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The Features of Vitamin D Deficiency in Jeddah City: A Cross-Sectional Study

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Abstract Background: Unhealthy lifestyles can lead to a deficiency in vitamin D, as it is found in few food sources. Objective: To investigate the characteristics of vitamin D deficiency in the people of Jeddah City, especially in relation to obesity. Methods: Vitamin D level was assessed for 141 visitors to university clinic in year 2023, including 107 females and 34 males. Vitamin D level and body mass index (BMI) were assessed for each visitor. Immunoassay was used to measure vitamin D level. Vitamin D levels were divided into phases following clinical practice recommendations. Data were recorded in an Excel sheet and three tables were extracted. Results: Visitors aged between 20 and 50 years are the most interested to measure vitamin D as 70.4% of total number of cases are mostly between 40 and 50 years and 43 are visitors (30.6%), followed by young population between 20 and 30 years with 34 visitors (24.1%), and then 30s population with 22 visitors (15.7%). Females are the most frequent visitors as 105 (74.5%). Most of the cases are vitamin D-deficient with 122 patients (86.5%). Mild deficiency is the most common in 60 individuals (42.5%) followed by moderate deficiency with 57 patients (40.5%). Most of Jeddah population have high BMI with 59.6% of total cases. Most of the cases are overweight with 43 patients (30.5%) and class I obesity with 25 patients (17.7%). Conclusion: Most of Jeddah City citizens have minor vitamin D deficiency between 30 and 40 ng/mL, particularly middle-aged women. Highest interest to measure vitamin D is mainly the age between 20 and 50 years, mostly 40–50 years. Most of Jeddah residents are overweight or have first-degree obesity in their late 30s. The relationship between BMI and vitamin D level is inverse. These results are consistent with the Saudi findings, and obese Saudi females are considered as the highest risk for vitamin D deficiency. The most important clinical action which can give a huge positive effect is health education. To our knowledge, this is the first study which relates vitamin D deficiency with obesity in Jeddah city.

Keywords Vitamin D, Fat Soluble Vitamin, Body Mass Index, Jeddah, Saudi

1. Introduction

Vitamin D is a fat-soluble vitamin which dissolves in adipose cells. The primary issue with vitamin D is that its food sources are few, and thus its level drops quickly. The finest source of vitamin D is seafood like fish, tuna, fish liver oil, and others. Additional sources with lower concentrations include beef liver, eggs, and cheese. Meat also contains vitamin D, but in smaller amounts, such as beef and chicken. Consequently, it is crucial to offer foods which are fortified with vitamin D, such as milk, yogurt, cheese, and others. Sunlight exposure is another recommended source of vitamin D. Due to the limited availability of vitamin D sources, certain populations within our cultures are more susceptible to vitamin D deficiency than others. Children are the most exposed

group. Sadly, the current lifestyle of most children is unhealthy because they are constantly sitting in front of devices, without movement, exercise, or exposure to the sun, in addition to frequent consumption of fast foods. This unhealthy lifestyle will undoubtedly result in vitamin D deficiency and obesity as well. Adults who are more prone to vitamin D deficiency include breastfeeding mothers, elderly, people with dark complexion, obese adults, and people with any condition that impairs food absorption from the gut [1]. Vitamin D deficiency is common in Saudi Arabia, and there are numerous articles that have been published about it. One of such papers is this study which was conducted in Riyadh City and was published in 2013. Vitamin D levels were tested for 488 adults. Findings revealed that 50% had vitamin D deficiency, and most of them were females, particularly those suffering from anemia. It has also been observed that the younger the adult age, the more the vitamin D deficiency. Regretfully, 50% of Saudi people with vitamin D deficiency is considered as a high prevalence. These findings can be explained by the proliferation of the contemporary unhealthy lifestyle in Saudi [2]. We have also meta-analysis about the prevalence of vitamin D deficiency in Saudi society, published in 2018, and many papers were collected and sample was huge on 20,787 Saudi residents. However, the result of this meta-analysis was not 50% adults suffering from vitamin D deficiency, as was the case in the earlier research, but rather more, as it reached up to 63% who are suffering from vitamin D deficiency in Saudi society. Unfortunately, this is a common prevalence because it is almost two-thirds of Saudi society. This puts a heavy burden on health professionals to inform the public about the value of sun exposure, consuming foods high in vitamin D, frequent vitamin D measurement, and replacement if needed [3]. What about the rate of vitamin D deficiency among Saudi children? There are two studies, the first one for children 4–15 years and the other one for children under 2 years. The first study involved 510 healthy children in Jeddah, published in 2012, aged between 4 and 15 years. It was discovered that 87% of children suffer from vitamin D deficiency which is a very high prevalence. It was also discovered that vitamin D deficiency is mainly higher in Saudi and Yemeni children than from other countries. The second study was published in 2022, on children under 2 years, on 484 healthy toddlers, and vitamin D was deficient in 70.5% of them. It has been noted that most of vitamin D deficiency happens in newborns during their first year of life. It was also discovered that educational level has a bigger impact, because vitamin D deficiency was more common in areas surrounding Jeddah City, particularly children who are not exposed to the sun or who are exclusively breastfed [4,5]. What are the circumstances which can cause vitamin D deficiency in Saudi Arabia? We have a review which was released in 2016. Findings indicated that vitamin D deficiency is mostly related to women with unhealthy lifestyle. For instance, it was discovered that vitamin D deficiency is common in obese women, with no exercise, lacking sun exposure, with poor nutrition, and lacking vitamin D food sources. Vitamin D deficiency is common before menopause but is more prevalent after menopause. Vitamin D deficiency is correlated with frequent falls after menopause. Additionally, it was observed that the higher the vitamin D level, the lower the risk of breast cancer. Another discovery is that normal level of vitamin D strengthens muscles and increases its efficacy, particularly for women over 60 years. It was also shown that vitamin D deficiency is widespread among husbands, particularly wives. Vitamin D deficiency is intimately related with diabetes in Saudi society [6]. Few researches have been studied the correlation between vitamin D deficiency and obesity in the kingdom of Saudi Arabia population. Thus, in this cross-sectional study, we aim to identify the correlation between the obesity and the vitamin D deficient individuals, and the demographic factors associated with vitamin D deficiency. Therefore, the outcome results of this study can be useful to promote national awareness programs as well as the further research in this field.

2. Methods

This study was conducted at the university of Jeddah medical services clinic where the vitamin D level was assessed for 141 visitors of patients during year 2023. The vitamin D level was measured by using the VITROS TTL 25-OH VITAMIN D CAL kits according to the manufacturing instructions in the VITROS ECiQ Immunodiagnostic System device. The number of females was 107 and the number of males was 34. Height and weight were measured before initial visit, and BMI was determined for each patient. Age and gender of each patient were also noted. Data were entered into an Excel sheet and three tables were retrieved. First table showed the relationship between Jeddah population demographics and vitamin D level. Second table showed the categorization of cases according to vitamin D levels. Third table showed the link between vitamin D level and BMI. It was determined to categorize stages of vitamin D deficiency based on blood levels, as stated in clinical practice guideline released in 2020. First stage was elevated level ≥250 nanogram per ml (ng/mL). Second stage was sufficient level ≥50 ng/mL. Third stage was mild deficiency for level between 30 and 49 ng/mL. Fourth stage was moderate deficiency for level between 12.5 and 29 ng/mL. Fifth stage was severe deficiency for any level below 12.5 ng/mL [7]. BMI was split based on its value into multiple phases. First phase is normal where BMI is between 18.5 and 24.9 kg/m2. Second phase is overweight where BMI is between 25 and 29.9 kg/m2. Third phase is obese where BMI is >30 kg/m2. Then obesity was divided into three levels, obesity class I where BMI is between 30 and 34.9 kg/m2, obesity class II where BMI is between 35 and 39.9 kg/m2, and obesity class III (morbid obesity) where BMI is ≥40 kg/m2 [8]. All

patients with vitamin D deficiency were advised to take replacements. Vitamin D sources are natural like sunlight exposure, foods which contain vitamin D such as fish oil, fortified foods with vitamin D. Another vitamin D source is medical like oral vitamin D according to age. The recommended dose for adults is 4000 international units (IU) per day taken in form of tablets or capsules. In children, the recommended dose is 1000 to 2000 IU per day, taken in form of oral drops. Three months after starting the vitamin D replacement therapy, the patients are highly advised to visit the clinic to remeasure vitamin D level again for reassessment and to take the suitable action [9, 10].

3. Results

Table 1 shows that 70.4% of the clinic visits to measure vitamin D are for the average age between 20 and 50 years, and third of the visits are for the age between 40 and 50, with 43 patients (30.6%), which indicates the interest of this group in vitamin D. This was followed by the youth stage between 20 and 30 years old with 34 patients (24.1%), and then the 30s stage between 30 and 40 years old with 22 patients (15.7%). Visits between 50 and 60 years were few with only 16 patients (11.3%) and sadly rare for those over 60, with only 8 visits (5.6%). It was also observed that females were the most frequent visitors, which was three-quarters of the visits. It indicates their interest in vitamin D, at 105 female patients (74.5%), compared to the number of male visits, was a quarter of the sample, at 36 patients (25.5%). The average vitamin D level for all visits was 33.3 nanograms per ml, which indicates a slight vitamin D deficiency. Also, most of the BMI excess was overweight.

Table 2 shows that most cases have vitamin D deficiency with 122 (86.5%) and that the majority were mild deficiency with 60 (42.5%) and then moderate deficiency with 57 (40.5%) which was expected, while only fifth of cases have normal vitamin D level with 19 (13.5%). Cases of severe vitamin deficiency were uncommon. It was also observed that three-quarters of the cases involved women with 107 (75.9%), while only a quarter of the cases were males with 34 (24.1%).

Table 3 showed that the greater the BMI, the lesser the vitamin D, meaning that the association between the two is inverse. It was also observed that most of the vitamin D values were deficient in the population of Jeddah and that nearly all fell in the category of mild deficiency. As for BMI, it was high in two-thirds of cases (59.6%), whereas normal weight was one-third of cases (32.6%). Additionally, most cases of high BMI were overweight with 43 (30.5%) plus first-degree obesity with 25 (17.7%), while second- and third-degree obesity cases were few with 8 (5.7%) for both. Cases of underweight were uncommon with 11 (7.8%). It was observed also that most of the individuals with high BMI were in the late 30s of their age while those with normal weight were in their early 30s. Underweight visitors were younger in their early 20s.

Table 1. The relation between demography of Jeddah population to vitamin D level

Age	Number of patients	Females	Males	Average vitamin D level	Average BMI
>60	8 (5.6%)	3	5	32.33 ng/ml	28.6 kg/m ²
50–60	16 (11.3%)	10	6	29.3 ng/ml	32.1 kg/m ²
40–50	43 (30.6%)	35	8	37.5 ng/ml	27.3 kg/m ²
30–40	22 (15.7%)	13	9	35.5 ng/ml	29 kg/m ²
20–30	34 (24.1%)	28	6	37.0 ng/ml	26.5 kg/m ²
10–20	18 (12.7%)	16	2	28.0 ng/ml	22.3 kg/m ²
Total	141	105 (74.5%)	36 (25.5%)	Average vitamin D is 33.3 ng/ml	

Table 2. Classification of cases according to vitamin D levels

Vitamin D status	Number of total vitamin D level patients	Average total vitamin D values ng/ml	Gender	
			Number of males	Number of females
Sufficient	19 (13.5%)	63.9 ng/ml	5	14
Mild deficiency	60 (42.5%)	38.6 ng/ml	18	42
Moderate deficiency	57 (40.5%)	22.8 ng/ml	10	47
Severe deficiency	5 (3.5%)	11.4 ng/ml	1	4
Total	141		34 (24.1%)	107 (75.9%)

Table 3. The relation between vitamin D level and BMI

Body weight classification*	Number of patients	Average total vitamin values ng/ml	Average BMI	Number of males	Number of females	Average age
Obesity class III	8 (5.7%)	29.8 ng/ml	46.9 kg/m ²	3	5	41.6
Obesity class II	8 (5.7%)	33.3 ng/ml	37.2 kg/m ²	3	5	38.7
Obesity class I	25 (17.7%)	33.1 ng/ml	32.1 kg/m ²	4	21	39.4
Overweight	43 (30.5%)	34.3 ng/ml	27.4 kg/m ²	13	30	39.2
Normal weight	46 (32.6%)	37.2 ng/ml	22.3 kg/m ²	10	36	32.0
Underweight	11 (7.8%)	33.3 ng/ml	16.7 kg/m ²	1	10	23.9
Total	141			34	107	

*According to the the World Health Organization's (WHO) recommended body weight based on BMI values. Underweight <18.5 kg/m ², Normal weight 18.5-25 kg/m ², Overweight 25-30 kg/m ², Obesity class I 30-35 kg/m ², Obesity class II 35-40 kg/m ², Obesity class III > 40 kg/m ²[11].

4. Discussion

What connection exists between vitamin D and obesity? Numerous studies claim that there is a relationship, but not all areas are clear; some areas are clear while others are not. We have review which was completed in Greece and released in 2021 about this topic. The point which was highlighted by this review is that the association between vitamin D and obesity is inverse relationship, meaning that the higher the BMI, the lower the level of vitamin D in the blood. However, if obese person loses weight, can this lead to increase in vitamin D level or not? Alternatively, if we give vitamin D to an obese individual, will this cause weight loss or not? Or if obese individual undergoes stomach surgery to decrease weight, does this lead to vitamin D loss or not? All these questions are ambiguous and require further investigation [12]. Another crucial query: does normal vitamin D level have a preventive role in preventing obesity in the future or not? We have one review which was conducted in France and published in 2022 about this regard. This review emphasizes that yes, we have some preventive roles in rodents, but whether this is possible to apply clinically in humans or not remains controversial. If this theory is proven in the future, this means that we can practice primary prevention on normal weight individuals to prevent obesity in the future by routine vitamin D measurement. However, still this needs more work [13]. One idea attributes vitamin D deficiency in obese persons to increase volume of adipose tissue because vitamin D is fat soluble and will dissolve in larger volume. Is this theory correct or not? We have an article review which was completed in Croatia and published in 2019 regarding this topic which supports this theory. This means that reducing weight is a great way to immediately raise vitamin D. However, this does not rule out the possibility of other mechanisms which are not identified yet. One illustration is the presence of vitamin D receptors on adipose tissue cell surface. What connection exists between vitamin D deficiency and slow metabolism? Can we speed up metabolism by replacing vitamin D or not? Still these sections remain unknown [14]. Therefore, due to increased amount of adipose tissue in obese individuals, we require bigger vitamin D replacement dose to achieve normal vitamin D level. There is a review which highlights this discovery. It was conducted in Lebanon and published in 2019, where numerous randomized trials were searched, and it was shown that we require a higher dose in an obese person than that of a normal weight by 1600–2000 IU/d until we attain the 30 ng/ml level. However, it is still uncertain what will be the given vitamin D dose at the end. Does this higher dose prevent the bones from fractures? [15]. Is there a connection between vitamin D, diabetes, metabolism, and insulin resistance? We have a review conducted in the USA and released in 2018 about this topic. This review establishes this association, but with many observations, and requires randomized trials with larger samples. This review says that normal vitamin D level lowers insulin resistance, reduces diabetes harms, reduces prediabetes risk, and speeds up metabolism drive and vice versa. Normal vitamin D level affects favorably pancreatic beta-cells and speeds up metabolism by regulating calcium entry to cells. But to which level these findings can be implemented in clinical practice? Still, we require extensive, randomized trials [16]. What other conditions are linked to vitamin D deficiency? We have an analysis that was completed in Italy and released in 2021. It states that there are further conditions which are potentially linked to vitamin D deficit like heart diseases, poor metabolism, elevated waist circumference, high blood pressure, and lipid profile abnormalities. This is quite significant that one vitamin may have such an influence on all these illnesses. Nevertheless, still there are many secrets at the molecular level which have not yet been discovered and still require more investigation [17]. Is there a connection between vitamin D deficiency and adult depression or not? We discovered a comparative study which was conducted in Iran published in 2021 concerning this topic. Vitamin D level was compared between depressed and nondepressed adults. It was found that vitamin D level was lower in depressed adults, and the

difference was statistically significant. It was also discovered that vitamin D is lower in younger ages when compared to older ones. This discovery is significant and supports the link between vitamin D deficiency and depression, but this result remains merely observational. But is it a causal relationship or not? To which level we can take this discovery in clinical setting? We require larger studies [18]. What connection exists between vitamin D and immune system? Evidence suggests that vitamin D is anti-inflammatory, and inflammation grows with vitamin D deficiency, but we need to understand why. There is a review which illustrates this relationship which was released in the UAE in 2016. This article indicates that there are receptors for vitamin D present on cell surfaces. When BMI increases, adipose tissue increases, and vitamin D deficiency occurs, and this triggers the transcription process in the adipose tissue, which secretes immune substances called cytokines. These cytokines cause chronic inflammation in the adipose tissue. This explains why chronic inflammations are more likely in obese people [19]. Which illnesses are linked to vitamin D deficiency in obese children and adolescents? We have a review on this subject that was released in Russia in 2019. This review demonstrated that vitamin D deficiency is prevalent among obese children and adolescents. It has also been discovered that vitamin D deficiency is associated with diabetes and insulin resistance in obese children and that it causes adipose tissue to release cytokines that cause future inflammations. This explains why obese children and adolescents have recurrent infections. This analysis also noted that vitamin D replacement needs larger vitamin D doses in obese children and adolescents. This review is warning sign to parents to avoid obesity in their children and adolescents [20]. Nutritionist plays numerous vital responsibilities. First role is the education about the link between vitamin D deficiency and obesity. Second is the significance of replenishing vitamin D when it is deficient. Third is the significance of healthy lifestyle including sun exposure, exercise, and balanced diet. Fourth is nutritionist must discuss the consequences of disregarding vitamin D deficiency. The nutritionist must also explain that decreasing weight is the quickest way to raise vitamin D level in obese persons, in addition to its many health advantages. These details are available in article review that was released in 2017 in Italy [21].

5. Conclusions

Most of Jeddah City people have minor vitamin D deficiencies between 30 and 40 ng/mL, particularly middle-aged women. Highest interest to measure vitamin D and clinic visits is mainly 20–50 years, mostly 40–50 years. Regretfully, interest is minimal over 50 years. Most of Jeddah residents are overweight or have first-degree obesity in their late 30s. The relationship between BMI and vitamin D level is inverse in Jeddah communities. These results are consistent with the Saudi findings, and obese Saudi women are considered as the highest risk. Health education about healthy lifestyle and vitamin D replacement is the most important function.

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