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Original Article

Vitamin D, body mass composition and metabolic risk factors in healthy young Indians

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ABSTRACT

Background: Studies have linked vitamin D to risk factors for cardiovascular disease. Obesity is a potential confounder in these studies. This study examined the relationship of 25 (OH) cholecalciferol (25[OH] D3) with insulin resistance, blood glucose, and lipid profile in lean male adults.

Method: We enrolled two hundred and thirty four military recruits before beginning of military training. Demographic and anthropometric data were collected from them. The participants underwent body mass composition analysis by dual energy X ray absorptiometry. Fasting samples were collected for measurement of blood glucose, lipid profile, 25(OH) D3, serum parathormone (PTH) and insulin.

Results: Vitamin D deficiency and insufficiency was found in 47.7% (107/224) and 31.6% (71/224) of participants, respectively. Using Pearson's correlation coefficient 25(OH) cholecalciferol and fasting blood glucose (FBG) were inversely correlated ($p = 0.023$). However, similar relation was not found between 25(OH) D3 and total cholesterol, triglycerides, high-density lipoprotein–cholesterol, low-density lipoprotein–cholesterol, homeostatic model assessment of insulin resistance and levels of PTH. On body composition analysis, there was no correlation of 25(OH) cholecalciferol with body mass index or fat mass index.

Conclusion: This study showed that in lean young male population, 25(OH) cholecalciferol and FBG are inversely correlated but no association of 25(OH) D3 with other cardiometabolic risk factors could be demonstrated.

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Introduction

Vitamin D is an important micronutrient and a hormone necessary for skeletal functions.[1] It is primarily synthesised in the skin on exposure to sunlight. Dietary source becomes important only when sunlight exposure is inadequate.[2] Vitamin D levels are influenced by age, ethnicity, latitude, season, pollution, use of sunscreen creams and body composition.[3] Though vitamin D is mainly responsible for maintaining the calcium homeostasis, it also has extra skeletal actions such as secretion of parathormone (PTH) and insulin, modulation of adaptive immune responses, effect on differentiation and proliferation of keratinocytes, as well as effect on proliferation of cells in certain malignancies.[4] The most common serum marker of Vitamin D used in studies is 25 hydroxycholecalciferol (25 [OH] D3). Studies have shown a link between 25(OH) D3 and cardiometabolic risk factors such as diabetes, hypertension and dyslipidemia.[5–17]

Vitamin D deficiency (VDD) is common in Indian subcontinent with up to two-third participants showing low levels of 25(OH) D3 in studies conducted in diverse populations.[18–21] There are limited studies studying the relationship of 25(OH) D3 level and metabolic risk factors in Indian population.[10,12,13,16] Furthermore studies have been reported with participants having higher body mass index (BMI), where overweight/obesity and physically inactivity becomes a potential confounder. Study participants who were lean and physically active would obviate the confounders. This study was intended to examine relationship of 25 (OH) D3 with fasting homeostatic model assessment of insulin resistance (HOMA-IR), fasting blood glucose (FBG) and lipid profile in lean young adult Indians.

Material and Methods

The institutional ethical committee approved the study. We conducted a cross-sectional, observational study from April to August 2017 on recruits screened for VDD at a regimental training centre located in North India at 26.8° N, 80.9° E. We included in the study recruits who were yet to begin military training (zero week) and willing to participate. Individuals reporting with systemic illness, musculoskeletal symptoms, those who had taken nutritional supplement or vitamin D before enrolment and those who declined to participate were excluded. The sample size for studying the prevalence of VDD in recruits was calculated using the following formula $n = 4Xpq/d2$, where n = required sample size, p = prevalence, q = 1-p,d = margin of error.2. Assuming 80% power, 5% significance level with 95% confidence interval, as well as assuming 10% margin of error, the required sample size was 97. Two hundred and twenty-four recruits were enrolled after informed consent. Demographic, dietary pattern, sunlight exposure and assessment of socio-economic status were collected through standard questionnaire. Height and weight was measured for calculation of BMI using portable stadiometer and electronic weighing scale. Lean mass and fat mass was measured with dual energy X ray absorptiometry performed on Hologic Discovery A model. Fat mass index [body fat mass (kg)/height (m2)] and lean mass index [lean mass (kg)/height (m2)] was calculated. Blood pressure was recorded with validated electronic device. After overnight, fast venous blood was collected for FBG, lipid profile, 25(OH) D3, serum PTH and nsulin. FBG was assessed by ERBA XL300 autoanalyser. Low-density lipoprotein–cholesterol (LDL-C) was calculated by direct assay. Roche Chemiluminiscence analyser (model COBAS e 401) assayed serum insulin, 25 (OH) vitamin D and serum PTH. Insulin resistance (IR) was estimated using HOMA-IR [insulin (mIU/mL) x glucose (mmol/L)/22.5]. We used the following vitamin D values $\geq$ 30 ng/ml, 20–30 ng/ml and $\leq$20 ng/ml, suggesting sufficiency, vitamin D insufficiency (VDI) and vitamin D deficiency (VDD), respectively. Normally distributed continuous variable was reported as mean (±standard deviations) and skewed continuous variables were represented as median. Comparisons of means and medians were carried out using unpaired t-test and Mann-Whitney test, respectively. Chi-square test was used to compare categorical variables. Association between 25(OH) D3 and cardiometabolic risk factors was carried out using linear regression models. All statistical analysis was carried out using SPSS 16.0, version (SPSS Inc, Chicago, Illinois, USA).

Results

Two hundred and twenty-four male recruits in zero week of training were enrolled for the study. The baseline parameters of the participants are as given in Table 1. Vitamin D, serum PTH and metabolic parameters of the participants are given in Table 2. VDD was found in 47.7% (107/224), VDI in 31.6% (71/

Table 1 – Baseline parameters of participants.

Parameter	Mean ± SD (range)	SE	Lower bound	Upper bound	95% CI
Age	20.74 ± 1.43	0.10	20.55	20.92	0.19
Height (cm)	171.9 ± 4.0	0.27	171.37	172.42	0.53
Weight (kg)	58.28 ± 4.51	0.30	57.68	58.87	0.59
SBP	103.34 ± 11.67	0.78	101.8	104.88	1.54
DBP	58.38 ± 8.68	0.58	57.24	59.52	1.14
BMI (Kg/m2)	19.73 ± 1.50	0.10	19.53	19.93	0.20
Lean mass/h2 (kg/m2)	17.38 ± 1.17	0.08	17.22	17.53	0.15
Fat mass/Ht 2 (kg/m2)	2.44 ± 0.57	0.04	2.37	2.52	0.07

SD, standard deviation; SE, standard error (of mean); CI, confidence interval; SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index.

Table 2 – Biochemical parameters and 25(OH) vitamin D of participants.

Parameter	Mean ± SD (range)	SE	Lower bound	Upper bound	95% CI
25 (OH) vitamin D (ng/ml)	21.44 ± 9.5 (4.6–56.65)	0.66	20.13	22.74	1.31
Serum PTH (pg/ml)	44.12 ± 15.80 (8.43–103.3)	1.10	41.94	46.30	2.18
Fasting blood glucose (mg/dl)	79.41 ± 8.23 (62–110)	0.55	78.33	80.49	1.08
Total cholesterol (mg/dl)	130.95 ± 11.53 (102–167)	0.77	129.43	132.47	1.52
Triglycerides (mg/dl)	66.23 ± 11.74 (50–116)	0.78	64.69	67.78	1.55
HDL-cholesterol (mg/dl)	45.8 ± 5.83 (30–61)	0.39	45.03	46.57	0.77
LDL-cholesterol (mg/dl)	74.38 ± 11.50 (50–110)	0.77	72.86	75.89	1.51
Insulin (U/l)	6.23 ± 3.63 (0.21–23.96)	0.25	5.73	6.73	0.50
HOMA-IR	1.21 ± 0.70 (0.04–4.61)	0.05	1.11	1.31	0.10

HDL, high density lipoprotein; LDL, low density lipoprotein; HOMA-IR, homeostatic model assessment of insulin resistance; PTH, parathormone.

224) and the rest were sufficient 12.0% (27/224). Using Pearson correlation coefficient (also known as bivariate correlation), there was negative e correlation between 25(OH) D3 and FBG ($p = 0.023$). No correlation could be demonstrated between 25(OH) D3 and total cholesterol, triglycerides, high-density lipoprotein–cholestrol (HDL-C), LDL-C, HOMA-IR and levels of PTH. On body composition analysis, there was no correlation of 25(OH) D3 with BMI or fat mass index (Table 3).

Participants were separated into four groups in accordance with the level of 25(OH) D3 (group1: <10 ng/ml; group 2: 10.1-20 ng/ml; group 3: 20.1–30 ng/ml, group 4: >30 ng/ml). Analysis of Variance (ANOVA) was used to explore the levels of total cholesterol, HDL-C, triglycerides, LDL-C, FBG, insulin and HOMA-IR values across levels of 25(OH) vitamin D3. Trend analysis suggested an inverse relation between FBG and 25(OH) D3 but not with other parameters.

Discussion

We studied the relation of 25(OH) D3 and metabolic parameters in a cohort of lean young healthy male adults. In our study, VDD was observed in 47.7% of the participants, which corroborates with the accepted prevalence in India.[19–21] Our study, demonstrated that levels of 25(OH) D3, and FBG are inversely correlated. GannagéYared et al.[5] studied a cohort of non-obese young adults (20–28 y) for correlation of 25 (OH) vitamin D and metabolic risk factors, as well as found a similar correlation of 25 (OH) vitamin D and FBG. The inverse correlation was observed across diverse population (varying ethnicity, young/old) and in obese after controlling for BMI.[5–10] However, these findings are not universal as some cross sectional studies have failed to show any correlation between 25(OH) D3 and FBG.[11,13–16]

In a prospective study of a cohort of 9841 participants (Copenhagen City heart study) for more than twenty nine years, 810 (8.2%) developed diabetes. The researchers had measured values of blood glucose and 25(OH) D3 at baseline and studied occurrence of diabetes on follow-up. After controlling for multiple factors, the risk of developing diabetes was higher in those with lowest quartile of serum 25(OH) D levels versus those in highest quartile [OR: 1.5 (1.33–1.70)].[22]

Vitamin D is involved in two essential processes linked to glucose homeostasis, i.e., insulin secretion and IR. Evidence suggests that a role for vitamin D influences insulin secretion. Vitamin D receptor and 1α-hydroxylase enzyme are present in β cells.[23,24] VDD or vitamin D receptor knockout impairs glucose-induced insulin secretion both in vitro and in vivo studies.[25] Evidence supports a role for vitamin D in influencing insulin sensitivity; the vitamin D receptor is present in skeletal muscle cells and vitamin D stimulates insulin-induced glucose transport and insulin receptor expression in vitro.[25,26] Cross-sectional observational studies have shown an inverse correlation of 25 (OH) D3 with HOMA-IR.[5,7,8] We did not find any correlation between 25 (OH) D3 and HOMA-IR in our study.

Vitamin D has been reported to influence serum lipid concentration. Studies have shown inverse correlation of 25(OH) D3 and components of lipid profile.[6,7,9,12,17] A retrospective analysis of data (anthropometry and lab values) of 217 obese children and adolescents (12.9 ± 5.5 years) at an endocrine clinic in the United States showed a negative correlation of Vitamin D and BMI and significantly lower HDL-C in those with VDI.[27] However no correlation could be demonstrated between 25(OH) D3 and triglycerides, HDL-C, total cholesterol and LDL-C in our study. In the Andhra Pradesh

Table 3 – Correlation of 25(OH) D with various parameters.

Parameters	Pearson correlation (r)	P value
SBP	0.039	0.577
DBP	0.022	0.754
BMI (Kg/m2)	0.044	0.523
T cholesterol (mg/dL)	0.056	0.433
Triglycerides (mg/dL)	0.076	0.277
HDL-cholesterol (mg/dL)	0.095	0.175
LDL-cholesterol (mg/dL)	−0.032	0.646
Fasting plasma glucose (mg/dL)	−0.158	0.023
HOMA-IR	0.026	0.709
PTH (pg/mL)	−0.085	0.225
Lean mass index	−0.014	0.839
Fat mass index	0.044	0.525

HDL, high density lipoprotein; LDL, low density lipoprotein; HOMA-IR, homeostatic model assessment of insulin resistance; PTH, parathormone; BMC, body mass composition; SBP, systolic blood pressure; DBP, diastolic blood pressure.

children and parents study (APCAPS) conducted in rural region of South India investigators studied the association of 25 (OH) D3 with metabolic parameters (lipid profile, FBG, insulin), blood pressure, BMI and percent body fat. The cohort consisted of 1038 (40.3% females) individuals in the age group of 18–24 years. The mean BMI was 19.63 kg/m2 in males and 19.12 kg/m2 in females. Male participants showed an inverse association (weak) between 25(OH) D3 with serum insulin levels but no association was observed between 25(OH) D3 and other metabolic parameters in either sexes.[13]

Our study is one of the few observational studies conducted in India, which examined the association between 25 (OH) D3 and metabolic risk factors in a young, non-obese, physically active population. Sample size was calculated as per prevalence and adequately powered to study the outcome measure. We had eliminated key confounding variable of obesity and physical inactivity. Our analyses are cross-sectional and hence causality cannot be inferred. The cardiometabolic risk factors emerge over lifetime hence we cannot rule out the possible role of serum vitamin D in CVD outcomes later in life.

Conclusion

Our data limited to a lean young male population, showed between 25 (OH) D3 and FBG are inversely correlated but did not support an association of vitamin D with other cardiometabolic risk factors.

Disclosure of competing interest

The authors have none to declare.

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