

The proportion of vitamin D deficiency in reproductive age group women in Baghdad/Iraq, and its association with menstrual cycle characteristics and anthropometric measurements

Mohammed Mohammed Bakir Al-Moosawi , Rana Faisal Hammadi, Iman Midhat Abbas, Bushra Jaafar Abdulbaqi, Athraa Alauddin Abdullah

Abstract— Background: Vitamin D deficiency is the most common medical condition worldwide. There is a wide variation by and within regions in the prevalence of vitamin D deficiency especially in developing countries [varying between 30–90%]. The role of vitamin D in reproduction is a new, active area of investigation. Vitamin D receptor is expressed in the ovary, placenta, and the uterus. Lower vitamin D has been related to uterine fibroids. Anti-Mullerian Hormone regulates follicular recruitment, which provides a mechanism for vitamin D to influence ovarian function and menstrual cycle regularity. Many conditions may influence the vitamin D status and excess body weight may be one of them. Body fat may act as a reservoir for storage of the fat soluble vitamin D, reducing its bioavailability.

Objectives: To determine the proportion of vitamin D deficiency and its association with menstrual cycle characteristics and anthropometric measurements in reproductive age group women in Baghdad/Iraq.

Methodology: 99 women within the reproductive age were recruited in this cross-sectional study. The participants were classified as having oligomenorrhea if their menstrual cycles were greater than 35 days and less than 6 months; polymenorrhea if their menstrual cycles were 21 days or less; or having regular menstrual cycle. The regular menstrual cycle group was used in the study for comparison. Height, weight, and waist circumference were measured, and body mass index was calculated. Vitamin D status was determined by the measurement of serum 25 hydroxy vitamin D. Vitamin D status was defined as deficiency if 25 hydroxy vitamin D was <20 ng/mL, insufficiency as 25 hydroxy vitamin D of 21-29 ng/mL, and sufficiency if the 25[OH]D concentration was between 30 – 100 ng/mL].

Results: The proportion of vitamin D deficiency among participants was dramatically high [93%]. There was no significant relationship between Vitamin D Status and menstrual cycle irregularity, although that irregular cycle group was more likely to be deficient than the regular cycle group [93.9% to 92.0%]. There were no significant relationships between vitamin D status and age, age of menarche, marital status, dysmenorrhea, and body mass index. The relationship between vitamin D status and waist circumference was not significant, but the vitamin D deficient group had higher waist circumference [Mean=83.8 cm] compared to the vitamin D sufficient group [Mean=76.6 cm]. The effect of vitamin D supplementation was obvious in improving the vitamin D status.

Conclusion: The proportion of vitamin D deficiency was very high among the studied group. Although that the prevalence of deficiency was higher among irregular cycle group, the relation was not significant. The relation of vitamin D status with other parameters was insignificant.

Key words— Body mass index, Irregular menstrual cycle, Proportion, Reproductive age group, Vitamin D deficiency, Vitamin D supplementation, Waist circumference.

1 INTRODUCTION

VITAMIN D is produced endogenously through exposure of skin to sunlight, and is absorbed from foods containing

- *Mohammed Mohammed Bakir Al-Moosawi is holding a fellowship of the Iraqi Council for Medical Specializations in Pathology (Chemical Pathology)(FICMS/Chem Path), and a fellowship of the American Association of Clinical Chemistry Academy (FAACC), Mobile:009647711811543, Email: mohammed73@hotmail.com.*
- *Rana Faisal Hammadi is holding a fellowship of the Iraqi Council for Medical Specializations in Pathology (Chemical Pathology)(FICMS/Chem Path), Mobile: 009647707267429, Email: dr.rana.hammadi81@gmail.com.*
- *Eman Medhat Abbas is holding a bachelor degree in Science (Chemistry), Mobile: 009647901203059, Email: ammona83@yahoo.com*
- *Bushra Jaafar Abdulbaqi is holding a bachelor degree in Pharmacy.*
- *Athraa Alauddin Abdullah is holding a bachelor degree in Medical Technology.*

or supplemented with vitamin D. The vitamin is metabolized to its biologically active form, 1, 25-dihydroxyvitamin D [1, 25(OH) 2D], a hormone that regulates calcium and phosphate metabolism [1]. Vitamin D2 and vitamin D3 are metabolized to 25-hydroxyvitamin D [25(OH)D] in the liver by vitamin D 25-hydroxylase enzyme[2].

The half-life of circulating 25(OH)D is 2 to 3 weeks. At 25(OH)D concentrations near 30 ng/mL, dietary calcium absorption is maximal. Therefore any reference interval for 25(OH)D should not be confused with the “optimal” or “healthy” range for 25(OH)D. At physiologic concentrations, 25(OH)D is biologically inactive in affecting dietary calcium absorption.

25[OH]D₂ and 25[OH]D₃ are metabolized to 1,25-dihydroxyvitamin D [1,25[OH]D₂], the biologically active hormone, by 25[OH]D 1 α -hydroxylase enzyme, in kidney and placenta. The half-life of 1,25[OH]D₂ is 4 to 6 hours[1].

Vitamin D nutritional status is best determined through the measurement of 25[OH]D, rather than vitamin D, because 25[OH]D is the main circulating form of vitamin D, its longer day to-day variation, exposure to sunlight, or food intake, and because measurement of 25[OH]D is relatively easy compared with the more technically complicated methods used to measure vitamin D[2], [3], [4].

Serum 25[OH]D concentration is generally accepted as the functional indicator of an individual's vitamin D status[1].

Diagnosis of vitamin D deficiency is not based on measurement of 1,25[OH]D₂, however, because the circulating concentration of this metabolite is often normal because of a compensatory hyperparathyroidism[5].

The assay is not useful in confirming intoxication with vitamin D or 25[OH] D, because in this situation, 1,25[OH]D₂ concentrations may be low, normal, or increased[1].

Vitamin D deficiency is the most common medical condition worldwide. An estimated one billion people in the world have vitamin D deficiency or insufficiency [6]. The prevalence of vitamin D deficiency among adult population was reported to be 14-59% with a higher prevalence in Asian countries [7].

The prevalence especially in developing countries, varying widely by and within regions between 30 – 90% [20].

The role of vitamin D in reproduction is a new and active area of investigation [8], [9]. Vitamin D receptor is expressed in the ovary, placenta, and the uterus [10].

The promoter region for the gene encoding anti-Müllerian hormone [AMH] contains a domain for the vitamin D response element, suggesting that vitamin D can regulate AMH expression [11]. Therefore the ability of AMH to regulate follicular recruitment provides a mechanism for vitamin D to influence ovarian function and menstrual cycle regularity [8].

Although termed the 'menstrual cycle', since menstruation is the obvious monthly event during reproductive life, the normal menstrual cycle is mostly a reflection of ovarian events [12].

The mean age of menarche is 12.8 years and it may take over three years before the menstrual cycle establishes a regular pattern. Initial cycles are usually anovulatory and can be unpredictable and irregular [13].

The length, regularity and frequency of normal menstrual cycles have been described in both population and observational studies. Mean menstrual cycle length between the ages of 20 and 34 years varies between 28 and 30.7 days. Physiologically regular menses indicate cyclical ovarian activity, in turn dependent upon an intact HPO axis. Aberrations in menstrual pattern are thus an indication of disorder of ovarian function. The average age of the menarche is 12.8 years, but this has been gradually decreasing. Factors such as ethnic origin, socioeconomic status and nutrition can affect age of menarche. With obesity presently such a prominent problem, it is interesting to note that there is a relationship between age of men-

arche and body mass index [BMI], with early menarche associated with raised BMI.

Many conditions may influence the vitamin D status and excess body weight may be one of them. Body fat may act as a reservoir for storage of the fat soluble vitamin D, reducing its bioavailability. A negative correlation between serum 25[OH]D levels and magnitude of weight loss in patients after surgical treatment of morbid obesity confirms this theory. A contributing factor to the low vitamin D status among obese people might be lower than average exposure of large body areas to the sun. It is assumed that secondary hyperparathyroidism, observed frequently in overweight and obese populations, may be the result of low serum 25[OH] D levels [14].

2 AIM OF THE STUDY

To determine the proportion of vitamin D deficiency and its association with menstrual cycle characteristics and anthropometric measurements in reproductive age group women in Baghdad/Iraq.

3 MATERIALS AND METHODS

3.1 Participants

99 women within the reproductive age [15-44 years old], who referred to the gynecologic outpatient clinic at Al-Elwiya Maternity and Gynecology Teaching Hospital, Baghdad, Iraq from July 2017-March 2018, for having gynecologic problems were recruited in this cross-sectional study. The participants were classified as having oligomenorrhea if their menstrual cycles were greater than 35 days and less than 6 months, polymenorrhea if their menstrual cycles were 21 days or less, or having regular menstrual cycle [n=50]. The regular menstrual cycle group was used in the study for comparison.

All the participants provided informed consent and completed a [self] administered questionnaire that includes reproductive, personal, and demographic history data.

17 participants were excluded from the study; surgically and naturally menopausal women [N = 2], women who may have used hormonal contraception [N = 8], women who were perimenopausal [45 or over] [N =2], and women who did not fully complete the [self] administered questionnaire [N = 5] were excluded.

3.2 Methods

3.2.1 Clinical and anthropometric characteristics

Height, weight, and waist circumference were measured at 08:00 a.m. to 10:00 a.m. after 12 hours of fasting.

Height was measured using a stadiometer, and weight was obtained with participants wearing light clothing and no shoes using RGZ-160 dial type weighing scale [Jiangsu, China].

The BMI was calculated using the standard equation [kilograms per meters squared].

BMI was classified into four categories; underweight <18.5,

Normal 18.5 – 24.9, overweight 25 – 29.9, obesity 30 – 39.9[15]. Waist circumference was measured at the midpoint between the lower margin of the least palpable rib and the top of the iliac crest, using a stretch - resistant tape.

The participants stood with feet close together, arms at the side and body weight evenly distributed, and they wore little clothing and at the end of a normal expiration. Each measurement was repeated twice.

The average was calculated if the measurements were within 1 cm of one another,

If the difference between the two measurements exceeded 1 cm, the two measurements were repeated [16].

3.2.2 Laboratory measurements

Blood samples were collected in plastic tubes with separation gel and clot activator using standard method [17].

The blood left to coagulate and then centrifuged. Serum was separated and stored at -25°C until analysis. After thawing, the serum samples were homogenized before testing, and mixed using a vortex-type mixer [18].

25 [OH] Vitamin D was measured by VIDAS equipment using the ELFA technique [Enzyme Linked Fluorescent Immunoassay].

Calibration, using the calibrator provided in the kit, was performed every time a new lot of reagent was opened. A second calibration was done after 28 days according to the manufacturer instructions [18].

Quality control materials were tested according to the laboratory local regulations [18].

3.2.3 Statistical analysis

25[OH]D was structured as a trichotomous variable, as a vitamin D deficiency if the 25[OH]D concentration was below 20 ng/mL, vitamin D insufficiency, insufficiency as 25 hydroxy vitamin D of 21-29 ng/mL, and as vitamin D sufficient if the 25[OH]D concentration was between 30 – 100 ng/mL based on Endocrine Society Clinical Practice Guideline[19].

Data are reported as mean ± SD for continuous variables and as numbers [frequency] or percentage for categorical variables.

Clinical and biochemical characteristics were compared using the Independent sample t-test or the chi-square test when the variables were continuous or categorical, respectively.

The one-way analysis of variance [ANOVA] was used to determine whether there were any statistically significant differences between the means of two or more independent groups.

If $p < 0.05$, the relation was considered significant.

Statistical analyses were performed using SPSS software, version 24.0 [SPSS Inc., Chicago, IL, USA].

4 RESULTS

There were no significant statistical differences between the means for age, weight, height, BMI, WC, age of menarche, and length of menses between the regular cycle group and the irregular cycle group. However the percentage of women complaining from dysmenorrhea, Menorrhagia, and who were taking vitamin D supplementation was significantly higher in

the irregular cycle group than the regular cycle group [Table 1].

TABLE 1 BASIC CHARACTERISTICS OF THE PARTICIPANTS

Variables	Regular cycle(n=50)		Irregular cycle (n=49)		P-value
	Mean	SD	Mean	SD	
Age (yr)	33.4	8.4	31.0	9.7	0.197*
Weight (kg)	71.6	13.4	68.6	13.7	0.285*
Height (cm)	159.8	5.8	158.9	7.2	0.536*
BMI (kg/m2)	28.06	5.1	27.08	4.7	0.325*
WC	85.4	10.9	82.6	10.6	0.205*
Marital Status	Single (13) 26% Married (37) 76%		Single(9) 18.3% Married(40) 81.7%		0.361**
Dysmenorrhea	(23) 46%		(40) 81.6%		0.000**
Vitamin D Supplementation	(3) 6.1 %		(23) 46%		0.000**
Age of Menarche	12.8	1.6	12.7	1.4	0.64**

* Independent sample t test was applied

** Chi square test was applied

The proportion of vitamin D deficiency among participants was high [Figure 1]. 93% of the participants were deficient with vitamin D [< 20 ng/mL]. 3% of the participants complained from Vitamin D insufficiency [21-29 ng/mL], and only 4% of the participants were sufficient with vitamin D [30-60 ng/mL].

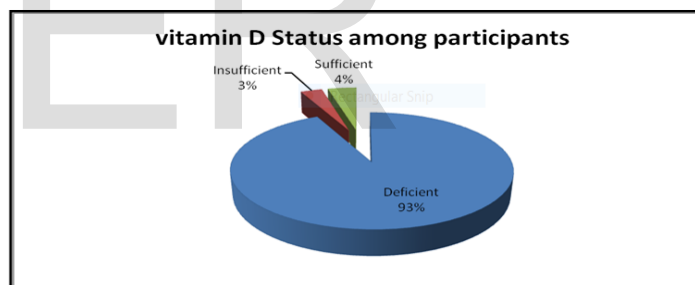


Fig. 1 The proportion of vitamin D deficiency among participants

There was no significant relationship between Vitamin D Status and menstrual cycle status, $\chi^2(2, N = 99) = 1.37, p > 0.503$ [Table 2]. However irregular cycle group was more likely to be deficient with vitamin D than the regular cycle group [93.9% to 92.0%] [Figure 2].

TABLE 2 THE RELATION BETWEEN VITAMIN D STATUS AND REGULARITY OF MENSTRUAL CYCLE

Vitamin D status	Regular cycle(n=50)		Irregular cycle(n=49)		P-Value
	Frequency	%	Frequency	%	
Deficient < 20 ng/mL	46	92	46	93.9	0.503
Insufficient 21-29 ng/ mL	1	2	2	4.1	
Sufficient 30-100 ng/ mL	3	6	1	2	

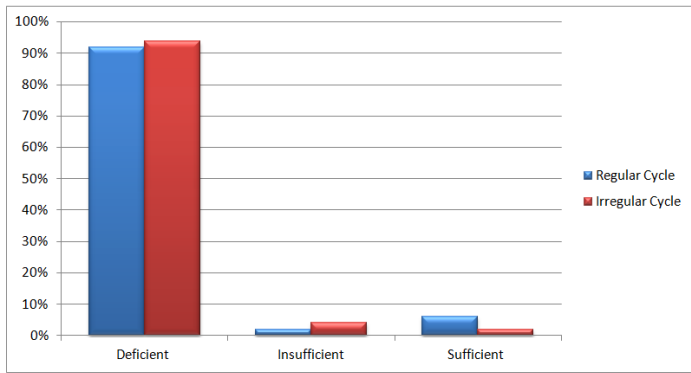


Fig. 2 Vitamin D status in participants (regular vs irregular cycle groups)

Vitamin D Status did not differ significantly between 68.7% of the participants who had dysmenorrhea and 32.3% who did not suffer from dysmenorrhea, $\chi^2(2, N = 99) = 2.4, p = 0.301$ [Table 3].

TABLE 3 THE RELATION BETWEEN VITAMIN D STATUS AND DYSMENORRHEA IN THE PARTICIPANTS

Vitamin D status	Dysmenorrhea (n=68)		Dysmenorrhea (n=31)		P-Value
	Frequency	%	Frequency	%	
Deficient < 20 ng/mL	62	91.2	30	96.8	0.301
Insufficient 21-29 ng/ mL	3	4.4	0	0	
Sufficient 30-100 ng/ mL	3	4.4	1	3.2	

The effect of Vitamin D supplementation was obvious in decreasing the prevalence of vitamin D deficiency in 8.8% of the participants who were taking vitamin D supplementation [Figure 3].



Fig. 3 The effect of vitamin D supplementation on vitamin D status

There is a significant relationship between Vitamin D Status & Vit D Supplementation, $\chi^2(2, N = 99) = 20.8, p = 0.000$ [Table 4].

TABLE 4 THE RELATION BETWEEN VITAMIN D STATUS AND VITAMIN D SUPPLEMENTATION AMONG PARTICIPANTS

Vitamin D status	Vitamin D Supplementation (n=8)		without Vitamin D Supplementation (n=91)		P-Value
	Frequency	%	Frequency	%	
Deficient < 20 ng/mL	3	37.5	89	97.8	0.000
Insufficient 21-29 ng/ mL	2	25	1	1.1	
Sufficient 30-100 ng/ mL	3	37.5	1	1.1	

Our study showed that there were no statistically significant effect for marital status [p=0.67], age [p=0.32], age of menarche [p=0.34], and body mass index [p=0.33] of the participants on their vitamin D status [Table 5,6,7,8].

TABLE 5 THE EFFECT OF MARITAL STATUS OF PARTICIPANTS ON THEIR VITAMIN D STATUS

Vitamin D status	Single (n=22)		Married (n=77)		P-Value
	Frequency	%	Frequency	%	
Deficient < 20 ng/mL	21	95.5	71	92.2	0.67
Insufficient 21-29 ng/ mL	0	0	3	3.9	
Sufficient 30-100 ng/ mL	1	4.5	3	3.9	

TABLE 6 THE EFFECT OF AGE OF PARTICIPANTS ON THEIR VITAMIN D STATUS

Vitamin D status	Frequency	Age (Years)		P-Value
		Mean	SD	
Deficient < 20 ng/mL	92	32.0	9.2	0.327
Insufficient 21-29 ng/ mL	4	38.7	9.2	
Sufficient 30-100 ng/ mL	3	30.0	4.0	

TABLE 7 THE EFFECT OF MENARCHE OF PARTICIPANTS ON THEIR VITAMIN D STATUS

Vitamin D status	Frequency	Age of Menarche (Years)		P-Value
		Mean	SD	
Deficient < 20 ng/mL	92	12.7	1.5	0.341
Insufficient 21-29 ng/ mL	4	13.0	1.8	
Sufficient 30-100 ng/ mL	3	14.0	1.0	

TABLE 8 THE RELATION BETWEEN VITAMIN D STATUS AND BMI OF PARTICIPANTS

Vitamin D status	Frequency	BMI		P-Value
		Mean	SD	
Deficient < 20 ng/mL	92	27.6	5.0	0.33
Insufficient 21-29 ng/ mL	4	29.4	2.2	
Sufficient 30-100 ng/ mL	3	23.8	4.0	

The relationship between vitamin D status and waist circumference was not significant [p=0.075] [Table 9], although that the deficient group had higher waist circumference [Mean=83.8 cm] compared to the sufficient group [Mean=76.6 cm] [Figure 4].

TABLE 9 THE RELATION BETWEEN VITAMIN D STATUS AND WAIST CIRCUMFERENCE OF PARTICIPANTS

Vitamin D status	Frequency	WC (cm)		P-Value
		Mean	SD	
Deficient < 20 ng/mL	92	83.8	10.8	0.075
Insufficient 21-29 ng/mL	4	94.5	6.0	
Sufficient 30-100 ng/mL	3	76.6	5.0	

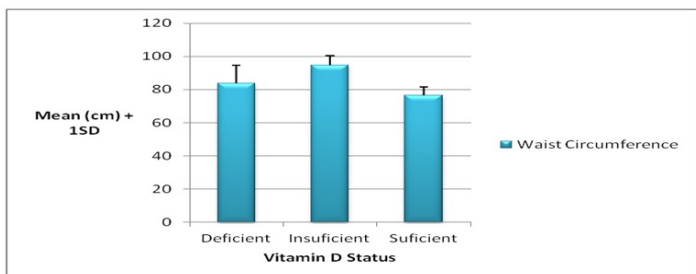


Fig. 4 Waist circumference of participants according to their vitamin D status

Vitamin D deficiency was more prevalent among obese participants [97%] than the normal weight participants [93.9%] as shown in [Figure 5], but there was no significant statistical difference between the vitamin D status in the three weight categories, normal weight, overweight, and obese [Table 10].

TABLE 10 VITAMIN D STATUS AMONG WEIGHT CATEGORIES OF THE PARTICIPANTS

Weight(n=99)	Vitamin D status(Frequency/Percent)			P-Value
	Deficient < 20 ng/mL	Insufficient 21-29 ng/mL	Sufficient 30-100 ng/mL	
Normal(n=33)	31(93.9%)	0(0%)	2(6.1%)	0.125
Overweight(n=33)	29(87.9%)	3(9.1%)	1(3%)	
Obese(n=33)	32(97%)	1(3%)	0(0%)	

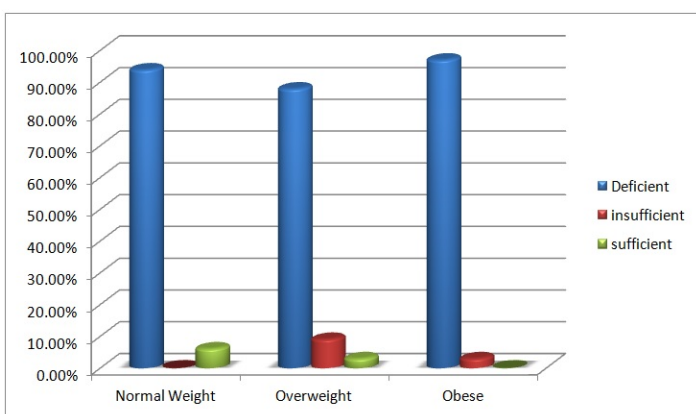


Fig. 5 The prevalence of vitamin D deficiency among participants (normal weight vs overweight vs obese)

5 DISCUSSION

Estimation of vitamin D status in reproductive age women is an important public health issue due to the vital role of those women in their community and because of the clinical nature of vitamin D status disorders which can be prevented and treated.

In our study we aimed to find the proportion of vitamin D deficiency and its association with menstrual cycle characteristics and anthropometric measurements in reproductive age group women in Baghdad/Iraq.

The data collected by the National Health and Nutrition Examination Surveys within North America found that there was a 4-fold increase in the prevalence of vitamin D deficiency over the past 10-15 years with as much as 36% of the USA population being affected [29] ,[30].

We found that the proportion of vitamin D deficiency among participants [N=99] was [93.0%].

There was a considerable variation in the prevalence of vitamin D deficiency in developing countries and within regions between 30 - 90% [20].

A study of Al-Hilali K. A. documented a prevalence of 90% in below optimal level for 25 [OH] D in child-bearing women in Iraq [21].

Shiva Faghieh and her colleagues concluded that 95.1 % of female university students in Shiraz, Iran were not sufficient with vitamin D [22].

Vitamin D deficiency is prevalent in many countries of the Middle East and Africa. A very low serum level of Vitamin D which ranges between [4.0-15.8 ± 11.6 ng/ml] with a mean level of [<10 ng/ml] was observed [23] ,[24] ,[25] ,[26].

In our study, the proportion of vitamin D deficiency in child bearing women was dramatically high; a finding that is consistent with the above studies that were done in Iraq and some of the neighboring countries suggesting that there are similar etiological factors for these findings.

Vitamin D is produced endogenously through exposure of skin to sunlight, and is absorbed from foods containing or supplemented with vitamin D [1].

There are many factors that can influence the production of vitamin D3 by the skin such as latitude, season, aging, sunscreen use, and skin pigmentation [1].

Most vitamin D in the body is that produced by synthesis in the skin. On the other hand only a few foods primarily fish liver oils, fatty fish, egg yolks, and liver, naturally contain significant amounts of vitamin D[1].

The concentration of 25[OH] vitamin D can be decreased by reduced availability of vitamin D, inadequate conversion of vitamin D to 25[OH] vitamin D, accelerated metabolism of 25[OH] vitamin D, and urinary loss of 25[OH] vitamin D[1].

The availability of vitamin D can be reduced with inadequate exposure to sunlight, dietary deficiency, malabsorption syndromes, and gastric or small bowel resection [1].

Therefore as the main source of vitamin D in our country is by its synthesis in the skin; we can consider women wearing style, those spending most of their time at indoor places, and

those using sunscreen lotion to prevent the harmful effect of sunrays especially during summer, are vulnerable to vitamin D deficiency. The contribution of the dietary habits of Iraqi people that could be poor with vitamin D containing food must be kept in mind.

This may explain the high prevalence of vitamin D deficiency in our studied group.

In our study, we found that irregular cycle group was more likely to be deficient with vitamin D than Regular Cycle group [93.9% to 92.0% respectively].

However, there was no significant relationship between Vitamin D Status & Menstrual Cycle Status.

The role of vitamin D in reproduction is a new, active area of investigation [24], [25].

Anne Marie Z Jukic and her colleagues found that lower levels of 25[OH] D were not associated with short or long menstrual cycles [27], a finding agrees with our study.

Anne Marie Z Jukic and her colleagues did another study at 2018, a study showed different results. They concluded that lower levels of 25[OH] D are associated with longer follicular phase and an overall longer menstrual cycle, when they studied late reproductive-aged women in North Carolina [2010-2015] [31].

Observational studies showed that lower 25[OH] D levels were associated with menstrual and ovulatory irregularities. A limited evidence for beneficial effects of Vitamin D supplementation on menstrual dysfunction in women with PCOS was observed in some studies. The results of human studies are contradictory about the role of Vitamin D on human fertility and reproductive physiology which merits further assessment by appropriate longitudinal studies. However, the effects of Vitamin D deficiency on human reproduction and fetal development are poorly studied [32].

More than that; among the total number of the participants [N=99], only four [4] women have Sufficient level of 25 [OH] D [30-100 ng/mL] which mean that Vitamin D deficiency is a very common problem in our community, therefore studying the effect of vitamin D deficiency on other parameters could be difficult.

The high prevalence of vitamin D deficiency in Iraq [21] and other neighboring countries in the Middle East [22], [23], [24], [25], [26], [28] makes it hard to find a significant relationship between 25-OH vitamin D deficiency and other factors such as irregular cycle, and this was the main limitation in our study.

Our study showed that there was no statistically significant effect for the age of menarche [p=0.34] on vitamin D status.

This finding agrees with previous studies that showed no relation between vitamin D status and age of menarche [33].

Our study found that the mean age of menarche in the vitamin D deficient group is less than that of the vitamin D sufficient group. This finding goes with the finding of a previous study that showed girls with evidence of vitamin D deficiency; 25 [OH] D <20 ng/mL were twice as likely to reach menarche during the observation period of 30 months compared with girls who were vitamin D sufficient [34].

There was no statistically significant effect for age [p=0.32] on

the vitamin D status.

Previous studies showed the decline in vitamin D status with age [35]. A significant inverse relationship between age and 25[OH] vitamin D levels was observed in other studies [36].

The finding in our study may be explained that the upper limit of age in our participants, which was 45 years, while the study of Baker MR and his colleagues [35] studied females between 20 – 96 years, and a study of Baily and his colleagues showed that age groups from [51 – 70 years] and [> 70 years] had less 25 OH vitamin D concentrations than younger age groups [37].

Our study showed that there was no statistically significant relationship between Body Mass index and vitamin D status [p=0.33].

Also vitamin D status did not differ significantly between the three weight categories of participants, although that the prevalence of vitamin D deficiency in the obese group was higher than the normal weight group.

The results of previous studies are controversial. Some studies showed that Vitamin D deficiency was significantly associated with a BMI of 85 kg/m² or higher [38], [14], [39], [40].

The association serum 25[OH] D is stronger with adiposity than that with body weight and BMI [41]. The reason for that may be explained by the fact that BMI and body weight do not necessarily reflect the percentage of body fat. Despite the quite low total fat mass for athletes and well trained persons; they still may have relatively high BMI and may be considered overweight or even obese [42].

The above causes could contribute to the finding of our study. Our study did not find any significant relationship between Vitamin D Status and marital status of the participants, but it showed that the prevalence of vitamin D deficiency was higher in single women [95.5%] compared the married women [92.2%].

Previous studies showed controversial results regarding this finding.

Saudi study showed that there was a statistically significant relationship between vitamin D level and marital status. Mean 25 [OH] D level was low in single participants compared to married [P=0.014] [43].

Also a Turkish study found that vitamin D deficiency rate was almost double as severe in single participants [44]. In studies investigating marital status in the literature, similarly, it was shown that the vitamin D levels of married individuals are higher [45], [46].

Our study agree with a study done in Cameroon, a study showed that marital statuses did not have any significant effect on the median vitamin D levels [39].

Vitamin D level was not significantly correlated with marital status in another study in Pakistan [47].

Also a study by Farid Ahmed Toor and his colleagues showed that when the Vitamin D deficiency was cross tabulated against marital status, statistically the difference was non-significant [48].

A study showed that higher proportions of institutionalized subjects, in the lower educational level, single, divorced or

widowed, reporting low levels of physical activity and presenting cognitive impairment were also found to be at risk of 25 [OH] D deficiencies [49].

Therefore, the effect of duration of indoor activities, educational level, physical activity, or even psychological status that may affect food habits can contribute to these controversial findings.

Our study did not show a significant relationship between vitamin D status and the occurrence of dysmenorrhea.

Previous results showed that High dose vitamin D supplementation can reduce the prevalence of premenstrual syndrome and dysmenorrhea [50].

There was a significant relationship between Vitamin D Status & Vitamin D supplementation.

This finding indicates that there is an important role for the vitamin D supplements on the vitamin D status, and further discussion about introducing these supplements to specific population groups like pregnant, elderly, and children should be discussed.

There was no significant relationship between Vitamin D status and waist circumference of participants in our study, although that vitamin D deficient group had higher waist circumference than the vitamin D sufficient group.

Our study showed that the relation between vitamin D concentration and waist circumference was more powerful than the relation between vitamin D concentration with BMI.

The results of some other studies can explain this finding. Dabhani and his colleagues showed that there was a positive association between obesity, measured as BMI, waist circumference, and waist-to-hip ratio and vitamin D deficiency with stronger associations observed with waist circumference [51]. Similar results were found in both prospective and cross-sectional studies, including the Aus-Diab study [52], the British Birth Cohort [53], and Middle Eastern populations [54], [55].

6 CONCLUSIONS

The proportion of vitamin D deficiency was very high among the studied group. Although that the prevalence of deficiency was higher among irregular cycle group, the relation was not significant. Vitamin D deficient group had higher waist circumference [Mean=83.8 cm] compared to the vitamin D sufficient group [Mean=76.6 cm] but the relation was not significant. The relation of vitamin D status with other parameters was insignificant. The effect of vitamin D supplementation was obvious in improving the vitamin D status.

7 RECOMMENDATIONS

1. Studying more population groups of different age, gender for finding the prevalence of vitamin D deficiency and its related etiological factors.

2. Establishment of the reference ranges for vitamin D in the Iraqi population; taking into consideration factors like age, gender.
3. The addition of fortified food containing vitamin D to the daily dietary regimes of people at risk of vitamin D deficiency.
4. Studying the response of vitamin D deficient women complaining from menstrual cycle irregularity to vitamin D supplementation within a specified time using prospective cohort study.
5. Measurement of other biochemical markers associated with the normal metabolic pathway of vitamin D such as serum calcium, and parathyroid hormone.
6. Finding the association between vitamin D status with other metabolic syndrome parameters which represent risk factors for cardio vascular diseases.

ACKNOWLEDGMENT

The authors like to express their deepest thank and sincere gratitude to the staff of outpatient laboratory department at Al-Elwiya Maternity and Gynecology Teaching Hospital, Baghdad, Iraq, for their help and cooperation. The authors are greatly indebted for the suggestions and assistance of Dr Zina Najeeb.

The authors would like to apologize gratefully to all people who helped us to complete this work without being able to mention them by names.

REFERENCES

- [1] Carl A. Burtis, Edward A. Ashwood, David E. Bruns. Tietz Textbook of Clinical Chemistry and molecular Diagnostics, Chapter 52, 1765, Fifth Edition, 2012.
- [2] Lensmeyer GL, Binkley N, Drezner MK. New horizons for assessment of vitamin D status in man. In: Seibel MJ, Robins SP, Bilezikian JP, eds. Dynamics of bone and cartilage metabolism, 2nd edition. San Diego, Calif: Academic Press, 2006:513-27.
- [3] Hollis BW. Assessment of circulating 25[OH]D and 1,25[OH]2D: emergence as clinically important diagnostic tools. *Nutr Rev* 2007; 65:S87-90.
- [4] Hollis BW. Measuring 25-hydroxyvitamin D in a clinical environment: challenges and needs. *Am J Clin Nutr* 2008; 88:507S-105.
- [5] Lips P. Relative value of 25[OH]D and 1,25[OH]2D measurements. *J Bone Miner Res* 2007; 22:1668-71.
- [6] Holick MF. Vitamin D deficiency. *N Engl J Med*. 2007; 357:266-81.
- [7] Silva Hovsepian, Massoud Amini, Ashraf Aminorroaya, et al. Prevalence of Vitamin D Deficiency among Adult Population of Isfahan City, Iran. *J HEALTH POPUL NUTR* 2011 Apr; 29[2]:149-155.
- [8] Lerchbaum E, Obermayer-Pietsch B. Vitamin D and fertility: a systematic review. *Eur J Endocrinol*. 2012; 166:765-78.
- [9] Luk J, Torrealday S, Neal Perry G, Pal L. Prevalence of vitamin D in reproduction. *Hum Reprod*. 2012; 27:3015-27.
- [10] Baird DD, Hill MC, Schectman JM, Hollis BW. Vitamin D and the risk of uterine fibroids. *Epidemiology*. 2013; 24:447-53.
- [11] Malloy PJ, Peng L, Wang J, Feldman D. Interaction of the vitamin D receptor with a vitamin D response element in the Mullerian-inhibiting substance

- [MIS] promoter: regulation of MIS expression by calcitriol in prostate cancer cells. *Endocrinology*. 2009; 150:1580-7.
- [12] Kieth Edmonds. DEWHURST'S TEXTBOOK OF OBSTETRICS & GYNAECOLOGY, Chapter 35, 348, 7th Edition, 2007.
- [13] Asha Monga, Stephen Dobbs, *Gynecology by Ten Teachers*. Chapter 3, 24, 19th Edition, 2011.
- [14] ZOYA LAGUNOVA, ALINA CARMEN POROJNICU, FEDON LINDBERG. The Dependency of Vitamin D Status on Body Mass Index, Gender, Age and Season. *ANTICANCER RESEARCH* 29: 3713-3720 [2009].
- [15] F.Xavier Pi-Sunyer; Diane M. Becker; Claude Bouchard. October 2000. The Practical Guide Identification, Evaluation, and Treatment of Overweight and Obesity in Adults. NIH Publication Number 00-4084.
- [16] WHO. December 2008. Waist Circumference and Waist-Hip Ratio: Report of a WHO Expert Consultation Geneva. 8-11.
- [17] WHO guidelines on drawing blood: best practices in phlebotomy, WHO, 2010.
- [18] BioMérieux SA. 2015/06. Package insert / VIDAS® 25 OH VITAMIN D TOTAL [VITD]. 9304004 D - en. www.biomerieux.com/techlib.
- [19] Michael F. Holick, Neil C. Binkley, Heike A. Bischoff-Ferrari, et al. Evaluation, Treatment, and Prevention of Vitamin D Deficiency: an Endocrine Society Clinical Practice Guideline. *J Clin Endocrinol Metab* 96: 1911-1930, 2011.
- [20] Asma Arabi, Rola El Rassi, and Ghada El-Hajj Fuleihan. Hypo-vitaminosis D in developing countries. *Nut Rev Endocrinol.*, 6: 550-561. 2010.
- [21] Al-Hilali K. A. Prevalence of Hypovitaminosis D in Adult Iraqi People Including Postmenopausal Women. *Scientific Research Journal [SCIRJ]*, Volume IV, Issue IX, September 2016.
- [22] Shiva Faghil, Maryam Abdolazadeh, Mohsen Mohammadi, Prevalence of Vitamin D Deficiency and Its Related Factors Among University Students in Shiraz, Iran. *Int J Prev Med*. 2014 Jun; 5[6]: 796-799.
- [23] El-Rassi R, Baliki G, El-Hajj F. Vitamin D Status in Middle East and Africa. International Osteoporosis Foundation. 2009. Available at: www.ofboneheart.org/site/default/files/pdf/Vitamin-D-MEast-Africa.pdf.
- [24] Moussavi M, Heidarpour R, Aminorroaya A, et al [2005] Prevalence of Vitamin D deficiency in Isfahan high school students in 2004. *Horm Res.*, 64: 144-148.
- [25] Siddiqui AM, Kamfar Z [2007] Prevalence of Vitamin D deficiency rickets in adolescent school girls in western region Saudi Arabia. *Saudi M J.*, 28: 441-444.
- [26] Elsonbaty MR, Abdul-Ghaffar NU [1996] Vitamin D deficiency in veiled Kuwaiti women. *Eur J Clin Nutr.*, 50: 315-318.
- [27] Anne Marie Z Jukic, Anne Z Steiner, and Donna D Baird. Lower plasma 25-hydroxyvitamin D is associated with irregular menstrual cycles in a cross-sectional study. *Reproductive Biology and Endocrinology* [2015] 13:20.
- [28] Samira Rajaei P1P M.D., Ph.D., Azadeh Akbari Sene P2P M.D., Sara Norouzi P2P M.D., et al. International Journal of Reproductive BioMedicine Vol. 14. No. 10. pp: 665-668, October 2016.
- [29] Nesby-O'Dell S, Scanlon KS, Cogswell ME, Gillespie C, Hollis BW, Looker AC, Allen C, et al. Hypovitaminosis D prevalence and determinants among African American and white women of reproductive age: third National Health and Nutrition Examination Survey, 1988-1994. *Am J Clin Nutr*. 2002;76:187-192. [PubMed].
- [30] Looker AC, Pfeiffer CM, Lacher DA, Schleicher RL, Picciano MF, Yetley EA. Serum 25-hydroxyvitamin D status of the US population: 1988-1994 compared with 2000-2004. *Am J Clin Nutr*. 2008;88:1519-1527. [PubMed].
- [31] Anne Marie Z. Jukic; Allen J. Wilcox; D. Robert McConaughy, et al. 25-Hydroxyvitamin D and Long Menstrual Cycles in a Prospective Cohort Study. *Epidemiology*. May 2018. 29[3]:388-396.
- [32] Dipanshu Sur* and Ratnabali Chakravorty. The Relationship between Vitamin D, Insulin Resistance and Infertility in PCOS Women. *Gynecol Obstet [Sunnyvale]* 2015, 5:5].
- [33] Hua, Alexandra. Vitamin D Status And Age Of Menarche. 2016. Public Health Theses. 1132.
- [34] Eduardo Villamor, Constanza Marin, Mercedes Mora-Plazas, et al. Vitamin D deficiency and age at menarche: a prospective study *Am J Clin Nutr* 2011; 94:1020-5.
- [35] Baker MR, Peacock M, Nordin B. The decline in vitamin D status with age. *Age Ageing*. 1980 Nov;9[4]:249-52.
- [36] Delphine A. Tangoh, Tobias O. Apinjoh, Yasir Mahmood, et al. Vitamin D Status and Its Associated Risk Factors among Adults in the Southwest Region of Cameroon. *Journal of Nutrition and Metabolism* Volume 2018, Article ID 4742574, 9 pages.
- [37] Bailey RL, Dodd KW, Goldman JA, et al. Estimation of total usual calcium and vitamin D intakes in the United States. *J Nutr* 2010;140[4]:817-22].
- [38] Mohan Kumaratne, MD, FAAP1, Gayle Early, PhD, FNP-BC2, and Jasmine Cisneros, BS3. Vitamin D Deficiency and Association with Body Mass Index and Lipid Levels in Hispanic American Adolescents. *Global Pediatric Health* Volume 4: 1-6. 2017.
- [39] Reinehr T, de SG, Alexy U, Kersting M and Andler W: Vitamin D status and parathyroid hormone in obese children before and after weight loss. *Eur J Endocrinol* 157: 225-232, 2007.
- [40] Bischof MG, Heinze G and Vierhapper H: Vitamin D status and its relation to age and body mass index. *Horm Res* 66: 211-215, 2006.
- [41] Arunabh S, Pollack S, Yeh J and Aloia JF: Body fat content and 25-hydroxyvitamin D levels in healthy women. *J Clin Endocrinol Metab* 88: 157-161, 2003.
- [42] Ode JJ, Pivarnik JM, Reeves MJ and Knous JL: Body mass index as a predictor of percent fat in college athletes and non athletes. *Med Sci Sports Exerc* 39: 403-409, 2007.
- [43] Ebtehal Solaiman Al-Mogbel. Vitamin D status among Adult Saudi Females visiting Primary Health Care Clinics. *International Journal of Health Sciences, Qassim University*, Vol. 6, No.2, [June 2012/Rajab 1433H].
- [44] Hasan Durmuş, Fevziye Çetinkaya. Vitamin D status of adults in Kayseri. *J Clin Anal Med* 2017;8[suppl 4]: 325-9.
- [45] Travis RC, Crowe FL, Allen NE, Appleby PN, Roddam AW, Tjønneland A et al. Serum vitamin D and risk of prostate cancer in a case-control analysis nested within the European Prospective Investigation into Cancer and Nutrition [EPIC]. *American Journal of Epidemiology* 2009; 169[10]:1223-32.
- [46] Kilkkinen A, Knekt P, Heliövaara M, Rissanen H, Marniemi J, Hakulinen T et al. Vitamin D status and the risk of lung cancer: a cohort study in Finland. *Cancer Epidemiology Biomarkers & Prevention* 2008;17[11]:3274-8.
- [47] Mahmood K, Akhtar ST, Talib A, Haider I. Vitamin-D status in a Population of Healthy Adults in Pakistan. *Pak J Med Sci* 2009;25[4]:545-550.
- [48] FARID AHMAD TOOR1, UMAR FAROOQ DAR2, NAEEM MAHMOOD MUGHAL3 et al. Vitamin D Deficiency among Pre-Menopausal Women Attending OPD with Generalized Body Aches and Pains. *P J M H S* Vol. 10, NO. 3, JUL - SEP 2016. 949.
- [49] Santos A, Amaral TF, Guerra RS, et al. Vitamin D status and associated factors among Portuguese older adults: results from the Nutrition UP 65 cross-sectional study. *BMJ Open*. 2017;7:e016123. doi:10.1136/bmjopen-2017-016123.
- [50] Afsane Bahrami, Amir Avan, Hamid Reza Sadeghnia, et al. High dose vitamin D supplementation can improve menstrual problems, dysmenorrhea, and premenstrual syndrome in adolescents. *Gynecological Endocrinology*. Volume 34, 2018-issue 8.

- [51] K Al-Dabhani, KK Tsilidis, N Murphy, et.al. Prevalence of vitamin D deficiency and association with metabolic syndrome in a Qatari population. *Nutrition & Diabetes* [2017] 7, e263; doi:10.1038/nutd.2017.14.
- [52] Gagnon C, Lu ZX, Magliano DJ, Dunstan DW, Shaw JE, Zimmet PZ et al. Low serum 25-hydroxyvitamin D is associated with increased risk of the development of the metabolic syndrome at five years: results from a national, population-based prospective study. *The Australian Diabetes, Obesity and Lifestyle Study: AusDiab J Clin Endocrinol Metab* 2012; 97: 1953-1961.
- [53] Hyppönen E, Boucher BJ, Berry DJ, Power C. 25-hydroxyvitamin D, IGF-1, and metabolic syndrome at 45 years of age A cross-sectional study in the 1958 british birth cohort. *Diabetes* 2008; 57: 298-305.
- [54] Sadiya A, Ahmed SM, Skaria S, Abusnana S. Vitamin D status and its relationship with metabolic markers in persons with obesity and type 2 diabetes in the UAE: a cross-sectional study. *J Diabetes Res* 2014; 2014: 869307.
- [55] Ardawi M-SM, Sibiany AM, Bakhsh TM, Qari MH, Maimari AA. High prevalence of vitamin D deficiency among healthy Saudi Arabian men: relationship to bone mineral density, parathyroid hormone, bone turnover markers, and lifestyle factors. *Osteoporos Int* 2011; 23: 675-686.

IJSER