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Position statement

Recommended Vitamin D Intake and Management of Low Vitamin D Status in Adolescents: A Position Statement of the Society for Adolescent Health and Medicine

The Society for Adolescent Health and Medicine

Vitamin D deficiency is common in adolescents worldwide, and the list of reported detrimental health effects associated with this deficiency continues to grow [1]. Even subclinical deficiency during adolescence may affect bone acquisition, potentially reducing peak bone mass and increasing the risk of osteoporosis in later life. Current evidence suggests that giving vitamin D supplements to adolescents who are vitamin D–deficient may improve their bone mineral density as well as increase their total bone mineral content [2–4]. There is also recent evidence to suggest that an adequate vitamin D intake is associated with decreased stress fracture risk among physically active females [5]. Because adolescence is a critical period for bone mineral accrual, it is clear that attention should be paid to the vitamin D status of adolescents.

Sources of Vitamin D

In humans, the main source of vitamin D is from cutaneous synthesis through a process initiated by incidental natural sun exposure/ultraviolet B irradiation. However, prolonged sun exposure is discouraged because of the increased risk of skin cancer, and a threshold of sun exposure sufficient to maintain a healthy vitamin D status without measurable cancer risk is difficult to define. The ability to synthesize vitamin D in the skin varies considerably by skin type, season, and geography [6]. At some latitudes, cutaneous synthesis of vitamin D is precluded during the winter months [6]. The use of sunscreen also almost completely blocks cutaneous vitamin D synthesis [7]. Only small amounts of vitamin D can be derived from dietary sources including oily fish, eggs, and from vitamin D–fortified foods such as dairy products and breakfast cereals. Because vitamin D is fat-soluble, there are manufacturing challenges encountered when attempting to fortify food products and many beverages. Thus, only small amounts of vitamin D can be feasibly provided through the diet.

Assessment of Vitamin D Status

Body vitamin D stores can be assessed by measuring serum concentration of 25-hydroxyvitamin D [25(OH)D].

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When serum 25(OH)D decreases, parathyroid hormone (PTH) secretion may increase, leading to increased osteoclast activity and bone resorption. Although maximal suppression of PTH has been suggested as a way to determine sufficiency of serum 25(OH)D [8], one recent study of 735 children and adolescents did not show a clear inflection point for 25(OH)D concentration above which PTH secretion was inhibited [9]. Although there has been an intense debate as to which serum 25(OH)D concentrations are optimal for the acquisition and maintenance of bone mass, it is believed that serum 25(OH)D concentrations of at least 32 ng/mL (80 nmol/L) may be needed for optimal calcium absorption efficiency [8]. Weaver and Fleet estimated that consumption of 1,063 IU of vitamin D a day is necessary in order to achieve a serum 25(OH)D level of 32 ng/mL (80 nmol/L) in female adolescents aged 12 to 19 years [8].

Society for Adolescent Health and Medicine Recommendations

1. Provide vitamin D supplementation of 600 IU daily (400–800 IU daily, given preparation availability on market) for healthy adolescents, and at least 1,000 IU daily for adolescents who are at risk for vitamin D deficiency or insufficiency (Table 1), in addition to vitamin D received through the diet or via sun exposure.
2. Measure serum 25(OH)D concentration in adolescents who are at risk for vitamin D deficiency or insufficiency (Table 1).
3. Consider a serum 25(OH)D concentration of 30 to 50 ng/mL (75–125 nmol/L) as optimal for adolescents.
4. Treat vitamin D deficient adolescents [25(OH)D <20 ng/mL (50 nmol/L)] with 50,000 IU of vitamin D once weekly for 8 weeks.
5. Supplement vitamin D insufficient adolescents [25(OH)D 20–29 ng/mL (50–72.5 nmol/L)] with vitamin D 1,000 IU/day for at least 3 months.
6. Supplement/treat with a vitamin D3 preparation, if this preparation is easily available to the patient/family.
7. Recommend taking vitamin D treatment/maintenance/supplement with dinner.

Table 1

Indications for obtaining serum 25(OH)D measurement in adolescents

Increased skin pigmentation
Frequent use of sunscreen
Obesity (>95th percent body mass index for age and gender)
Specific diets such as vegan/macrobioitic
Cultural convention associated with body coverage
Chronic gastrointestinal diseases that can lead to malabsorption (inflammatory bowel disease, celiac disease, cystic fibrosis)
Amenorrhea
Pregnancy or lactation
Immobilization (cerebral palsy, neuromuscular disease)
Following bariatric surgery
Chronic kidney disease
Chronic liver disease
Use of medications that can increase catabolism of vitamin D such as glucocorticoids, anticonvulsants, and HIV medications
Recurrent fractures or known low bone mineral density status

Rationale for Recommendations

Recommended intake of vitamin D for adolescents

In 2010, the Institute of Medicine (IOM) recommended 600 IU of vitamin D/day as dietary allowance for adolescents [10], with an upper level of safe intake set at 4,000 IU of vitamin D/day [10]. Society for Adolescent Health and Medicine (SAHM) agrees with these recommendations for healthy adolescents. Although there are some data to suggest that even higher intake levels of up to 10,000 IU vitamin D/day are safe [11], care providers should be cognizant of signs of vitamin D intoxication such as hypercalciuria and hypercalcemia.

In 2011, the Endocrine Society published guidelines focusing on children, adolescents, and adults who are at risk either for a low vitamin D status and/or a low bone mineral density [11]. In these guidelines, a vitamin D supplementation dose of at least 1,000 IU daily is recommended for high-risk children and adolescents. Even higher doses may be needed for adolescents with obesity, receiving anticonvulsants, or possessing multiple risk factors known to be associated with hypovitaminosis D. Unfortunately, the current mean (\pm SE) vitamin D intake from food and dietary supplements in adolescents (14–18 years) in the United States is 210 ± 9.2 IU/day in females and 310 ± 16 IU/day in males [12], reaching far short of the IOM's goals. Therefore, SAHM recommends a supplementation dose of 600 IU vitamin D daily for all healthy adolescents in order to avoid vitamin D deficiency. In particular, SAHM believes that supplementation with vitamin D is critically important for adolescents who are at risk for low vitamin D status. If a 25(OH)D measurement is not obtained for an at-risk adolescent, SAHM recommends that youth with increased skin pigmentation and adolescents who use sunscreens frequently as well as obese adolescents empirically receive a daily supplement of 1,000 IU of vitamin D. Additionally, adequate calcium intake per IOM guidelines is essential for adolescents [10], and counseling should be provided in this regard.

To measure or not to measure serum 25(OH)D in adolescents?

Similar to the Endocrine Society's published guidelines [11], SAHM recommends against universal measurement of 25(OH)D levels in healthy adolescents. However, many adolescents and young adults are considered "at risk" for vitamin D deficiency or insufficiency and may benefit from ascertainment of their

25(OH)D status. Measurement of 25(OH)D levels is recommended for teens with increased skin pigmentation, adolescents who use sunscreens frequently, obese adolescents, and adolescents suffering from a chronic condition known to be associated with vitamin D deficiency (Table 1). Consideration should also be given to teens who have an underlying condition or receive medications that put them at risk for bone loss; the rationale is that optimization of vitamin D status in these patients may improve their compromised bone health. Measurement of calcium, phosphorous, alkaline phosphatase, and parathormone should be considered when long-standing vitamin D deficiency is suspected.

Optimal vitamin D status

SAHM regards a serum 25(OH)D concentration of more than 30 ng/mL (75 nmol/L) as sufficient and indicative of a normal vitamin D status. Because some studies have shown health risks with serum 25(OH)D concentrations of 50 to 100 ng/mL (125–250 nmol/L), SAHM regards serum 25(OH)D concentration of 30 to 50 ng/mL (75–125 nmol/L) as optimal for adolescents. A recent systematic literature review concluded that vitamin D supplements were unlikely to be beneficial to the skeletal health of adolescents with normal vitamin D levels [4]. Furthermore, existing data do not justify vitamin D supplementation in patients with sufficient vitamin D for the purpose of reducing the risk of cardiovascular disease or certain types of cancer.

Treatment of vitamin D deficiency

SAHM agrees that the threshold for vitamin D deficiency is a serum 25(OH)D level of less than 20 ng/mL (50 nmol/L), as stated in the IOM report [10]. Vitamin D–deficient adolescents should be treated with 50,000 IU of vitamin D administered with food once a week for 8 weeks. A repeat 25(OH)D measurement can be obtained at the end of treatment. A repeat course of treatment may be indicated if the adolescent remains vitamin D–deficient. If the deficiency has been corrected, SAHM recommends that the adolescent continue a supplement/maintenance dose of 1,000 IU vitamin D daily to prevent recurrence of vitamin D deficiency.

Treatment of vitamin D insufficiency

In support of the position of the Endocrine Society [11], SAHM regards adolescents with serum 25(OH)D concentrations between 20 and 29 ng/mL as vitamin D–insufficient. For vitamin D–insufficient adolescents, SAHM recommends supplementation with vitamin D 1,000 IU/day for at least 3 months. A longer period of supplementation may be required, particularly in adolescents at risk for vitamin D deficiency (Table 1).

To supplement/treat with vitamin D2 or D3?

SAHM favors supplementation/treatment with vitamin D3 for adolescents, if this preparation is easily available to the patient/family. Some reports have found vitamin D3 to be more potent than vitamin D2 [13,14], whereas other studies have observed that vitamin D2 and vitamin D3 were equipotent in raising serum 25(OH)D concentrations [15,16]. However, vitamin D2 may have a shorter half-life than vitamin D3 in the body [14].

Best time to take vitamin D supplement/treatment

Because taking vitamin D with the largest meal may improve absorption [17], SAHM recommends that vitamin D treatment/maintenance/supplement should be taken with dinner.

Adherence to daily/weekly intake of supplements—a special challenge for adolescents. Low adherence may limit the effectiveness of daily or weekly supplementation in some adolescents. Because the half-life of vitamin D may be as long as 2 to 3 months [18], especially when administered in large doses, intermittent high doses of vitamin D administered during a clinic visit every 2 to 3 months could be considered for adolescents with vitamin D deficiency who cannot comply with daily or weekly supplementation taken at home. A single oral dose of 600,000 IU of vitamin D3 has been shown to rapidly enhance and maintain 25(OH)D levels up to 90 days after administration in adults aged 25 to 56 years [18], but the appropriate periodic dose for vitamin D-deficient adolescents remains to be determined in future studies. Safety and toxicity need to be evaluated before such high-dose therapy can be recommended as routine therapy.

The Low Risk of Vitamin D Toxicity

Vitamin D intoxication is a rare medical condition and is usually not observed until more than 10,000 IU of vitamin D are ingested daily for more than 5 months [19,20]. Blood 25(OH)D levels are usually more than 200 ng/mL (500 nmol/L) before manifestations of vitamin D toxicity including hypercalcemia, hyperphosphatemia, and soft-tissue calcification are observed [20]. However, the more prudent upper limit of 100 ng/mL (250 nmol/L) of 25(OH)D has to be retained to ensure a wide safety margin [21].

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