ORIGINAL ARTICLE

COMPARISON OF VITAMIN D AND LIPID PROFILE BETWEEN RURAL AND URBAN POPULATION

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Background: The two major sources of vitamin D are food and sunlight. Main factor that influence the extent of solar shortwave ultraviolet B radiation reaching earth is the air pollution. Uncontrolled urbanization leads to undue air pollution which may lead to increased prevalence of hypovitaminosis D among the urban population. Vitamin D deficiency is prevalent worldwide and studies have associated it with an altered lipid profile. This study was designed to compare the levels of serum vitamin D and lipid profile in adequately sun exposed population of rural and urban areas. **Methods:** This cross-sectional comparative study was conducted on 80 male participants. Group 1 (n=40) comprised of rural residents and group 2 (n=40) of urban residents, all with adequate and equal exposure to sunlight. Serum vitamin D levels were measured using ELISA. Lipid profile was measured using enzymatic colorimetric methods. **Results:** Median age of participants was 51 (37–62) and 38 (25–46) years for rural and urban groups respectively. In rural group, sixteen participants (40%) had sufficient whereas 24 (60%) had insufficient vitamin D. No participant was found to be in deficient category. In urban group one participant (2.5%) was found in deficient and one (2.5%) in sufficient categories whereas 38 (95%) were found to be in insufficient category. The difference in frequency was found to be significant (p<0.001). Median and interquartile range of vitamin D in group 1 and II was 68 (56–54) and 49 (42–56) ηg/ml and the difference was significant (p<0.001). There was no difference between the two groups for triglycerides, total cholesterol and low-density lipoproteins, however, high density lipoproteins were significantly lower in group II as compared to group I (39.5±7.6 vs 47.6±9.0, p<0.001). **Conclusion:** Despite adequate and equal sun exposure, urban population had lower levels of vitamin D and high-density lipoproteins as compared to rural population.

Keywords: Vitamin D, lipid profile, ultraviolet rays

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INTRODUCTION

Vitamin D is a group of fat-soluble secosteroids which are responsible for absorption of calcium and phosphate from intestines to maintain the normal development and health of bones.[1,2] It is now well acknowledged that a vast range of acute and chronic health diseases are caused by vitamin D deficiency.[3] The sources of Vitamin D_2 are largely human-made and added to foods, whereas vitamin D_3 known as cholecalciferol is synthesized from 7-dehydrocholesterol in human skin following exposure to ultraviolet B (UVB) radiations.[4]

Pakistan is a sun rich country and high prevalence of vitamin D deficiency (70–97% in healthy asymptomatic volunteers) has been reported in literature.[5] The most important cause of vitamin D deficiency is the lack of awareness that sun exposure is the major source of vitamin D.[6] Cutaneous absorption of UVB is influenced by various factors such as latitude, altitude, season, skin pigmentation, protection of sun-exposed skin areas by sunscreens and clothing and place of living.[7,8] A main factor influencing the extent of solar UVB that reaches earth's surface is the air pollution. Epidemiological data indicates that atmospheric pollution, especially high tropospheric ozone content, may play a noteworthy role in the causation of vitamin D deficiency.[9] The major sources of atmospheric ozone is the air mass exchange between the stratosphere and troposphere parts of atmosphere, and higher levels of ozone concentration in urban areas as compared to rural area.[10] Mannicourt in 2009 stated that stratospheric ozone efficiently absorbs solar UVB photons; therefore any increase in the ozone content of the troposphere is likely to reduce the amount of photons penetrating the skin leading to decreased production of cutaneous Vitamin D.[8]

Urbanization is a shift of population from rural to urban areas, and a gradual change in their way of living.[11] Uncontrolled urbanization leads to undue air pollution, narrowing of streets, lack of proper housing, noise, dust and heat, and the problems of solid hazardous waste disposal.[12] Considering high tropospheric ozone content in urban area, prevalence of hypovitaminosis D among the people living in urban area can be more than twice higher than those of rural inhabitants.[7,8] However, a study conducted by Butt et al in 2014 showed lower levels of vitamin D in young rural residents as compared to urban.[13]

A significant inverse association has been reported between serum 25(OH)D levels and prevalence of type 2 diabetes, hypertension, hyperlipidemia, peripheral vascular disease, heart failure, cancer and asthma.[2] Hypovitaminosis D has also been reported to be linked with atherogenic lipid profile.[14] This study was planned to compare the levels of vitamin D and lipid profile in adequately sun exposed residents of urban and rural area of Punjab.

MATERIAL AND METHODS

This cross-sectional comparative study was conducted from September to November 2016 at Postgraduate Medical Institute, Lahore, after getting approval from Research Ethical Committee of the institute. Written informed consent was obtained from each participant at the time of selection. Sample size was calculated using WHO sample size calculator. Considering the values of alpha as 0.05, power as 0.8 and effect size as 0.65, a sample size of 80 was calculated. The study population was Lahore and a village near Nankana Sahib about 78 Km away from Lahore. Only healthy male participants were recruited to ensure adequate sun exposed areas. Participants were divided into two equal groups; Group I (from rural setting), and Group II (from urban population). Participants with known history of malabsorption and gastrointestinal surgeries, liver cirrhosis, diabetes mellitus, hypertension, chronic renal failure, hepatitis B or C and use of multivitamin or vitamin D supplementation were excluded from this study. A questionnaire was used to consider different parameters that may affect vitamin D status like nutritional evaluation (dietary calcium and vitamin D intake), awareness of food fortification, area of residence, socioeconomic status, age and body mass index. Questionnaire also assessed the number of exposed body parts to sunlight as well as time spent per day outside without sun protection. Duration of sun exposure of more than 10–15 minutes a day, 2 days a week was considered sufficient.[5] Body Mass Index (BMI) was calculated by using the standard formula.[15]

Vitamin D levels were measured by ELISA using 25 D3 Hydroxy Vitamin D kit of Cal Bio Tech Company manufactured in USA. Vitamin D deficiency, insufficiency and normal cut off values were considered as 25-OH-D<10 ηg/ml, 11 to 20 ηg/ml, and >20 ηg/ml respectively. Lipid profile consisted of total cholesterol (TC), triglycerides (TG), low density lipoproteins (LDL) and high-density lipoproteins (HDL) which were assessed using enzymatic colorimetric methods.

Statistical analysis was done using SPSS-21. Mean±SD and median IQR were calculated according to data distribution. Comparison between the two groups was performed by independent *t*-test and Mann Whitney U test. Chi-square test was used for the analysis of qualitative data, and $p \leq 0.05$ was considered statistically significant.

RESULTS

Comparison of age, BMI and duration of sun exposure between Group I and II is shown in Table-1. Table-2 illustrates frequency comparison of participants with deficient, insufficient and sufficient levels of Vitamin D between the two groups. Table-3 shows comparison of mean/median values of Vitamin D and lipid profile between Group I and II.

Table-1: Comparison of age, BMI and duration of sun exposure between the two groups

Variable	Group I [frequency (IQR)]	Group II [frequency (IQR)]	*p*
Age (Yr)	51 (37–62)	38 (25–46)	<0.001*
Sun exposure (Hr)	9 (8–10)	8 (6.7–80)	0.78
BMI (Kg/m²)	22.12 (20.19–25.22)	22.5 (20.50–25.50)	0.82

*Significant. BMI=body mass index, IQR=interquartile range

Table-2: Frequency comparison of vitamin D between rural and urban population

Vitamin D status	Group I	Group II
Deficient (<10 ηg/ml)	0	1 (2.5)
Insufficient (11–20 ηg/ml)	24 (60)	38 (95)
Sufficient (>20 ηg/ml)	16 (40)	1 (2.5)
p	<0.001*	

*Significant

Table-3: Comparison of Vitamin D and lipid profile between rural and urban population

Variable	Group I (n=40)	Group II (n=40)	p-value
Vitamin D ng/ml frequency (IQR)	68(56- 54)	49(42-56)	< 0.001*
Triglyceride mg/dl frequency (IQR)	112(79-118)	143(102-194)	0.12
Total cholesterol mg/dl	194.1±39.5	210.4±33.8	0.12
HDL mg/dl	47.6± 9.0	39.5±7.6	< 0.001*
LDL mg/dl	119.1±33.4	139.9±57.1	0.06

*Significant. IQR=interquartile range, HDL=high density lipoprotein, LDL=low density lipoprotein

DISCUSSION

Results of our study showed that vitamin D levels were significantly higher in rural as compared to urban participants. Similar results were reported in female subjects by Hoeisinpinnah *et al*[7] who showed decreased levels of vitamin D in females living in urban area as compared to rural areas. A study conducted by Wakayo *et al*[16], and Selvarajan[17] also showed lower levels of vitamin D in urban population as compared to the rural population. Riaz *et al*[18] reported high levels of vitamin D deficiency in both rural and urban dwellers and in all age groups.

Ultra violet B rays in sunlight are more intense between 10:00 AM and 3:00 PM, and are more in summer months accounting for 70% of person's yearly UVB dose.[5] The current study was conducted just after summers and the participants being farmers in rural setting and gardeners or labourers in urban, spent between 48–70 hours per week in sunlight. The two study locations were at the same latitude, so the angle of sunlight penetrating the earth's atmosphere was similar for the two groups. This angle vividly affects the amount of UVB photons reaching the earth's surface and eventually penetrating the skin.[8] Our findings are suggestive of the fact that cutaneous synthesis of vitamin D was less in urban as compared rural residents.

Insufficient vitamin D levels were present in 60% of rural and 95% of urban participants in the current study. Although advancing age is one of the causes of vitamin D deficiency, the rural population in our study, despite being in higher age range, had higher levels of vitamin D. Stone *et al*[19] reported Lahore to be heavily polluted by particulate matter in air. Living in more polluted areas like Lahore leads to a significant increase in the probability of vitamin D insufficiency and deficiency as seen in Group II. Urbanization also leads to changes in diet which may decrease vitamin D levels.[20] Contrary to this, Butt *et al*[13] showed higher levels of vitamin D in urban population as compared to rural and related it to dietary intake. All participants included in our study belonged to low socioeconomic status and mostly consumed similar diet with only few of the urban participants reported to have more frequent ingestion of processed and fast food. In our study the amount of fresh, non-fortified milk intake was significantly high in rural residents.

In our study, both groups were similar in terms of lipid profile except HDL which was significantly lower in urban population. Ponda *et al*[21] reported that vitamin D were associated with healthier lipid profile, that is an increase in vitamin D level was associated with a decrease in LDL, cholesterol, and TG and an increase in HDL levels. Association of vitamin D deficiency with dyslipidaemia had been reported in literature[22,23]. Urbanization has been perceived to be related with modernization of lifestyle, including physical inactivity and change in dietary habits leading to obesity.[24] However, all subjects of this study were physically active and majority had normal BMI, so low levels of vitamin D could be responsible for this difference observed in lipid profile.

The effect of vitamin D on lipid profile is still not clear and several mechanisms have been proposed. It is suggested that vitamin D increases intestinal absorption of calcium which in turn reduces serum triglyceride levels by reducing hepatic formation and secretion. Calcium also decreases the absorption of fat, by forming insoluble calcium fatty complexes in gut thereby decreasing the serum levels of total and LDL cholesterol. Another mechanism by which Ca^{+2} can decrease serum cholesterol levels is by increasing the conversion of cholesterol to bile acids due to its ability to bind with bile acids. Vitamin D is also proposed to decrease the level of serum TG in body by increasing the activity of the enzyme lipoprotein lipase.[25]

Yet another link of Vitamin D and TG concentrations is by regulating parathyroid hormone (PTH) levels. Vitamin D has suppressive effect on serum PTH concentration which decreases serum triglycerides levels by increasing peripheral uptake. Vitamin D may control the metabolism of triglycerides by increasing the expression of very low-density lipoprotein (VLDL) gene receptors. Another mechanism which could be responsible for association between 25(OH)D and triglycerides is through insulin resistance; hypovitaminosis D leads to increase in the risk of insulin resistance which is associated with increase in VLDL and triglyceride levels.[26]

In our study, in spite of having an adequate sun exposure, majority of urban participants had insufficient vitamin D levels. Air pollution, the main hazard of urbanization could be one of the factors responsible for insufficient vitamin D formation. Further studies need to be carried out in order to establish the role of air pollution in causation of hypovitaminosis D.

CONCLUSION

Despite adequate and equal sun exposure, urban population had lower levels of vitamin D and high-density lipoproteins as compared to rural population.

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