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Vitamin D Status in Egypt and its Seasonal Variation During Infancy and Preschool Children

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Abstract

Background: Several factors have been implicated in causing low levels of vitamin D, which is an important hormone regulating the calcium homeostasis in the body.

Aim of Study: To assess vitamin D status in Egyptian infants and children from age of 6 months up to age of 5 years and to assess if there is seasonal variation in its level.

Patients and Methods: The present study was conducted as a cross section study included infants and children aged 6 months up to 5 years attending the outpatient clinic of Mansoura University Children Hospital, 100 of them were taken during winter time and 100 during summer time. Each child underwent: Full history taking, thorough clinical examination, laboratory investigations and assessment of Vitamin D.

Results: 33.5% of the total studied children had vitamin D deficiency <20ng/ml) and 41.5% had vitamin D insufficiency (≥20ng/ml-<30ng/ml). The median of serum vitamin D was (54.5ng/ml) in the summer group which was significantly increased than its level in the winter group (23.7ng/ml) (p-value=0.001). Winter season and absence of sun exposure had significant risk of developing vitamin D deficiency or insufficiency (p-value=0.001).

Conclusion: High prevalence of vitamin D deficiency in apparently healthy Egyptian children was observed in this study. There was a significant relationship between vitamin D status of the children and both of seasonal variations and sun exposure which reflects that sun exposure play a vital role in the synthesis of this vitamin and vitamin D status in children.

Key Words: *Children – Seasonal – Sun – Vitamin D.*

Introduction

VITAMIN D is an important hormone regulating the calcium homeostasis in the body, in addition to the bone health. Its deficiency is suggested to be the causative factor in many endocrines and immune diseases and it also affects neurophysiological functioning. In infants and young children Vitamin D plays an important role in bone mineralization hence its deficiency is leading to rickets and hypocalcaemic symptoms **[1]**.

Although vitamin D is important throughout life, an adequate status is particularly crucial early in life. Vitamin D is necessary for calcium absorption and normal bone health, and deficiency in utero and during childhood may lead to growth retardation and skeletal deformities. Vitamin D is also important for the immune system, and a sufficient vitamin D status has been suggested to be protective against different diseases, including cancer, autoimmune disease, infection, and cardiovascular disease. In addition, vitamin D can be important for brain development and mental health **[2]**.

Several factors have been implicated in causing low levels of vitamin D in the region, including low sun exposure and limited outdoor activity due to extreme hot climate, dark skin color, prolonged breastfeeding without vitamin D supplementation, the low calcium content of diets, and lack of policies regarding food fortification with vitamin D **[3]**.

Aim of this study:

Assessment vitamin D status in Egyptian infants and children from age of 6 months up to age of 5 years and assessed if there is seasonal variation in its level.

Patients and Methods

The present study was conducted as a cross section study during the period one year starting from January 2020 to January 2021. Informed written consents were obtained from parents of all children before their involvement in the study to

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ensure their approval to participate in research and to publish. All study procedures were carried out and approved by the Ethical Committee of Mansoura Faculty of Medicine and in accordance with the declaration of Helsinki. Non-essential identifying details should be omitted. Informed consent should be obtained if there is any doubt that anonymity can be maintained. Participant's names were kept on a password-protected database and linked only with a study identification number for this research. The present study was conducted on 200 infants and children attending the outpatient clinic of Mansoura University Children Hospital, 100 of them were taken during winter time and 100 during summer time. Inclusion criteria were: healthy infants and children with age range from 6 months to 5 years and not complaining of chronic disease or evident rickets. Exclusion criteria were: infants and children with any chronic disease (e.g. cardiac, respiratory, hepatic or renal disease) or evident rickets and age group less than 6 months or more than 5 years. Each child underwent: Full history taking, thorough clinical examination, laboratory investigations and assessment of serum Vitamin D.

Data were collected and entered to the computer using SPSS (Statistical Package for Social Science) program for statistical analysis (version 21) (IBM Corp., Released 2012). The results were considered significant when the probability of error is less than 5% (p-value ≤ 0.05). Qualitative data was analyzed using Chi-Square test for comparison of 2 or more groups. Quantitative data between groups was analyzed using Mann-Whitney U test was used to compare 2 independent groups. Binary stepwise logistic regression analysis was used for prediction of independent variables of binary outcome.

Results

There was no statistically significant difference was found between the two groups regarding demographics (Table 1).

In the present study, the median of serum vitamin D was significantly higher in the summer group compared to the winter group (p-value= 0.001) (Fig. 1).

Fig. (2) and Table (2) showed that 33.5% of the total studied children had vitamin D deficiency (<20ng/ml) and 41.5 % had vitamin D insufficiency (≥20ng/ml-<30ng/ml). 61% of winter group and 6% of summer group had vitamin D deficiency, on the other hand, 53% of summer group and 30% of winter group had vitamin D deficiency.

Table (1): Comparison of demographics data between the studied groups.

	All groups (n=200)		Summer groups (n=100)		Winter groups (n=100)		Test of sig. χ^2	p
	No.	%	No.	%	No.	%		
Gender:								
Male	97	48.5	45	45	52	52	0.13	0.71
Female	103	51.5	55	55	48	48		
Age:								
6 mon.-2y.	100	50	50	50	50	50	0	1
2y.-5y.	100	50	50	50	50	50		

χ^2: Chi square test.

Table (2): Classification of vitamin D between the two studied groups.

Serum vitamin D level	All groups (n=200)		Summer groups (n=100)		Winter groups (n=100)		χ^2	p-value
	No.	%	No.	%	No.	%		
Deficient (<20 ng/ml)	67	33.5	6	6	61	61	72	0.001*
Insufficient (≥20 ng/ml-<30 ng/ml)	83	41.5	53	53	30	30		
Sufficient (≥30 ng/ml)	50	25	41	41	9	9		

χ^2: Chi square test. *: Significant difference.

Table (3) showed the risk elements for vitamin D deficiency or insufficiency including season, gender, age, father occupation, weight chart, height chart, food entry time, recurrent respiratory tract infection (RTI) and vitamin D supplement during 1st year of life sun exposure. It found that winter season and absence of sun exposure had significant risk of developing vitamin D deficiency (*p*-value= 0.001 for each). A binary logistic regression for prediction of vitamin D deficiency or insufficiency was close (Table 4). It showed that winter and less exposure were independent predictors to develop vitamin D deficiency.

Table (3): Risk estimates for vitamin D deficiency or insufficiency.

Risk factors	All patients (n=200)		Vitamin D deficiency and insufficiency (n=150)		RR	χ^2	*p*-value
	No.	%	No.	%			
Season:							
Summer ®	100	50	59	59	0.66	25.29	0.001*
Winter	100	50	91	91	(0.55-0.78)		
Gender:							
Male ®	97	48	73	75.3	0.99	0.01	0.89
Female	103	52	77	74.8	(0.482-1.2)		
Age:							
6 mon.- 2 y. ®	100	50	70	70	0.86	2.23	0.14
2y. -5 y.	100	50	80	80	(0.69-1.05)		
Father occupation:							
Manual worker ®	107	53.5	81	75.7	0.98	0.04	0.84
Employee	93	46.5	69	74.2	(0.8-1.2)		
Weight chart:							
<50th percentile ®	102	51	74	72.5	0.97	0.05	0.85
>50th percentile	98	49	76	77.6	0.8-1.2		
Height chart:							
<50th percentile ®	104	52	74	71.2	0.98	0.04	0.83
>50th percentile	96	48	76	79.1	0.79-1.1		
Food entry time:							
<6mon ®	165	82.5	125	75.8	1.07	0.41	0.52
>6 mon	35	17.5	25	71.4	0.87-1.31		
Recurrent RTI:							
Yes ®	54	27	35	64.8	0.81	3.6	0.06
No	146	73	115	78.8	(0.67-1.07)		
Vitamin D supplement during 1st year of life:							
Yes ®	70	35	50	72.8	0.96	0.14	0.7
No	130	65	100	76.9	0.77-1.2		
Sun exposure:							
Yes ®	92	46	43	46.7	0.47	45.2	0.001*
No	108	54	107	99.1	0.36-0.63		

χ^2: Chi square test. RR: relative risk. RTI: respiratory tract infection. ®: Reference group. *: Significant difference.

Table (4): Binary logistic regression for prediction of vitamin D deficiency or insufficiency.

Predictors	β	*p*	OR (95%CI)
Season:			
- Summer®			
- Winter	0.67	0.03 *	0.79 (0.59-0.84)
Sun exposure:			
- Yes®			
- No	1.23	0.001	0.54 (0.43-0.68)

OR: odds ratio. ®: Reference group. * *p*-value <0.05. β: The coefficient of the slope of the regression line.

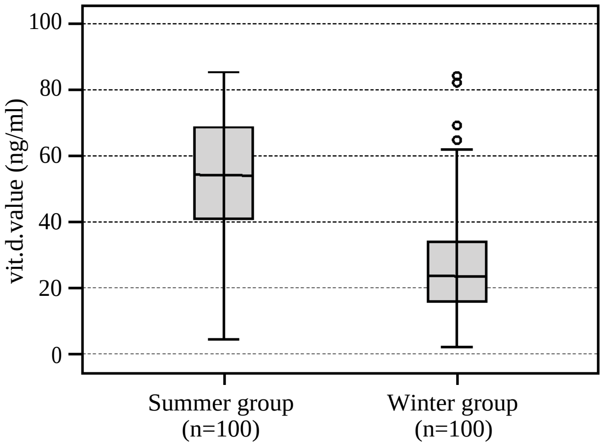

Fig. (1): Comparison of Vitamin D level between the two groups regarding season.

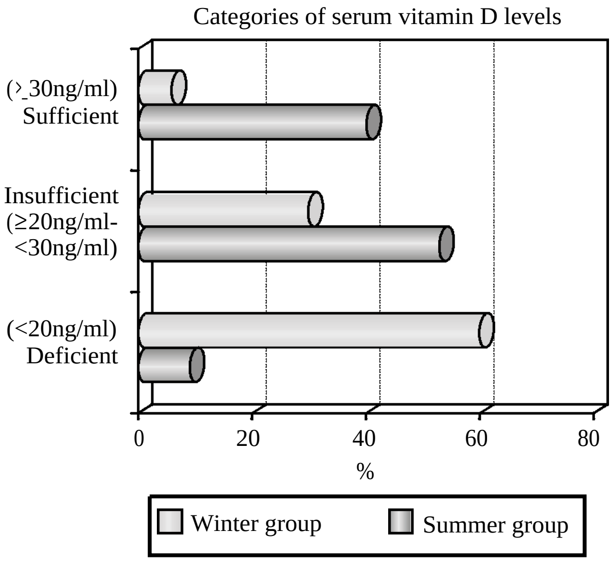

Fig. (2): Categories of vitamin D level between the two groups.

Discussion

Vitamin D testing has exponentially increased in recent years [3]. The definition and relevance of vitamin D deficiency are still under debate. Recent large observational data have suggested that ~40% of Europeans are vitamin D deficient, and 13% are severely deficient [5]. The relevance of this widespread deficiency and necessity for supplementation has been questioned [6].

The current study showed that 33.5% of the total studied children had vitamin D deficiency (<20ng/ml) and 41.5% had vitamin D insufficiency (≥20ng/ml - <30ng/ml). A previous study conducted in Jeddah, KSA showed that 72% had normal 25(OH)D level (ranging 20-70ng/mL), 58.82% had relative 25(OH)D deficiency (<20ng/mL) and 27.45%) had severe deficiency (<7ng/mL) [7].

Also, our result is in agreement with a cross-sectional study was conducted Western India by Sharawat and Dawman [8], which included 96 apparently healthy school going children (50 male and 46 female) from age 5-10 years. They found that 33.3% of the children had vitamin D levels less than 25nmol/l and 33.3% of them had between 25 and 50nmol/l. Moreover, 20.83% had levels between 50 and 75nmol/l and 12.50% had more than 75nmol/l.

For the countries of the Middle East, contrary to what one might expect, the prevalence of vitamin D deficiency is great and this is probably due to the prototype, the lack of solar exposure (most vitamin D in circulation is produced naturally when 7-dehydrocholesterol in the skin is exposed to ultraviolet B (UVB) radiation to produce vitamin D3 [9].

In contrast, among the European countries, it is in Norway and Sweden, the concentrations of 25-OHD are higher, mean value was in the order of 28ng/mL, probably because of a traditionally high consumption of oily fish. In southern Europe, vitamin D levels range between 18 and 12ng/mL, which can be understood by avoidance of solar exposure during the hottest hours and more pigmented skin [10,11].

The present study showed that there was no relation between vitamin D status of children and their sex. Our results agree with a previous study which did not find a significant difference between vitamin D levels in boys and in girls [12]. This may be due to some circumstances of clothing and feeding.

However, our findings are different from other study conducted in Jordan, as females were 74% more likely to have VDD than males [13]. This variation may be due to differences in the study population and different settings and cultural believes that tend to prefere administration of Vitamin D drops to males than females.

In the present study, there was a statistically significant relationship between vitamin D status of the children and sun exposure. This in agreement with a previous study, conducted in 2014 in Kasr Al Aini teaching hospital, showed a significant correlation between vitamin D level and skin exposure [14]. Moreover, a cross-sectional study including 50 Pakistani children stated that vitamin D levels were significantly affected by sunlight exposure [15].

Considering that vitamin D is primarily made in the skin after exposure to ultraviolet radiation (UVR), low sunlight exposure reflects the absence of its most important source [16].

In the present study, the median of serum vitamin D was significantly higher in the summer group compared to the winter group (*p*-value= 0.001). This association between the seasonal changes and vitamin D status has also been addressed in several previous studies, some of which are from mid-latitude areas, as a previous study conducted in Czech showed that the highest levels of 25(OH)D were reached in autumn, followed by summer and winter [17]. Another study conducted in Romania showed that Serum 25(OH)D showed a marked seasonal variation with highest levels in September and lowest levels in March [18].

On investigating the seasonal fluctuation of the serum vitamin D levels, the results differ considerably between different countries, possibly because of different factors such as the latitude where the subjects belong and the skin color and lifestyle habits of the locality. Also, positive correlation between seasonal abundance of sunshine and serum vitamin D levels was recognized, with about 8-10 weeks between sunlight exposure and vitamin D synthesis and accumulation [19].

A previous study conducted in Jeddah showed significant direct correlation between 25(OH)D level and duration of sunlight exposure, body surface area (BSA) exposed to sun [7].

Another study showed significant direct correlation between 25(OH) D levels and duration of sunlight exposure. BSA exposed to sun and daily intake of vitamin D [20].

Most vitamin D in the human body is synthesized by exposure to 290-315nm UVB radiation. Factors influencing vitamin D3 production in the skin include UV ray intensity, location where the person resides, UV exposure time, vitamin D intake, physical activity, and skin color [21].

A previous study showed that vitamin D levels are higher in most subjects in summer than in winter, suggesting that seasonal changes in sunshine quantity influence serum vitamin D concentration. This is affected by the solar altitude. Solar illumination angle and sunshine duration affect vitamin D production [22]. In these areas, it is not possible to synthesize sufficient amounts of vitamin D in certain seasons [23].

There was a significant inverse correlation between 25(OH)D deficiency and BSA exposed to the sun, which had an average of $920 \pm 1367 cm^2$ [24]. As at least 20% of the body's surface should be exposed to UV-B for blood vitamin D concentrations to increase, women and children in KSA, who wear traditional outfits, are at great risk for vitamin D deficiency. The nature of clothing is important, for example, black wool is twice as effective as white cotton in preventing transmission of incident UV-B radiation to the skin as white cotton [25].

As known the majority (80%) of the vitamin D requirement comes from exposure to sunlight [26]. The major causes of low vitamin D levels seem to come from insufficient vitamin D supplementation, long-sleeved clothing, and limited outdoor lifestyle [27], in addition to the usual avoidance of outdoor activity due to great humidity and hot weather [28].

Also, a previous study showed that the mean duration of sunlight exposure was too short reflecting the absence of an important source of vitamin D as most of the children tend to spend more time indoors than outdoors. Moreover, most of the children of vit D deficiency tend to spend more time indoors than outdoors, doing homework, playing computer games and watching television [7].

Also, subjects with vitamin D deficiency have indoor lifestyle and using cars when commuting under sun rather than walking. The clothes and habits of the child play a major role towards vitamin D deficiency [26]. Increased urbanization and increased time spent indoors at work may lead to decreased time spent outdoors, and therefore decreased vitamin D synthesis, even in light-skinned populations. Shade reduces the amount of solar radiation by 60% and windowpane glass blocks UVR [20].

Conclusion:

High prevalence of vitamin D deficiency in apparently healthy Egyptian children was observed in this study. There was a significant relationship between vitamin D status of the children and both of seasonal variations and sun exposure which reflects that sun exposure play a vital role in the synthesis of this vitamin.

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حالة فيتامين (د) فى مصر وتنوعها الموسمى أثناء الرضاعة والأطفال ما قبل المدرسة

فيتامين د عنصر غذائى مهم لازم لنمو الأطفال وتطورهم. نقص فيتامين د هو حالة يمكن الوقاية منها، وتكلفة قليلة فى معظم البلدان. يؤثر الوقت من اليوم والفصول وتلوث الغلاف الجوى على تركيبه هذا الفيتامين. بالنظر إلى المصدر الجلدى كمصدر أساسى لفيتامين (د)، هناك متغيرات تؤثر على انتاج الفيتامين مثل مدة التعر ض للشمس، المنطقة المعرضة وتصبغ الجلد

المرضى وطرق الدراسة : أجريت الدراسة الحالية كدراسة مقطعية خلال فترة سنة واحدة تبدأ من يناير ٢٠٢٠ إلى يناير ٢٠٢١. أجريت الدراسة على ٢٠٠ رضيع وطفل يترددون على العيادة الخارجية بمستشفى الأطفال بجامعة المنصورة، ١٠٠ منهم تم أخذهم خلال فصل الشتاء و ١٠٠ خلال فصل الصيف. اخترنا الرضع والأطفال الأصحاء الذين تتراوح أعمارهم من ٦ أشهر إلى ٥ سنوات ولا يشكون من مرض مزمن أو كساح واضح.

النتائج : ٣٣.٥٪ من مجموع الأطفال الذين شملتهم الدراسة يعانون من نقص فيتامين (د) (أقل من ٢٠ نانوجرام/مل) و ٤١.٥٪ يعانون من مستوى غير كافى من فيتامين (د) (≤٢٠ نانوجرام/مل – هـ٣٠ نانوجرام/مل) ٦١٪ من المجموعة التى اشتملتها الدراسة أثناء فصل الشتاء و ٦٪ من المجموعة الصيفية يعانون من مستوى غير كاف من فيتا مين د. من ناحية أخرى، كان ٥٣٪ من المجموعة الصيفية و ٣٠٪ من المجموعة الشتوية يعانون من نقص فيتامين (د). كذلك فصل الشتاء وقلة التعرض للشمس كانت عوامل تنبؤية مستقلة للإصابة بنقص فيتامين د فى الرضع والأطفال.

الخلاصة : لوحظ ارتفاع معدل انتشار نقص فيتامين (د) فى الأطفال المصريين الأصحاء . وجود كانت هناك علاقة معنوية بين حالة فيتامين (د) للأطفال وكل من التغيرات الموسمية والتعرض لأشعة الشمس مما يعكس أن التعرض للشمس يلعب دوراً حيوياً فى تكوين هذا الفيتامين.