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## Original Article

## Prevalence and predictors of vitamin D insufficiency in adult population of yazd – The sun province in center of Iran

Omid Afkhami-Ardekani <sup>a</sup>, Arezoo Afkhami-Ardekani <sup>b</sup>, Nasim Namiranian <sup>c</sup>,  
Mohammad Afkhami-Ardekani <sup>c</sup>, Maryam Askari <sup>c,\*</sup><sup>a</sup> Student, Faculty of Medicine, Pecs University, Hungary<sup>b</sup> Shahid Sadoughi University of Medical Sciences, Yazd, Iran<sup>c</sup> Diabetes Research Center, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

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## ABSTRACT

**Background:** Vitamin D insufficiency (VDI) is one of impaired calcium absorption causes. It is associated with increased risk of several diseases. The aim of this study was to survey the prevalence and predictors of VDI in Yazd.

**Method and material:** This cross sectional study was conducted on 700 participant aged between 20 and 70 years old on second phase of the Iranian Multi-Center Osteoporosis Study (IMOS) in Yazd province. All analyzes were performed with the SPSS 20 and Stata 14.1 software. Chi-squared test, Pearson correlation and binary logistic regression were used. A significance level was considered for all tests  $P \leq 0.05$ .

**Results:** The prevalence of VDI was 55.1% (51.37–58.87%) in total participant of this study. Predictors of VDI including: age 31–45 years old (OR = 1.68, CI = 1.04–2.70), female (OR = 3.49, CI = 1.80–6.78), live in the apartment houses (OR = 2.15, CI = 1.06–4.35), inability of climbing of steps (OR = 2.59, CI = 1.17–5.69), serum Calcium (OR = 0.53, CI = 0.34–0.81) and serum PTH (OR = 1.04, CI = 1.02–1.06).

**Conclusions:** The prevalence of VDI in Yazd is high. It is recommended to people that to be exposed to sunlight per day. And people should consumption vitamin D supplements under their physician.

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## 1. Introduction

Serum 25-hydroxy vitamin D (25-OHD) as a fat-soluble vitamin is the main factor in sufficient calcium and phosphorus bone intake [1]. Serum 25-hydroxy vitamin D (25-OHD) can be taken by eating foods, consumption of supplements or by influence of ultraviolet irradiation of sun on the bare skin [2].

Vitamin D insufficiency (VDI) is one of the impaired calcium absorption causes. It is associated with osteopenia, osteoporosis and osteomalacia. VDI is known as risk factor of cancer, hypertension, cardiovascular disease, infection, type 1 diabetes and autoimmune disease [3–5].

Although middle East countries such as: United Arab Emirates, Qatar, Saudi Arabia and Iran are rich in sunlight (sunny), but recent studies showed that VDI is prevalent in these countries. Prevalence of VDI in different countries such as China, Turkey, India, Iran, and

Saudi Arabia, is reported between 30% and 93% [6,7].

In Iran, the prevalence of moderate VDI is 32.9%, 45.8%, 37.4%, 29.7%, 23% in Tabriz, Tehran, Mashhad, Shiraz, Bushehr in 50–60 years old respectively [7].

Since the population is aging, and vitamin D has a strong association with bone strength; the present study was conducted to survey the prevalence and predictors of VDI in Yazd.

## 2. Method and material

## 2.1. Study design and study population

This cross-sectional study was based on second phase of the Iranian Multi-Center Osteoporosis Study (IMOS) in Yazd province. Data was collected by the Endocrine and Metabolism Research Center of Tehran University of Medical Sciences (EMRC-TUMS) and Yazd Diabetes Research Center.

Yazd province (latitude: 31.8974° N; longitude 54.3569° E) is located in the central Iran. It is restricted to Semnan, Kerman and Fars, South Khorasan and Isfahan from north, south, east and west,

\* Corresponding author. Diabetes Research Center, Talar-e-Honar Alley, Shahid Sadoughi Blvd, Yazd, 8917693571, Iran.

E-mail address: [AskariM204@gmail.com](mailto:AskariM204@gmail.com) (M. Askari).

respectively [8]. Yazd is a province in center of Iran with most sunlight hours [9] (Fig. 1).

Sample size for this study was 700 participants aged between 20 and 70 years old. The sample size was calculated as a part of IMOS. Participants were selected by cluster sampling. Thirty five post-codes (5 blocks) were requested from Yazd Civil Registration Organization by simple randomization. Twenty participants were selected in each cluster and no two people were selected from the same family. The data was collected by thirty five health experts trained. Among 1000 included participants, 700 people were included.

All included participants were healthy. Exclusion criteria included: Rheumatoid arthritis, hypoparathyroidism, hyperthyroidism, parathyroid, adrenal, diabetes mellitus, renal failure, advanced hepatic failure, malignancy, menstrual disorders, menopause in the last three months, premature menopause (before 40), menopause in the past year in a woman younger than 40 years old, oophorectomy before menopause, infertility, pregnancy or lactation at the time of study, cigarette smoking more than 10 cigarettes per day, drinking alcohol for more than 5 years or more than one glass per day, opioid addiction, professional athlete, spinal fracture, fractures caused by a fall, spinal deformity, hospitalization in the last two weeks, immobility more than 1 week at the time of study, bed rest for 3 consecutive months, medication of estrogen, progesterone, anticonvulsants, steroids, heparin, thiazides and other diuretics drugs, drugs that affect the metabolism of calcium and vitamin D, premarin medication in postmenopausal women, daily

calcium, multivitamin or vitamin D supplements consumption during the last three months and vitamin D3 injections over the past year.

Written informed consent was obtained from all participants. The study protocol was approved by the research ethics committee of (EMRC-TUMS).

## 2.2. Definition of variables

Physical activity (PA) was evaluated as history of PA twice weekly at least 1 h. Weight was measured at minimum clothing and without shoe. The weight measurement was done using a digital scale with a precision of half kilogram and height was measured using an inflexible bar in a standing position with a precision of 1 cm (cm). The body mass index was calculated by dividing the weight (kg) per height (m<sup>2</sup>). Ten milliliter (mL) sample of venous blood (after 12 h fasting) was taken from participant. Serum calcium, phosphorus, albumin, alkaline phosphatase and total protein was measured by autoanalyzer Biosystem BA400 set and Parathyroid hormone (PTH) and 25-OH Vit. D3 Calisferol was measured by Liaison set. VDI was defined as blood serum vitamin D < 30 ng/ml.

## 2.3. Statistical analysis

All analyzes were performed with the SPSS 20 software. Stata software, version 14.1 (StataCorp, College Station, TX) was used to

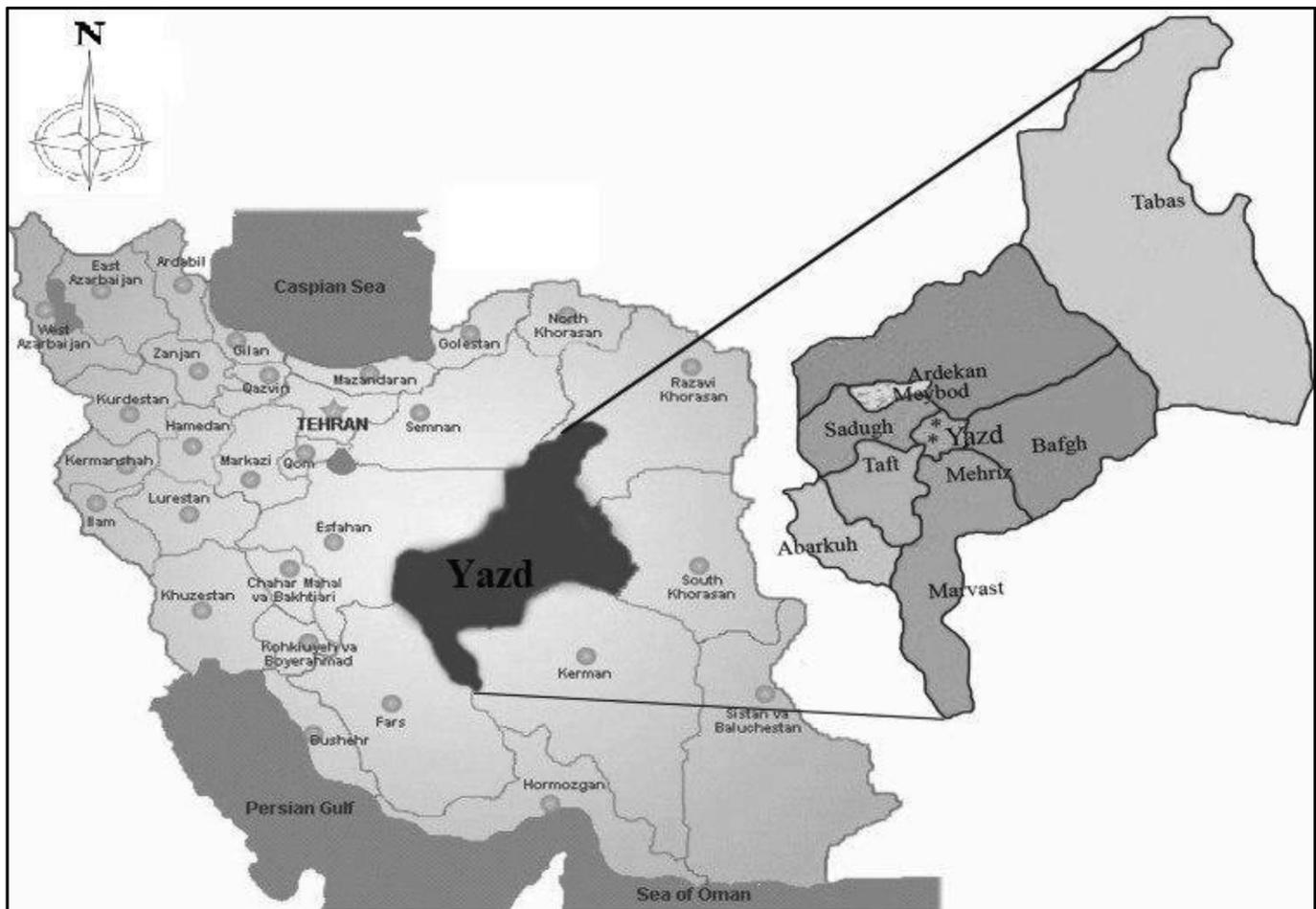


Fig. 1. Location of Yazd province in Iran.

**Table 1**  
Demographic characteristics of the study population.

Variables		number	Percent
Sex	Male	281	40.1
	Female	419	59.9
Age	15–30	248	35.4
	31–45	295	42.1
	>46	157	22.4
Job	Employed	108	15.4
	Housewife	337	48.1
	Others	255	36.4
Kind of house	Apartment	57	8.1
	Single-family house	643	91.9
BMI	Normal	248	35.4
	Overweight	295	42.1
	Obese	157	22.4
History of using sun screen	Yes	92	13.1
	sometimes	77	11
	No	457	65.3
Physical Activity	Yes	76	10.9
	No	624	89.1
Inability of climbing of steps	Yes	46	6.6
	No	654	93.4
History of low back pain (LBP)	Yes	258	36.9
	No	441	63

calculation the 95% confidence interval (95% CI) for prevalence of VDI. Chi-squared test was used for analyzing qualitative data and to investigate the relationship between vitamin D deficiency and related factors the Pearson correlation was used. Also binary logistic regression was used for predictors modeling. A significance level was considered for all tests  $P \leq 0.05$ .

### 3. Results

#### 3.1. Demographic characteristics

Seven hundred participants from Yazd province entered in this study. The mean ( $\pm$ SD) age of studied population in total, female and male respectively were 37.21 ( $\pm$ 12), 36.90 ( $\pm$ 11.35), 37.67 ( $\pm$ 12.91). Most of participants were female 419 (59.9%). The prevalence of overweight was 42.1%. Only 13.1% of the participants used sunscreen and 89.1% of the subjects had not history of PA twice weekly at least 1 h (Table 1).

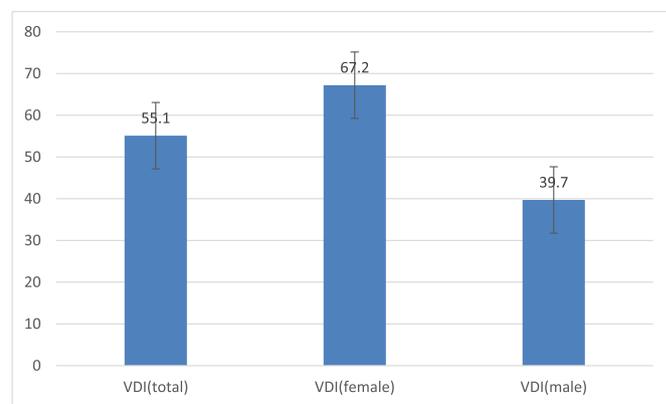
#### 3.2. Prevalence of insufficient vitamin D

The mean ( $\pm$ SD) of vitamin D was 30.86 ( $\pm$ 15.84). The prevalence of VDI (95%CI) in total, female and male were 55.1% (51.37%–58.87%), 67.2% (62.37%–71.67%) and 39.7% (33.90%–45.73%) respectively. The mean ( $\pm$ SD) of calcium and PTH were 9.78 ( $\pm$ 0.50) and 24.74 ( $\pm$ 16.91) totally. (Table 2 and Fig. 2).

The prevalence of VDI was 59.4% with 95% CI: 52.97–65.64 in participants younger than 30 years old. The highest prevalence of VDI was detected in participants who used sunscreen sometimes

**Table 2**  
The mean and standard deviation (M  $\pm$  SD) of laboratory factors.

Total	Female	Male	Variables
30.86 $\pm$ 15.84	27.39 $\pm$ 14.86	36.02 $\pm$ 15.87	Serum 25-hydroxy vitamin D (25-OHD)
9.78 $\pm$ 0.50	9.67 $\pm$ 0.47	9.93 $\pm$ 0.51	Calcium
3.86 $\pm$ 0.56	3.86 $\pm$ 0.52	3.84 $\pm$ 0.61	Phosphorus
7.24 $\pm$ 0.50	7.19 $\pm$ 0.48	7.32 $\pm$ 0.51	Total Protein
24.74 $\pm$ 16.91	26.30 $\pm$ 18.56	22.41 $\pm$ 13.80	PTH
4.14 $\pm$ 1.16	4.11 $\pm$ 1.47	4.18 $\pm$ .35	Albumin
149.45 $\pm$ 45.01	143.14 $\pm$ 42.01	158.86 $\pm$ 47.68	Phosphatase Alkaline

**Fig. 2.** Prevalence of VDI in Yazd.

(72.4%, 95%CI: 60.91–82.01) and in the second ranking, there were who lived in the apartment houses (72.2%, 95% CI: 56.59–81.57) (Table 3).

#### 3.3. Association between factors and vitamin D insufficiency

Statistically significant positive correlation was detected between vitamin D and calcium ( $r = +0.27$ ,  $p < 0.001$ ), phosphorus ( $r = +0.10$ ,  $p = 0.005$ ), total protein ( $r = +0.10$ ,  $p = 0.005$ ), albumin ( $r = +0.12$ ,  $p = 0.003$ ), and phosphatase alkaline ( $r = +0.12$ ,  $p = 0.001$ ). But statistically significant negative correlation was seen between Vitamin D and PTH ( $r = -0.19$ ,  $p < 0.001$ ).

The Odds Ratio (OR) of VDI was (OR = 1.73, CI = 1.15–2.60) in participants younger than 30 years old. But after adjusting according to other factors it was not statistically significant (OR = 1.65, CI = 0.97–2.81). The OR of VDI was (OR = 1.69, CI = 1.14–2.50) and (OR = 1.68, CI = 1.04–2.70) in age 31–45 years old before and after adjusting. Adjusted OR of morbidity was (OR = 3.49, CI = 1.80–6.78) in female. The OR of VDI was increased after adjusting in those who lived in the apartment houses (OR = 2.15, CI = 1.06–4.35). The OR of VDI was 1.86 (95% CI = 0.97–3.55) in participants who were unable of climbing of steps that was not statistically significant. But after adjusting, it reached about triple, which was statistically significant (OR = 2.59, CI = 1.17–5.69). After adjusting OR of VDI was (OR = 0.53, CI = 0.34–0.81) and (OR = 1.04, CI = 1.02–1.06) for serum Calcium and PTH that was statistically significant (Table 4).

### 4. Discussion

Vitamin D insufficiency is one of the health problems and its associated with many chronic diseases, such as diabetes and cancers [10,11]. Various prevalence of VDI was reported in studies [12–15].

The prevalence of VDI in our study was 55.1%, 67.2% and 39.7%,

**Table 3**  
Prevalence of VDI in the total, male and female participants in terms of demographic variables\*.

Variables		Male		Female		Total		95%Confidence Interval	
		F	%	F	%	F	%	Min	Max
		Age	15–30	35	35.7	110	75.3	145	59.4
	31–45	48	44	122	67.8	170	58.8	52.90	64.55
	>46	27	38.6	44	51.8	71	45.8	37.78	53.98
Job	Employed	28	41.8	34	85	62	57.9	48.01	67.42
	Housewife	2	50	207	63.5	209	63.3	57.88	68.54
	Others	80	38.8	35	77.8	115	45.8	39.53	52.19
Kind of house	Apartment	7	36.8	33	86.8	40	72.2	56.59	81.57
	Single family house	103	39.9	243	65.1	346	54.8	50.85	58.76
BMI	Normal	45	37.5	118	70.7	163	56.8	50.84	62.60
	Overweight	50	40.7	49	65.7	159	55	49.08	60.84
	Obesity	15	44.1	109	62.8	64	57.1	47.44	66.45
History of using sunscreen	Yes	5	45.5	59	74.7	64	71.1	60.60	80.8
	No	88	40.2	144	62.1	232	51.4	46.72	56.14
	sometimes	5	45.5	50	76.9	55	72.4	60.91	82.01
Physical Activity	Yes	13	35.1	29	76.3	42	56	44.05	67.45
	No	97	40.4	247	66.2	344	56.1	52.08	60.80
Inability of climbing of steps	Yes	5	38.5	27	81.8	32	69.6	54.24	82.25
	No	105	39.8	249	65.9	354	55.1	51.19	59.03
History of LBP	Yes	36	41.9	101	60.8	137	54.4	47.99	60.62
	No	73	38.4	175	71.4	248	57	52.20	61.71

Chi-squared test.

**Table 4**  
: Odds ratios (95% CI) for VDI in the total<sup>a</sup>.

Variables	OR (Crude)	OR (Adjusted)	
Age	15–30	1.73(1.15–2.60)	1.65(0.97–2.81)
	31–45	1.69(1.14–2.50)	1.68(1.04–2.70)
	>46	1	1
sex	Male	1	1
	Female	3.10(2.26–4.26)	3.49(1.80–6.78)
Kind of house	Apartment	1.93(1.07–3.49)	2.15(1.06–4.35)
	Single family house	1	1
Inability of climbing of steps	Yes	1.86(0.97–3.55)	2.59(1.17–5.69)
	No	1	1
Serum Calcium		0.34(0.24–0.487)	0.53(0.34–0.81)
Serum PTH		1.04(1.02–1.06)	1.04(1.02–1.06)

<sup>a</sup> Binary Logistic Regression.

in total, female and male respectively. The prevalence of VDI is reported between 14% and 59%, while the Asian countries have the highest prevalence [16]. The prevalence of mild, moderate and severe VDI in Isfahan was 19.6%, 23.9%, and 26.9% respectively [5]. This content showed that the prevalence of VDI in Yazd is much higher than Isfahan which is neighbor. In our study, the prevalence of VDI in female was higher than male. The morbidity risk of VDI was 3 times higher in female than men, which is consistent with the study of Hovsepian et al [5]. This can be explained that females are less exposed to sunlight than men and also more sunscreens use and coverage. Prevalence of mild, moderate and severe VDI was 14.2%, 57.6% and 9.5% respectively in 20–64 years old in Tehran [13].

Vitamin D levels <10 was 65.26% (4902; 57.81% of men and 72.07% of women) in the cross-sectional study in Mashhad (northeastern Iran) and it was more common in women than men in 2015–2016 [17].

A meta-analysis on 48 papers showed that the prevalence of vitamin D deficiency among male, female, and pregnant women was estimated to be 45.64%, 61.90% and 60.45% respectively [6].

In the study of IMOS in 2008, the results showed that the highest prevalence of vitamin D deficiency in men is in the age

group of 50–60 (9.4%) and also under 50 years old (8.3%) in Mashhad. And this amount in women in the age group less than 50 years old (15.4%) in Tehran and also 50 years old (8.3%) in Tbiris [18].

Another study on women of reproductive age (15–45 years) in Tehran, was showed that the prevalence of severe vitamin D deficiency ( $\leq 12.5$  nmol/L) was 43.37% in non pregnant women and in first trimester, Second trimester and third trimester was 42.86%, 32.5%, 30.77% in pregnant women.

The prevalence VDI was higher in those who did not use the sunscreen than those who used it always or sometimes. The study by Labon et al. showed that sunscreen decreases significantly vitamin D production in the skin [19].

People living in apartment houses had a higher prevalence of VDI than single family house, and the risk of VDI was more than doubled. This finding is consistent with the study of Al-Faris et al. [20]. People who live in apartments are less exposed to sunlight.

The risk of VDI was reduced in people with higher levels of calcium and lower PTH, the study findings of Martins et al. confirmed our findings [21].

Prevalence of VDI in Yazd is considerable, while Yazd is one of the sunny cities of Iran. On the other hand, VDI can increase the risk of many chronic diseases. Also Iran is a country that is aging and the

cost and burden of chronic diseases is enormous. Therefore, appropriate and cost-effective preventive methods for at risk populations are vital. Especially for certain diseases, such as diabetes, that is more prevalent in Yazd.

## 5. Conclusions

The prevalence of VDI in Yazd is high. Age and sex are unmodifiable predictors of VDI. But women should be considered as a high-risk population for VDI. People are exposed to less sunlight, with the economic progress and the transformation of Single-family house into apartments. It is recommended to people that to be exposed to sunlight per day. Of course, in the hours of the day, sunlight is not completely perpendicular.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.dsx.2019.07.050>.

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