Prevalence of Vitamin D Deficiency in Children and Adolescents Referred to Pediatric Orthopedic Clinic

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Abstract

Background: Vitamin D deficiency is the most common nutritional deficiency in the world. Vitamin D is important for bone health and calcium metabolism and also has non skeletal health benefits. The aim of this study was to determine prevalence of vitamin D deficiency and insufficiency in children and adolescents presenting for primary care to the pediatric orthopedic clinic.

Materials and Methods: We retrospectively reviewed the records of a total of 212 children and adolescents between 1-15 years who referred to Mofid Children's tertiary center. The subjects were classified as three groups according to their Vitamin D status (deficiency ≤ 20 ng/mL, insufficiency 21-29 ng/mL and sufficiency ≥ 30 ng/mL) and also were divided according to their age (preschool 1-5 years, primary school age 6-10 years and adolescence11-15 years).

Results: Altogether 62.2% of the subjects had Vitamin D level less than 30 ng/mL. Vitamin D deficiency was found in 77 cases (36.3%) and vitamin D insufficiency was found in 55 cases (25.9%). There is no significant difference between males and females in terms of low 25 hydroxy vitamin D levels. Prevalence of vitamin D deficiency and insufficiency was evidently lower in 1-5 years group than older age groups.

Conclusion: There is a high rate of subclinical vitamin D deficiency in children referred to the pediatric orthopedic clinic that is more evident in the 6-10 years group. This indicates a need for more comprehensive supplementation programs especially for school age children.

Key words: Vitamin D, Deficiency, Prevalence, Health.

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Introduction

Vitamin D deficiency is the most common nutritional deficiency in the world(1). It is presumed to be one of the most common undiagnosed medical conditions (2). Prevalence of this disorder is about 30-80% in the pediatric and adult community(3-5). It has been estimated that one billion people worldwide have vitamin D deficiency or insufficiency(5). Effects of vitamin D deficiency is not limited to calcium metabolism and bone health; it has an essential role in decreasing risk of many chronic diseases such as Systemic Lupus erythematosus (SLE), rheumatoid arthritis, multiple sclerosis, type I diabetes mellitus, cardiovascular diseases, infectious diseases and cancers(6-8). This function is based on presence of vitamin D receptors in all cells and tissues in the human body and its participation in the adjustment of genes controlling cell proliferation and differentiation, apoptosis and angiogenesis(6,8). Very few foods, for example oily fish, egg yolk and wild mushroom naturally contain Vitamin D, but a major natural source of vitamin D (>90%) is from skin photosynthesis following ultra violet solar irradiation(9,10). In this process 7-dehydro cholesterol is converted to pre vitamin D3, that after isomerization forms vitamin D3. Both vitamin D3 (cholecalciferol) from photosynthesis in skin or dietary source and vitamin D2 (ergocalciferol) undergo hydroxylation in the liver to make storage form of vitamin D, 25-Hydroxyl vitamin D (calcidiol). In the kidney (also in colon, prostate, breast, brain, β-islet cells of pancreas, vascular smooth muscle cells and macrophages) hydroxylation of calcidiol creates the active metabolite, 1,25-dihydroxy vitamin D (calcitriol) (6, 9-11).

Calcitriol is responsible for increasing calcium absorption, bone resorption, and decreasing renal calcium and phosphate excretion to maintain bone health. The synthesis of calcitriol is mediated by parathyroid hormone (PTH), serum phosphate concentration and growth hormone(9-11). The primary objective of this study was determination of prevalence of subclinical vitamin D deficiency in children and adolescents who referred to pediatric orthopedic clinic and the secondary objective was to determine the relationship between levels of vitamin D with age, sex and cause of presentation.

Material and Methods

This study was performed by Shahid Beheshti University of Medical Sciences and conducted in the Mofid Children's tertiary center, situated in Tehran, Iran. We retrospectively studied 212 primary care patients (1-15 years) who presented consecutively between August1, 2016 to July 31, 2017 to pediatric orthopedic clinic. There were not any symptoms and signs that directly related to Rickets in history and primary examination of all cases. Exclusion criteria included chronic illnesses and use of medications known to affect bone metabolism. We surveyed age, sex, cause of referral, levels of serum calcium (Ca), Phosphorus(P), alkaline phosphatase (ALP) and 25-hydroxyl vitamin D [25(OH)D]. Serum calcium (Ca) and phosphorus (P) levels were measured using the end point colorimetric method [Pars Azmoon kit and Prestige (Biolis 24i) fully automated autoanalyzer] and serum alkaline phosphatase (ALP) levels were measured by kinetic method [Pars Azmoon kit and Prestige (Biolis24i)] fully automated autoanalyzer, while serum 25 hydroxy vitamin D [25(OH)D] levels were evaluated by conjunction Ag-Ab ELISA method [autobio kit, Dynex2 fully automated ELISA].

For evaluation of results, the subjects were classified into three groups according to their vitamin D status (deficiency ≤ 20 ng/mL, insufficiency 21-29 ng/mL and sufficiency ≥30ng/mL) (11-15). Subjects were also divided according to their age (preschool l1-5 years, primary school age 6-10 years and adolescence 11-15 years). Range of Ca, P, ALP (12) of patients was compared between three groups of vitamin D level.

Statistical analysis

Data analysis was performed by the IBM SPSS (Statistical Package for the Social Sciences, version 21.0) statistics. Continuous data were analyzed by the Kolmogorov-Smirnov test for normality distribution. All quantitative data were reported as mean ± standard deviation and analyzed using the Student t-test or the Mann-Whitney U test, where appropriate. For comparisons between the 3 groups, the analysis of variance and the Tukey test were applied. Qualitative data were reported as frequency and percentage and analyzed using the chi-square and Fisher exact test, where appropriate. A P-value less than 0.05 was considered significant, and 95% confidence intervals (CIs) were calculated for adjusted odds ratios(ORs).

Results

We retrospectively reviewed information of a total 212 children and adolescents aged between 1-15 years old. Main causes of referral to the pediatric orthopedic clinic in order of frequency were knee deformity, gait abnormalities (including rotational problem), lower limb pain and other causes.(Figure 1)

From 212 cases, 104 patients (49.1%) were female. Mean age of patients was 4.8 ± 3.3 years.(Table 1)

Level of vitamin D was sufficient in 80 cases (37.7%), insufficient in 55 cases (25.9%) and deficient in 77 cases (36.3%). Abnormalities of laboratory findings are shown in Table 2.

Prevalence of vitamin D deficiency and insufficiency in sex and age groups are presented in Table 3. There was no difference between sex in terms of level of vitamin D. Level of vitamin D is evidently higher in the 1-5 years group than older age groups and the lowest level of vitamin D was seen in the 6-10 years group (P=0.013).(Figure 2)

Mean age in the vitamin D sufficient group was 4.3 ± 3.3 years, in the vitamin D insufficient group were 5.1 ± 3.2 years and in the vitamin D deficient group was 5.2 ± 3.3 years (P<0.001). Mean ALP in the vitamin D sufficient group was 536.6±207.8 ng/ml, in the vitamin D insufficient group was 583.5±224.9 ng/ml and in the vitamin D deficient group was 606.7±197.6 ng/ml (P=0.007)(Table 4).

Figure 1: The cause of referral to pediatric orthopedic clinic

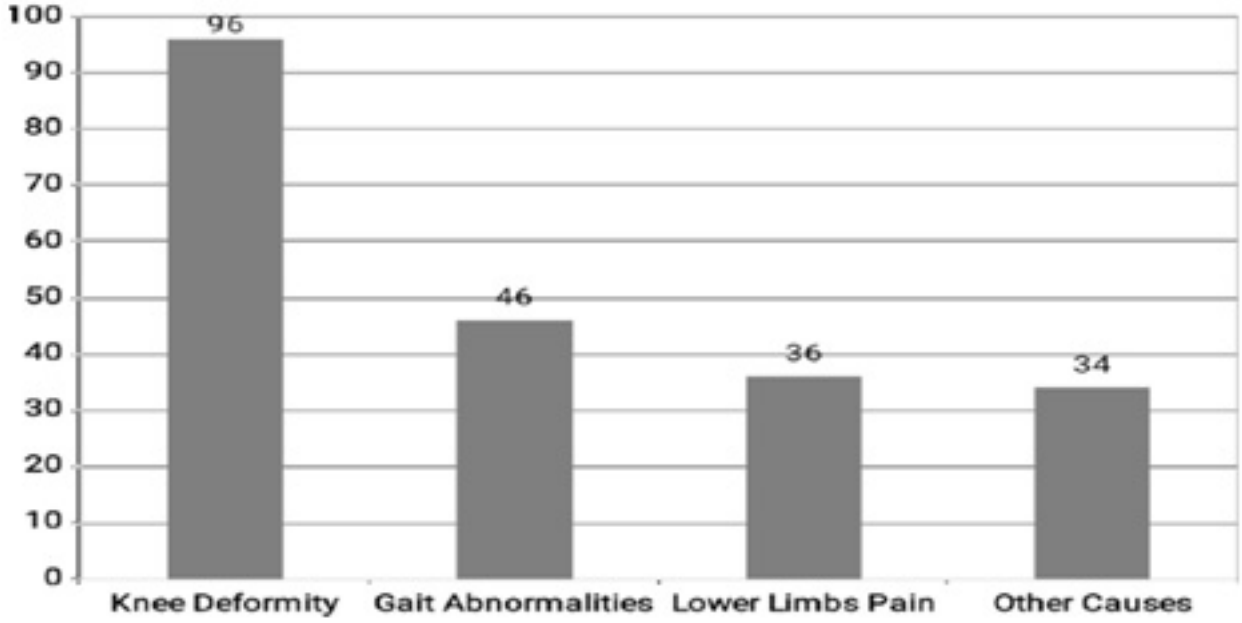

Table 1:Clinical Characteristics of the 212 Patients

Characteristic	Values
Sex, No.(%)	
Female	104(49.1%)
Male	108(50.9%)
Age, years	
Mean ± SD	4.8 ± 3.3
Range	1 - 15
Calcium , mg/dl	
Mean ± SD	9.73 ± 0.65
Range	8.1 – 14.0
Phosphorus, mg/dl	
Mean ± SD	5.11 ± 0.74
Range	2.2 – 7.2
Alkaline phosphatase, IU/L	
Mean ± SD	574.2 ± 210.1
Range	152 - 1600
Vitamin D, ng/ml	
Mean ± SD	30.78 ± 22.31
Range	3.0 – 178.0

Table 2: Laboratory Findings in 212 Patients

Characteristic	No.(%)
Hypocalcemia	8(3.8%)
Hypophosphatemia	4(1.9%)
Alkaline phosphatase Elevation	196(92.5%)
Vitamin D	
Sufficient	80(37.7%)
Insufficient	55(25.9%)
Deficient	77(36.3%)

Table 3: Prevalence of Vitamin D Deficiency with Sex and Cause of referral to pediatric orthopedic Clinic

Variables	Vitamin D No.(%)		Odds Ratio (95%CI)	P-Value
	Sufficient	Insufficient/Deficient		
Sex				
Female	35(33.7%)	69(66.7%)	1.408(0.806-2.461)	0.258
Male	45(41.7%)	63(58.3%)		
Age				
1-5years	63(44.1%)	80(55.9%)		0.013
6-10years	10(20.4%)	39(79.6%)	—	
11-15years	7(35%)	13(65%)		
Causes				
Knee Deformity	37(38.5%)	59(61.5%)	—	
Gait Abnormalities	11(23.9%)	35(76.1%)		0.036
Lower limbs pain	13(36.1%)	23(63.9%)		
Others	19(55.9%)	15(44.1%)		

Figure 2: Box plot of Age Variation in Vitamin D Levels. The median Vitamin D Level was higher in 1-5years than older age groups. The center line in the box indicates bars of minimum and maximum values. Circles and stars show more extreme values and out layers, respectively

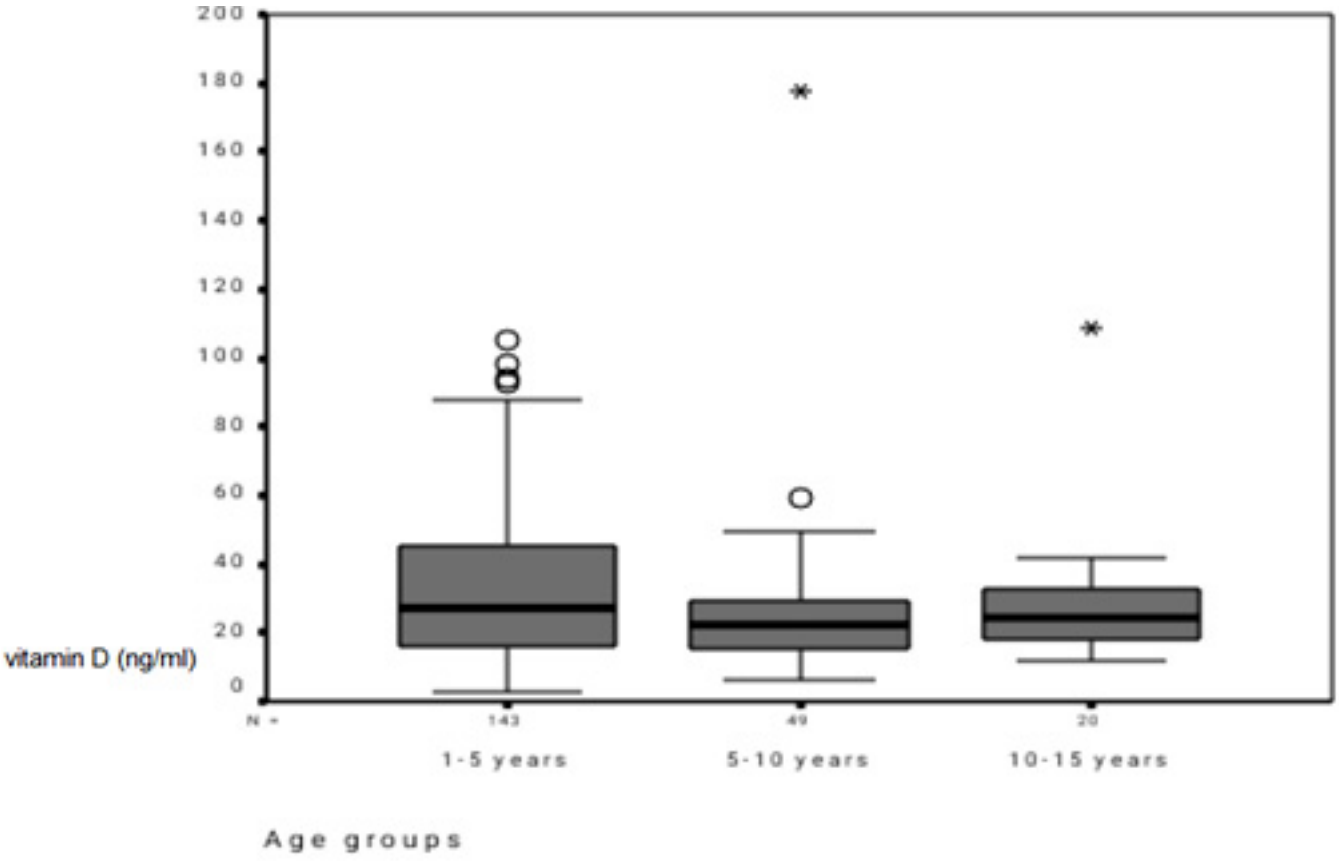

Table 4: Relationship of demographic and Metabolic Characteristics with Vitamin D deficiency

Variables (Mean ±SD)	Vitamin D			P-Value
	Sufficient	Insufficient	Deficient	
Age(years)	4.3±3.3	5.1±3.2	5.2±3.3	<0.001
Calcium (mg/dL)	9.8±0.6	9.9±0.8	9.6±0.6	0.948
Phosphorus(mg/dL)	5.2±0.7	5.3±0.7	4.9±0.8	0.077
Alkaline phosphatase (IU/L)	536.6±207.8	583.5±224.9	606.7±197.	0.007
Vitamin D(ng/ml)	51.4±23.7	24.9±2.8	13.5±4.4	0.073

Discussion

Vitamin D deficiency is an important health problem and its worldwide prevalence is 30 to 80 percent in the pediatric and adult community (3-5). Deficiency is generally measured by 25-OH vitamin D (calcidiol) concentration, because it has a long half-life (2-3 weeks). 1,25 OH vitamin D3 has a short half life and is closely linked to parathyroid hormone production, so serum level of calcitriol doesn't reflect vitamin D status(10,11).

Vitamin D deficiency can be easily diagnosed in prescence of clinical features of Rickets, but Rickets is an excessive form of vitamin D deficiency and can be considered as the tip of an iceberg(11).

Improved information about harmful non-skeletal effects of insufficient vitamin D before the appearance of Rickets led to a growing interest in diagnosing this pre rachitic, subclinical vitamin D deficiency(11,16).

In this study, we found a notable high prevalence of vitamin D deficiency and insufficiency among 1-15 years children and adolescents. Only 37.7% of cases had sufficient amounts of 25 hydroxy vitamin D and more than 62.2% had vitamin D deficiency and insufficiency(Table 2). There is a high prevalence of subclinical Rickets in children referred to the pediatric orthopedic clinic that confirms results of other studies about the importance of vitamin D deficiency as a health problem (1-5). There is no significant difference between males and females in prevalence of vitamin D deficiency or insufficiency (P-value=0.258), although Odds ratio of 1.408 (0.806-2.461) shows that risk of vitamin D deficiency is higher in girls(Table 3).

In comparison between age groups, we found that the rate of vitamin D deficiency and insufficiency is lower in 1-5 years group than older age groups (P-value=0.013), also mean vitamin D level was higher in the preschool age group. It may be due to preventive health care programs that are conducted for lower age groups. Lowest level of vitamin D was seen in 6-10 groups, so more comprehensive health care program for prevention of vitamin D deficiency can be considered in the school age group.

We also compared different causes of referral to the pediatric orthopedic clinic in terms of prevalence of vitamin D deficiency (Table 3) and we found significant difference between these groups (P-value = 0.036).

A variety of causes were described for vitamin D deficiency such as decreased skin synthesis (because of cultural practice, seasonal variation, atmospheric pollution and strict sun screen use), malabsorption, multiple short interval pregnancies, obesity, decreased dietary intake and drug interaction(10,11).

According to our study more attention should be paid to school age children and adolescents for prevention, diagnosis and treatment of sub clinical vitamin D deficiency, also we emphasis that a nationwide study can help to define the true prevalence and etiologic factors of vitamin D deficiency in children and adolescents.

Pediatric orthopedic is surgeon best to consider the high prevalence of subclinical vitamin D deficiency in patients who were referred to the clinic.

Conclusion

There is a high prevalence of vitamin D deficiency and insufficiency in children age 1-15 years who referred to the pediatric orthopedic clinic (more than 62.2%). This high prevalence of poor vitamin D status is more obvious in school age and adolescent groups and this may be caused by decreased skin synthesis owing to low sunlight exposure, skin coverage, air pollution or low vitamin D intake. Improvement in mean of vitamin D level in children and adolescents can help to prevent many chronic diseases, so we recommend designing more comprehensive health programs for prevention and diagnosis of subclinical vitamin D deficiency especially for school age children.

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