International Journal of Research in Medical Sciences
Amitha TA et al. Int J Res Med Sci. 2022 Mar;10(3):660-665
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20220514

Original Research Article

An analysis of vitamin D levels and the factors affecting vitamin D levels among the adult population attending a tertiary care hospital

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Received: 06 December 2021
Revised: 31 December 2021
Accepted: 27 January 2022

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ABSTRACT

Background: The aim of the study was to determine the vitamin D levels and the factors affecting vitamin D levels among the adult population attending a tertiary care hospital.
Methods: An observational cross-sectional study was conducted among 568 adult individuals attending various outpatient departments at Sree Gokulam Medical College and Research Centre, Venjaramoodu over a period of 3 months from 1st January to 30th March of 2021. 119 males and 449 females were recruited in the study. Only adult patients between the age of 18 to 70 were included in the study. Blood samples were collected randomly from patients attending different OPDs. Serum 25-hydroxyvitamin D (25(OH) D) level was measured using electrochemiluminescence immunoassay (ECLIA) in Roche Cobas e 411 fully automated analyzer.
Results: Among the study population, 52.9% of males had Vitamin D deficiency and 70.8% of females had vitamin D deficiency with a p value 0.001. Based on age, the study population was subdivided into three groups-young, middle age and old age groups. 76.9% of the young age group had vitamin D deficiency. 57.2% of middle age group and 56.8% of old age group were Vitamin D deficient with a p value 0.0001.
Conclusions: Age and gender are significantly related to Vitamin D levels. While individual's occupation, BMI and their religion are less significant factors correlated to vitamin D levels in an individual.

Keywords: Factors affecting vitamin D level, 25-hydroxyvitamin D [25(OH) D], Gender, Age group

INTRODUCTION

Vitamin D is often described as a vitamin, which is indeed a misnomer and is well established as a hormone. Its active form, 1,25-dihydroxy cholecalciferol, also known as Calcitriol, involved in bone metabolism and also in many non-skeletal physiological processes.[1] Calcitriol has an important role in bone metabolism through regulation of calcium and phosphate equilibrium.[2]

Vitamin D is synthesized in the skin through sunlight exposure mostly during summer. It is also found in fish oil, eggs and fortified food products.[3] The production of vitamin D is directly proportional to the skin's exposure to sunlight and inversely proportional to pigmentation of skin. The Solar zenith angle can increase or decrease the wavelength of UV rays. Short wavelength UV rays favour vitamin D synthesis more than long-wavelength UV rays during winter. Calcitriol promotes calcium and phosphorous absorption from the intestinal brush border passively and actively from the intestinal cells to the blood by sodium- calcium exchange mechanism or by pumping calcium-calbindin complex.[4] When calcitriol enters a cell, it binds to VDR (vitamin D receptor), a specific nuclear receptor, forms a heterodimeric complex with RXR (retinoid X receptor), and binds to VDRE (vitamin D response elements) on specific DNA,

resulting in transcriptional activation of a specific gene that codes for calcitriol.[5] In bone, calcitriol coordinates remodelling of bone through the activity of osteoblasts and increases bone mineral density. The kidneys have an important role in activating plasma 25-hydroxycholecalciferol (25-HCC) to 1,25-dihydroxy cholecalciferol (1,25-HCC), the active vitamin D-Calcitriol, by the action of 1-alpha hydroxylase located in the mitochondria of proximal convoluted tubules (PCT).[6] This calcitriol helps the kidney tubules reabsorb calcium and phosphorous, in turn balancing their concentrations in our body. Calcitriol is also involved in the regulation of parathyroid hormone (PTH) action, which raises blood calcium levels through bone resorption.[7] It was also observed that patients with kidney failure are at high risk for developing secondary hyperparathyroidism.[8,9] Most organs and tissues in the body express VDR, so vitamin D modulates the expression of more than 500 genes by regulating the transcriptional activity of vitamin D responsive genes.[10] It has been found that Vitamin D is necessary for signal transduction mechanisms in all organs, especially in the brain and immune cells.

Vitamin D deficiency is common among the general population. Recent studies found an unpredictable high prevalence of vitamin D deficiency in apparently healthy adults in different countries, which could result in major health problems in the future. Vitamin D deficiency is common among pregnant women in certain populations and it is associated with an increased risk of GDM (gestational diabetes mellitus), preterm birth and pre-eclampsia. Vitamin D supplementation and improvement in maternal Vitamin D status reduce the risk of pre-eclampsia, low birth weight and pre-term birth.[11] So, current evidence available infers that vitamin D supplementation in pregnancy improves maternal and infant health outcomes. The health effects of Vitamin D on the musculoskeletal system in children and adults prevent rickets and osteoporosis, respectively. In conditions like respiratory illness, cardiovascular disease, cancers and certain neurological conditions, the potential role of Vitamin D are immense which is proved by recent studies.[12] So, maintenance of adequate Vitamin D status is warranted in reducing the risk of many diseases like cancer, diabetes mellitus, cardiovascular diseases, and autoimmune diseases. Clinical and epidemiological studies support the link between vitamin D deficiency and chronic disease progression such as obesity, diabetes, and hypertension.[13,14] It is also noted that susceptibility to infection has increased in vitamin D deficiency because of impairment of toll-like mediated induction of antimicrobial peptide cathelicidin from macrophages.[11]

25-HCC formed in the liver is used to determine a patient's vitamin D status. Vitamin D status is considered as follows: less than 20 ng/ml indicates a deficiency, levels of 20–29 ng/ml indicate relative insufficiency of vitamin D, and a level of 30 ng/ml or greater can be considered sufficient.[16] Considering this definition, about a billion people around the world have vitamin D deficiency. Even in the sunniest countries like India, vitamin D deficiency is very common due to inadequate exposure to sunlight.[17] Several factors can affect this, including the use of sunscreen, age, skin pigmentation, clothing, and season. This study aims to find the factors affecting the vitamin D levels and estimate the vitamin D deficiency in people visiting our tertiary care hospital.

METHODS

A retrospective observational cross-sectional study was conducted among 568 adult individuals at Sree Gokulam Medical College and Research Centre, Venjaramoodu over a period of 3 months from January to March of 2021. The socio-demographic data, religion, lifestyle, dietary habits and psychosocial factors were noted. Blood samples were collected randomly from patients attending Obstetrics and gynaecology, General Medicine, Orthopaedics and Endocrinology outpatient departments. Only adult patients between the ages of 18 to 70 were included in the study.

Blood samples were obtained by venipuncture and collected in clot-activator tubes. The tubes were centrifuged for 10 minutes at 35000 rpm within 2 hours of sample collection to separate serum. The serum 25-hydroxyvitamin D (25(OH) D) level was determined using a Roche Cobas e 411 electrochemiluminescence immunoassay (ECLIA). Although there is no definite normal level of vitamin D, experts opine that vitamin D deficiency is less than 20 ng/ml, levels of 20-29 ng/ml indicate a relative insufficiency of vitamin D and a level of 30 ng/ml or greater can be considered as sufficient.[14]

Inclusion criteria

Both males and females of the age 18-70 years, visiting our tertiary care hospital.

Exclusion criteria

Subjects under 18 years of age and age more than 70 years of age. Critically ill patients. Liver and kidney pathology. On vitamin D supplements. History of Parathyroid disease.

Data analysis was done in Statistical package for social sciences (SPSS) Software version 22. Quantitative data is presented with the help of mean, median and SD. Correlation among various variables was assessed with the Pearson correlation coefficient. Qualitative data are presented with the help of the frequency and percentage table and the association among study group was assessed with the help of the Chi-Square test. P value less than .05 is taken as a significant level.

RESULTS

568 adults including both genders were included in the study. The mean value of vitamin D from this study is

19.38 ng/ml and the standard deviation is 13.397 (Table 1).

Table 1: Vitamin D level, mean and standard deviation in the sample population.

Total number of samples	568
Mean	19.381
Std. Deviation	13.397

The study found that among 568 adults, 381 individuals had vitamin D deficiency, while 98 individuals had inadequate vitamin D levels and only 89 individuals had adequate vitamin D levels in their bodies.

The comparison of the age among the study group was done and shown in Figure 1. The study population was divided into 3 subgroups based on age as young aged group of 18-35 years (286), middle aged group of 36-59 years (187) and old-aged group with 60-70 years (95). Among the young aged group, 220 (76.9%) individuals were vitamin D deficient, while 33 (11.5%) had inadequate vitamin D levels and 33 (11.5%) had normal vitamin D levels. Among the 187 middle aged individuals, 107 (57.2%) individuals had Vitamin D deficiency, 45 (24.1%) had inadequate vitamin D levels and 35 (18.7%) had normal vitamin D levels. Among the 95 individuals of old aged group, 54 (56.8%) of them were Vitamin D deficient, 21 (22.1%) had inadequate levels and 20 (21.1%) had normal levels of Vitamin D levels. This showed a very significant association with a P value .001 and a chi-square value of 26.29.

Comparing gender with vitamin D levels is shown in Figure 2, among them 63 (52.9%) males were vitamin D deficient and 29 (24.4%) males had inadequate vitamin D levels and 27 (22.7 %) males had normal vitamin D levels. Among the 449 females enrolled in the study, 318 (70.8%) females were vitamin D deficient, 39 (13.4%) females had inadequate vitamin D levels while 71 (15.8%) females had normal vitamin D levels. This was found to be statistically significant with a p value 0.001 and a chi-square value of 14.33.

Table 2: Association of vitamin D levels and body mass index.

BMI	Deficiency (≤20 ng/ml)	Inadequate (21-29 ng/ml)	Normal (≥30 ng/ml)	Total
Underweight	1 (33.3%)	0 (0 %)	2 (66.7 %)	3
Normal	99 (72.8 %)	17 (12.5%)	20 (14.7 %)	136
Overweight	138 (65.4 %)	31 (14.7 %)	42 (19.9 %)	211
Obese	143 (65.6 %)	41 (18.8 %)	34 (15.6 %)	218
Total	381 (67.1%)	89 (15.7%)	98 (17.3%)	568

P value 0.119; Chi square value of 10.136

Table 3: Association of vitamin D with different occupation.

		Deficiency (≤ 20 ng/ml)	Inadequate (21-29 ng/ml)	Normal (≥30 ng/ml)	Total
Occupation	Professional	35 (9.2%)	7 (7.9%)	10 (10.2%)	52 (27.3%)
	Semi-professional	32 (8.4%)	10 (11.2%)	14 (14.3%)	56 (33.9%)
	Clerical work	27 (7.1%)	5 (5.6%)	6 (6.1%)	38 (18.8%)
	Skilled	105 (27.6%)	18 (20.2%)	11 (11.2%)	134 (59%)
	Semiskilled	107 (28.1%)	28 (31.5%)	36 (36.7%)	171 (96.3%)
	Unskilled	30 (7.9%)	10 (11.2%)	14 (14.3%)	54 (33.4%)
	Unemployed	45 (11.8%)	11 (12.4%)	7 (7.1%)	63 (31.3%)

P value of 0.063; Chi square value of 20.22.

While comparing the body mass index (BMI) in the study population (Table 2), 218 (38.5%) individuals, were obese, 211 (37.1%) overweight, 136 (23.9%) normal and 3 (0.5%) underweight subjects. Out of these obese individuals, 143 (37.5%) were Vitamin D deficient, 41 (56.1%) had inadequate vitamin D levels and 34 (34.7%) had normal vitamin D levels. Among the overweight subjects, 138 (36.2%) individuals had a deficiency, 31 (34.8%) had inadequate levels and 42 (42.9%) had adequate vitamin D levels. Among the individuals with normal BMI, 99 (26 %) were Vitamin D deficient, 17 (19.1%) had inadequate vitamin D levels and 20 (20.4%)

had adequate vitamin D levels. This was found to be statistically insignificant with a p value 0.119 and a chi-square value of 10.136.

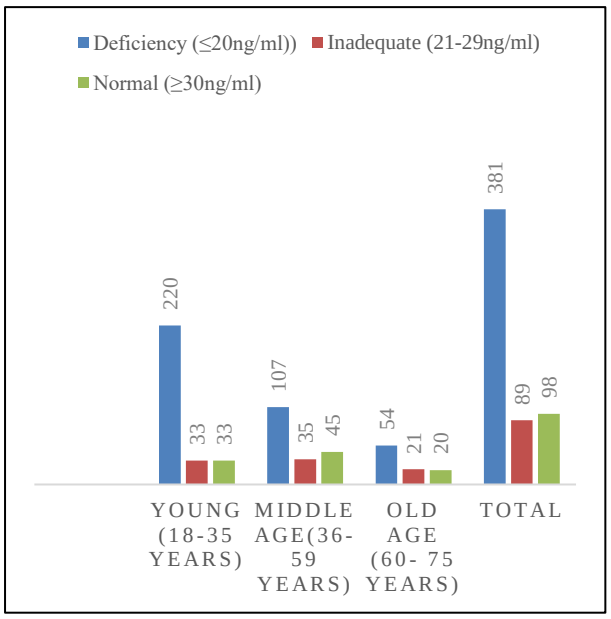
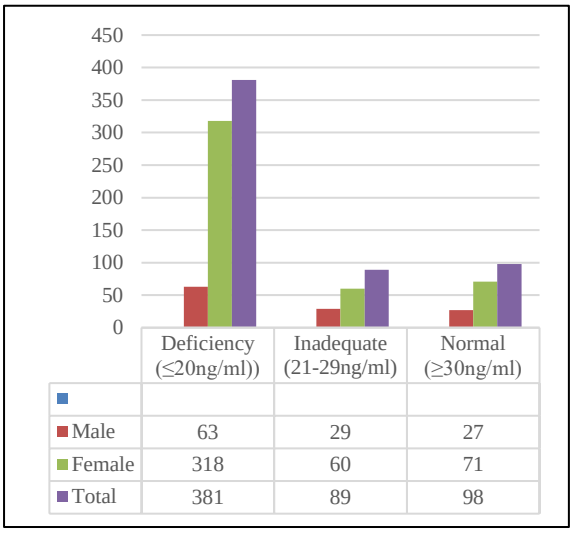


Figure 1: Comparison of vitamin D levels and different age groups.



	Deficiency (≤20ng/ml))	Inadequate (21-29ng/ml)	Normal (≥30ng/ml)
Male	63	29	27
Female	318	60	71
Total	381	89	98

Figure 2: Comparison of vitamin D levels with gender.

The comparison of religion among the study group was found to be statistically insignificant with a p value 0.630 and a chi-square value of 2.58. The study population was categorized into 3 groups based on religion- 343 Hindus, 122 Muslims and 103 Christians (Figure 3). Among Hindus, 223 (65%) individuals were vitamin D deficient, 59 (17.2%) individuals had inadequate vitamin D levels, and 61 (17.8%) individuals had normal vitamin D levels. Out of the Muslim population, 88 (72.1%) individuals were vitamin D deficient, 16 (13.1%) individuals had inadequacy and 18 (14.8%) had normal vitamin D levels. Among Christians,70 (68%) individuals had Vitamin D deficiency, 14 (13.6%) individuals had inadequate levels, and 19 (18.4%) individuals had normal vitamin D levels.

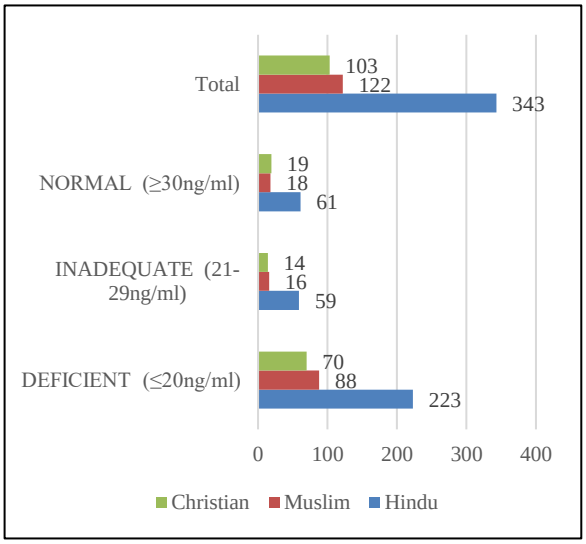


Figure 3: Comparison of vitamin D levels and religion in the study groups.

The comparison of the study population with the occupation (Table 3) also had an insignificant relationship between Vitamin D levels with a p value 0.063 and Chi-square value of 20.22. The study group included 52 (27.3%) professionals, 56 (33.9%) semiprofessionals, 38 (18.8%) clerical workers, 134 (59%) skilled workers, 171 (96.3%) semiskilled workers, 54 (33.4 %) unskilled workers, and 63 (31.3%) unemployed individuals. Among the professionals, 35 (9.2%) had vitamin D deficiency, 7 had inadequate levels and 10 had normal vitamin D values. Of the semiprofessionals, 32 (8.4%) had a deficiency,10 had normal levels and 14 had high vitamin D values. Among the clerical workers, 27 (7.1%) had a deficiency, 5 had inadequate and 6 had normal vitamin D levels. Among the skilled workers,105 (27.6%) were vitamin D deficient, 18 had inadequate and 11 had normal vitamin D levels. Among the semiskilled workers, 107 (28.1%) had a deficiency, 28 had inadequate and 36 had normal vitamin D values. Among the unskilled workers, 30 (7.9%) had Vitamin D deficiency, 10 had inadequate and 14 had normal values for vitamin D and in unemployed subjects, 45 (11.8%) had Vitamin D deficiency, had inadequate and 7 had normal vitamin D values.[11]

DISCUSSION

In this retrospective observational cross-sectional study done among 568 subjects in our tertiary care hospital, it was revealed that there is vitamin D deficiency in the majority of the people 381 (67.1%) and only a small percentage had adequate or normal vitamin D levels 98 (17.3%). This was more evident among females, where 318 (70.8%) had vitamin D deficiency and only 71 (15.8%) had adequate levels of vitamin D. There was a

statistically significant correlation between vitamin D levels and gender (p<0.001). This result was consistent with the study outcomes of Sreekrishnan et al and was contradicting the findings in AlQuaiz et al study.[11,18] Most of the women who had vitamin D deficiency belonged to the reproductive age group. So, the deficiency of vitamin D would affect them seriously. Similar findings were observed in the study done by Hashemipour et al.[19] The reason for vitamin D deficiency among younger females may be due to low dietary intake, less time spent out of doors, insufficient sun exposure, hyperpigmentation, insufficient intake of vitamin D and special dietary habits.[20,21] The extent of clothing due to cultural or religious factors or using topical sunscreen which can block effective dermal synthesis would be the cause. A sunblock of SPF 30 can reduce vitamin D production by 95%.[22] On comparing different age groups in the study population, vitamin D deficiency was more evident among the younger age group, 220 (76.9%), and had a significant correlation between vitamin D levels and age (p value 0.001). But the study of Kader et al had found that vitamin D level decreases in both gender as age progress.[23] Correlation of vitamin D levels with other factors like occupation, religion, and body mass index (BMI) was not significant (p values of 0.063, 0.630 and 0.119 respectively) which was against the study outcomes of Alfawaz et al.[24] Some of the studies mentioned that certain religious practices on the diet, clothing and socioeconomic aspects would affect the vitamin D levels along with other nutrient deficiencies 25 which had not shown any significance in this study.

There were limitations to our study. Firstly, 25-hydroxy vitamin D was checked instead of 1,25-hydroxy vitamin D in the subjects, which would have been a better parameter to detect vitamin D deficiency. Secondly, the correlation of vitamin D and other related parameters like alkaline phosphatase and calcium was not checked. Our observations warrant further studies to define the incidence of vitamin D deficiency in different populations.

CONCLUSION

The study conducted in a tertiary care hospital regarding the vitamin D deficiency in patients coming to the hospital concludes that out of the 568 patients studied, 381 patients were found to be vitamin D deficient irrespective of their BMI, occupation and religion. Of them, 89 were found to have inadequate vitamin D levels, in otherwise healthy adults. Among the 381 vitamin D deficient subjects, the majority of them were females of younger age. It is quite an alarming scenario as vitamin D deficiency can affect the reproductive age group seriously. While considering the occupation of the study subjects, the percentage of individuals who had vitamin D deficiency was found to be less in the professionals (9.2%) and in the semi-professionals (8.4%) compared to the skilled (27.6%) and the semiskilled workers (28.1%). Among the unskilled (7.9%) only a low percentage had vitamin D deficiency and among the unemployed (11.8%) population considerably a high percentage had vitamin D deficiency. This difference may be due to the vitamin D supplement intake in the first group of professionals and semi-professionals. This could be attributed to the high literacy rate of the population in Kerala which could have led to the increased awareness of the importance of supplement intake. In the second population containing the skilled and the semiskilled workers, relatively middle to low socioeconomic status might have affected them, unawareness of supplement intake or difficulties in maintaining a proper diet despite long indoor working hours would be the cause for vitamin D deficiency. Considering the unskilled population, adequate sunlight exposure during their working period would have helped them to maintain adequate vitamin D levels in the majority and among the unemployed group, which mainly consists of homemakers and students who had little sun exposure would have affected them and their poor socioeconomic status, unawareness of importance of vitamin supplements, even diet and clothing habits would have resulted in vitamin D deficiency. Low vitamin D levels in younger and middle age groups in both genders may also derange bone health which ultimately impairs the quality of life of the adults. So, it is better to give Vitamin D supplements to all patients, especially for young adults rather than to advise for a confirmatory test for vitamin D deficiency which costs around 2000 Indian rupees, that cannot be afforded by most of the patients. While Vitamin D supplement of 60000 International units once a week; the only cost is around 25 Indian rupees- initially for 3 months and then monthly once lifelong in order to prevent vitamin D deficiency further. So, in the general population, Vitamin D toxicity should be anticipated, a strict follow-up of regimen should be promoted that would render a good result. It is also imperative to do further studies among the general population to understand the incidence of vitamin D toxicity.

ACKNOWLEDGEMENTS

Dr Jithu SJ nath, Assistant professor, Community Medicine, SGMC & RF, Thiruvananthapuram, Kerala.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Amitha TA, Lekshmi GS, Roy J. An analysis of vitamin D levels and the factors affecting vitamin D levels among the adult population attending a tertiary care hospital. Int J Res Med Sci 2022;10:660-5.