Vitamin D Guidelines in Healthy Children

Guideline developed by Alba Morales Pozzo, MD, in collaboration with the ANGELS team. Last reviewed by Alba Morales Pozzo, MD, May 8, 2017.

Key Points

Key points for primary care providers

- At ages 3 and 9 years review dietary history with family, ask specific questions about dairy and carbonated drinks intake, type and amount of physical activities, and other sources of Vitamin D and calcium intake. Review this information with adolescents on an annual basis.
- Encourage weight bearing activities in addition to cardiovascular exercise. Jumping, jogging, skipping and running are good examples of weight bearing exercise.
- Re-measure 25 OH vitamin D level after treatment has been completed on children who are Vitamin D deficient.
- DXA scans may be indicated in children with medical conditions that are associated with decreased bone density and in patients who have suffered bone fractures after minimal trauma. DXA scan interpretation should be made using Z-Scores appropriate for pubertal status and age.
- Adolescent females need to be discouraged from pursuing severe thinness. Athletes with low BMI who've had amenorrhea for 6 or more months should be considered candidates for a DXA screening.
- At this time, bisphosphonates use is only indicated in osteogenesis imperfecta and conditions associated with severe osteoporosis causing vertebral fractures and/or pain.

Definitions

- 25 OH Vitamin D (ng/ml) assay should utilize highly specific monoclonal antibodies
    - ≤ 5 (Severe deficiency)

    - 5-15 (Deficiency)
    - 15-20 (Insufficiency)
    - 20-100 (Sufficiency)
    - 100-150 (Excess)
    - ≥ 150 (Intoxication)
- Estimated Average Requirement (EAR): an average daily requirement for a healthy person
- Recommended Dietary Allowance (RDA): levels of intake that are likely to meet the needs of about 97.5% of the population derived from the EAR
- Tolerable Upper Intake Level (UL): above which the potential for harm increases
- Dietary Reference Intakes (DRI): B + C + D [1-3]

Assessment

- Vitamin D is a pro-hormone required for normal calcium absorption from gut.
- Vitamin D deficiency is associated with rickets in children and osteomalacia in adults.
- Signs and symptoms of Vitamin D deficiency
    - Bone deformities/fractures
    - Bone pain
    - Irritability
    - Developmental delay
    - Delayed tooth eruption
    - Craniotabes
    - Frontal bossing
    - Delayed fontanelle closure
- Severe Vitamin D deficiency
    - Hypocalcemia presenting as seizures
    - Tetany in infants and adolescents due to increased growth velocity

Table 1. Biochemical Characteristics in Different Stages of Vitamin D Deficiency

To view a larger image on your device, please click or touch the image.

Table 1. Biochemical Characteristics in Different Stages of Vitamin D Deficiency[4]

	Ca	PO4	ALP	PTH	25(OH)-D	1-25	X-ray
Early- no symptoms	N/↓	N/↓	↑	↑	↓	N	osteopenia
Mod- bone pain	N/↓	↓	↑↑	↑↑	↓↓	↑	+rachitic changes
Severe- bone pain	↓↓	↓↓	↑↑↑	↑↑↑	↓↓↓	↑/N/↓	++ rachitic changes

- Sources of Vitamin D

    - Cutaneous synthesis
    - Dietary sources
        - Fatty fishes such as salmon, tuna, mackerel, sardines
        - Liver organ meats and egg yolk
        - Fortified cereals, milk, foods
    - Supplements
- Causes of deficiency
    - Decreased synthesis related to
        - Geography
        - Latitude (above 33°)
        - Season
        - Air pollution
    - Decreased nutritional intake of Vitamin D
    - Decreased maternal Vitamin D stores and exclusive breastfeeding
    - Malabsorption resulting from
        - Celiac disease
        - Cystic fibrosis
        - Biliary atresia
    - Decreased synthesis or increased degradation of 25-OH vitamin D brought on by
        - Chronic liver disease
        - Drugs
            - Rifampicin
            - Isoniazid
            - Anticonvulsants
    - Obesity

Prevention of Vitamin D Deficiency

- Sun exposure
- Fortified foods
    - Cereals
    - Milk
    - Orange juice
- Supplements for
    - Light skinned infants, 400 IU/day
    - Dark-skinned infants, at least 400 IU/day, probably need more
    - Pre-term infants, supplement from birth 400-800 IU/day
    - Breast-feeding mothers, 4000-6400 IU/day[5]
- Screening
    - Infants with non-specific symptoms or poor growth
    - Dark-skinned infants living at higher latitudes
    - Children on anticonvulsants or glucocorticoids
    - Children with malabsorption
    - Fractures or low bone density
    - Elevated serum
        - Alkaline phosphatase (ALP)[6] suspicious for rickets
        - 25-OH-D
        - Calcium
        - Phosphates (PO4)
        - Parathyroid hormone (PTH)
        - X-rays of distal ends radius and ulna or tibia and femur

- Normal ALP levels
    - < 500 IU/L in neonates
    - < 1000 IU/L in children up to age 9
- Wrist x-ray most reliable test for detecting subclinical rickets[7,8]

Treatment of Vitamin D Deficiency

- When to treat
    - Hypocalcemia and/or rickets as consequence of Vitamin D deficiency
    - Vitamin D levels are in the deficient range
- How to treat[3, 9-13]
    - The Endocrine Society Clinical Practice Guidelines[13]
    - Treat deficient infants and toddlers with 2000 day or 50,000 per week for 6 weeks (do not use liquid formulation, use capsule). Followed by maintenance of 400-1000/day; goal is to reach 25OHD level of 30 ng/ml.
    - Treat deficient 1-18 year olds with 2000 per day or 50,000 per week for 6 weeks (capsule), followed by maintenance of 600-1000/day; goal is to reach 25OHD level of 30 ng/ml.
    - Treat deficient adults with 50,000/week for 8 weeks or 6,000 per day, maintenance of 1500-2000/day after achieving 25OHD level of 30 ng/ml.
    - Radiologic evidence of healing seen in 2-4 weeks, then scale down therapy to maintenance dosing
    - If compliance is an issue 100,000-600,000 IU given over 1-5 days followed by maintenance dosing
    - If using high doses, give high dose in a capsule or tablet instead of using liquid formulations designed for babies.
    - Teens and adults→50,000 IU once/week for 8 weeks
    - Co- supplementation with oral supplements of calcium in order to
        - Avoid “hungry-bone” syndrome
        - Treat hypocalcemia
        - IV calcium in cases of tetany
        - Calcium dose-30-75 mg/kg/day of elemental calcium (dose may be cut in half after initial therapy for next 1-2 weeks, then may stop once vitamin d levels and PTH are normal)

Monitoring Therapy

- One (1) month after therapy starts obtain levels for
    - Calcium
    - PO4
    - ALP
- Stoss therapy biochemical response occurs within 1-2 weeks; first sign is ↑PO4.
- ALP levels may increase in short term as bone formation rates increase.
- Also early initial increase in 1,25 (OH) 2D levels
- Later, ALP and 1,25-D levels decrease to normal and 25OH-D increases to normal level.
- Complete radiologic healing may take months but changes can be seen within 1-2 weeks.
- At 3 months obtain
    - Calcium level
    - PO4 level
    - Magnesium (Mg) level
    - ALP level

- 25-OH vitamin D level
- PTH levels
- Consider urine for calcium/creatinine ratio
- Repeat radiograph
- If all normal, repeat 25(OH)-D levels yearly[1]

Other Population-based Recommendations

- USA and Canadian governments requested analysis by a committee from the Institute of Medicine of the National Academies to arrive at DRIs and review health outcomes associated with calcium and Vitamin D.
- Institute of Medicine of the National Academies considered health outcomes
  - Bone and skeletal health; sound scientific evidence supporting cause-effect role of Vitamin D in skeletal health but not in extra-skeletal health including
    - Cardiovascular diseases and hypertension
    - Type 2 diabetes and metabolic syndrome
    - Falls
    - Immune disorders
    - Infectious diseases
    - Neuropsychological functioning
    - Disorders of pregnancy (preeclampsia)
  - Recommended dietary allowance for Vitamin D in children 1-18 is 600 IU/day.
  - Estimated average requirement for Vitamin D in children 1-18 is 400 IU/day.
- To maintain plasma levels of 25-OH vitamin D >30 ng/ml requires a daily intake of more than 1000 IU of Vitamin D per day for most children and adults.
- IOM Committee's review of data suggests that persons are at risk of deficiency relative to bone health at serum 25OHD levels <12 ng/ml.
- Some persons are potentially at risk for inadequacy at levels between 12-20 ng/ml.
- Almost all persons are sufficient at serum levels of at least 20 ng/ml.
- Serum 25OHD concentrations >30 ng/ml are not consistently associated with increased benefit[2]

Table 2. IOM Recommendations on Vitamin D and Calcium Daily Intake

To view a larger image on your device, please click or touch the image.

Table 2. IOM Recommendations on Vitamin D and Calcium Daily Intake[3]						
Life Stage Group	Vitamin D, IU/day			Calcium, mg/day		
	Old	New	Upper limit	Old	New	Upper limit
0-6 months*	200	400 (AI)	1000	210	200 (AI)	1000
6-12 months*	200	400 (AI)	1500	270	260 (AI)	1500
1-3 years	200	600 (RDA)	2500	500	700 (RDA)	2500
4-8 years	200	600 (RDA)	3000	800	1,000 (RDA)	2500
9-13 years	200	600 (RDA)	4000	1300	1300 (RDA)	3000
14-18 years	200	600 (RDA)	4000	1300	1300 (RDA)	3000
19-30 years	200	600 (RDA)	4000	1000	1000 (RDA)	2500
*AI for infants established based on evidence that maintaining serum 25OHD levels in the range of 16-20 ng/mL was desirable						

Table 3. Vitamin D intakes recommended by the IOM and the Endocrine Practice Guidelines Committee

To view a larger image on your device, please click or touch the image.

TABLE 3. Vitamin D intakes recommended by the IOM and the Endocrine Practice Guidelines Committee

Life stage group	IOM recommendations				Committee recommendations for patients at risk for vitamin D deficiency	
	AI	EAR	RDA	UL	Daily requirement	UL
Infants						
0 to 6 months	400 IU (10 μg)			1,000 IU (25 μg)	400–1,000 IU	2,000 IU
6 to 12 months	400 IU (10 μg)			1,500 IU (38 μg)	400–1,000 IU	2,000 IU
Children						
1–3 yr		400 IU (10 μg)	600 IU (15 μg)	2,500 IU (63 μg)	600–1,000 IU	4,000 IU
4–8 yr		400 IU (10 μg)	600 IU (15 μg)	3,000 IU (75 μg)	600–1,000 IU	4,000 IU
Males						
9–13 yr		400 IU (10 μg)	600 IU (15 μg)	4,000 IU (100 μg)	600–1,000 IU	4,000 IU
14–18 yr		400 IU (10 μg)	600 IU (15 μg)	4,000 IU (100 μg)	600–1,000 IU	4,000 IU
19–30 yr		400 IU (10 μg)	600 IU (15 μg)	4,000 IU (100 μg)	1,500–2,000 IU	10,000 IU
31–50 yr		400 IU (10 μg)	600 IU (15 μg)	4,000 IU (100 μg)	1,500–2,000 IU	10,000 IU
51–70 yr		400 IU (10 μg)	600 IU (15 μg)	4,000 IU (100 μg)	1,500–2,000 IU	10,000 IU
>70 yr		400 IU (10 μg)	800 IU (20 μg)	4,000 IU (100 μg)	1,500–2,000 IU	10,000 IU
Females						
9–13 yr		400 IU (10 μg)	600 IU (15 μg)	4,000 IU (100 μg)	600–1,000 IU	4,000 IU
14–18 yr		400 IU (10 μg)	600 IU (15 μg)	4,000 IU (100 μg)	600–1,000 IU	4,000 IU
19–30 yr		400 IU (10 μg)	600 IU (15 μg)	4,000 IU (100 μg)	1,500–2,000 IU	10,000 IU
31–50 yr		400 IU (10 μg)	600 IU (15 μg)	4,000 IU (100 μg)	1,500–2,000 IU	10,000 IU
51–70 yr		400 IU (10 μg)	600 IU (15 μg)	4,000 IU (100 μg)	1,500–2,000 IU	10,000 IU
>70 yr		400 IU (10 μg)	800 IU (20 μg)	4,000 IU (100 μg)	1,500–2,000 IU	10,000 IU
Pregnancy						
14–18 yr		400 IU (10 μg)	600 IU (15 μg)	4,000 IU (100 μg)	600–1,000 IU	4,000 IU
19–30 yr		400 IU (10 μg)	600 IU (15 μg)	4,000 IU (100 μg)	1,500–2,000 IU	10,000 IU
31–50 yr		400 IU (10 μg)	600 IU (15 μg)	4,000 IU (100 μg)	1,500–2,000 IU	10,000 IU
Lactation[a]						
14–18 yr		400 IU (10 μg)	600 IU (15 μg)	4,000 IU (100 μg)	600–1,000 IU	4,000 IU
19–30 yr		400 IU (10 μg)	600 IU (15 μg)	4,000 IU (100 μg)	1,500–2,000 IU	10,000 IU
31–50 yr		400 IU (10 μg)	600 IU (15 μg)	4,000 IU (100 μg)	1,500–2,000 IU	10,000 IU

AI, Adequate intake; EAR, estimated average requirement; UL, tolerable upper intake level.

[a] Mother's requirement, 4,000–6,000 IU/d (mother's intake for infant's requirement if infant is not receiving 400 IU/d).

Source: Holick MF, Binkley NC, Bischoff-Ferrari HA, Gordon CM, et al. Evaluation, treatment, and prevention of vitamin D deficiency: an Endocrine Society clinical practice guideline. J Clin Endocrinol Metab 2011;96(7):1911-30.

This guideline was developed to improve health care access in Arkansas and to aid health care providers in making decisions about appropriate patient care. The needs of the individual patient, resources available, and limitations unique to the institution or type of practice may warrant variations.

References

References

1. Basile LA, Taylor SN, Wagner CL, Horst RL, Hollis BW. The effect of high-dose vitamin D supplementation on serum vitamin D levels and milk calcium concentration in lactating women and their infants. *Breastfeed Med* 2006;1(1):27-35.

2. Goel KM, Sweet EM, Logan RW, Warren JM, Arneil GC, et al. Florid and subclinical rickets among immigrant children in Glasgow. *Lancet* 1976;1(7970):1141-5.
3. Golden NH, Abrams, SA, Committee on Nutrition, American Academy of Pediatrics. Clinical report: Optimizing bone health in children and adolescents. *Pediatrics* 2014; 134(4):e1229-e1243.
4. Hochberg Z, Bereket A, Davenport M, Delemarr-Van de Waal HA, et al. Consensus development for the supplementation of vitamin D in childhood and adolescence. *Horm Res* 2002;58(1):39-51.
5. Holick MF, Binkley NC, Bischoff-Ferrari HA, Gordon CM, et al. Evaluation, treatment, and prevention of vitamin D deficiency: an Endocrine Society clinical practice guideline. *J Clin Endocrinol Metab* 2011;96(7):1911-30.
6. Misra M, Pacaud D, Petryk A, Collett-Solberg PF, et al. Vitamin D deficiency in children and its management: review of current knowledge and recommendations. *Pediatrics* 2008;122(2):398-417.
7. Institute of Medicine of the National Academies. Dietary Reference Intakes for Calcium and Vitamin D. 2010

---

8. Joiner TA, Foster C, Shope T. The many faces of vitamin D deficiency rickets. *Pediatr Rev* 2000;21(9):296-302.
9. Levine MA, Zapalowski C, Kappy, MS. Disorders of Calcium, Phosphate, PTH and Vitamin D. In: Kappy MS, Allen DB, Geffner ME, editors. Principles and practice of pediatric endocrinology. Springfield, Illinois: Charles C Thomas Publisher Ltd; 2005.
10. Malabanan A, Veronikis IE, Holick MF. Redefining vitamin D insufficiency. *Lancet* 1998;351(9105):805-6.
11. Munns C, Zacharin MR, Rodda CP, Batch JA, et al. Prevention and treatment of infant and childhood vitamin D deficiency in Australia and New Zealand: a consensus statement. *Med J Aust* 2006;185(5):268-72.
12. Pettifor JM, Isdale JM, Sahakian J, Hansen JD. Diagnosis of subclinical rickets. *Arch Dis Child* 1980;55(2):155-7.
13. Ross AC. The 2011 report on dietary reference intakes for calcium and vitamin D. *Public Health Nutr* 2011;14(5):938-9.
14. Shah BR, Finberg L. Single-day therapy for nutritional vitamin D-deficiency rickets: a preferred method. *J Pediatr* 1994;125(3):487-90.