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Association of Vitamin D with Diet Quality, Sun Exposure, Physical Activity, Sociodemographic and Anthropometrics Indices

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ABSTRACT

Background: Vitamin D has been linked to health conditions and many serious diseases including cardiovascular, diabetes, and cancer. This study was conducted to determine the correlation between vitamin D with diet quality, sun exposure, physical activity, sociodemographic, and anthropometrics indices.

Methods: In a cross-sectional study, 180 subjects (90 males and 90 females) aged from 14 to 57 years were enrolled. A questionnaire was used to collect sociodemographic and anthropometric data, physical activity and food intake information. The correlation between serum vitamin D with these variables was analyzed.

Results: Significant difference was noted between two genders regarding age, weight, body mass index, waist circumference, job, income, physical activity, LDL, HDL, TG, and cholesterol. Low quality diets denoted to a mean global score of 47±6.3 and 46±6.4 in male and females, respectively. No significant difference was found between diet quality, calcium intake (1310±734 mg), and vitamin D intake (1.8±1.5 mg) with serum vitamin D level. Further analysis revealed that there was a significant positive correlation between cholesterol and saturated fat intake and serum vitamin D. Between two genders, the correlation between physical activity ($p<0.005$), sitting time($p<0.04$), and income ($p<0.04$) with serum vitamin D level was significant.

Conclusion: Based on significant correlation between serum vitamin D level, with cholesterol, saturated fat intake, physical activity and income, we can conclude that physical activity has correlation with a favorable vitamin D status.

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Introduction

Vitamin D has been linked to health conditions and many serious diseases including cardiovascular, diabetes, and cancer (1). Hypovitaminosis D was shown to be very common in Middle East and a large proportion of adolescent girls and in Iran up to 70% of them had 25-Hydroxy vitamin D (25(OH) D) levels below 25 nmol/L. To control hypovitaminosis, evaluation of contributing factors such as diet quality, physical activity, sun exposure, and sociodemographic factors, which can affect vitamin D level is essential in every community (2-4).

Plasma Vitamin D level is influenced majorly by both sun exposure and diet intake, while more than 90% of the vitamin D requirement is provided from exposure to sunlight, a smaller part comes from food intake. So determination of diet quality may help defining the contributing factors for vitamin D level in healthy young adults. Beside, as fortified food sources are limited in developing countries, assessment of diet quality, dietary calcium, high phytate consumption, food source of vitamin D intake can help to a better health management in Iranian community (2, 5).

The Peak Bone Mass (PBM) are noticed at ages of 25 to 35 years and are primarily influenced by vitamin D status, calcium intake and physical activity (6). In males, vitamin D level was shown to predict the PBM; however, this is not directly applicable to females. Besides, the physical activity was shown to be correlated with vitamin D level and PBM in old age (7, 8). So determination of physical activity and calcium intake in young adults are of great importance to define detailed information for primary prevention.

Epidemiological studies showed that diet quality can be related to plasma level of 25 (OH) D levels and socioeconomic determinants (9, 10). Mirmiran et al.'s study indicated that low-income populations and a lower educational level are indicative of a poor diet quality (11). The association between vitamin D level and education is well recognized in the adult population, but is not well recognized in teenager (12). In several studies, Body mass index (BMI) was found to be inversely associated with vitamin D and socioeconomic status (13, 14); while, it is unknown that the plasma vitamin D level is related to diet quality or not.

In most studies, only old age people including subjects with chronic diseases that were studied was shown to have a lack of a lack of information on the contributing factors about vitamin D status in healthy young adult populations. In this study, to promote the public health aspect, we needed to investigate comprehensive predictors together for vitamin D level, so we measured we measured determinants of vitamin D status in healthy young adults in relation to diet quality, sun exposure, physical activity, sociodemographic and anthropometric factors that were not recognized in Iranian community.

Materials and Methods

This was a cross-sectional study enrolling information from 180 couples referred to 2 health centers in Shiraz, southern Iran that accomplished pre-marriage examinations. Questionnaires were provided to collect sociodemographic, anthropometric and lifestyle data (gender, age, job, income, education status, physical activity, sitting time and food intake) in individuals who agreed to participate in the study. Food intake was assessed by Food Frequency Questionnaire(FFQ), with validity and reliability (15). The nutritional values of foods reported on the FFQ were analyzed using the computer program for performing nutritional calculations of Nut4, and data were analyzed by SPSS software (Version 19, Chicago, IL, USA). The levels of income were shown regarding two groups of genders categorized as (i) No income, (ii) Under poverty line, and (iii) Above the poverty line.

Height was measured to the nearest centimeter while the subjects were barefoot, and body weight was assessed to the nearest 0.1 kg using a scale while the subjects wore light clothing. The BMI was calculated by determining the ratio between weight and squared height (kg/m^2). The waist circumference was taken at the arrows points between the lower costal margin and the superior iliac crest.

Blood pressure was recorded using a mercury Hg monometer twice in a sitting position after subjects had been in a relaxed state for at least 10 minutes. Hypertension was defined as 2 consecutive systolic/diastolic blood pressure measurements >140/90 mmHg or current treatment with antihypertensive medication. Serum biomarkers were measured in nutrition research laboratories. All participants provided a non-fasting venous blood sample of 16 mL. The serum was stored at −20 °C until analysis. For analyses of 25[OH] D, we used Chemi Luminescent Immune Assay (CLIA Diasorin, Stillwater, USA). The concentration of plasma biomarkers were determined using an auto-analyzer (Biotechnical 1500, Rome, Italy). The concentrations of plasm low-density lipoprotein (LDL), High-density lipoprotein (HDL), total cholesterol, and triglyceride (TG), were measured through an enzymatic colorimetric assay method using commercial kits (Pars Azmoon, Iran).

International Physical Activity Questionnaire (IPAQ) is an instrument designed primarily for adults (age range of 15-69 years). The IPAQ face-to-face interview format was used to assess the habitual physical activity during the previous 7 days ago. Additionally, energy consumption was calculated based on the second edition of codes and metabolic equivalent (MET) values. The IPAQ data were converted to MET scores (MET- min/week) for each type of activity by multiplying the number of minutes dedicated to each activity class by the specific MET score for that activity. Sitting time can be extracted from this questionnaire that defined as the time spent in a sedentary position. This variable was calculated based on minute per day (16).

The Diet Quality Index-International (DQI-I) focused on 4 major aspects: variety (0–20 points), adequacy (0–40 points), moderation (0–30 points), and overall balance (0–10 points). The scores for all 4 categories were from 0 to 100 (0 being the worst and 100 the best possible scores). The adequacy of intakes for minerals and vitamin D were evaluated on the basis of the percentage attainment of the dietary reference intakes (17).

Distribution of relevant variables was assessed for outliers or aberrant distributions. Spearman correlation coefficient was estimated between study variables and plasma vitamin D level. Adjusted general linear models were used to estimate the association between vitamin D level and contributing factors. Other components were evaluated in a multinomial or ordinal logistic regression model. A p value less than 0.05 was considered statistically significant.

Results

A total of 180 subjects (90 males and 9 females) aged from 14 to 57 years were included in this cross-sectional study. As Table 1 and 2 show, a significant difference was noted between 2 groups regarding age, height, weight, BMI, waist circumference, LDL, HDL, FBS, job, and income status.

The correlation between plasma vitamin D level with various factors among two groups of males and females showed that vitamin D did not have any significant correlation with total diet quality, adequacy, variety, moderation, and overall balanced subscale scores (Table 3). Beside, analysis of diet quality showed that low quality diets (total global score<50 score) denoted to a mean global score of 47±6.3 and 46±6.4 in males and females, respectively. Further analysis revealed that there was a significant positive correlation between cholesterol and saturated fat intake and plasma vitamin D ($p<0.02$, $p<0.01$ respectively). Furthermore, there was a significant correlation between plasma vitamin D level with income status ($p<0.04$), education level ($p<0.04$)and physical activity (MET per week) ($p<0.04$). In contrast to this finding, no significant difference was found between BMI, sitting time (minute per day), and calcium intake (1310±734 mg), and vitamin D intake (1.8±1.5 mg) with plasma vitamin D level.

As well as, participants had daily mean exposure of 184±157 and 120±125 minutes to sun in males and females, respectively. The plasm vitamin D level did not reveal any significant correlation with sun exposure time (β=0.005, $p<0.26$) and using daily sun blockers β=0.01, $p<0.16$). Also, 38% of participants used daily sun blocker and 12.8% had history of using vitamin D supplement.

Discussion

An adequate vitamin D level is important for

Table 1: The difference of variables between both sexes

	Total N=180	Male N=90	Female N=90	*p*-value
	Mean±SD	Mean±SD	Mean±SD	
Age (year)	27.10±7.27	29.13±7.31	25.06±6.66	<0.001
Height (meter)	1.67±0.08	1.73±0.07	1.61±0.05	<0.001
Weight (kg)	67.06±14.52	73.911±14.22	60.21±11.28	<0.001
BMI	23.82±4.23	24.53±4.41	23.11±3.95	0.024
Waist circumference	82.42±11.08	87.28±10.20	77.57±9.75	<0.001
Blood pressure	120.62±13.24	122.10±14.05	119.14±12.29	0.134
Systolic blood pressure	119.87±13.19	121.34±13.98	118.40±12.25	0.135
Diastolic blood pressure	75.25±8.86	76.32±9.11	74.17±8.52	0.105
Physical activity (MET/week)	504.70±740.80	651.41±869.51	357.98±551.49	0.008
Total diet quality score	48.48±6.40	48.76±6.38	48.21±6.44	0.562
TG	174.58±80.72	183.46±80.34	165.71±80.57	0.141
Cholestrol	177.05±36.53	180.14±38.80	173.96±34.05	0.258
LDL-cholestrol	107.65±27.20	111.78±27.75	103.52±26.15	0.041
HDL-cholestrol	46.18±11.06	42.66±9.31	49.71±11.59	<.001
FBS	85.52±11.45	4.45±0.13	4.42±0.12	0.049

TG: Triglyceride; FBS: Fasting blood sugar; BMI: Body mass index; LDL: Low density lipoprotein; HDL: High density lipoprotein

Table 2: The comparison between two genders regarding education, occupation and income.

		Both genders		Male (n=90)		Female (n=90)		*p*-value
		No	%	No	%	No	%	
Job	Unemployed, housewives	69	38.3	10	11.1	59	65.6	<0.001
	Employee	51	28.3	31	34.4	20	22.2	
	Self-employed	60	33.3	49	54.4	11	12.2	
Education	high school and diploma	98	54.4	52	57.8	46	51.1	0.25
	Associate Degree	12	6.7	8	8.9	4	4.4	
	Bachelor	53	29.9	21	23.3	32	35.6	
	MA and Ph.D	17	9.4	9	10.0	8	8.9	
Income	The first level (without income)	58	32.2	1	1.1	57	63.3	<0.001
	The second level (below poverty line)	74	41.1	51	56.7	23	25.6	
	The third level (above the poverty line)	48	26.7	38	42.2	10	11.1	

Table 3: Association between serum vitamin D3 with diet quality score and contribution factors.

Variables	Male (N=90)				Female (N=90)				Total (N=180)			
	r	CI		*p*-value	r	CI		*p*-value	r	CI		*p*-value
		Lower Bound	Upper Bound			Lower Bound	Upper Bound			Lower Bound	Upper Bound	
Total diet quality score	-0.10	-0.48	0.27	0.59	-0.02	-0.38	0.33	0.88	-0.01	-0.27	0.24	0.91
Variety subscale	-0.49	-1.27	0.28	0.21	-0.06	-1.07	0.61	0.59	-0.41	-0.98	0.156	0.15
Adequacy subscale	-0.07	-0.82	0.676	0.84	0.07	-0.48	0.97	0.50	0.14	-0.37	0.66	0.57
Moderation subscale	0.32	-0.40	1.05	0.38	-0.160	-1.06	0.20	0.17	0.02	-0.44	0.49	0.92
Overall balance subscale	-0.24	-1.53	1.03	0.70	0.06	-1.06	1.91	0.569	-0.04	-1.00	0.92	0.93
Sun exposure	0.005	-0.011	0.02	0.52	-0.001	-0.02	0.017	0.87	0.001	0.005	0.01	0. 26
Sun blocker	-2.46	-9.59	4.65	0.49	1.12	-3.66	5.91	0.64	0.31	-3.63	4.25	0.87
Physical activity (MET/week)	<0.001	0.003	0.003	0.81	0.005	0.001	0.010	0.02	0.002	-0.02	0.004	0.005
Sitting time (Min/day)	0.008	-0.005	0.02	0.22	-0.007	-0.019	0.006	0.28	0.00	-0.008	0.009	0.91
Income	2.19	2.61	7.01	0.36	3.89	0.83	8.62	0.10	3.205	0.11	6.30	0.04
Educational level	0.48	2.90	1.93	0.68	2.28	0.27	4.83	0.08	0.55	1.12	2.22	0.04
BMI	-0.39	-1.01	0.23	0.219	-0.005	-0.65	0.64	0.987	-0.36	-0.80	0.07	0.09

BMI: Body mass index

optimal function of many organs. Due to lack of scientific evidence on the role of vitamin D in the manifestation of non-communicable diseases (18), it becomes necessary to carry out further research and recognize the association of vitamin D with socioeconomic, diet quality, physical activity, sitting time and sun exposure time. So this study evaluated association of various factors with plasma vitamin D level.

We identified that plasma vitamin D level had a significant relationship with income status, physical activity, educational level, cholesterol and saturated fatty acid intake. As well as, no significant correlation was found between plasma vitamin D level and total diet quality score and subscales, sitting time, calcium intake, sun exposure, using sun blocker, and BMI.

The association between serum vitamin D levels and environmental factors, body composition, nutritional intake was previously studied (16). The relationship between serum vitamin D levels and physical inactivity, obesity and low vitamin D intake in a large population of healthy middle-aged men and women was investigated showing that the major modifiable predictors of low vitamin D status were low vitamin D dietary and supplement intake, BMI>30 kg/m^2, physical inactivity and low milk and calcium supplement intake. In men, 25(OH)D was determined more by milk intake on cereal and in women, by vitamin D and calcium supplement and menopausal hormone therapy (17).

In another study, the correlation between vitamin D status, body composition and physical exercise of adolescent girls was assessed. Cross-sectional analysis of 323 adolescent girls in winter showed that hypovitaminosis D was common in these subjects. In addition, BMI milk intake, participation in organized sports and total physical activity were all significant independent determinants of vitamin D status. An inverse association was noted between plasma 25(OH)D and intact-parathyroid hormone (iPTH) concentration. BMI, milk intake, participation in organized sports and total physical activities that all were emerged as major independent determinants of vitamin D status assessed by plasma 25(OH) D concentration. Vitamin D level was positively associated with lean body mass (LBM), but there was no correlation with the degree of body adiposity. Regardless of the concentration of 25(OH)D in blood used to define vitamin D deficiency, hypovitaminosis D was common in these subjects (18).

In another study, association between vitamin D level status and adiposity, physical activity, and fitness were surveyed. In this study, 559 subjects of 14 to 19 years old participated. There were significant inverse correlations between 25-hydroxyvitamin D levels and all adiposity measurements, including BMI percentile (p=0.02), waist circumference (p<0.01), total fat mass (p<0.01), percentage of body fat (p<0.01), visceral adipose tissue (p=0.015), and subcutaneous abdominal adipose tissue (p=0.039). There were significant positive correlation between 25-hydroxyvitamin D levels and vigorous physical activity (p<0.01) and cardiovascular fitness (p=0.025) (19).

Vitamin D3 (cholecalciferol) is derived from skin exposure to UV-B rays and dietary intake (including supplements). Few foods contain vitamin D2 (ergocalciferol) or vitamin D3 (20), and recommended doses of vitamin D supplementation have not changed significantly in the past 2 decades. Therefore, ingestions, at a small component can change the prevalence. Because exposure to UV-B rays is the primary determinant of vitamin D status in humans, this is more likely to be the primary cause of the increasing prevalence of vitamin D insufficiency. Sunscreen with a sun protection factor of 15 was shown to decrease the synthesis of vitamin D3 (21-23). Increased sunscreen use with a higher sun protection factor likely contributed to the reported trend of lower 25(OH)D levels. In addition, decreased outdoor activity and obesity have been associated with vitamin D insufficiency (24). Previously published data suggested that vitamin D insufficiency was more prevalent among older adults (owing to reduction of 7-dehydrocholesterol levels in skin), women (owing to lower outdoor activity), and individuals with darker skin (owing to increased melanin) (25).

Exercise itself may contribute the maintenance of vitamin D level, other than merely by increasing exposure of skin to sunlight. It is well established that physical activity increases local bone mass, reduces calcium excretion and raises absorption efficiency, thus increasing serum calcium which results in sparing serum vitamin D. In addition, physical activity which is known to reduce body weight by increasing the rate of lipolysis may enhance mobilization from adipose tissue, thus increasing its serum level (26).

High prevalence of vitamin D deficiency in population living in a sunny-rich area is surprising and is likely multi-factorial including sun exposure, vitamin D, calcium intake skin pigmentation, clothing, cultural practices obesity and increasing age and VDR polymorphisms (27, 28). Our study acknowledges a few limitations. Data on sun exposure and physical activity were based on administered questionnaires which are subject to recall bias. Data on which body parts were exposed were also not provided. Based on significant correlation between vitamin D level and cholesterol and saturated fat, physical activity time per week and income, we can conclude that physical activity is associated with a favorable vitamin D status. A prospective approach using a more controlled environment (experimental setting) rather than interview questionnaire might provide more definitive answers to the differences observed in the present study.

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Conflict of Interest

None declared.

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