

Vitamin D Supplementation for the Prevention of Rickets and Multiple Fractures in Pediatrics

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ABSTRACT

Intro: In the US, an estimated 50% of children ages 1-5 and 70% of children 6-11 are vitamin D deficient or insufficient, placing them at increased risk of developing multiple fractures and rickets.¹ After developing hypovitaminosis D, pediatric patients are placed on a treatment regimen to reverse the deficiency. However, no guidelines exist to help in the prevention of developing the disease.

Methods: Randomized controlled trials of pediatric patients under 18 years old were obtained from multiple countries studying hypovitaminosis D. Dosing regimens in each trial were compared throughout the analysis to determine if proper vitamin D supplementation would improve the levels appropriately for treatment and if any evidence was provided of prevention methods.

Results: Between winter and spring seasons in Boston, a total of 24.2% and 42% of children ages 11 – 18 years old were deficient or insufficient in vitamin D, respectively. Another study determined that a weekly dose of 50,000 IU VD2 weekly improved vitamin D levels most effectively by 202%. An additional study of 100 children sustaining low-energy fractures discovered 21% were deficient and 49% were insufficient; exploring further, 50% of the individuals requiring surgery were deficient in vitamin D.

Discussion: Multiple studies have stated an average of 1,000-4,000 IU/day of vitamin D should be obtained through direct sunlight and food in a child. Nutritional and seasonal sun-exposure deficiency have direct correlation in pediatric levels of vitamin D. Nonetheless, all studies concluded further investigation is necessary to ensure proper prevention methods against rickets and fractures is obtained through appropriate intake of vitamin D.

Conclusions: Per the AAP, it is recommended for pediatric patients to receive 400 IU/day of vitamin D to ensure consumption.² Currently, there are no guidelines for supplementing vitamin D to prevent prolonged hypovitaminosis D, which can lead to multiple fractures or rickets.

INTRODUCTION

Vitamin D is a necessary nutrient for the absorption of calcium and maintaining bone health among pediatric patients.¹ Absence of this important vitamin and calcium causes a weakened bone core, thus allowing bones to fracture or bend easily, commonly known as rickets.

“More than 50 million teenagers in the US are either vitamin D deficient or insufficient. Fifty percent of children ages 1 to 5 and 70 percent of children 6 to 11 years of age were found to be vitamin D deficient or insufficient in the US.”¹

Bones grow at a high rate early in life, with more than half of the peak bone mass acquired during teenage years, and it is crucial to maintain adequate amounts of serum vitamin D in a child that is growing.

Lacking vitamin D increases the risk of pediatric patients to develop rickets or suffer from multiple fractures due to the weakness of the bones. Vitamin D is essential for proper skeletal growth and to maintain bone health in pediatrics, but there is no current guideline for vitamin D supplementation to prevent prolonged hypovitaminosis D leading to excessive fractures or rickets.

MATERIALS AND METHODS

- Criteria: Randomized controlled trials on pediatric patients under age of 18 years old. Publication within the past 20 years. No discriminations of exclusion based on gender, race, or ethnicity.
- Subjects studied included individuals who were previously diagnosed with hypovitaminosis D or had normally measuring levels of vitamin D. Each trial had different dosing regimens and were compared to establish the most effective treatment dose.
- Studies were obtained from multiple countries studying hypovitaminosis D and each had multiple groups given different doses of the supplement to treat the decreased levels. This research scope helped determine if supplementation worked efficiently in other countries compared to trials performed in the US.



Image 1 – X-ray of rickets⁴



Image 2 – X-rays before and after the treatment of rickets of a child.⁵

Vitamin D Status	Calcidiol Level (ng/mL)
Severe deficiency	< 5
Mild-moderate deficiency	5-15
Insufficiency	16-20
Sufficiency	21-100
Excess	101-149
Intoxication	>150

Table 2 – Values of vitamin D in deficiency and excess¹

Committee	Vit. D	Vit. D
	Insufficiency	Deficiency
American Academy of Pediatrics (AAP) & Institute of Medicine (IOM)	< 20 ng/mL	
Endocrine Society	< 30 ng/mL	<20 ng/mL
National Kidney Foundation Kidney Disease Outcomes Quality Initiative (KDOQI)	<30 ng/mL	<15 ng/mL

Table 3 – Values of vitamin D in deficiency and insufficiency based on committees³

Guidelines per AAP to treat hypovitaminosis D

Age group	Dosage of Vitamin D
Neonates	1000 IU/day
1-12 months	1000-5000 IU/day
12 months – older	5000 IU/day

Table 3 – Treatment of rickets⁶

RESULTS

- 50,000 IU VD2 weekly improved levels most effectively by 202%.⁶
- 14,000 IU VD3 weekly improved levels from 14±8 ng/mL to 38±31 ng/mL to help improve bone mineral density during pre-menarche.⁷
- 24.2% deficiency and 42% insufficiency in 11-18 year old's in Boston, MA between winter and spring seasons.⁸
- No studies continued surveillance on patients to determine if correction of hypovitaminosis D helped prevent future development of rickets or excessive fractures.

DISCUSSION

Studies continue to focus on the best regimen to prescribe a child after a diagnosis of rickets or multiple fractures occurrences, when providers should focus on how to prevent the development of these diseases from occurring. A child's body grows exponentially during the first 12 years of life, placing them at risk for developing health problems if not adequately receiving nutrients or vitamins, especially musculoskeletal.

Rickets is one of the five most preventable diseases in developing countries.⁸ Healthcare providers do their best to protect patients through limiting sun exposure, but this decreases the amount of vitamin D received from natural sunlight and necessitating proper intake through food.

Studies have concluded that high-dose weekly vitamin D would be most beneficial in a child suffering from deficiency, varying in doses between 14,000 and 50,000 IU/week.^{6,7}

50% of 1-5 year old's, 70% of 6-11 year old's, and 50 million teenagers in the US suffer from vitamin D deficiency or insufficiency.¹ Healthcare providers can easily overlook a tranquil preventable health condition when patients present without complaints. It is the duty of providers to ensure adequate intake of all vitamins and nutrients are maintained for proper growth in the pediatric population.

CONCLUSIONS

Currently, no guidelines are available for supplementing vitamin D to prevent prolonged hypovitaminosis D, which may lead to excessive fractures or rickets. Although studies have been performed, none have discovered if there is a specific amount of intake that will prevent the destructive bone diseases from developing.

Per the AAP, it is recommended for pediatric patients to receive 400 IU/day of vitamin D.² These recommendations are only to ensure the child is receiving daily doses of vitamin D, but not enough evidence to support that it is the correct dose to be helpful in preventing rickets and fractures as the child develops.

Further studies must be performed to follow patients for a longer period of time to determine the best regimen of vitamin D used for an end goal of preventing rickets and multiple fractures in their life-time.

How do we get vitamin D?



Image 1 – Sources of vitamin D.⁹

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Table 1 – Prevalence of vitamin D deficiency in pediatric patients sustaining upper or lower extremity fractures between 2008 – 2015, in multiple studies.²

Year	Included fracture population	Prevalence of vitamin D deficiency
2011	118 children younger than 2 years old	8%
2012	100 children with a fracture of the upper or lower extremity	12%
2015	369 children	18%
2014	100 children with a fracture	20%
2008	68 children with two or more fractures in the past	21%
2013	213 children with a fracture of the upper extremity	24%
2012	76 African-American children with a forearm fracture	47%