Original Article

Effect of physical activity level on vitamin D in teenagers

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ABSTRACT

Background: Vitamin D has a dramatic effect on health and a significant role in disease prevention. Inadequate dietary system and decreased sun exposure are the most important causes of vitamin D deficiency. The traditional intervention for vitamin D deficiency is supplements. Aim: The aim of our study was to evaluate the vitamin D status in teenagers and investigate the influence of activity level on vitamin D in this age group. Materials and methods: 204 male teenagers were recruited from Taif secondary schools. Their age ranged from 14 to 16 years, they had the same pubertal stage. They had not used vitamin D or calcium supplements for four months. Physical activities were measured using the piezoelectric pedometer. Dietary intake was calculated using the food frequency questionnaire. Also, sun exposure was calculated by the number of day hours spent outdoor. Results: There were no significant differences among the groups regarding sun exposure and dietary intake ($P<0.05$). Regarding vitamin D level, there was a significant increase in the more active groups, (active and highly active groups) ($P>0.05$), when compared with the less active groups. Also, the Pearson correlation showed highly significant correlation between the activity level and vitamin D level ($r=0.418$) and significance value of. 0.000. Conclusion: Physical activity level can affect vitamin D serum levels when the effect of sun exposure and dietary intake is controlled. There is a highly significant correlation between physical activity level and serum vitamin D level.

Keywords: Physical activity, vitamin D, teenager.

Introduction

Vitamin D deficiency is a common problem all over the world. Vitamin D deficiency not only has an impact on bone health but also it is related to many other diseases such as diabetes, cancer, and heart disease [1-6]. Also, vitamin D was found to be an important factor in psychological health in young adults. Increased sun exposure was recommended to improve mental health by improving vitamin D status [5, 7, 8]

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It was observed that vitamin D deficiency is a common health problem among children of sunny cities such as Jeddah, Kingdom of Saudi Arabia, which is associated with health problems such as rickets [9, 10]. Also, Vitamin D status was found to be inversely correlated to age in children and teenagers. This may be due to a decrease in the activity level, inappropriate diet or decreased sun exposure [11, 12].

Muscular tissue and muscular activities were found to have a significant effect on 25(OH)D plasma levels. It was proved that a certain exercise program can improve 25(OH)D levels. The muscular tissue is considered a pool for 25(OH)D, which protects it from hepatic catabolism and can release it to blood after muscular activities [13, 14].

Vitamin D status is assessed by serum 25-OH levels, which are classified according to the following struts: ≤10, 11–20, and 21–30 and >30 ng/mL, and they are demarcated as a severe deficiency, deficiency, insufficiency, and sufficiency, respectively, according to previously recognized guidelines for bone health. [15-17]

So, the aim of the current study was to evaluate the vitamin D status in teenagers and investigate the influence of activity level on vitamin D in this age group. Other factors, which may affect vitamin D status such as diet and sun exposure were evaluated to ensure that any change in vitamin D status was due to change in the physical activities.

Materials and Methods

204 male students were recruited from the Taif secondary public schools. The enrollment was done by telephone calls to their parents to illustrate the nature and importance of the study. After that, we interviewed the parents and their sons to take the anthropometric parameters, illustrate to them the steps of the study, signing a consent form, take a medical history, and train them on how to use the pedometer, and food frequency questionnaire (FFQ). This study was ethically approved by the Ethical Committee at Taif University with application No. 41-34-0041. The sample size was determined using the G power program at medium effect size (0.25), power of (0.85) and alpha level of (0.05) [18]. This study was conducted at the college of applied medical sciences, Taif University, Saudi Arabia. The study started on January 1, 2020, and last for one month.

Subjects:

The subjects' inclusion criteria were: age ranged from 14-16 years, having the same pubertal stage (one to two year after the onset of puberty), body mass index (BMI) ranged from 15-22 (which is considered normal BMI according to WHO [19], free from any systemic diseases, having no previous major surgeries, taking no vitamin D or calcium supplements during last four months, the main portion of the dietary intake was homemade.

Dietary intake and sun exposure:

Saudi (FFQ) was used, which is a modified form of food frequency questionnaire developed by the European prospective investigation into cancer and nutrition study (EPIC). It includes the food items that frequently consumed by the Saudi population [20]. This questionnaire was used to estimate the nutrients intake in mg especially vitamin D and calcium throughout the study period. The subjects documented the consumed food, its types and its estimated amount, for every meal. The documentation was done daily for one week then the data were submitted to the researchers by the end of the week. The FETA computer program was used to analyze the data obtained from the FFQ [21]. Monitoring and analysis of dietary intake were done by a trained dietitian. Sun exposure was calculated as the number of day hours spent outdoor reported by the participants of the study.

Pedometer:

Omron HJ-324U digital pocket was used for one week including the weekend time. It is a simple, light-weight device that can be clipped easily and one can move with it everywhere. It can monitor the physical activities by counting the steps, and data for each day is stored separately. The memory can store data for seven days. The data are displayed on the screen by pressing the MEM button. the MEM button shows the results (days 1-7) in memory. The display changes with each press of the MEM button.

The procedures were conducted under the supervision of the primary researcher. She instructed the teenagers and their parents about the appropriate use of the pedometer. The pedometer was put on at the waist level using an elastic band that contained a pocket for the pedometer. It was put on all over the day except during bedtime, bathing or swimming. The subjects were instructed to practice their normal activities. If the subject removed the pedometer one hour or more during any day, the data of this day were excluded. Omron HJ-324U is one of the most accurate pedometers, which can be worn in different positions [22].

The data from the pedometer were collected by the end of the week. Data were processed by a personal computer for calculating the physical activities for each subject. Physical activities were classified as sedentary life, low active, somewhat active, active and highly active according to the number of steps as the following: $<5,000$ steps/day were classified as a sedentary lifestyle, 5,000–7,499 steps/day were classified as low active, 7,500–10,000 steps/day were classified as somewhat active, 10,000–12,499 steps/day were classified as active, and individuals walking $>12,500$ steps/day were considered as highly active [23, 24].

Vitamin D evaluation

ELISA reader:

ELISA (Enzyme-Linked ImmunoSorbent Assay) technique was used to detect 25(OH)D levels in plasma. Blood samples were withdrawn from all participants at the chemistry lab, faculty of Applied Medical Sciences, male section, Taif University after a week of data collection (diet, sun exposure, and physical activities). The samples were withdrawn at the same time from the day (9 AM) to avoid the effect of hormonal diurnal rhythm. Three cubic centimeters of blood were withdrawn after fasting more than 10 hours.

The current study was a case-control study. SPSS version 20 was used for statistical analysis. ANOVA was used to reveal any significant difference among the groups of different activity levels regarding sun exposure and dietary intake. After this step, we compared the vitamin D level (25(OH)D) among the groups of different activity levels. Also, the Pearson correlation test was used to declare the level of correlation between activity level and serum vitamin D. The alpha level of significance was set at 0.05.

Results

The aim of the current study was to evaluate the vitamin D status in teenagers and investigate the influence of activity level on vitamin D in this age group. According to pedometer data, the samples were divided into four groups: 42 subjects low active, 55 subjects somewhat active, 86 subjects active, and 17 subjects highly active. According to the Shapiro Wilk test, skewness, kurtosis and their standard errors and inspection of stem and leaf graphs and QQ plots, our data showed almost normal distribution. ANOVA showed that there were not any significant differences between the four groups regarding age, stage of puberty, and BMI. The demographic data of the four groups are illustrated in Table (1).

Table 1: Demographic data of the four groups.

	low active No. 42	somewhat active No. 55	active No. 86	highly active No. 17	F value	Sig.
Age (M±SD)	14.8±0.63	15.0±0.81	15.07±4.09	14.9±0.84	0.076	0.93
Months after puberty (M±SD)	16.41±1.86	17.1±2.04	17.25±10.75	17.09±2.03	0.611	0.6
BMI (M±SD)	16.47±1.83	17.11±2.22	15.18±2.56	15.28±1.41	1.05	0.37

Regarding the difference between the four groups in sun exposure and dietary intake, ANOVA revealed that there was no significant difference between the four groups in these two variables (Table 2).

Table 2: Difference between the four groups in sun exposure and dietary intake.

	ANOVA					
					F	P
	Low active	Somewhat active	Active	Highly active		
Sun exposure Mean ± SD	42.97±8.9	43.18±7.8	45.40±9.7	43.82±11.5	0.95	0.414
Vitamin D intake mg/day Mean ± SD	102.09±13.8	102.16±11.8	105.53±20.9	114.41±23.8	2.43	0.066

According to the effect of physical activities on vitamin D serum level, ANOVA, and post hock test (Bonferroni) showed a significant increase in the more active groups, (active and highly active groups), when compared with the less active groups, (low active and somewhat active) (Table 3). Pearson correlation showed a highly significant positive correlation between the activity level and vitamin D level with a Pearson correlation value of 0.418 and the significance value of 0.000.

Table 3: Effect of physical activities on vitamin D serum level.

	ANOVA					
	Low active	Somewhat active	Active	Highly active		
Vitamin D ng/ml Mean ± SD	15.42±1.7	16.11±1.8	17.3±2.02	18.66±3.2	14.26	.000*

Bonferroni test

Pairs	**Sig.**	**Pairs**	**Sig.**
low active vs. somewhat active	.624	low active vs. active	.000*
low active vs. highly active	.000*	Active vs. highly active	.083

Discussion:

The results of our study revealed that there were no significant differences between the groups of different activity levels regarding sun exposure. This may be attributed to the nearly equal time of sun exposure during a day, which is the break time in the school schedule in addition to physical activity lessons in the school. In Saudi Arabia, sun exposure does not play an important role in vitamin D status as customs and traditions make people wear clothes that almost cover the whole body, so there is not enough directly exposed skin [25]. Concerning the dietary intake of vitamin D, statistical analysis showed that the difference between the four groups was non-significant. This may be attributed to the fact that most of the dietary sources are fortified by vitamin D [26].

Regarding the effect of physical activity on serum vitamin D level, our results revealed that the increase in the level of physical activities is associated with increased serum level of vitamin D. This comes in agreement with Wanner et al., 2015 [27], who found an association between the physical activity measured using Acti-Graph 7164 accelerometer and vitamin D level in individuals older than 18 years and they concluded that the physical activities may play a role in the improvement of vitamin D status. Also, Manios et al., 2018 [28], found a positive association between moderate physical activities more than 30 minutes measured by accelerometer and vitamin D level. The results of Elsayyad et al., 2019 [14] support our results as they found that conducting a selected treadmill exercise program for 12 weeks can improve vitamin D status in young adults. Gudjonsson et al., 2018 [29] found that there is an association between physical activity during leisure time and vitamin D level in normal and overweight older adults.

Our results contradict Gudici et al., 2017 [30], who conducted a cross-sectional study and found no association between physical activity level measured by international physical activity questionnaire and serum level of vitamin D. This contradiction may be attributed to the difference in the assessment tool between the current study and theirs. The results of Wanner et al., 2015 [27] showed that the association of physical activity and vitamin D depends on the assessment method of physical activities.

Conclusion

We concluded that physical activity level can affect vitamin D serum level when the effect of sun exposure and dietary intake is controlled. There is a highly significant correlation between physical activity level and serum vitamin D level.

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