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Abstract: Background: High prevalence of vitamin D deficiency has been reported from Pakistan. Association of sociodemographic factors with vitamin D status has received little attention in this region. Therefore, we embarked on investigating the relationship of sociodemographic factors with vitamin D levels in a healthy Pakistani population. Venous blood from 226 healthy participants (age range 19-69 years) was collected and analyzed for serum concentrations of 25(OH) vitamin D [25(OH)D] and other related biomarkers. Demographic characteristics of the study participants were collected. Vitamin D deficiency (25(OH)D levels less than 20 ng/ml) was found to be 75% in this cohort. Gender, sunlight exposure and monthly household income emerged as predictors of hypovitaminosis D. Mean serum 25(OH)D levels in the groups with monthly household income less than Pakistani Rupees (PKR) 20,000, between PKR 20,000-50,000 and above PKR 50,000 were found to be 11.0±7.5, 13.9±9.6 and16.9±11.7 ng/ml, respectively. Using logistic regression the odds of having vitamin D deficiency was 3.22 (95% CI, 1.65-6.28) in the group with household income less than PKR 50,000 per month compared to the group with household income more than PKR 50,000 per month when the model was adjusted for gender and exposure to sunlight. There is an association between household income and hypovitaminosis D in a healthy Pakistani population.

Keywords: Household income, hypovitaminosis D, sociodemographic factors, vitamin D levels.

INTRODUCTION

For decades, hypovitaminosis D [25(OH) vitamin D levels <20 ng/ml] was considered only as a risk factor for rickets in children and osteomalacia in adults (Bischoff-Ferrari, 2012). In recent years, hypovitaminosis D has been found to be associated with several other diseases including malignancies (Garland *et al.,* 1989), autoimmune diseases (Marques *et al.,* 2010) and metabolic disorders (Miñambres *et al.,* 2012). Hypovitaminosis D has become a global health problem (Mithal *et al.,* 2009). High prevalence of hypovitaminosis D has also been reported from Pakistan with as high as 91.5% in premenopausal women (Khan *et al.,* 2012), 89% in pregnant women (Hossain *et al.,* 2011) and 76% in healthy adults (Mahmood *et al.,* 2009).

Food and sunlight are two major sources of vitamin D. Oily fish, cod liver oil and some mushrooms are the main natural sources of vitamin D. A few food items can be fortified with vitamin D due to their fat soluble nature, however, consumption of vitamin D fortified food alone is not enough to achieve sufficient levels of this vitamin (Holick, 2004; Holick and Chen, 2008). Moreover, accessibility of natural and fortified resources of vitamin D could vary among populations because of socioeconomic background of individuals (Mark *et al.,* 2012; Weishaar and Vergili, 2013). Therefore, exposure to sunlight remains the major source to achieve adequate levels of vitamin D. In a country like Pakistan, which is located near the equator with plenty of sunlight, it is surprising to have such a high prevalence of vitamin D deficiency. Several sociodemographic and lifestyle factors have been reported to be associated with hypovitaminosis D. Gender and age have significantly been linked with hypovitaminosis D in a Canadian population (Naugler *et al.,* 2013).

Lower education and unhealthy lifestyle have been shown as predictors of hypovitaminosis D in a Finnish population (Jaaskelainen *et al.,* 2013); while socioeconomic status has emerged as a significant predictor of hypovitaminosis D in premenopausal Bangladeshi women (Islam *et al.,* 2002). Very few studies, however, have been carried out to investigate the relationship of sociodemographic factors with hypovitaminosis D in this region. Therefore, we embarked on investigating the relationship of sociodemographic factors with vitamin D levels in a healthy population of Pakistan.

MATERIALS AND METHODS

Study subjects

Two hundred and twenty six healthy Pakistani subjects (age range 19-69 years) were enrolled in this study from

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the personnel of the Aga Khan University and other healthcare institutions in Karachi with informed consent. Demographic characteristics which included ethnicity, eating habits, monthly income of family (Pakistani rupees/PKR), ownership of car, motorcycle and TV, use of *burqa* (only for female), exposure time to sunlight (at least 2 hours/day), smoking history, type of fat in cooking, duration of planned exercise and physical activity were determined using a questionnaire. Exclusion criteria included pregnant females, use of vitamin D injections or supplements during the last 6 months, malabsorption syndrome, cancer, liver disease, uremia or diabetes. The study had been approved by the Ethics Review Committee of the Aga Khan University.

Blood sampling and measurement of Biomarkers

Fasting venous blood (10 ml) was collected from healthy subjects. Serum/plasma concentrations of 25 (OH) vitamin D [25(OH)D], parathyroid hormone (PTH), calcium, alkaline phosphatase (ALP) and phosphate were determined using commercially available kits (Roche Diagnostics, Indianapolis, USA).

STATISTICAL ANALYSIS

All statistical analyses were carried out using IBM Statistical Package for Social Sciences® (SPSS) software version 19 for Windows® (Apache Software Foundation, USA). Independent sample t test was used to compare mean ± SD values of continuous variables [25(OH)D, PTH, calcium, ALP, phosphate] . However, analysis of variance (ANOVA) was used to compare mean levels of 25(OH)D among different monthly household income groups followed by Tukey's HSD test for multiple pairwise comparisons. Binomial logistic regression was applied to examine the association of monthly household income with vitamin D status. A p value of <0.05 was considered significant.

Table 1: Vitamin D status in the study population

Vitamin D status	n (%)
Deficiency (25 (OH)D < 20 ng/ml)	170 (75.2)
Insufficiency (25 (OH)D =20-29.9 ng/ml)	35 (15.5)
Sufficiency (25 (OH)D ≥ 30 ng/ml)	21 (9.3)

RESULTS

Mean age of participants was 44.4 ±9.1 years (age range 19-69 years), while mean values of BMI and waist circumference were 25.4±3.7 (kg/m^2) and 91.8±10.6 cm, respectively. 72.1% of the study participants were males and 27.9% were females. Mean serum/plasma concentrations of 25(OH)D, PTH, calcium, ALP and phosphate were 15.0±10.7 ng/ml, 36±23.0 pg/ml, 9.1±1.0 mg/dl, 76.1±22.1U/l and 3.6±0.69 mg/dl, respectively. Regarding vitamin D status of the study population, 75% were vitamin D deficient (25(OH)D levels <20 ng/ml), 16% insufficient (25(OH)D levels =20-29.9 ng/ml) and only 9% sufficient (25(OH)D ≥30 ng/ml) table 1.

Comparison of mean vitamin D levels among different ethnic groups revealed that vitamin D deficiency was prevalent in all major ethnic groups in Pakistan and no significant difference was observed in any particular ethnic group (data not shown).

Study participants were categorized on the basis of their monthly household income into three groups: PKR< 20,000; PKR 20,000-50,000; PKR >50,000. As shown in Table 2, there was a significant difference between mean levels of 25(OH)D of the income group less than PKR 20,000 per month and the group with monthly income more than PKR 50,000 (p =0.003). Socio-economic status of the study participants in the 3 income groups was pretty much in sync with various items in their household. In the first group (monthly income <PKR 20,000), 67.3% possessed TV, and 22.4% owned motorcycle while no one owned a car. In the second group (monthly income PKR 20,000-50,000), 36.2% had TV, 40.4% owned motorcycle and 23.4% had cars. In the third group (monthly income > PKR 50,000), only 13.1% had motorcycle, while 86.9% of the participants had their own cars.

Mean ± SD serum levels of 25(OH)D with respect to lifestyle factors have been shown in Table 3. Majority of the study participants were working in shade (88.1%), were non-smokers (83.2%), not doing exercise regularly (66.8%) and were engaged in some physical activity for more than 4 hours per day (43.6%). Use of burqa was only 28.5% among female participants of the study. Mean serum levels of vitamin D were not significantly different between study participants when compared with respect to these life style factors.

For further analysis, study participants were divided into two groups on the basis of their vitamin D status as vitamin D deficient (25(OH)D levels <20 ng/ml) and non-deficient subjects. Baseline comparisons between vitamin D deficient and non-deficient subjects by age, BMI, waist circumference, PTH, calcium and ALP showed insignificant differences between the two groups. However, significant differences were observed regarding gender, monthly household income and exposure to sunlight (Table 4), while ownership of car, motorcycle, TV and ethnicity remained insignificant between the two groups. To determine the association between monthly household income and vitamin D status, the model was adjusted for gender and sunlight exposure .Odds ratios (with 95% CI) of vitamin D deficient subjects adjusted for gender and sunlight exposure are shown in Table 5. After adjustments, the odds of having vitamin D deficiency was 3.22 (95% CI, 1.65-6.28) in the group with household income less than PKR 50,000 compared to the group with monthly income more than this figure.

Table 2: Mean ± SD serum levels of vitamin D with respect to monthly household income

Monthly House Hold Income (PKR)	n (%)	Vitamin D levels (ng /ml)Mean±SD
Group 1 <20K	49 (21.7)	11.0±7.5
Group 2 20-50K	47 (20.8)	13.9±9.6
Group 3 >50K	130 (57.5)	16.9±11.7*

*Significant at p value < 0.05 when the mean values were compared using One-way ANOVA followed by Tukey's HSD test for multiple pair-wise comparisons.

Table 3: Mean ±SD serum levels of vitamin D with respect to lifestyle

Variable	Categories (% Subjects)	Vitamin D levels (ng/ml) Mean ±SD
Job's nature	Work in shade (88.1) Work in open (11.9)	17.9±9.8 14.6±10.8
Smoking	Never used (83.2) Current users (7.1) Ever used (9.7)	15.0±11.1 15.2±8.2 14.6±8.9
Exercise	Daily (16.0) 2-5 times/week(6.6) <1 time/week (10.6) No exercise (66.8)	14.1±10.6 16.3±13.8 19.3±11.2 14.4±10.2
Physical activity	>4 hours/day (43.6) 1-4 hours/day (42.1) <1 hour/day (14.3)	18.6±10.4 19.2±12.0 20.1±13.1
Use of *Burqa* (females only)	Yes (28.6) No (71.4)	18.6±12.1 18.8±10.0

Table 4: Baseline comparisons between vitamin D deficient and non-deficient subjects by age, BMI, waist circumference, biomarkers and sociodemographic characteristics. Means ± SD

Variables	Vitamin D Status		
	Deficient [25 (OH)D < 20 ng/ml] (n=170)	Non Deficient [25 (OH)D ≥ 20 ng/ml] (n=56)	p value*
Age (years)	44.22 ± 8.33	45.18 ± 11.23	0.5
Body mass index (kg/m^2)	25.56 ± 3.87	25.17 ± 3.30	0.52
Waist circumference (cm)	91.39 ± 9.91	93.31 ± 12.81	0.27
Serum PTH (pg/ml)	36.53 ± 25.49	37.42 ± 22.15	0.82
Serum calcium (mg/dl)	9.31 ± 2.19	10.10 ± 4.65	0.09
Serum ALP (IU/ml)	82.11 ± 72.76	77.62 ± 20.90	0.65
Serum phosphate (mg/dl)	3.58±0.68	4.20±1.19	<0.001
Gender [n (%)] Male Female	131(77) 39(23)	32(57) 24(43)	0.005
Household income [n (%)] Less than PKR50,000 PKR 50, 000 or more	83(49) 87(51)	15(27) 41(73)	0.004
Ownership of car [n (%)] Yes No	84(49) 86(51)	36(64) 20(36)	0.053
Ownership of motorcycle [n (%)] Yes No	63(37) 107(63)	14(25) 42(75)	0.1
Ownership of television [n (%)] Yes No	160(94) 10(6)	53(95) 3(5)	0.88
Exposure to sunlight [n (%)] Yes No	35(21) 135(79)	25(45) 31(55)	<0.001

*Means in two groups were compared using one-way ANOVA, while percentages were compared using chi-square.

Table 5: Odds ratios (with 95% CI) of vitamin D deficient subjects adjusted for gender and sunlight exposure

Monthly Household income	Crude OR (95% Cl)	Adjusted OR (95% Cl) for gender	Adjusted OR (95% Cl) for sunlight exposure
>PKR 50 000	1	1	1
<PKR 50 000	2.14(1.03-4.44)	1.95(0.96-3.96)	3.22(1.65-6.28)

DISCUSSION

Studies carried out in the West have shown association of certain sociodemographic factors with vitamin D deficiency/insufficiency (Jaaskelainen *et al.,* 2013; Naugler *et al.,* 2013). This study representing Pakistani population suggests that serum concentration of 25(OH)D is associated with household income but not with other lifestyle factors. To the best of our knowledge, this is the first study indicating socioeconomic factors as the determinant of vitamin D deficiency in a Pakistani population. Studies published so far were based on the prevalence of vitamin D deficiency with little focus on its determinants. The need of evaluating the role of sociodemographic factors in a Pakistani population has also been suggested by Sheikh *et al*. (2012).

In the current study, we found high prevalence (75%) of vitamin D deficiency in the study population. High prevalence of vitamin D deficiency has already been reported from several other studies carried out in Pakistani premenopausal women (Khan *et al.,* 2012), pregnant women and neonates (Hossain *et al.,* 2011; Anwar *et al*, 2016) , healthy adults (Mahmood *et al.,* 2009; Sheikh *et al.,* 2012) and Pakistani immigrants living in Oslo (Holvik *et al.,* 2005).

In the present study, we found an association between serum 25(OH)D concentration and gender. We found significantly higher levels of vitamin D in females as compared to males, while a few other studies have reported higher levels of vitamin D in males (Holvik *et al.,* 2005; Sheikh *et al.,* 2012). Higher concentration of vitamin D in females in the present study can be explained due to the fact that a significant proportion of females (86%) in this cohort belonged to higher socioeconomic group compared to males.

This was further substantiated by the inverse relationship we found between serum levels of 25 (OH)D and monthly household income. These finding are in line with several other reports from other countries. For example, socioeconomic status has been indicated as a significant predictor of hypovitaminosis D in premenopausal Bangladeshi women (Islam *et al.,* 2002), Canadian population (Naugler *et al.,* 2013), Finnish men and women (Jaaskelainen *et al.,* 2013), elderly German population (Jungert *et al.,* 2014) and Bahraini men (Al-Mahroos *et al.,* 2013). In a recently published study on a low-income peri-urban community in Karachi, no association of household income was found with serum levels of 25(OH)D (Mehboobali *et al.,* 2015). This could be due to the reason that all the subjects in this cohort belonged to a very low income group with nearly 88% having monthly household income less than PKR 10,000.

We also found that participants spending more than 2 hours per day in sunlight have higher vitamin D levels compared to participants who did not expose themselves daily to sunlight. Majority of Pakistani population has skin collagen of type IV or V which in turn requires extended sun exposure to achieve adequate levels of vitamin D (Farrar *et al.,* 2013). However, due to socio-cultural reasons, sun-tan seeking behavior is less popular in this population. Moreover, there is no proper vitamin D food fortification policy in place to fulfill recommended daily needs. A few food items that are vitamins D fortified are not easily accessible to masses especially people with lower socioeconomic status. Keeping this in view, it is suggested that government should formulate vitamin D food fortification policy and make the general population aware of the benefits of sunlight by providing specific guidelines regarding how much of sun exposure is required and how much of the body should be exposed to achieve optimal vitamin D levels.

This study should be viewed in the light of certain limitations which include relatively modest number of study participants and lack of information about skin pigmentation and dietary patterns of the study population. Therefore, it is important that prospective studies using a large sample size should be carried out to determine the role of poor socioeconomic status and the associated factors which increase the risk of hypovitaminosis D. Moreover, information about the dietary patterns would be extremely important to find out their relationship with hypovitaminosis D in Pakistani population.

CONCLUSION

Vitamin D deficiency is widely present in a healthy population of Pakistan. The prevalence is lower in females as compared to males. There is an inverse relationship between monthly household income and hypovitaminosis D. Extended sunlight exposure would be beneficial to protect against hypovitaminosis D in this population.

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REFERENCES

Al-Mahroos FT, Al-Sahlawi HS, Al-Amer E, Radhi HT and Khalaf S (2013). Prevalence and risk factors of vitamin D deficiency among men. *Bahrain Med. Bull*., **35**(3):

Anwar S, Iqbal MP, Azam I, Habib A, Bhutta S, Soofi SB and Bhutta ZA (2016). Urban and rural comparison of vitamin D status in Pakistani pregnant women and neonates. *J. Obstet. Gyneacol.,* **36**(3):318-323.

Bischoff-Ferrari H (2012). Vitamin D-From Essentiality to Functionality. *Intern. J. Vitam. Nutri. Res.,* **82**(5): 321-326.

Farrar MD, Webb AR, Kift R, Durkin MT, Allan D, Herbert A, Berry JL and Rhodes LE (2013). Efficacy of a dose range of simulated sunlight exposures in raising vitamin D status in South Asian adults: Implications for targeted guidance on sun exposure. *Am. J. Clin. Nutr.,* **97**(6): 1210-1216.

Garland C, Garland F, Shaw E, Comstock G, Helsing K and Gorham E (1989). Serum 25-hydroxyvitamin D and colon cancer: eight-year prospective study. *The Lancet*, **334**(8673): 1176-1178.

Holick MF (2004). Sunlight and vitamin D for bone health and prevention of autoimmune diseases, cancers, and cardiovascular disease. *Am. J. Clin. Nutr.,* **80**: 1678S-1688S.

Holick MF and Chen TC (2008).Vitamin D deficiency: A worldwide problem with health consequences. *Am. J. Clin. Nutr.,* **87**(4):1080S-1086S.

Holvik K, Meyer HE, Haug E and Brunvand L (2005). Prevalence and predictors of vitamin D deficiency in five immigrant groups living in Oslo, Norway: The Oslo Immigrant Health Study. *Eur. J. Clin. Nutr.,* **59**(1): 57-63.

Hossain N, Khanani R, Hussain-Kanani F, Shah T, Arif S and Pal L (2011). High prevalence of vitamin D deficiency in Pakistani mothers and their newborns. *Inter. J. Gyn. Obs.,* **112**(3): 229-233.

Islam MZ, Lamberg-Allardt C, Karkkainen M, Outila T, Salamatullah Q and Shamim AA (2002). Vitamin D deficiency: a concern in premenopausal Bangladeshi women of two socio-economic groups in rural and urban region. *Eur. J. Clin. Nutr.,* **56**(1): 51-56.

Jaaskelainen T, Knekt P, Marniemi J, Sares-Jaske L, Mannisto S, Heliovaara M and Jarvinen R (2013). Vitamin D status is associated with sociodemographic factors, lifestyle and metabolic health. *Eur. J. Clin. Nutr.,* **52**(2): 513-525.

Jungert A, Spinneker A, Nagel A and Neuhäuser-Berthold M (2014). Dietary intake and main food sources of vitamin D as a function of age, sex, vitamin D status, body composition, and income in an elderly German cohort. *Food Nutr. Res.,* **58**: 1 10.3402/fnr.v58.23632.

Khan A, Iqbal R, Naureen G, Dar FJ and Ahmed FN (2012). Prevalence of vitamin D deficiency and its correlates: Results of a community-based study conducted in Karachi, Pakistan. *Arch Osteoporos.,* **7**(1-2): 275-282.

Mahmood K, Akhtar ST, Talib A and Haider I (2009). Vitamin-D status in a population of healthy adults in Pakistan. *Pak. J. Med. Sci.,* **25**(4): 545-550.

Mark S, Lambert M, O'Loughlin J and Gray-Donald K (2012). Household income, food, insecurity and nutrition in Canadian youth. *Can. J. Public Health*, **103**(2): 94-99.

Marques CD, Dantas AT, Fragoso TS and Duarte ÂL (2010). The importance of vitamin D levels in autoimmune diseases. *Rev. Bras. Reumatol.*, **50**: 67-80.

Mehboobali N, Iqbal SP and Iqbal MP (2015). High prevalence of vitamin D deficiency and insufficiency in a low income peri-urban community in Karachi. *J. Pak. Med. Assoc*., **65** (9): 946-959.

Miñambres I, Sánchez-Hernández J, Sánchez-Quesada JL, Rodríguez J, de Leiva A and Pérez A (2012). The Association of Hypovitaminosis D with the Metabolic Syndrome Is Independent of the Degree of Obesity. *ISRN Endocrinol.,* **2012**: 691803.

Mithal A, Wahl DA, Bonjour JP, Burckhardt P, Dawson-Hughes B, Eisman JA, El-Hajj Fuleihan G, Josse RG, Lips P and Morales-Torres J (2009). Global vitamin D status and determinants of hypovitaminosis D. *Osteoporos. Int.,* **20**(11):1807-1820.

Naugler C, Zhang J, Henne D, Woods P and Hemmelgarn BR (2013). Association of vitamin D status with socio-demographic factors in Calgary, Alberta: An ecological study using Census Canada data. *BMC Public Health*, **13**: 316.

Sheikh A, Saeed Z, Jafri SA, Yazdani I and Hussain SA (2012). Vitamin D levels in asymptomatic adults- a population survey in Karachi, Pakistan. *PLoS One*, **7**(3): e33452.

Weishaar T and Vergili JM (2013). Vitamin D status is a biological determinant of health disparities. *J. Acad. Nutr. Diet*, **113**(5): 643-651.