)	124.62± 3.4	116.75 ± 0.3	109.68 ± 1.3	3.12	0.000*
HDL (mg/dL)	56.48 ± 0.2	56.02 ± 0.23	58.94± 0.96	3.14	0.130
LDL (mg/dL)	87.89 ± 3.3	79.56 ± 1.26	74.26 ± 1.9	6.20	0.000*
CRI 1	3.37 ± 0.72	3.27 ± 0.37	1.63± 0.53	3.21	0.000*
CRI 2	1.89 ± 0.65	1.77 ± 0.41	1.56 ± 0.5	2.21	0.320
Apo A1 (mg/dL)	53.99 ± 2.4	124.26 ± 0.93	152.05 ± 1.42	5.61	0.000*
Apo B-100 (mg/dL)	137.89 ± 3.3	129.56 ± 1.2	43.52 ± 0.34	6.71	0.000*
Vit D (ng/mL)	16.67 ± 2.75	24.32 ± 2.44	31.16 ± 0.50	7.81	0.000*
Apo B/Apo A ratio	0.96 ± 0.34	0.90 ± 0.21	0.84 ± 0.22	5.44	0.000*

n: *number*, **SBP**: *Systolic blood pressure*, **DBP**: *Diastolic blood pressure*, **T.C**: *Total cholesterol*, **HDL-C**: *High density lipoprotein cholesterol*, **TG**: *Triglycerides*, **LDL-C**: *Low density lipoprotein cholesterol*, **CRI 1**: *Castelli Risk Index I*, **CRI 2**: *Castelli Risk Index II,* **Apo A1***: Apolipoprotein A,* **Apo B-100***; Apolipoprotein B,* **Vit D***: Vitamin D*

Table 5: Assessment of cardiovascular risk factors across Vitamin D groups

Variables	Deficient (n=19)	Insufficient (n=35)	Sufficient (n=26)	p value
Low HDL(<60mg/dl)	13 (68)	23 (66)	10 (39)	0.001*
High TC (>200mg/dl)	1 (5)	-	-	
High LDL (>100mg/dl)	3(16)	3(8)	2(7)	0.62
High TG (>150mg/dl)	5(26)	7(21)	5(19)	0.09
Low Apo A (<110 mg/dl)	3(16)	3(8)	1(4)	0.17
High Apo B (> 133mg/dl)	11(58)	14(40)	7(27)	0.66
Apo B/Apo A ratio > 0.7	15(79)	23(68)	9(35)	0.11
CR-1 >4.0	2(11)	1(4)	-	0.13
CR-2 >3.0	1(5)	-	-	

n (%): *Frequency (percentage)*, **SBP**: *Systolic blood pressure*, **DBP**: *Diastolic blood pressure*, **T.C**: *Total cholesterol*, **HDL-C**: *High density lipoprotein cholesterol*, **TG**: *Triglycerides*, **LDL-C**: *Low density lipoprotein cholesterol*, **CRI 1**: *Casteli Risk Index I*, **CRI 2**: *Castelli Risk Index II*

prevalence of high TC (>200mg/dl) and high LDL-c (>100mg/dl) is relatively low across all groups, ranging from 7% to 16%. The prevalence of high TG (>150mg/dl) is higher in the deficient (27%) and insufficient (21%) groups compared to the sufficient group (19%). Prevalence of low Apo A (<110 mg/dl) is relatively low across all groups. However, the prevalence of high Apo B (>133mg/dl) is higher in the deficient (58%) and insufficient (40%) groups compared to the sufficient group (27%). Apo B/Apo A ratio > 0.7 is higher in the deficient (79%) and insufficient (68%) groups compared to the sufficient group (35%). High cardiovascular risk scores (CR-1 >4.0 and CR-2 >3.0) is relatively low across all groups, although the deficient group has a slightly higher prevalence. The Vitamin D deficient group had the highest risk of cardiovascular disease with 16% having low Apo A (<110 mg/dL), 58% high Apo B (>133 mg/dL), 79% with Apo B/Apo A ratio >0.7, 10% with CR-1 >4.0, and 5% with CR-2 >3.0. Variables like High TC, High LDL, and Low Apo A have very few positive cases, which radically reduces statistical power to find a true statistically significant differences in these groups.

Table 6. Relationship between vitamin D and Cardiovascular risk factors in Office Workers using Pearson Correlation

Variables	r	p-value
Vit. D vs TG	0.48	0.07
Vit. D vs TC	0.06	0.20
Vit. D vs HDL	0.77	0.001*
Vit. D vs LDL	0.04	0.22
Vit. D vs CRI-1	0.09	0.18
Vit. D vs CRI-2	0.05	0.21
Vit. D vs Apo A1	0.49	0.07
Vit. D vs Apo B-100	0.04	0.22
Vit. D vs Apo A/Apo B ratio	0.37	0.10

TC: *Total cholesterol*, **HDL-C**: *High density lipoprotein cholesterol*, **TG**: *Triglycerides*, **LDL-C**: *Low density lipoprotein cholesterol*, **Apo A1***: Apolipoprotein A,* **Apo B-100***; Apolipoprotein B,* **Vit D***: Vitamin D*, **r**: Pearson correlation constant

The correlation table (Table 6) shows there was a significant positive relationship between vitamin D and HDL-c, suggesting that higher levels of vitamin D may be associated with increased HDL-c concentration. Also, vitamin D showed moderate positive non-significant relationship with TG and Apo A1). Other variables, showed no significant correlations with vitamin D.

DISCUSSION

Vitamin D is a fat-soluble vitamin which plays significant role in numerous physiological processes in the human body, these processes include calcium metabolism, bone health, immune function, and cell growth and differentiation. Vitamin D deficiency could be the risk factor for cardiovascular diseases such as heart disease and stroke, which are the leading cause of morbidity and mortality worldwide. Thus, this study investigated the influence of vitamin D status on the cardiovascular health of apparently healthy office workers.

The findings of this present study showed that 62.5% of the office workers were overweight (>25.0 kg/m^2) according to W.H.O classification. An overweight BMI is a concern for office workers due to their sedentary lifestyles and the associated health risks. Office jobs often involve prolonged sitting, which can contribute to weight gain and increase the risk of various health issues associated with obesity.[13] In this present study, 24% of office workers had vitamin D deficiency and 44% insufficiency, with these groups having higher BMI when compared with the vitamin D sufficient group as shown in Table 3. This suggests that vitamin D deficiency or insufficiency may be

associated with increased body weight and BMI as supported by the study of Sonuga *et al.*, 2025.[14] Obesity (BMI>30kg/m^2) is recognized to be associated with vitamin D deficiency as adipose tissue sequesters 25(OH)D, resulting in an inverse relationship between vitamin D and BMI.[15] Previous study has shown that 1-α, 25-dihydroxy vitamin D (1α, 25 (OH) 2D) may interfere with adipogenesis suppression through actions regulated by vitamin D-dependent receptors.[16] Therefore, when vitamin D is inadequate, a substantial number of preadipocytes may develop. Vitamin D may play a role in regulating body weight and composition by influencing lipolysis, adipogenesis, and energy metabolism.[17]

The slight increase in mean systolic blood pressure (SBP) in the vitamin D deficient group is also consistent with previous research that has suggested a complex relationship between vitamin D and blood pressure[18.] Vitamin D may influence blood pressure regulation by modulating the renin-angiotensin aldosterone system, endothelial function, and vascular smooth muscle cell contraction[19].While some studies have found that vitamin D deficiency is associated with hypertension, others have found no association or even an inverse association.[6]

This study also observed that 44% of the office workers had vitamin D insufficiency and 24% had vitamin D deficiency, this is similar to the work of Divakar *et al.*[20,] where assessment of vitamin D status in office and workshop workers versus control room workers was investigated. The study concluded that prevalence of vitamin D deficiency was 32.9% amongst office workers and night shift workers and that they are at higher risk for vitamin D deficiency, after adjusting for socio-demographic characteristics, lifestyle habits, and clinical and biochemical characteristics. In fact, a recent study has shown that in the majority of occupational groups, vitamin D levels were far below the levels thought to be ideal for health.[21]

Our study involved participants working in an academic tertiary institution where many remain indoor all through the day, reducing opportunities for sunlight exposure and vitamin D synthesis in them. As shown in Table 2, about 25% of the study participants do not get exposed to early morning sunlight at all, while only 30% get exposed more than three times a week. This is a major factor that might affect the synthesis of vitamin D in the body since adequate ultraviolet light is not available to react with 7-dehydro cholesterol on the skin for the synthesis of cholecalciferol and ultimately active vitamin D. Also, consumption of vitamin D-rich foods was limited among the office workers, and many of them do not consume sufficient amounts to meet their needs as shown in Table 2, possibly because of their limited going out of the office. To increase accessibility to daytime sunlight in office workers, the workplace architectural structure should be designed in a way that would ensure that windows are strategically placed in the offices to increase light exposure. Also, office workers should be encouraged to take routine walks during their break and also practice outdoor lunchtime in a bid to enhance skin absorption of ultraviolet light and consequently enhance Vitamin D synthesis.

The findings of this study suggest that vitamin D deficiency might be associated with alterations in lipid profile, including higher TC, TG, and LDL levels, as shown in Table 4. This finding is similar to result of a study by Sonuga *et al.*[14], where it was concluded that dyslipidemia might be associated inadequate vitamin D status. The finding is also consistent with a cross-sectional study that investigated the relationship between vitamin D levels and blood lipid levels in 15,600 patients.[22] Thus, we suggest that vitamin D status may play a role in regulating lipid metabolism and may have implications for the prevention and treatment of cardiovascular disease. The prevalence of low HDL cholesterol and high TG in the deficient and insufficient groups is consistent with previous studies that have found an association between vitamin D deficiency and dyslipidaemias.[14,23] The development of atherosclerosis-related conditions like peripheral vascular disease, ischemic cerebrovascular disease, and coronary heart disease is known to be influenced by dyslipidaemia.[24]

The Castelli Risk Index (CRI) is a widely used metric to assess cardiovascular disease risk. Our study found that the CRI was significantly higher in the deficient and insufficient groups compared to the sufficient group and also 11% of the deficient group had CR-1 >4.0, while 5% had CRI-2 >3.0 as seen in Table 5, which is significant risk for CVDs. The deficient and insufficient groups also have abnormal lipid profile, a risk for CVDs. A higher CRI indicates a higher risk of cardiovascular disease. Thus, the results from our study suggest that the office workers with vitamin D deficiency or insufficiency are at a higher risk of cardiovascular diseases. This is consistent with previous research that found a link between vitamin D deficiency and increased cardiovascular risk.[25] The vitamin D receptors (VDR) have been found to be expressed in most cells of the body; and in addition to expressing the VDR, fibroblasts, cardiomyocytes, and vascular endothelial and smooth muscle cells also contain 1α-hydroxylase, which facilitates the synthesis of the active form of vitamin D.[26] Experimental models have shown that vitamin D deficiency has a wide range of

cardiovascular effects, including antihypertrophic effects, inhibition of cardiomyocyte proliferation, stimulation of smooth muscle cell proliferation, expression of endothelial growth factor, and inhibition of the renin-angiotensin-aldosterone system and natriuretic peptide emission.[16] Angiotensin I expression and local angiotensin II production in the heart, kidney tissue, and renal arteries can be directly inhibited by activating VDR with calcitriol or its analogues.[27] Vitamin D also regulates the renin-angiotensin-aldosterone system (RAAS) via angiotensin-converting enzyme-2, the enzyme that converts angiotensin II into angiotensin I. This enzyme is observed to be expressed better when vitamin D receptor is present.[28] Additionally, vitamin D has anti-inflammatory properties, inhibiting tumor necrosis factor-alpha (TNFα) and nuclear factor kappa B (NFkα) activation, which are both known to play major roles in the development of CVDs.[28]

A significant positive relationship between vitamin D and HDL-cholesterol was observed in the office workers in this study as seen in Table 6. Conversely, previous studies have linked reduced levels of HDL-cholesterol and apolipoprotein A1 to the development of atherosclerosis.[29] Hence, these findings suggest that Vitamin D sufficiency may be associated with a more favorable lipid profile and reduced cardiovascular risk.

Limitations of study

The sample size of this study is small, and further study involving larger population is encouraged. Also, serum glucose and HbA1c levels were not measured, this would have given an insight on how vitamin D deficiency might be associated with impacting insulin resistance in office workers.

CONCLUSION AND RECOMMENDATION

The results of this study suggest that there is high prevalence of vitamin D deficiency and insufficiency amongst office workers in Ibadan. This may be a prevalent risk factor for cardiovascular disease like coronary heart disease, ischemic cerebrovascular disease, and peripheral vascular disease in office workers in Ibadan, South West Nigeria. Ensuring adequate vitamin D levels through sunlight exposure while at work, dietary sources of vitamin D or supplementation may be beneficial for maintaining cardiovascular health.

Author contributions

Author AAS designed the study, supervised the research, interpreted the results and wrote the final draft of the manuscript. Author TAA, carried out sample collection, all laboratory analysis, and also wrote the initial draft of the manuscript. Author TCA reviewed the initial draft and performed literature searches. Author OOS reviewed the study design, performed literature searches and submitted the final draft. All authors read and approved the final manuscript.

Competing interests

All authors declare no conflict of interest.

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REFERENCES

1. World Health Organization. World Health Statistics. Geneva: World Health Organization; 2021
2. **Awosoga OA,** Oyewole OO, Adegoke OM, *et. al.* Cardiovascular disease risk perception among community-dwelling adults in southwest Nigeria: A mixed-method study. PLoS One. 2024 12,19 (11): e0313578.
3. **Mbakwem AC,** Amadi CE, Ajuluchukwu JN, Kushimo OA. Trends and outcomes of cardiovascular disease admissions in Lagos, Nigeria: a 16-year review. Cardiovasc J Afr. 2023; **23**;34(3):140-148.
4. **Balasubramanian A,** Kunchala K, Shahbaz A, et al. Association of Vitamin D Deficiency as an Independent Risk Factor for Myocardial Infarction and Its Therapeutic Implications: A Systematic Review. Cureus, 2025; 17(1): e77375.
5. **Barbarawi M,** Kheiri B, Zayed Y, *et al.* Vitamin D Supplementation and Cardiovascular Disease Risks in more than 83/000 Individuals in 21 randomized clinical trials: A meta-analysis. JAMA Cardiol. 2019;4(8):765–776.
6. **Aliyu AA,** Amadu L. Urbanization, cities, and health: The challenges to Nigeria - A review. Ann Afr Med; 2017;16(4):149-158.
7. **Imannezhad M.,** Kamrani F., Shariatikia A. *et al.* Association of atherogenic indices and triglyceride-total cholesterol-body weight index (TCBI) with severity of stenosis in patients undergoing angiography: a case-control study. BMC Res Notes 2025;18, 180.
8. **Gaggini M,** Gorini F, Vassalle C. Lipids in Atherosclerosis: Pathophysiology and the Role of Calculated Lipid Indices in Assessing Cardiovascular Risk in Patients with Hyperlipidemia. Int J Mol Sci. 2022; 21;24(1):75.
9. **Holick MF.** Vitamin D status: measurement, interpretation, and clinical application. Ann Epidemiol. 2009 Feb;19(2):73-78.
10. **Cochran WG.** Sampling techniques (3rd ed.). John Wiley & Sons. 1977.

11. **Doðruel F,** Gönen ZB, Canpolat DG, *et al.* Investigation of Vitamin D Levels in Medical Staff in a Dental Clinic. Niger. J. Clin. Pract, 2019; 22(4): 573-577.
12. **Shahwan M,** Hassan N, Mazin N, *et al.* Assessment of Serum 25-Hydroxyvitamin D and Its Association in Type 2 Diabetes Mellitus Elderly Patients with Kidney Disease: A Retrospective Cross Sectional Study. Metabolites, 2023; 13(3), 357.
13. **Daneshmandi H,** Choobineh A, Ghaem H, Karimi M. Adverse Effects of Prolonged Sitting Behavior on the General Health of Office Workers. J Lifestyle Med. 2017;7(2):69-75.
14. Sonuga O, Shittu Z, Sonuga A *et al.* Vitamin D Status and Dyslipidemia among Obese Individuals in Ibadan, Nigeria: A Pilot Study. Journal of the ASEAN Federation of Endocrine Societies. 2025. Retrieved fromhttps://asean-endocrinejournal.org/index.php/JAFES/article/view/4943.
15. **Turer CB,** Lin H, Flores G. Prevalence of vitamin D deficiency among overweight and obese US children. Pediatrics. 2013;131: e152-e161.
16. **Alzohily B,** AlMenhali A, Gariballa S, *et al.* Unraveling the complex interplay between obesity and vitamin D metabolism. Sci Rep. 2024;30; 14(1):7583.
17. **Barrea L,** Savastano S, Di Somma C. *et al.* Low serum vitamin D-status, air pollution and obesity: A dangerous liaison. Rev Endocr Metab Disord, 2017;18, 207–214.
18. **Bauer P,** Kraushaar L, Dörr O. *et al.* Association of 25-hydroxy vitamin D level with the blood pressure response to a maximum exercise test among professional indoor athletes. Eur J Appl Physiol, 2020 ;120, 1931–1941.
19. **Gahramanova S.** Mechanism of Development of Arterial Hypertension Associated with the Exchange of Level Vitamin D. Hypertension - An Update. IntechOpen; 2022.
20. **Divakar U,** Sathish T, Soljak M *et al.* Prevalence of Vitamin D Deficiency and Its Associated Work-Related Factors among Indoor Workers in a Multi-Ethnic Southeast Asian Country. Int. J. Environ. Res. Public Health, 2020: 17(1), 164.
21. **Sowah D,** Fan X, Dennett L. *et al.* Vitamin D levels and deficiency with different occupations: a systematic review. BMC Public Health 2017; 17, 519.
22. **Gholamzad A,** Khakpour N, Kabipour T. *et al.* Association between serum vitamin D levels and lipid profiles: a cross-sectional analysis. Sci Rep 2023;13, 21058.
23. **Li B,** Wang J, Xu J, *et al.* Association between dyslipidemia and vitamin D deficiency: a cross-sectional study in Chinese healthy population. Front Endocrinol (Lausanne). 2025 30; 16:1450924.
24. **Pappan N,** Awosika AO, Rehman A. Dyslipidemia. [Updated 2024 Mar 4]. In: Stat Pearls [Internet]. Treasure Island (FL): Stat Pearls Publishing; 2025 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK560891/
25. **Vernie Soh,** Shawn Jia Xiang Tan, Rijuvani Sehgal, *et al.* The Relationship Between Vitamin D Status and Cardiovascular Diseases, Current Problems in Cardiology; 2021;46, Issue 7,100836,ISSN 0146-2806.
26. **Haider F,** Ghafoor H, Hassan OF. *et al.* Vitamin D and Cardiovascular Diseases: An Update. Cureus. 2023 30;15(11):e49734.
27. **Cui C,** Xu P, Li G, *et al.* Vitamin D receptor activation regulates microglia polarization and oxidative stress in spontaneously hypertensive rats and angiotensin II-exposed microglial cells: Role of renin-angiotensin system. Redox Biol.2019; 26:101295.
28. **Fenercioglu AK.** The Anti-Inflammatory Roles of Vitamin D for Improving Human Health. Curr Issues Mol Biol. 2024;46(12):13514-13525.
29. **Sonuga AA,** Adeyanju MM, Ladokun OA, Sonuga OO. Effects of vitamin D3 supplementation on lipid profile and renal indices in rat model of drug induced renal injury. Eur J Clin Exp Med. 2024;**22**(4):729–738.