ORIGINAL ARTICLE

Comparison of Nutritional and Serum 25-Hydroxyvitamin D_3 Status in Urban Residents and Urban Slums Dwellers of Lahore, Pakistan

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ABSTRACT

Aim: To compare the vitamin D status of two different socioeconomic group individuals for better understanding the factors essential to overcome vitamin D deficiency in Pakistan.
Study design: Cross-sectional analytical study
Place and duration of study: NHRC, Shaikh Zayed Hospital, Lahore 1st January 2019 to 30th June 2019.
Methodology: One hundred and sixty participants (40-60 years) further divided into two equal groups of urban residents and slum dwellers. After obtaining written consent, necessary information was received by questionnaire filling. Serum was tested for vitamin D3 levels in each participant.
Results: The mean age of urban residents was 47.2±6.3 years and of slum dwellers was 49.4±6.1. The mean serum 25(OH) vitamin D levels were found to be almost same for both groups as 39.5±16 and 37.5±12.7 respectively with p-value 0.592. The smoking status, skin colour (whitish vs dark), activity factor (sedentary vs active), sun exposure (2.55±2.13 vs 8.68±0.47), BMI (25.9±3.8vs 22.4±3.2) and vitamin D intake through nutrition (35±30 vs 7±6) were all significantly different between urban residents and slum dwellers.
Conclusion: It was observed that despite low nutritional vitamin D intake; the slum dwellers had equaled or insignificantly different vitamin D level than urban residents. They also had higher sun exposure and lesser BMI values than the other group.
Keywords: Vitamin D; Urban residents; Slum dwellers; Sun exposure

INTRODUCTION

Vitamin D is a fat soluble seco-steroid which acts as a pro-hormone. It is also called the sunshine hormone due to the need of sunlight for its activation.[1] Vitamin D2 (ergoclaciferol) and vitamin D3 (cholecalciferol) are physiologically important forms of vitamin D[2] Vitamin D (anti ricketic factor) has its important role in regulating calcium and maintaining bone mineral density. The role of vitamin D3 as an immune modulator and involvement in many cellular processes has increased scientist attention towards this vitamin in maintaining physical and mental health and in preventing cardiovascular diseases as well as cancers[3,4].

Human skin can produce up to 80% vitamin D3 on activation by UV rays.[2] The amount of vitamin D produced by UVB rays is affected by different factors including latitude, distance from equator, season, climatic conditions, and pollutants in the atmosphere.[5] Factors such as skin color, type of clothing and use of UV protection additionally plays an important role in assessing levels of vitamin D in an individual. Vitamin D3 can be obtained in a small amount from dietary sources; mushrooms and fatty fish like salmon, mackerel, herring, sardines, fish oils like cod and tuna liver oil are rich in vitamin D3. These foods are recommended for patients suffering from vitamin D3 deficiency[6].

Pakistan has limited data on vitamin D deficiency and its consequences, in spite the fact that most of the Pakistanis are suffering from critical diseases especially at early middle age due to low levels of vitamin D.[7] General population has little or no access to vitamin D rich foods[8]. People in this country either resides in urban areas with proper built houses, well organized sanitary, street, electricity and clean water system and have long indoor working hours or in undeveloped slum areas beside road, devoid of such facilities.[9] Most of the people living at slums are nomads (slum dwellers) who are travelling for money from one city to other and lives in open tents. Studies suggest that long indoor working hours prevent UV light exposure which is prerequisite for the production of vitamin D3[10].

Present study aimed in providing better understanding of reasons behind vitamin D deficiency in Pakistani population. This study also assisted in proposing methods of enhancing vitamin D levels in low socioeconomic groups living in malnourished conditions.

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SUBJECTS AND METHODS

It was a cross sectional analytical study. The place of study was urban residences and slums located inside urban areas. The test analytes were conducted in National Health Research Complex laboratory, Lahore. Duration of study included nine months. The study population consisted of Group 1: Eighty urban residents, participants living in proper brick built houses, with waste management scheme, sanitization and availability of clean water and power supply. The houses were built under well organized colony system.[11] Group 2: Eighty individuals living in urban Slums: It is a place inside a city where communities were living in open tents on a land with lack of basic living needs i.e. proper waste management, sanitization, built houses,

electricity, water, clean environment.[9] Both groups were selected from Lahore.

The city of Lahore is divided into 9 towns and Defense Housing Authority (DHA). Two stages simple random sampling technique was applied with only four towns selected for urban residents and sampling located in cardinal directions of Lahore. Similarly four major slum areas located at four cardinal points of Lahore were selected for nomads sampling. The sample size was 40 participants per Town/slum area (20 participants from each urban area and 20 from urban slums). The names of the Town selected were Ravi Town, Nishtar Town, Iqbal Town and Wagha Town located in North, South, West and East of Lahore respectively. There were no names of slum areas. The selected urban residences and urban slums were located away from busy roads and industrial environment. One hundred and sixty cases with equal number of both group participants. The inclusion criteria consisted of 40-60 years healthy adults from both genders. Pregnant women, participants suffering with diseases like autoimmune disorders, diabetes, cardiovascular, hypertension and bone problems, and participants diagnosed with 25 (OH) vitamin D3 deficiencies or using sun blocks or else on multivitamin were excluded.

An informed consent was obtained in Urdu (national language of Pakistan). For each participant an interview was conducted and study proforma was completed. The study proforma gathered their complete information including their profession, indoor working hours, diet history, type of clothing they wear, BMI grade and their each day exposure to sunlight. Nutritional status was assessed by estimating the average composition of the daily diet in terms of energy, carbohydrate, protein, fat, calcium by use of a semi-quantitative food-frequency and usual intake questionnaire. Measuring cups, plates, models of one ounce piece of meat, specified amount of grains were shown to the participant in order to know the exact amount of diet they eat. Trained phlebotomist drew 5ml of venous blood for serum generation using a 5cc (BD Company) syringe. Fresh needles and syringes were opened under self-observation of each participant to assure participants biosafety. Blood samples were placed into serum vacutainers (BD Company) requiring only 3 minutes for serum separation. Serum was stored in a single aliquot at -20°C until the time of analysis (within 1 week). For the estimation of 25-Hydroxy vitamin D3 ELISA kits from Immuno Diagnostic System (IDS, Germany) were used. All conditions for performing the test were followed as prescribed by the manufacturer. Body mass index (kg/m2) was calculated and obesity was defined as ≥ 30 kg/m2 within both genders.[12]

The data was analyzed using SPSS version 20. The comparison of age, sun exposure, BMI, Vitamin D intake and vitamin D3 levels was done by using Mann Whitney U test between two groups. Gender, skin colour, smoking status and activity factor were compared between two groups by using chi-square test. Multiple linear regression analysis with backward removal method was performed to see the effect of their residential status of urban and slum dwellers by considering all confounding variables. P-value less than or equal to 0.05 was considered statistically significant.

RESULTS

The major profession adapted by slum dwellers was beggary (65%), daily wage labor (10%) and prostitution (25%) while individuals living in urban residents were earning through either business at small or large scale, office jobs or white collar professions with almost insignificant distribution. Among nomads 57.5% were smokers in comparison to 17.5% in urban residents. There were 42.5% nomad participants with dark skin and 32.5% with wheatish complexion, while among urban residents these skin shades were found in 21.2% and 55% of cases respectively. Active life style was persistent for all 80 nomads whereas in urban residents only 11.2% had very active life style. There were 56.2% of urban residents who had sedentary life style. The differences for smoking status, skin colour and life style were all significant between two groups with p-values <0.001, 0.006 and <0.001 respectively. It was observed that individuals living in urban slums were very active than people residing in urban areas. The people who were active were more likely to be normal weight than sedentary or lightly active people (Table 1).

The mean age for nomads was 49±6 years and for urban residents it was 47±6 years. The urban residents had significantly lower daily sun exposure (p<0.001) with a median (IQR) of 2 (1–3.63) hours as compare to nomads with 9 (8–9) hours. Similarly the BMI were higher for urban residents with a p-value <0.001 as compare to nomads. The serum vitamin D levels were not found significantly different between two groups (p= 0.592). The mean vitamin D levels for nomads and urban residents were 37.5±12.7 nmol/L and 39.5±16.0 nmol/L and the median levels were 33.1 (28.2–47.6) nmol/L and 38.2 (25.4 – 53.2) nmol/L respectively (Table 2).

Observing results in terms of regression analysis with backward removal method, criteria of removal (p >0.1) gave a significant model with p-value <0.001 and adjusted R-square of 0.184 was obtained. Interestingly the status of urban residence had a highly significant impact on vitamin D levels in the presence of age, sun exposure, BMI and smoking status as confounding variables. It was estimated that the urban residents expected to have on average 28.1 nmol/L higher vitamin D level as compare to nomads with p-value <0.001 while keeping age, BMI, sun exposure and smoking status constant or at same level. The other two most significant contributor determined through this regression model were the sun exposure and BMI with p-values <0.001 and 0.002 respectively. It was estimated that per hour increase of sun exposure per day causes an average increase of 3.32 nmol/L increase in vitamin D level, and per kg/m2 increase in BMI causes an average decrease in vitamin D level of 0.93 nmol/L, provided the other variables included their residential status are kept constant. The age and smoking though had p-values >0.050 (0.052 and 0.060 respectively) but were not excluded from model as the cutoff level for removal was decided to be >0.100. According to regression analysis the age is suggesting 0.33 nmol/L increase in vitamin D with every one year upturn in age between 40 and 60. While smokers are supposed to have an average 4.47 nmol/L of vitamin D level as compare to non-smokers with keeping other variables constant (Table 3). Out of sedentary lifestyle people, 48% were overweight and 15.5% were

obese. Urban slums dwellers were all active people with 82.5% having normal weight, only 10% overweight and 3.8% obese (Fig 1).

Apart from regression analysis the results showed that 37.5% of participants from urban residents group were having insufficient vitamin D as compared to 60% slum dwellers while 25% and 10% urban resident and slum dwellers were deficient of vitamin D respectively. The number of participants with sufficient vitamin D in blood was insignificantly different among both groups (Fig 2). As mentioned earlier the time of sun exposure varied among urban residents as shown in figure 3 but was constantly high in slum dwellers (Fig 3).

Table 1: Status and comparison of smoking, skin colours and activity factors between nomads and urban residents

Variable	Nomads	Urban Resident	P value
Smoker			
Yes	46 (57.5%)	14 (17.5%)	<0.001
No	34 (42.5%)	66 (82.5%)	
Skin color			
Whitish	26 (32.5%)	44 (55%)	0.006
Dark	34 (42.5%)	17 (21.2%)	
Fair	20 (25%)	19 (23.8%)	
Activity factors			
Sedentary	-	45 (56.2%)	<0.001
Lightly active	-	14 (17.5%)	
Moderately active	-	12 (15%)	
Very active	80 (100%)	9)11.3%)	

Table 2: Comparison of basic input variables and vitamin D status between nomads and urban residents

Variable	Nomads					Urban Residents					P value
	Mean	SD	Q1	Median	Q3	Mean	SD	Q1	Median	Q3	
Sun exposure	8.68	0.47	8.00	9.00	9.00	2.55	2.13	1.00	2.00	3.63	<.001
BMI	22.4	3.2	20.2	22.1	23.9	25.9	3.8	23.1	25.7	28.1	<.001
Vit-D intake from food	7	6	3	6	12	35	30	14	21	62	<.001
Serum Vit-D	37.5	12.7	28.2	33.1	47.6	39.5	16.0	25.4	38.2	53.2	0.592

Table 3: Multiple linear regression model with backward removal method, presenting the effect of residential status on vitamin D level in the presence of major confounding variables

Variable	Unstandardized coefficients		Standardized coefficients	T	Sig.
(Constant)	10.83	12.54		0.864	0.389
Age	0.33	0.17	0.14	1.957	0.052
Sun exposure	3.32	0.68	0.79	4.884	<0.001
BMI	-0.93	0.30	-0.25	-3.113	0.002
Smoker	4.47	2.36	0.15	1.896	0.060
Group	28.08	4.92	0.98	5.707	

Adjusted R-square = 0.184
Vitamin D = 10.83 + 0.33 * Age + 3.32 * Sun exposure – 0.93 * BMI + 4.47 (if smoker) + 28.08 (if urban resident)

Fig. 1: Comparison of activity rate and BMI in urban residents and individuals living in urban slums

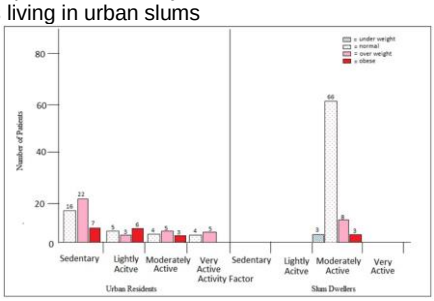
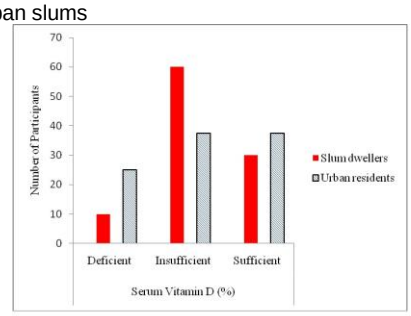


Fig. 2: Serum Vitamin D levels in urban residents and individuals living in urban slums



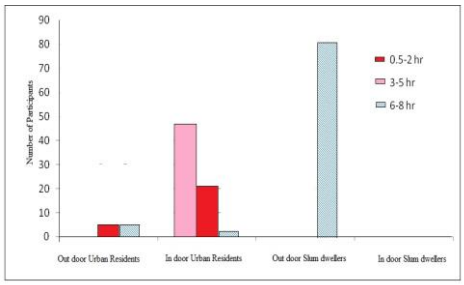


Fig. 3: Time spent by indoor and outdoor workers under sunlight

DISCUSSION

A wide range of studies carried out at South Asia and South East Asia reveals a high prevalence of vitamin D deficiency or insufficiency in these areas.[13] Pakistan is one of the many countries present in this area. Despite of the fact that Pakistan is located between 33.6 N, 76.16 E, with an excessive sunlight available throughout the year still people living in this country are deficient or insufficient of vitamin D in their body. Epidemiological studies reported 70-80% of Pakistani population to be suffering from hypovitaminosis.[14] Hypovitaminosis has also been found in other studies from Pakistan. A study reported 76% Pakistani population to be suffering from vitamin D insufficiency with a mean level of vitamin D in serum as 37.44±24.7 nmol/L[15] which is almost similar to the one reported in present study. In the present study the participants of the study belong to an age group of 40 to 60 years. This age 40-60 years group was selected due to the reason that a number of diseases initiates between this age group[16-19].

In this study urban residents were people who had access to nutritionally healthy diet and clean environment for vitamin D synthesis. Still their mean vitamin D levels were almost similar to nutritionally poor status individuals living in urban slums. Rather vitamin D deficiency was more prevalent in urban residents than individuals living in urban slums. Dietary intake of vitamin D was also below

recommended daily allowance in urban residents whereas it was very negligible in individuals living in urban slums. The reason for these result was the fact that vitamin D is highly present in foods such as fish, mushrooms, beef liver and in lower units in dairy products and egg yolks. In Pakistan most of the population has a taste developed for continental foods consisting of chicken meat, fish is not eaten on daily basis due to its cost and seasonal variation, leaving only those foods which are low in vitamin D units and does not provide sufficient vitamin D status. A study on South Asians elaborates that eating fishes and mushrooms which are major sources of vitamin D in food might help in maintaining vitamin D status.[20] Individuals in urban slums are already nutritionally very poor. They cannot afford eating diets rich in vitamin D. Their diet is almost lacking vitamin D on daily basis. Research reveals that lack of knowledge and low standard of living conditions (over-crowding, improper methods of cooking and food storage) results in improper and nutritionally low food habits in urban dwellers.[21]

This creates sunlight to be the only available source of vitamin D in both groups. In present study urban residents had a very less sun exposure in comparison with participants from urban slums. Their job type also justified this increased sun exposure time. Upsurge sun exposure might be protecting individuals in urban slums from deficiency of vitamin D inspite of their poor nutritional status. Requirement of greater time exposure for vitamin D production could be due to layers of smog on city like Lahore which minimizes the UV rays reaching earth ground.[22] The duration of exposure rely on different factors such as day, season, skin pigmentation.[23-25] However the present study was carried out only in early winter and had no follow up data for other seasons.

Individuals in urban slums live in tents. They are naturally more resistant to strong heat as they have adapted themselves to this environment. Their profession is mostly either beggary or labor. Both of which are outdoor works providing enough time for them to stay under direct sun in a casual clothing. Whereas, majority of urban residents are working indoor and have limited body exposures due to official dress codes; which might add to their low vitamin D status. Studies also reported that regardless of the fact that Asian countries such as Pakistan being situated near equator, sun-seeking behavior seem uncommon in general populations within these countries in urban population due to hot climate.[26]

Activity rate and BMI is also major causes of low vitamin D status. In the present study it was seen that urban residents were more prone towards sedentary and obese lifestyles. Obesity and overweight cause skin layer to have more fats which makes UV light difficult to penetrate in the skin and produce vitamin D.[19,27,28]

It was observed that urban slums had more participants with dark complexion than whitish or fair while urban residents were mostly having a whitish complexion. The dark skin contains melanin which protects UV to penetrate in the skin.[29] This can also be the reason why long sun exposure was facilitating vitamin D production in nomads group.

Lastly the participants in the present study were also questioned about their smoking habits. It was recorded that a high frequency of urban dwellers were smoking cigarettes verses urban residents. Research reveals that smoking reduces vitamin D level in the body.[30] This might be an additional reason of reduced vitamin D levels in slum dwellers in spite the fact that they have excessive sun exposure. It can also be concluded that slum dwellers might had higher vitamin D levels if they were non-smokers.

CONCLUSION

The slum dwellers had equal or insignificantly different Vitamin D level when compare to urban residents. Most slum dwellers had better active lifestyle and normal body weights. Sun UV light was main source for vitamin D production in their body. Urban residents were having better vitamin D intake from diet yet less sun exposure, higher BMI with sedentary lifestyle was leading to their low vitamin D status.

REFERENCES

1. Quint JK and Wedzicha JA. Is vitamin D deficiency important in the natural history of COPD? Thorax 2010; 65: 192-4.
2. Stroud ML, Stilgoe S and Stott VE. Vitamin D A review. AustFam Physician 2008; 37: 1002-5.
3. Clodoveo F, Marco S and Dilia G. Current treatment of hepatitis C-associated rheumatic diseases. Arthritis Res Ther 2012; 14: 215.
4. Danik JS and Manson JE. Vitamin D and cardiovascular disease. Curr Treat Options Cardiovasc Med 2012; 14: 414-24.
5. Bandeira F, Griz L, Dreyer P, Eufrazino C, Bandeira C and Freese E. Vitamin D deficiency: A global perspective. Arq Bras Endocrinol Metabol 2006; 50: 640-46.
6. Berendsen AA, van Lieshout LE, van den Heuvel EG, Matthys C, Péter S, de Groot LC. Conventional foods, followed by dietary supplements and fortified foods, are the key sources of vitamin D, vitamin B6, and selenium intake in Dutch participants of the NU-AGE study. Nutr Res 2016; 36(10): 1171-81.
7. Rabail J, Sidra YM, Saima Y, Farkhanda G and Muhammad A. Levels of 25-OH Vitamin D in Healthy Asymptomatic Adults: Pilot Study. Pak J Med Res 2012; 51: 82-6.
8. Calvo MS, Whiting SJ and Barton CN. Vitamin D intake: a global perspective of current status. J Nutr 2005; 135: 310-6.
9. Mahabir R, Crooks A, Croitoru A, Agouris P. The study of slums as social and physical constructs: Challenges and emerging research opportunities. Regional Studies, Regional Sci 2016;3(1):399-419.
10. Itoh H, Weng Z, Saito H, Ogawa Y, Nakayama K, Hasegawa-Ohira M, Morimoto K, Maki S, Takahashi M. Association between night-shift work and serum 25-hydroxyvitamin D levels in Japanese male indoor workers: a cross-sectional study. Ind Health 2011: 49: 658-62.
11. McFarlane C, Desai R, Graham S. Informal urban sanitation: Everyday life, poverty, and comparison. Ann Assoc Am Geogr 2014; 104: 989-1011.
12. Nuttall FQ. Body Mass Index: Obesity, BMI, and Health: A Critical Review. Nutr Today 2015; 50: 117-28.
13. Babu US and Calvo MS. Modern India and the vitamin D dilemma: evidence for the need of a national food fortification program. Mol Nutr Food 2010; 54: 1134-47.
14. Haroon K, Muhammad AA, Usman W and Najam F. Prevalence of Vitamin D Deficiency in General Population of Islamabad, Pakistan. Ann Pak Inst Med Sci 2013; 9: 45-47.

15. Mahmood K, Akhtar ST, Talib A and Haider I. Vitamin-D status in a Population of Healthy Adults in Pakistan. Pak J Med Sci 2009; 25: 545-50.
16. Harinarayan CV. Prevalence of vitamin D insufficiency in postmenopausal south Indian women. Osteoporos Int 2005; 16: 397-402.
17. Levis S, Gomez A, Jimenez C, Veras L, Ma F, Lai S, Hollis B, Roos BA. Vitamin D deficiency and seasonal variation in an adult South Florida population. J Clin Endocrinol Metab 2005; 90(3): 1557-62.
18. Masud F. Vitamin D levels for optimum bone health. Singapore Med J 2007; 48: 207-10.
19. Orwoll E, Nielson CM, Marshall LM, Lambert L, Holton KF, Hoffman AR et al. Osteoporotic Fractures in Men (MrOS) Study Group. Vitamin D deficiency in older men. J Clin Endocrinol Metab 2009; 94(4): 1214-22.
20. Nakamura K. Vitamin D insufficiency in Japanese populations: from the viewpoint of the prevention of osteoporosis. J Bone Miner Metab. 2006; 24: 1-6.
21. Srivastava A, Mahmood SE, Srivastava PM. Nutritional status of school-age children-A scenario of urban slums in India. Arch Public Health 2012; 70: 8.
22. Hosseinpanah F, Heibatollahi M, Moghbel N, Asefzade S, Azizi F. The effects of air pollution on vitamin D status in healthy women: a cross sectional study. BMC Public Health 2010; 10(1): 1-6.
23. Holick MF. Vitamin D: importance in the prevention of cancers, type 1 diabetes, heart disease, and osteoporosis. Am J Clin Nutr 2004; 79: 362-71.
24. Holick MF. Vitamin D deficiency. N Engl J Med. 2007; 357: 266-81.
25. Prentice A. Vitamin D deficiency: a global perspective. Nutr Rev 2008; 2: S153-64.
26. Mithal A, Wahl DA, Bonjour JP, Burckhardt P, Dawson-Hughes B, Eisman JA et al. IOF Committee of Scientific Advisors (CSA) Nutrition Working Group. Global vitamin D status and determinants of hypovitaminosis D. Osteoporos Int 2009; 20(11): 1807-20.
27. Shea MK, O'Donnell CJ, Vermeer C, Magdeleyns EJ, Crosier MD, Gundberg CM et al. Circulating uncarboxylated matrix gla protein is associated with vitamin K nutritional status, but not coronary artery calcium, in older adults. J Nutr 2011; 141(8): 1529-34.
28. Bell DS. Protean manifestations of vitamin D deficiency, part 1: the epidemic of deficiency. South Med J 2011; 104: 331-4.
29. D'Orazio J, Jarrett S, Amaro-Ortiz A and Scott T. UV radiation and the skin. Int J Mol Sci 2013; 14: 12222-48.
30. Ren W, Gu Y, Zhu L, Wang L, Chang Y, Yan M et al. The effect of cigarette smoking on vitamin D level and depression in male patients with acute ischemic stroke. Compr Psychiatr 2016; 65: 9-14.