

# AMERICAN ACADEMY OF PEDIATRICS

## CLINICAL REPORT

Guidance for the Clinician in Rendering Pediatric Care

Lawrence M. Gartner, MD; Frank R. Greer, MD;  
and the Section on Breastfeeding and Committee on Nutrition

### Prevention of Rickets and Vitamin D Deficiency: New Guidelines for Vitamin D Intake

**ABSTRACT.** Rickets in infants attributable to inadequate vitamin D intake and decreased exposure to sunlight continues to be reported in the United States. It is recommended that all infants, including those who are exclusively breastfed, have a minimum intake of 200 IU of vitamin D per day beginning during the first 2 months of life. In addition, it is recommended that an intake of 200 IU of vitamin D per day be continued throughout childhood and adolescence, because adequate sunlight exposure is not easily determined for a given individual. These new vitamin D intake guidelines for healthy infants and children are based on the recommendations of the National Academy of Sciences.

---

ABBREVIATIONS. NAS, National Academy of Sciences; AAP, American Academy of Pediatrics.

---

#### BACKGROUND

Cases of rickets in infants attributable to inadequate vitamin D intake and decreased exposure to sunlight continue to be reported in the United States.<sup>1-3</sup> Rickets is an example of extreme vitamin D deficiency. A state of deficiency occurs months before rickets is obvious on physical examination. The new recommended adequate intake of vitamin D by the National Academy of Sciences (NAS) to prevent vitamin D deficiency in normal infants, children, and adolescents is 200 IU per day.<sup>4</sup> This differs from the 400 IU per day that has been recommended in previous editions of the *Pediatric Nutrition Handbook* of the American Academy of Pediatrics (AAP). The new NAS guidelines for infants are based on data primarily from the United States, Norway, and China, which show that an intake of at least 200 IU per day of vitamin D will prevent physical signs of vitamin D deficiency and maintain serum 25-hydroxy-vitamin D at or above 27.5 nmol/L (11 ng/mL). Although there are generally less data available for older children and adolescents, the NAS has come to the same conclusions for this popula-

tion.<sup>4</sup> Also, it is acknowledged that most vitamin D in older children and adolescents is supplied by sunlight exposure.<sup>4</sup> However, dermatologists and cancer experts advise caution in exposure to sun, especially in childhood, and recommend regular use of sunscreens.<sup>5-11</sup> Sunscreens markedly decrease vitamin D production in the skin.

#### SUNLIGHT EXPOSURE

A potential source of vitamin D is synthesis in the skin from the ultraviolet B light fraction of sunlight. Decreased sunlight exposure occurs during the winter and other seasons and when sunlight is attenuated by clouds, air pollution, or the environment (eg, shade). Lifestyles or cultural practices that decrease time spent outdoors or increase the amount of body surface area covered by clothing when outdoors further limit sunlight exposure. The effects of sunlight exposure on vitamin D synthesis are also decreased for individuals with darker skin pigmentation and by the use of sunscreens.<sup>5</sup> All of these factors make it very difficult to determine what is adequate sunshine exposure for any given infant or child. Furthermore, the Centers for Disease Control and Prevention, with the support of many organizations including the AAP and the American Cancer Society, has recently launched a major public health campaign to decrease the incidence of skin cancer by urging people to limit exposure to ultraviolet light.<sup>6</sup> Indirect epidemiologic evidence now suggests the age at which direct sunlight exposure is initiated is even more important than the total sunlight exposure over a lifetime in determining the risk of skin cancer.<sup>7-11</sup> Thus, guidelines for decreasing exposure include directives from the AAP that infants younger than 6 months should be kept out of direct sunlight, children's activities that minimize sunlight exposure should be selected, and protective clothing as well as sunscreens should be used.<sup>11</sup>

#### BREASTFEEDING AND VITAMIN D

Infants who are breastfed but do not receive supplemental vitamin D or adequate sunlight exposure are at increased risk of developing vitamin D deficiency or rickets.<sup>1-3,12,13</sup> Human milk typically contains a vitamin D concentration of 25 IU/L or

The guidance in this report does not indicate an exclusive course of treatment or serve as a standard of medical care. Variations, taking into account individual circumstances, may be appropriate.

PEDIATRICS (ISSN 0031 4005). Copyright © 2003 by the American Academy of Pediatrics.

less.<sup>14–16</sup> Thus, the recommended adequate intake of vitamin D cannot be met with human milk as the sole source of vitamin D for the breastfeeding infant. Although there is evidence that limited sunlight exposure prevents rickets in many breastfed infants,<sup>17,18</sup> in light of growing concerns about sunlight and skin cancer and the various factors that negatively affect sunlight exposure, it seems prudent to recommend that all breastfed infants be given supplemental vitamin D. Supplementation should begin within the first 2 months of life. As noted above, it is very difficult to determine what is adequate sunlight exposure for an individual breastfed infant. Additional research is suggested to more fully understand the factors underlying the development of vitamin D deficiency and rickets in some breastfed infants.

#### FORMULAS AND VITAMIN D

All infant formulas sold in the United States must have a minimum vitamin D concentration of 40 IU/100 kcal (258 IU/L of a 20-kcal/oz formula) and a maximum vitamin D concentration of 100 IU/100 kcal (666 IU/L of a 20-kcal/oz formula).<sup>19</sup> All formulas sold in the United States actually have at least 400 IU/L.<sup>20</sup> Thus, if an infant is ingesting at least 500 mL per day of formula (vitamin D concentration of 400 IU/L), he or she will receive the recommended vitamin D intake of 200 IU per day.

#### VITAMIN D SUPPLEMENTS

If the intake of vitamin D-fortified milk or formula is less than 500 mL per day, a vitamin D supplement can be provided by currently available multivitamin preparations containing 400 IU of vitamin D per mL or tablet. Currently available solitary vitamin D preparations (containing up to 8000 IU/mL) are too concentrated to be safe for routine home use. It is important that special efforts be directed toward supplementing populations at increased risk of developing rickets and vitamin D deficiency, including those with increased skin pigmentation and decreased sunlight exposure.

#### SUMMARY

To prevent rickets and vitamin D deficiency in healthy infants and children and acknowledging that adequate sunlight exposure is difficult to determine, we reaffirm the adequate intake of 200 IU per day of vitamin D by the National Academy of Sciences<sup>4</sup> and recommend a supplement of 200 IU per day for the following:

1. All breastfed infants unless they are weaned to at least 500 mL per day of vitamin D-fortified formula or milk.
2. All nonbreastfed infants who are ingesting less than 500 mL per day of vitamin D-fortified formula or milk.
3. Children and adolescents who do not get regular sunlight exposure, do not ingest at least 500 mL per day of vitamin D-fortified milk, or do not take a daily multivitamin supplement containing at least 200 IU of vitamin D.

SECTION ON BREASTFEEDING, 2002–2003  
Lawrence M. Gartner, MD, Chairperson  
Linda S. Black, MD  
Ruth A. Lawrence, MD  
Audrey J. Naylor, MD, DrPH  
Donna O'Hare, MD  
Richard J. Schanler, MD

Arthur I. Eidelman, MD  
Policy Committee Chairperson

#### LIAISONS

Alice Lenihan, MPH, RD, LDN  
National WIC Association  
John Queenan, MD  
American College of Obstetricians and Gynecologists

#### STAFF

Betty Crase, IBCLC

#### COMMITTEE ON NUTRITION, 2002–2003

Nancy F. Krebs, MD, Chairperson  
Robert D. Baker, Jr, MD, PhD  
Frank R. Greer, MD  
Melvin B. Heyman, MD  
Tom Jaksic, MD, PhD  
Fima Lifshitz, MD

#### LIAISONS

Donna Blum-Kemelor, MS, RD  
US Department of Agriculture  
Margaret Patricia Boland, MD  
Canadian Paediatric Society  
William Dietz, MD, PhD  
Centers for Disease Control and Prevention  
Van S. Hubbard, MD, PhD  
National Institute of Diabetes and Digestive and Kidney Diseases and National Institutes of Health  
Elizabeth Yetley, PhD  
US Food and Drug Administration

#### CONSULTANT

Susan Baker, MD, PhD

#### STAFF

Pamela Kanda, MPH

#### REFERENCES

1. Kreiter SR, Schwartz RP, Kirkman HN Jr, Charlton PA, Calikoglu AS, Davenport ML. Nutritional rickets in African American breast-fed infants. *J Pediatr*. 2000;137:153–157
2. Pugliese MF, Blumberg DL, Hludzinski J, Kay S. Nutritional rickets in suburbia. *J Am Coll Nutr*. 1998;17:637–641
3. Sills IN, Skuza KA, Horlick MN, Schwartz MS, Rapaport R. Vitamin D deficiency rickets. Reports of its demise are exaggerated. *Clin Pediatr (Phila)*. 1994;33:491–493
4. Institute of Medicine, Food and Nutrition Board, Standing Committee on the Scientific Evaluation of Dietary Reference Intakes. Vitamin D. In: *Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride*. Washington, DC: National Academy Press; 1997:250–287
5. Fuller KE, Casparian JM. Vitamin D: balancing cutaneous and systemic considerations. *South Med J*. 2001;94:58–64
6. National Coalition for Skin Cancer Prevention. *The National Forum for Skin Cancer Prevention in Health, Physical Education, Recreation and Youth Sports*. Reston, VA: American Association for Health Education; 1998
7. Marks R, Jolley D, Leclerc S, Foley P. The role of childhood exposure to sunlight in the development of solar keratoses and non-melanocytic skin cancer. *Med J Aust*. 1990;152:62–66
8. Autier P, Dore JF. Influence of sun exposures during childhood and during adulthood on melanoma risk. EPIMEL and EORTC Melanoma Cooperative Group. *Int J Cancer*. 1998;77:533–537
9. Westerdahl J, Olsson H, Ingvar C. At what age do sunburn episodes play a critical role for the development of malignant melanoma? *Eur J Cancer*. 1994;30A:1647–1654
10. Gilchrist BA, Eller MS, Geller AC, Yaar M. The pathogenesis of mel-

- noma induced by ultraviolet radiation. *N Engl J Med.* 1999;340:1341-1348
11. American Academy of Pediatrics, Committee on Environmental Health. Ultraviolet light: a hazard to children. *Pediatrics.* 1999;104:328-333
  12. Binet A, Kooh SW. Persistence of vitamin D-deficiency rickets in Toronto in the 1990s. *Can J Public Health.* 1996;87:227-230
  13. Daaboul J, Sanderson S, Kristensen K, Kitson H. Vitamin D deficiency in pregnant and breast-feeding women and their infants. *J Perinatol.* 1997;17:10-14
  14. Reeve LE, Chesney RW, DeLuca HF. Vitamin D of human milk: identification of biologically active forms. *Am J Clin Nutr.* 1982;36:122-126
  15. Hollis BW, Roos BA, Draper HH, Lambert PW. Vitamin D and its metabolites in human and bovine milk. *J Nutr.* 1981;111:1240-1248
  16. Lammi-Keefe CJ. Vitamins D and E in human milk. In: Jensen RG, ed. *Handbook of Milk Composition.* San Diego, CA: Academic Press; 1995:706-717
  17. Specker BL, Valanis B, Hertzberg V, Edwards N, Tsang RC. Sunshine exposure and serum 25-hydroxyvitamin D concentrations in exclusively breast-fed infants. *J Pediatr.* 1985;107:372-376
  18. Greer FR, Marshall S. Bone mineral content, serum vitamin D metabolite concentrations and ultraviolet B light exposure in human milk-fed infants with and without vitamin D<sub>2</sub> supplements. *J Pediatr.* 1989;114:204-212
  19. Life Sciences Research Office Report. Assessment of nutrient requirements for infant formulas. *J Nutr.* 1998;128(11 suppl):2059S-2293S
  20. Tsang RC, Zlotkin SH, Nichols BL, Hansen JW, eds. *Nutrition During Infancy: Principles and Practice.* 2nd ed. Cincinnati, OH: Digital Education Publishing; 1997:467-484

---

*All clinical reports from the American Academy of Pediatrics automatically expire 5 years after publication unless reaffirmed, revised, or retired at or before that time.*

## Prevention of Rickets and Vitamin D Deficiency: New Guidelines for Vitamin D Intake

Lawrence M. Gartner, Frank R. Greer, Section on Breastfeeding and Committee on Nutrition

*Pediatrics* 2003;111;908

### Updated Information & Services

including high resolution figures, can be found at:  
<http://pediatrics.aappublications.org/content/111/4/908>

### References

This article cites 16 articles, 3 of which you can access for free at:  
<http://pediatrics.aappublications.org/content/111/4/908.full#ref-list-1>

### Subspecialty Collections

This article, along with others on similar topics, appears in the following collection(s):  
**Fetus/Newborn Infant**  
[http://classic.pediatrics.aappublications.org/cgi/collection/fetus:newborn\\_infant\\_sub](http://classic.pediatrics.aappublications.org/cgi/collection/fetus:newborn_infant_sub)

### Permissions & Licensing

Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at:  
<https://shop.aap.org/licensing-permissions/>

### Reprints

Information about ordering reprints can be found online:  
<http://classic.pediatrics.aappublications.org/content/reprints>

Pediatrics is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since . Pediatrics is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2003 by the American Academy of Pediatrics. All rights reserved. Print ISSN:

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™



# PEDIATRICS®

OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

## **Prevention of Rickets and Vitamin D Deficiency: New Guidelines for Vitamin D Intake**

Lawrence M. Gartner, Frank R. Greer, Section on Breastfeeding and Committee on Nutrition

*Pediatrics* 2003;111:908

The online version of this article, along with updated information and services, is located on the World Wide Web at:

<http://pediatrics.aappublications.org/content/111/4/908>

Pediatrics is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since . Pediatrics is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2003 by the American Academy of Pediatrics. All rights reserved. Print ISSN:

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™

