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Evaluation of Serum Vitamin D Levels in Foster's Children Care Center

Mohamadreza Amiri, MD[1,*]

[1]Mashhad University of Medical Sciences, Mashhad, Iran

Abstract

Vitamin D, the sunshine vitamin, is now recognized not only for its importance in promoting bone health in children and adults, but also for its other health benefits, including reducing the risk of chronic diseases such as autoimmune diseases, common cancer, and cardiovascular diseases. Ultraviolet radiation of the sun with wavelengths of 290-310 nm penetrates into the skin and converts 7-dehydrocholesterol to previtamin D3, which quickly transforms to vitamin D3. Vitamin D (D represents either D2 or D3) made in the skin or ingested through diet is biologically inert and requires two successive hydroxylations first in the liver on carbon 25 to form 25-hydroxyvitamin D [25(OH)D] and then in the kidney for a hydroxylation on carbon 1 to form the biologically active form of vitamin D, 1,25-dihydroxyvitamin D [1,25(OH)2D] [1,2,14,19].

The concentration of the produced 25-hydroxy vitamin D in blood circulation is 1,000 times more than 1,25-dihydroxy vitamin D [4], and it is regarded as a standard indicator of vitamin D status in humans [3].

25-hydroxy vitamin D half-life is about 2-3 weeks and it is regulated by calcium (Ca), phosphorus (P), and serum parathyroid hormone (PTH) to some extent. 25-hydroxy vitamin D content also reflects the amount of vitamin D produced in the skin after exposure to sunlight or received through food intake [5,6].

Guidelines for vitamin D insufficiency/deficiency defined by serum 25(OH)D concentrations have been published from many countries and regions all over the world [7-11]. Vitamin D deficiency is a pandemic problem. According to global estimations, more than one billion people around the world suffer from vitamin D deficiency. Among Iranian population, the incidence of vitamin D deficiency varies from 2.5 to 98.5% based on geographic area [12,13]. Various factors may give rise to vitamin D deficiency, including skin pigments, low levels of vitamin D in diet (insufficient fish oil and egg yolk intake), malnutrition, genetic factors, exclusive breast feeding, vitamin D deficiency of mother during pregnancy, prematurity, chronic use of drugs (e.g., anticonvulsants, aluminum-containing anti-acids, rifampcin, isoniazid, antifungal drugs, antiviral drugs, and glucocorticoids), winter and obesity [1,13]. Cultural habits, the need for full body coverage during outdoor activities and the lack of sunlight programs are the risk factors for low vitamin D levels in women [15-17].

Children enter foster care due to early childhood adverse experiences such as poor prenatal and infant health care, food insecurity, chronic stress, and the effects of abuse and neglect. As a result, they are at higher risk for poor physical, psychological, neuroendocrine and neurocognitive outcomes compared to others. Foster children are at risk for growth and nutritional deficiencies due to their poor nutritional environment prior to placement in foster care. Insufficient caloric intake results in growth deficiencies. Evidence showed that the risk of stunting and underweight is high in this population [18].

The risk of developing hypovitaminosis D was significantly higher in children living in foster homes. One reason is that they are at higher risk of child abuse, emotional deprivation and physical neglect than children living with their families. Moreover, these children most likely do not spend much time outdoors and they lack adequate sun exposure. Another reason is that as children grow up in institutional care, they shift from a diet of vitamin D–fortified formula milk to cooked food, which may not be fortified with vitamin D [1].

Iranian government has made some efforts to apply efficient interventions to reduce the prevalence of vitamin D deficiency, and the country's healthcare system should be managed through accurate planning. Yet, in this country, studies on vitamin D deficiency in children living in foster homes are very limited, and given that timely diagnosis and treatment of this deficiency is vital, this research is conducted in Ali Asghar foster home in Mashhad, Iran.

Corresponding author: Mohamadreza Amiri, MD, Mashhad University of Medical Sciences, Mashhad, Iran, Tel: 98-91-5501-2453, Email: amiri.mza@gmail.com

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Introduction, Statement of the Problem and Importance of the Research

Vitamin D, the sunshine vitamin, is now recognized not only for its importance in promoting bone health in children and adults, but also for its other health benefits, including reducing the risk of chronic diseases such as autoimmune diseases, common cancer, and cardiovascular diseases. Ultraviolet radiation of the sun with wavelengths of 290-310 nm penetrates into the skin and converts 7-dehydrocholesterol to previtamin D3, which quickly transforms to vitamin D3. Vitamin D (D represents either D2 or D3) made in the skin or ingested through diet is biologically inert and requires two successive hydroxylations first in the liver on carbon 25 to form 25-hydroxyvitamin D [25(OH)D] and then in the kidney for a hydroxylation on carbon 1 to form the biologically active form of vitamin D, 1,25-dihydroxyvitamin D [1,25(OH)2D] [1,2,14,19].

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Children enter foster care due to early childhood adverse experiences such as poor prenatal and infant health care, food insecurity, chronic stress, and the effects of abuse and neglect. As a result, they are at higher risk for poor physical, psychological, neuroendocrine and neurocognitive outcomes compared to others. Foster children are at risk for growth and nutritional deficiencies due to their poor nutritional environment prior to placement in foster care. Insufficient caloric intake results in growth deficiencies. Evidence showed that the risk of stunting and underweight is high in this population [18].

The risk of developing hypovitaminosis D was significantly higher in children living in foster homes. One reason is that they are at higher risk of child abuse, emotional deprivation and physical neglect than children living with their families. Moreover, these children most likely do not spend much time outdoors and they lack adequate sun exposure. Another reason is that as children grow up in institutional care, they shift from a diet of vitamin D–fortified formula milk to cooked food, which may not be fortified with vitamin D [1].

Iranian government has made some efforts to apply efficient interventions to reduce the prevalence of vitamin D deficiency, and the country's healthcare system should be managed through accurate planning. Yet, in this country, studies on vitamin D deficiency in children living in foster homes are very limited, and given that timely diagnosis and treatment of this deficiency is vital, this research is conducted in Ali Asghar foster home in Mashhad, Iran.

Literature Review

Since, before admission to foster homes, these children have not received good health care and have not visited health care centers, it is usually very difficult to obtain their health records [19]. In a research by Chiappini et al., 962 internationally adopted children within the age range of 3.14-7.93 years were investigated in terms of 25-hydroxy vitamin D level. They found that hypovitaminosis D is common among these children. Thus, it is better to measure their 25-hydroxy vitamin D serum level on admission in foster homes [20]. In a research on these children by Salerno et al., researchers found similar results and emphasized that older children with dark skin and those accepted in winter and spring are at a higher risk for developing vitamin D deficiency [1]

Keywords

Vitamin D

Refers to levels of serum 25 hydroxyvitamin D (25-OHD) which reflects total body stores. Colecalciferol (vitamin D3) and ergocalciferol (vitamin D2) are converted to 25- hydroxyvitamin D (25-OHD) in the liver. It is a fat-soluble vitamin which, given its characteristics, also referred to as hormone. [1,2,24]

1,25 dihydroxy Vitamin D3

In the kidney, 25 hydroxy vitamin D (25-OHD) is hydroxylated to produce the biologically active form of vitamin D, 1,25- dihydroxy vitamin D (1,25-[OH]2D, or calcitriol). This step requires the activity of parathyroid hormone (PTH). [3]

Parathyroid Hormone

Parathyroid hormone (PTH) is produced in the parathyroid glands and is required to convert the inactive form of vitamin D (25-OHD) to the active form, 1,25-(OH)2D.[19]

ALP

ALP is produced by bone and is elevated in conditions of increased bone turnover. This is often associated with calcium deficiency, vitamin D deficiency, and elevated PTH.[21]

Vitamin D Deficiency

Recommended guidelines for defining vitamin D deficiency in children and adolescents [7-11]

Calcium

Blood cation, in addition to its role in bone mineralization, is also involved in a variety of cellular activities [22].

Phosphor

Blood anion, in addition to the role in bone mineralization, has important intracellular and extracellular functions [23]

Research Purpose

General Purpose

Assessing the prevalence rate of vitamin D deficiency in infants and children aged between 2 months and 6 years old admitted to Ali Asghar foster home of Mashhad, Iran, from December 22, 2018 to December 22, 2019.

Secondary Purposes

A. Determining the frequency of vitamin D deficiency among the subjects in terms of age, gender, place of residence, maternal educational level, the number of family members in the child's previous place of residence, body mass index, skin color, and exposure to sunlight.
B. Determining serum level of calcium in the samples.
C. Determining serum level of phosphorous in the samples.
D. Determining serum level of alkaline phosphatase in the samples.
E. Determining serum level of parathyroid hormone in the samples.
F. Determining urine level of calcium in the samples.
G. Determining urine level of phosphorus in the samples.

Functional Purpose

Determining the prevalence rate of vitamin D deficiency in the samples for timely and proper treatment.

Materials and Methods

Target Population

The study population consists of all the infants and children aged between 2 months and 6 years old admitted to Ali Asghar foster home from December 22, 2018 to December 22, 2019.

Exclusion Criteria

Rheumatic, thyroid, parathyroid and adrenal disease, diabetes mellitus, renal failure, any type of malignancy, Cushing syndrome, consumption of calcium or multivitamin products over the last two weeks, injection of vitamin D over the last six months, and use of anticonvulsants.

Research Category

This is a descriptive cross-sectional research, which will be carried out from December 22, 2018 to December 22, 2019.

Determining Sample Size

All the infants and children aged between 2 months and 6 years old admitted to Ali Asghar foster home from December 22, 2018 to December 22, 2019 will be included in the research.

Sampling Method

In order to perform sampling, during the routine blood sampling of infants and children aged between 2 months and 6 years old . additional blood samples will be taken for this study. Urine samples of these children will be sent to laboratory for calcium and phosphorus measurement. Prior to the onset of the study, the necessary permissions will be obtained from the authorities of State Welfare Organization.

Data Collection Method

At first, full clinical examination will be performed on the children and infants included in this study. Also, their health records and social work reports will be studied. For the children not meeting the exclusion criteria, a demographic form will be completed through interviews (if possible) and study of social work records (the attached proposal sheet). The children’s height, weight, and head circumference will be measured as well. Then, the children will be referred to a nurse for blood sampling. Sampling will be performed at 8 am to 9 am at the blood sampling room of Ali Asghar foster home. In detail, 5-ml venous blood samples will be drawn from the children in fasting state. Urine samples of these children will be sent to laboratory for calcium and phosphorus evaluation.

In case of clinical suspicion of vitamin D-deficient rickets, X-rays of the wrists or knees will be requested (cupping, splaying, fraying, coarse trabecular pattern of metaphysis, osteopaenia, and fractures).

If the results do not suggest nutritional vitamin

D deficiency, the table 1 will be used for differential diagnosis. If a cause other than vitamin D deficiency is suspected, appropriate investigation and management for that condition will be instituted [19].

Data Analysis Method

After data collection and performing the tests, all the data will be entered into SPSS (version 18) for analysis. To examine the relationship between 25-OHD serum level and variables, Chi-square test will be run. P-value less than 0.05 is considered statistically significant.

Limitations and Implementation Problems of the Research

A) Obtaining permission from the State Welfare Organization for blood sampling from children.

B) Convincing the respective authorities regarding the necessity of this research.

C) Communicating with older children to obtain their permission for taking blood samples and gaining their cooperation for responding to the questionnaires accurately.

D) Checking if there was any missing information in social work and medical records of the admitted children to extract the required information from them.

Ethical Considerations

In performing this study, all the ethical principles of research will be observed.

Cost Information

The research costs will be covered through funds provided by financial resources of Mashhad University of Medical Sciences and State Welfare Organization. The honorable journal authorities will be kept informed in case of facing with any problems.

(Tables 2-3)

Table 1. Differential diagnosis for rickets: laboratory results

Causes	Ca	Pi	PTH	250HD	1,250HD	ALP	Urine Ca	Urine Pi
Vitamin D deficiency	N / ↓	↓	↑	↓	↓ / N / ↑	↑	↓	↑
VDDR, type 1	N / ↓	↓	↑	N	↓	↑	↓	↑
VDDR, type 2	N / ↓	↓	↑	N	↑↑	↑	↓	↑
Chronic renal failure	N / ↓	↑	↑	N	↓	↑	N / ↓	↓
Dietary Pi deficiency	N	↓	N / ↓	N	↑	↑	↑	↓
XLH	N	↓	N	N	RD	↑	↓	↑
ADHR	N	↓	N	N	RD	↑	↓	↑
HHRH	N	↓	N / ↓	N	RD	↑	↑	↑
ARHR	N	↓	N	N	RD	↑	↓	↑
Tumor-induced rickets	N	↓	N	N	RD	↑	↓	↑
Fanconi syndrome	N	↓	N	N	RD or↑	↑	↓ or ↑	↑
Dietary Ca deficiency	N / ↓	↓	↑	N	↑	↑	↓	↑

ADHR, autosomal dominant hypophosphatemic rickets; Alp Phos, alkaline phosphatase; ARHR, autosomal recessive hypophosphatemic rickets; Ca, calcium; HHRH, hereditary hypophosphatemic rickets with hypercalciuria; N, normal; Pi, inorganic phosphorus; PTH, parathyroid hormone; RD, relatively decreased (because it should be increased given the concurrent hypophosphatemia); VDDR, vitamin D dependent rickets; XLH, X-linked hypophosphatemic rickets; 1,25-(OH),D, l, 25-dihydroxyvitamin D; 25-0HD, 25-hydroxyvitamin D; ↓, decreased; ↑ increased; ↑↑, extremely increased.

Table 2. Variables

Variables	(Quantitative-integrated, quantitative-unintegrated, qualitative)	Role (dependent, independent, contextual, confusing)	Functional definition	Measurement unit
25-OHD	Quantitative - integrated	Dependent	a fat-soluble vitamin which, given its charcteristics, also referred to as hormone	Radioimmunoassey
Calcium	Quantitative - integrated	Dependent	Blood electrolyte	Automated colorimetric
Phosphor	Quantitative - integrated	Dependent	Blood electrolyte	Automated colorimetric
ALP	Quantitative - integrated	Dependent	A kind of blood enzymes	colorimetric
PTH	Quantitative - integrated	Dependent	A kind of endocrine hormones secreted by the parathyroid gland	Radioimmunoassey
Age	Quantitative - integrated	Contextual	Based on calendar age, social work report	Questioning
Gender	nominal - qualitative	Independent	Male, female	Observation
Place of residence	nominal - qualitative	Independent	Village, town, suburb	Questioning–social work report
Education level of parents (mother)	ranking – qualitative	Contextual	Less than cycle, cycle to diploma, academic degree	Questioning
number of family members who were in the child's previous place of residence	unintegrated – quantitative	Contextual	number of family member in previous family	Questioning–social work report
BMI	quantitative-integrated	Independent	Weight (Kg) divided by squared height (m)	Weighing with a scale and measuring height with meter
Skin color	nominal – qualitative	Independent	White, yellow, dark	Observation
Exposure to sunlight	quantitative-integrated	Independent	Duration of person exposure to sunlight	Questioning

Table 3. Time Schedule of Research Process and Progress

No	Separated Research Activities	Duration (months)	Runtime (month)													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Performing tests on the study subjects	12 months												+		
2	Collecting information and data	15 days													+	
3	Analyzing data by statistical methods	15 days													+	
4	Drafting and organizing the paper	1 month														+

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