Original Article

# Prevalence and cut-off point of vitamin D deficiency among secondary students of Arak, Iran in 2010

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## ABSTRACT

**Introduction:** Vitamin D has a basic role in bone growth and metabolism and has been noticed for its important role in many diseases, such as diabetes, depression, hypertension, and cardiovascular disease. Regarding some studies, detection of vitamin D deficiency in different places has important implication for health. This study determined prevalence of vitamin D deficiency in Arak, a centrally located city in Iran. **Materials and Methods:** Based upon a cross-sectional study in 2010, 420 students 10--16 years old including 220 girls and 200 boys, studied at Arak secondary schools, were selected by a multistage sampling. The level of 25 (OH) D and PTH (parathormone) was measured and also the prevalence of vitamin D deficiency in different intensities was evaluated and compared between girls and boys by the Student t-test. Vitamin D deficiency for the students was categorized into three intensities based on three levels of 25 (OH) D: mild deficiency - 15 ≤ 25 (OH) D < 20 ng/ml, moderate deficiency -- 8 ≤ 25 (OH) < 15 ng/ml, severe deficiency - 25 (OH) <8 ng/ml. The relationship between the 25 (OH) D and PTH was assessed by Scatter chart to define cut-off points for vitamin D deficiency. **Results:** Based on 25 (OH) D < 20 ng/ml, 84% of the students had vitamin D deficiency including 60.7% mild, 22.4% moderate, and 0.7% severe. Three local cut-off points including 13, 21, and 33 ng/ml were defined in the Scatter chart. The results showed that the deficiency of vitamin D in girls is much more than that in boys ($P$ = 0.05). **Conclusion:** The high prevalence of vitamin D deficiency could be probably a result of different etiologies. We recommended that people should be encouraged to take vitamin D and calcium supplements and also they should have more exposure to the sunlight.

**Key words:** Calcium, parathormone, phosphorous, student, vitamin D

## Introduction

It seems that complications of vitamin D deficiency have been completely removed by having enriched food by vitamin D, but Rachitism is the top of Iceberg of vitamin D deficiency. In fact vitamin D deficiency is entirely prevalent in children and adults. Vitamin D deficiency causes a delay in growth during embryonic and childhood period. It also causes skeletal deformity and also increases the risk of hip fracture.

Vitamin D deficiency can also causes osteopenia, osteoporosis, and muscle weakness and increases risk of hip fracture in adults.[1] The most important effect of vitamin D is on parathyroid and bone and also plays a key role on the calcium absorption from the gut.[2]

The discovery of vitamin D receptor in most tissues and organs has developed a new perception from effects of vitamin D. For instance, vitamin D can decrease risk of many chronic diseases, cancers, autoimmune disease, infectious, and cardiovascular disease.[1]

It has been estimated that one billion people are vitamin D deficient in the world. Vitamin D deficiency

| Access this article online | |
|---|---|
| Quick Response Code: | Website: www.ijem.in |
| | DOI: 10.4103/2230-8210.100676 |

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is prevalent in both developed and developing countries.[3]

Vitamin D deficiency is also commonly prevalent in the Middle East including Iran. This deficiency is common in all different cities with the same level of the sea or cities with lower geographic latitude.[4]

There is no agreement about the definition of the level of vitamin D deficiency. It has been accepted that 25 (OH) D < 20 ng/ml is the level of vitamin D deficiency and 20 < 25 (OH) D < 30 ng/ml is recognized as a vitamin D insufficiency.[3]

There are different ways to detect cut-off points for vitamin D deficiency. For instance, based on inverse relation between 25 (OH) D and PTH, a direct relation between 25 (OH) D and 1, 25 (OH) D and effect of vitamin D on fracture risk. The level of 25 (OH) D that would be enough for PTH suppression, probably, is a suitable criterion for bone health and cut-off point for vitamin D deficiency.[5]

The aim of this study was detection of prevalence of vitamin D deficiency in secondary students in Arak, a centrally located city in Iran, and also detection of cut-off points for vitamin D deficiency.

## Materials and Methods

In a cross-sectional study in November 2010, 420 students including 220 girls and 200 boys from secondary students from 10 to 16 years old were selected by a multistage sampling. First, all of the secondary schools were divided into two areas and then 21 schools including 11 girls' schools and 10 boys, schools were selected by a cluster sampling. Finally, the samples were picked up by a systematic random procedure based on the student's initials.

All the students and their parents were informed about the study and signed off the consent form. The students were interviewed and a questionaire was filled out for each of them.

The students who were not ready to participate in the study were excluded. The study was approved by the medical ethics committee of Arak University.

Inclusion criteria were lack of hepatic, renal, bone disease and cancer, no history of intake of anticonvulsant drugs, calcium, vitamin D, and antineoplastic drugs.

All of the students have been examined for weight, height, and BMI. Laboratory tests including hepatic, renal, calcium, phosphoros, ALP (alkaline phosphatase), albumin, PTH, 25 (OH) D.

25 (OH) D levels by RIA and PTH by IRMA were measured (made by Bio source Europe SA, Belgium) and its intensity categorized into three levels.[6]

- Mild deficiency: 15 ≤ 25 (OH) D < 20 ng/ml.
- Moderate deficiency: 8 ≤ 25 (OH) < 15 ng/ml.
- Severe deficiency: 25 (OH) <8 ng/ml.

The relation between vitamin D and PTH was assessed by the Scatter chart. The level of vitamin D that PTH was increasing, defined as cut-off points for vitamin D deficiency. The prevalence of vitamin D deficiency in different intensities was assessed by SPSS 15 and variables compared between girls and boys, and also between deficient and sufficient vitamin D groups by Student's test or Mann--Whitney U based on normal distribution based on K--S (Kolmogrov--Smirnov) test. The Pearson test was used to identify the relation between 25 (OH) D and age, weight, and BMI. Results were presented as mean ± SD (Standard Deviation). *P* values less than 0.05 were considered significant.

## Results

A total of 420 students including 46.9% boys and 53.1% girls participated in this study. Mean age for boys and girls was 12.5 ± 1 and 12.7 ± 1 years old respectively $P = 0.1$ [Table 1].

Mean age of vitamin D-deficient and nondeficient groups based on cut-off 25 (OH) D < 20 ng/ml were 12.6 ± 1 and 12.6 ± 2 years old respectively ($P = 0.5$). But mean BMI in two groups were 20 ± 3.5 and 19 ± 2.1 respectively ($P = 0.02$). There was no meaningful relation between 25 (OH) D and age ($P = 0.5$) but there was an inverse relation between 25 (OH) D level and BMI (r = -0.17) ($P = 0.01$), weight (r = -0.14) ($P = 0.05$), PTH (r = -0.262) ($P = 0.001$).

There was also a meaningful relation between vitamin D deficiency and sex ($P = 0.001$). Based on the logistic regression analysis, the girls have 54.4 times more chance than boys for vitamin D deficiency (OR 54.4) ($P < 0.001$). Totally 84% of the students had vitamin D deficiency [Table 2]. Three cut-off points 33, 21, and 13 ng/ml were defined for mild, moderate, and severe vitamin D deficiency [Figure 1] using the Scatter chart. The prevalence of vitamin D deficiency based on different intensities was evaluated in both genders [Table 3].

**Table 1: Mean characteristic of students (Mean ± SD)**

| index | Sex | | |
|---|---|---|---|
| | Boy | Girl | *P*-value |
| Age (year) | 12.5 ± 1 | 12.7 ± 1 | 0.1 |
| Height (cm) | 157.3 ± 9.9 | 155.5 ± 7.5 | 0.02 |
| Weight (kg) | 46.7 ± 12.8 | 48 ± 10.7 | 0.02 |
| BMI (kg/m$^2$) | 18.7 ± 3.8 | 19.7 ± 3.8 | 0.000 |
| Ca (mg/dl) | 10 ± 0.5 | 9.6 ± 0.5 | 0.5 |
| P (mg/dl) | 4.9 ± 0.7 | 4.6 ± 0.6 | 0.8 |
| ALP (U/l) | 552 ± 177 | 455 ± 177 | 0.8 |
| 25 (OH) D (ng/ml) | 18 ± 5.3 | 10.5 ± 2.8 | 0.000 |
| PTH (pg/ml) | 29.2±17.1 | 43.8±38.1 | 0.002 |

**Table 2: Prevalence of vitamin D deficiency in students (number/%)**

| Vitamin D deficiency N/% | All students | Boys | Girls | *P*-value |
|---|---|---|---|---|
| Vitamin D deficiency 25 (OH) D (ng/ml) | | | | |
| Total | 352 | 134 | 218 | <0.001 |
| (25 (OH) D<20) | 84 | 66/5 | 99/1 | |
| Mild | 255 | 129 | 126 | <0.001 |
| (15 ≤ 25 (OH) D<20) | 60.7 | 64.5 | 57.4 | |
| Moderate | 94 | 5 | 89 | <0.001 |
| (8 ≤ 25 (OH)D <15) | 22.4 | 2 | 40.4 | |
| Severe | 3 | 0 | 3 | <0.001 |
| (25 (OH) D <8) | 0.7 | | 1.3 | |

**Table 3: Prevalence of vitamin D deficiency based on local cut-off points (%)**

| Vitamin D deficiency (ng/ml) | Cut-off vitamin D deficiency Intensity (ng/ml) | | |
|---|---|---|---|
| | 13 | 21 | 33 |
| Total <33 | 99.8% | 87.6% | 53.6% |
| Mild 21 ≤ 25 (OH) D < 33 | 31.7% | 61% | - |
| Moderate 13 ≤ 25 (OH) D<21 | 60.7% | 25.9% | 39.4% |
| Severe 25 (OH) D <13 | 7.6% | 0.7% | 14.2% |

Title: Our study determined three cut-off points 13, 21, 33 ng/ml. Row: each row titled by a cut-off point, that followed by prevalence of vitamin D deficiency in different intensities for each cut-off point

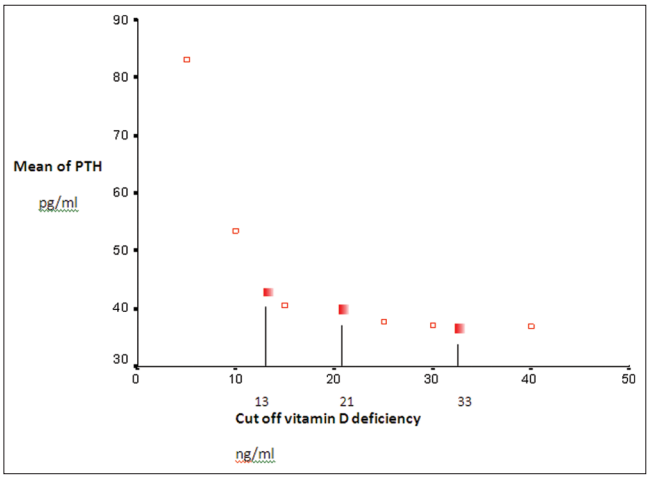


**Figure 1:** Mean of PTH of different cut-off points for vitamin D deficiency

## Discussion

Our findings in Arak, a centrally located city of Iran, showed a high prevalence of vitamin D deficiency of 84% among the students. The results showed that females were more likely to be vitamin D-deficient than males. The present study suggests three local cut-off points for vitamin D deficiency based on 25 (OH) D < 13, 21, and 33 ng/ml.

Vitamin D deficiency is a common medical problem throughout the world. It has been predicted that one billion people throughout the world are vitamin D deficient.[1] Prevalence of vitamin D deficiency in the countries where food is enriched by vitamin D (Scandinavian countries) is 1.6–14.8%.[7] In other European countries, among middle-aged and elderly people, 14--59.6[8] in Tunessia 47.6%[9] and finally among teenagers in Boston was 24.1%.[10]

Prevalence of vitamin D deficiency is much higher in Asia. A total of 30--50% of people in India, Lebanon, and Turkey[1] and also 45.2% of females in China[6] were vitamin D deficient.

Several studies in different parts of Iran and among different age groups have shown a high prevalence of vitamin D deficiency.[11-14] Prevalence of vitamin D deficiency in Tehran (the capital city of Iran) was 60% in males and 91% in females.[15] The prevalence of vitamin D deficiency in Isfahan, another central city of Iran, was 46.2% among students including 72.1% girls and 18.3% boys[16] and is similar to our findings in Tabriz, another city in the north west of Iran, which was 64.2% among females (mild 33.7%, moderate 15.5%, severe 15.1%) that in comparison with the present study is lower.[17]

Another study in different cities of Iran, with different climate, showed that 27.2% of females and 37.25% of males had a mild vitamin D deficiency, and also 47.85% of females and 34.75% of males had moderate to severe vitamin D deficiency[4] that confirms the present study.

Different etiologies, such as insufficient sun exposure, clothing habits, and insufficient intake of vitamin D, may explain high prevalence of vitamin D deficiency.[18] It has been shown that 2-years intake of calcium and vitamin D, increased serum 25 (OH) D level up to 28%.[19] There are also ethnic differences in vitamin D status. Serum 25 (OH) D levels were lowest in blacks and highest in white people.[20] African Americans and Hispanics had lower vitamin D levels.[21]

Clothing habits also influence on serum 25 (OH) D levels.[22] Although some studies found that sun expose and clothing habits were not different between sufficient and deficient groups.[12] The increased catabolism of vitamin D could be another reason for vitamin D deficiency. Decreased calcium intake lead to increased serum PTH level and increased catabolism of 25 (OH) D.[23]

Awumey *et al.* showed higher activity of 24-hydroxylase in fibroblasts that lead to increased catabolism of 25 (OH) D of Indian Americans.[24] Other explanations for high prevalence of vitamin D deficiency are hyperpigmentation and air pollution.[18] The darker skin of the Asian immigrants to European countries is another risk for vitamin D deficiency.[25] Erkal *et al.* found that 61% of the Turkish group (in Turkey) and 55% of the Turkish immigrant group in Germany had bone and muscle pain, while it was 15% within the German group with higher serum 25 (OH) D levels.[26]

Our findings showed that the prevalence of vitamin D deficiency is much more in girls than boys (girls 99.1%, 66.5% boys) ($P < 0.001$). Another study in Iran, Isfahan, also found that the prevalence of vitamin D deficiency was four times more in girls than boys and severe vitamin D deficiency in girls and boys were 14.5% and 0.6% respectively. [16] Another study in Iran also found that moderate-to-severe vitamin D deficiency was much more in females than males.[4]

Gender and age influence on serum 25 (OH) D levels. Differences according to gender and age group maybe because of biological differences but might also due to behavioral differences. There might be gender-specific clothing differences (necessarily not based on a culture religious). There also might be that females spend less time outside, resulting in less exposure to the sun.[12]

Another study in the United States among female soldiers found that vitamin D levels decrease during military training in the summer due to the type of clothing worn during training, coupled with inadequate vitamin D intake.[27]

Our study found that vitamin D deficiency was not associated with the age, while most studies found higher prevalence of vitamin D deficiency among elderly,[7,28,29] probably due to lower capacity of the skin to produce vitamin D after sun exposure[25] or less vitamin D intake in elderly,[28] although a few studies reported higher prevalence of vitamin D deficiency in young people.[29]

Our study shows a significant inverse association between BMI (Body Mass Index) and weight in one hand with vitamin D deficiency in another hand, same as the Tabriz study[17] and against the Isfahan study.[16] Considering the role of fat tissue as a depot of vitamin D, obese have increased storage capacity of 25 (OH) D, that leads to lower serum vitamin D levels.[30]

We determined three cut-off points for vitamin D deficiency based on 25 (OH) D < 33, 21, and 13 ng/ml for mild, moderate, and severe vitamin D deficiency, using Scatter chart, versus 12.5, 25, and 40 ng/ml in another study in Iran[4] and 32 ng/ml in Isfahan.[16]

## Conclusion

High prevalence of vitamin D deficiency probably could be the result of above-mentioned combination. We recommend that some efforts could be made to encourage people to intake vitamin D and calcium supplements and also have more exposure to the sunlight.

## References


1. Holick MF. Vitamin D Deficiency. N Engl J Med 2007;357:266-81.
2. Bringhurst FR, Demay MB, Kronenberg HM. Disorders of mineral metabolism. 11th ed., chap. 27. Williams Saunders; 2008. p. 1217-24.
3. Holick MF. High prevalence of vitamin D inadequacy and implications for health. Mayo Clin Proc 2006;81:353-73.
4. Moradzade K, Larijani B, Keshtkar A, Hosseinnejad A, Rajabian R, Nabipor A, *et al.* Normal values of vitamin D and prevalence of vitamin D deficiency among Iranian population. SJKUMS. (Scientific Kurdistan medicine university) 2006;10:33-43.
5. Lips P. Which circulating level of 25 hydroxyvitamin D is appropriate? J Steroid Biochem Mol Biol. (Journal of Steroid Biochemistry & Molecular Biology) 2004;89-90:611-614.
6. Du X, Greenfield H, Fraser DR, Ge K, Trube A, Wang Y. Vitamin D deficiency and associated factors in adolescent girls in Beijing. Am J Clin Nutr 2001;74:494-500.
7. Burnard B, Sloutskis D, Gianoli F, Cornuz J, Rickenbach M, Paccaud F. Serum 25-Hydroxy vitamin D: Distribution and determinants in the Swiss population. Am J Clin Nutr 1992;56:537-42.
8. Souberbielle JC, Cormier C, Kindermans C, Gao P, Cantor T, Forette F. Vitamin D status and redefining serum parathyroid hormone reference range in the elderly. J Clin Endocrinol Metab 2001;86:3086-90.
9. Meddeb N, Sahli H, Chahed M, Abdelmoula J, Feki M, Salah H, *et al.* Vitamin D deficiency in Tunisia. Osteoporos Int 2005;16: 180-3.
10. Gordon CM, DePeter KC, Feldman HA, Grace E, Emans SJ. Prevalence of vitamin D deficiency among healthy adolescents. Arch Pediatr Adolesc Med 2004;158:531-7.
11. Azizi F, Rais-Zadeh F, Mir Said Ghazi A. Vitamin D deficiency in a group of Tehran Population. Res Med 2000;4:291-303.
12. Hashemipour S, Larijani B, Adibi H, Javadi E, Sedaghat M, Pajouhi M, *et al.* Vitamin D deficiency and causative factors in population of Tehran. BMC Public Health 2004;4:1-6.
13. Shahla A, Charehsaz S, Talebi R, Omrani M. Vitamin D deficiency in young females with musculoskeletal complaints in Urmia, northwest of Iran. Int J Mol Sci 2005;30:88-90.
14. Salek M, Hashemipour M, Aminorroaya A, Gheiratmand A,

Kelishadi R, Ardestani PM, *et al.* Vitamin D deficiency among pregnant women and their newborns in Isfahan, Iran. Exp Clin Endocrinol Diabetes 2008;116:352-6.
15. Mirsaeid Ghazi AA, Rais ZF, Pezeshk P, Azizi F. Seasonal variation of serum 25-hydroxy-$D_3$ in residents of Tehran. J Endocrinol Invest 2004;27:676-9.
16. Moussavi M, Heidarpour R, Aminorroaya A, Pournaghshband Z, Amini M. Prevalence of Vitamin D deficiency in Isfahani High School Students in 2004. Horm Res 2005;64:1448.
17. Ostad Rahimi AA, Zarghami NB, Sadighi AC. Relationship between vitamin D and nutritional status in healthy reproductive age women. Int J Endocrinol Metab 2006;4:1-7.
18. Smith R. Asian rickets and osteomalacia. Q J Med 1990;76:899-901.
19. Jackson RD, LaCroix AZ, Gass M, Wallace R, Robbins J, Lewis C, *et al.* Calcium plus vitamin D supplementation and the risk of fractures. N Engl J Med 2006;669-83.
20. Dawson-Hughes B. Racial/ethnic considerations in making recommendations for vitamin D for adult and elderly men and women. Am J Clin Nutr 2004;80 Suppl 6:1763-6.
21. Ginde AA, Liu MC, Camargo CA Jr. Demographic differences and trends of vitamin D insufficiency in the US population. Arch Intern Med 2009;169:626-32.
22. Budak N, Cicek B, Sahin H, Tutus A. Bone mineral density and serum 25-hydroxyvitamin D level: Is there any difference according to the dressing style of the female university students. Int J Food Sci Nutr 2004;55:569-75.
23. Lips P. Vitamin D deficiency and secondary hyperparathyroidism in the elderly: Consequences for bone loss and fractures and therapeutic implications. Endocr Rev 2001;22:477-501.
24. Awumey EM, Mitra DA, Hollis BW, Kumar R, Bell NH. Vitamin D metabolism is altered in Asian Indians in the southern United States. J Clin Endocrinol Metab 1998;83:169-73.
25. van der Meer IM, Middelkoop BJ, Boeke AJ, Lips P. Prevalence of vitamin D deficiency among Turkish, Moroccan, Indian and sub-Sahara African populations in Europe and their countries of origin. Osteoporos Int 2011;22:1009-21.
26. Erkal MZ, Wilde J, Bilgin Y, Akinci A, Demir E, Bodeker RH, *et al.* High prevalence of vitamin D deficiency, secondary hyperparathyroidism and generalized bone pain in Turkish immigrants in Germany. Osteoporos Int 2006;17:1133-40.
27. Andersen N, Karl J, Cable S, Williams K, Rood J, Young A, *et al.* Vitamin D status in female military personnel during combat training. J Int Soc Sports Nutr 2010;7:1-5.
28. Omdahl JL, Garry PJ, Hunsaker LA, Hunt WC, Goodwin JS. Nutritional status in a healthy elderly population: Vitamin D. Am J Clin Nutr 1982;36:1225-32.
29. Hovsepian S, Amini M, Aminorroaya A, Amini P, Iraj B. Prevalence of Vitamin D Deficiency among Adult Population of Isfahan City, Iran. J Health Popul Nutr 2011;29:149-55.
30. Wortsman J, Matsuoka LY, Chen TC, Lu Z, Holick MF. Decreased bioavailability of vitamin D in obesity. Am J Clin Nutr 2000;72:690-3.

**Cite this article as:** Talaei A, Yadegari N, Rafee M, Rezvanfar MR, Moini A. Prevalence and cut-off point of vitamin D deficiency among secondary students of Arak, Iran in 2010. Indian J Endocr Metab 2012;16:786-90.
**Source of Support:** Nil, **Conflict of Interest:** None declared.