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List of Abbreviations

1,25(OH)₂D	1, 25-dihydroxyvitamin D
25(OH)D	25-hydroxyvitamin D
AIDS	Acquired immune deficiency syndrome
BBMI	brush border myosin I
BMD	bone mineral density
CaBP	calbindin
CaM	calmodulin
CaSR	calcium sensing receptor
CaT1	calcium transport channel
CD	Cluster of differentiation
CDC	Centers for Disease Control and Prevention
CDK	cyclin-dependent kinases
CHF	Congestive heart failure
CI	confidence interval
Creat	Creatinine
CVD	Cardio vascular disease
CVS	Cerebrovascular stroke
CYP	Cytochrome P
CYP24A1	Cytochrome P450, family 24, subfamily A, polypeptide 1
CYP27B1	cytochrome P450, family 27, subfamily B, polypeptide 1
CYP2R1	Cytochrome P450, Family 2, Subfamily R, Member 1
DBP	vitamin D binding protein
DC	dendritic cells
DNA	Deoxyribonucleic acid

List of Abbreviations

FGF23	Fibroblast growth factor 23
GC	Glucocorticoids
GH	Growth hormone
GHRH	Growth hormone releasing hormone
Hb	Hemoglobin
HCl	Hydrogen chloride
HIV	Human immunodeficiency virus
HPT	hypothalamus-pituitary-thyroid
IFN	interferon
IGF	Insulin growth factor
IL	Interleukin
IU	International unit
MARRS	membrane-associated rapid response steroid binding protein
m-CSF	macrophage colony-stimulating factor
MHC	Major histocompatibility complex
MS	Multiple sclerosis
NaPi-IIb	sodium-phosphate cotransporter type IIb
NCX1	sodium/calcium exchanger
OR	Odds ratio
PCOS	polycystic ovary syndrome
PD1A3	protein disulfide isomerase associated protein 3
PHEX	phosphate regulating endopeptidases X-linked
PO4	Serum Phosphorous
PTH	Parathyroid hormone

List of Abbreviations

<i>r</i>	Pearson correlation coefficient
RANK	Receptor activator of NF-κB
RANKL	Receptor activator of NF-κB ligand
RAS	Renin-angiotensin system
RCT	Randomized controlled trial
RDA	Recommended Dietary Allowance
RNA	Ribonucleic acid
RR	relative risk
RTIs	respiratory tract infections
RXR	Retinoic acid X receptor
SD	Standard deviation
SE	sun exposure
SES	Socio-economic status
SHOX gene	Short stature HOmeoboX-containing gene
Sig	Significant
<i>t</i>	Student t
T1DM	Type 1 diabetes mellitus
T2DM	Type 2 diabetes mellitus
T3	triiodothyronine
TH	Thyroid hormone
TNF	Tumor-necrosis factor
TRPV6	Transient Receptor Potential Cation Channel Subfamily V Member 6
UK	United Kingdom
US	United States
UVB	Ultraviolet B rays
VDD	Vitamin D deficiency

List of Abbreviations

VDDR	Vitamin D deficiency rickets
VDR	Vitamin D receptor
VDREs	Vitamin D response elements
WHO	World Health Organization

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Abstract

Background/objectives

Vitamin D deficiency is a worldwide health problem. High prevalence of vitamin D insufficiency in healthy children and adolescents has been reported worldwide (e.g. India, Turkey, France, Italy, etc.) in the past few years. Vitamin D deficiency during periods of growth can have a negative influence on bone development, causing not only rickets, but also interfering with attainment of genetically programmed height.

Materials and methods

Our study conducted on 180 healthy adolescent males and females aged 10-19 years, randomly selected from Ain Shams University Hospitals. Outpatients with minor intercurrent illness or companions of inpatients were invited to participate in the study after explaining the objective of the study. Samples collected from participants from January 2017 to May 2017.

Results

Sufficient group: 38/180 subjects (21.11%) with vitamin D level above > 30 ng/ml. Mild deficiency group: 48/180 subjects (26.67%) with vitamin D level between 21-29 ng/ml. Moderate deficiency group: 88/180 subjects (48.89%) with vitamin D level between 10-20 ng/ml. Severe deficiency group: 6/180 subjects (3.33%) with vitamin D level below < 10 ng/ml.

Our results showed a ***significant positive*** correlation between vitamin D level and stature for age percentile ($r=0.174$) ($p=0.019$).

Conclusion

Subclinical vitamin D insufficiency and deficiency are common problems in apparently healthy Egyptian adolescents with negative impact on height percentile.

Keywords: Vitamin D, adolescents, height, Egypt.

INTRODUCTION

Vitamin D deficiency is a worldwide health problem (*Hosseini-Nezhad and Holick, 2013*), spanning many continents and including all ages, genders and racial groups (*Lappe, 2011*). It is currently estimated that over a billion people worldwide are vitamin D deficient or insufficient (*Holick, 2011*).

Vitamin D deficiency during periods of growth can have a negative influence on bone development, causing not only rickets, but also interfering with attainment of genetically programmed height (*Bueno and Czepielewski, 2008*) as there is a positive correlation between circulating 25(OH)D and height (*Kremer et al., 2009*). Vitamin D deficiency increases the risk of many chronic diseases, including autoimmune diseases, diabetes mellitus, heart disease and hypertension, and infectious diseases (*Sabetta et al., 2010*). Vitamin D deficiency may even contribute to the development of cancers, especially breast, prostate and colon cancers (*Wacker and Holick, 2013*).

High prevalence of vitamin D insufficiency in healthy children and adolescents has been reported worldwide in the past few years. Studies in India found that hypovitaminosis D was seen in 95% of apparently healthy adolescents. Other studies reported prevalence of vitamin D deficiency as 59.4% in Turkey, 78% in France, 42.5% in Beijing, 47% in Greece (*Dhore and Wasnik, 2013*).

The prevalence of vitamin D deficiency in a study among adolescent girls from four European countries, ranged from 26% to 51%, while over 90% of the adolescents had suboptimal vitamin D levels (*Tylavsky et al., 2006*). American data showed that the prevalence of vitamin D deficiency is adjusted to 28% - 40% during the period of 2001 to 2006, and vitamin D insufficiency were 70% - 80% of cases for the same time period (*Saintonge et al., 2009*).

Despite the abundance of sunshine in the Middle East allowing vitamin D synthesis all year round, the region registers some of the lowest levels of vitamin D and the highest rates of hypovitaminosis D worldwide. Several studies in Iran, Jordan, Lebanon, Saudi Arabia, United Arab Emirates and Qatar revealed that is 30-75% of apparently healthy children and adolescents suffer from vitamin D deficiency (*Bassil et al., 2013*).

In a recent study conducted on 90 healthy Egyptian adults aged 20-60 years, the prevalence of vitamin D deficiency with level of 25(OH) D <20 ng/ml was 77%, while prevalence of vitamin D insufficiency with level of 25(OH) D between 20-29 ng/ml was 20% (*Boutros et al., 2016*).

However the status of vitamin D among adolescents in Egypt and its relation to growth has not been addressed yet.

AIM OF THE WORK

Vitamin D deficiency is endemic in Egyptian city population and we aimed to study its relation with height percentile in teenagers (age 10-19 years) in both genders.