Bone Deficit and Bone Health
Winston W. K. Koo

DOI: 10.1177/0115426507022003259

The online version of this article can be found at:
http://ncp.sagepub.com/content/22/3/259

Published by:
SAGE
http://www.sagepublications.com

On behalf of:
aspen
The American Society for Parenteral & Enteral Nutrition

Additional services and information for *Nutrition in Clinical Practice* can be found at:

Email Alerts: http://ncp.sagepub.com/cgi/alerts

Subscriptions: http://ncp.sagepub.com/subscriptions

Reprints: http://www.sagepub.com/journalsReprints.nav

Permissions: http://www.sagepub.com/journalsPermissions.nav

>> Version of Record - Jun 1, 2007

What is This?
Bone Deficit and Bone Health

Winston W. K. Koo, MB BS
The Carman and Ann Adams Department of Pediatrics, Wayne State University, and Hutzel Women’s Hospital, Detroit, Michigan

This issue of Nutrition in Clinical Practice features a wealth of information for nutrition support professionals on 2 critical nutrients for bone, namely, vitamin D and calcium. The articles1–7 cover a broad range of clinical situations that predispose the patient to bone deficit, such as critical care, prolonged parenteral nutrition (PN), treatment in rehabilitation programs, and patients with established osteoporosis. Many of the articles also incorporate state of the art recommendations to optimize vitamin D and calcium status.

The critical role of vitamin D and calcium in biologic states other than bone metabolism is demonstrated in reports on the role of vitamin D in cancer and immunity5 and the rate of hypocalcemia as determined by ionized calcium measurements in critically ill patients.7 The need for these 2 nutrients in patients with bone deficit, as in PN-induced metabolic bone disease1 and in osteoporosis,3,6 also has been reviewed comprehensively.1,3

For the population at large, it is important to be aware that the concept of recommended dietary allowance (RDA) applies to individuals, whereas estimated average requirement (EAR) or adequate intake (AI) applies to groups.6 RDA is the average dietary intake level that is sufficient to meet the nutrient requirements of nearly all (97%–98%) individuals, whereas EAR is the nutrient intake value that is estimated to meet the requirement defined by a specified indicator of adequacy in 50% of the individuals. AI is based on observed or experimentally determined estimates of average nutrient intake by a group (or groups) of healthy people. All recommendations are specific for each life stage and gender wherever possible. The RDA is set at 2 standard deviations above the EAR, and AI is substituted for RDA when there is insufficient evidence to calculate an EAR. It is assumed that AI is at or above the RDA, and at intakes between RDA and the tolerable upper intake level (UL), the risk of inadequacy and excess is close to zero.

It is also important to know that AI is the current recommendation for vitamin D and calcium.9,10 Thus, lower intakes may be adequate for some, and modifications to the dietary intake recommendations of these nutrients are possible pending further scientific evidence. Unfortunately, most individuals with vitamin D and calcium deficiency are asymptomatic, especially during the early stage. Thus, from a public health perspective, a broad-based recommendation that one maintain vitamin D and calcium intake at AI level is appropriate. Furthermore, as indicated in several of this issue’s reviews,3–6 some experts are recommending vitamin D intake at a higher level than AI for individuals in selected age ranges or with certain medical conditions.

Endogenous production of vitamin D from consistent exposure to sunlight, even with limited surface area of skin exposure and for brief periods on each occasion, can support the physiologic needs for this vitamin. However, vitamin D production is determined by length of exposure, latitude, season, and degree of skin pigmentation. The type of clothing11 and the use of sunscreen12 to prevent melanoma can block ultraviolet B photons that are required for endogenous vitamin D production. Shinchuk and Holick’s4 review of patients in rehabilitation programs highlights one of the numerous situations predisposing to vitamin D deficiency. This includes even free-living individuals, particularly those in northern latitudes, where the zenith angle of the sun limits the amount of ultraviolet B irradiation available year round for the cutaneous synthesis of vitamin D. Individuals who have a personal or cultural habit of staying indoors or complete body coverage with clothes while outdoors, or the elderly and the infirm with lack of mobility, can all have limited cutaneous exposure to sunlight and endogenous production of vitamin D, thus contributing to the potential for vitamin D insufficiency. Poor dietary intake of calcium also may lead to secondary vitamin D deficiency from increased metabolism of 25-hydroxyvitamin D.13 Thus sufficient intake of vitamin D from the diet or dietary supplements is needed if adequate exposure to sunlight cannot be
assured, as is the case for the majority of our population.

Food is generally recommended as the primary source of calcium because various foods offer the best source of multiple nutrients important for bone health, particularly the developing skeleton, and the best food source of calcium is dairy products. In addition to vitamin D and calcium, there are other nutrients critical to bone health, particularly during development of the skeleton over the first 2 decades of life. Numerous nutrients are needed for the formation of nonmineralized bone matrix and the subsequent mineralization phase. These other nutrients include protein; vitamins such as C, K, and A; minerals such as phosphorus and magnesium; and trace minerals such as copper and zinc, to name a few. Fortunately, intakes for most nutrients are adequate, and few nutrients such as vitamin D and calcium are limiting factors because of inadequate intake. Calcium-fortified foods and supplements are suitable alternatives if intake of other food nutrients is inadequate.

The availability of juice and soft drinks fortified with calcium and vitamin D, and increasingly fortified with multiple minerals and vitamins, poses a dilemma in public education by nutrition support professionals because their use potentially lowers the consumption of other beverages such as milk and milk products that contain a much greater range of nutrients. Practical considerations for the available forms of calcium supplementation, the indications and dosages for its use, its interaction with drugs and other nutrients, and the means to maximize bioavailability of calcium supplementation have been reviewed. When consumed in excess, vitamin D and calcium, like many other nutrients, have potential side effects. However, the recommended intake range from this series of articles and that of the many organizations are well below the UL.

Requirements for selected nutrients also may vary depending on the clinical situation; for example, vitamin D needs during PN may be lower than when consuming a normal diet, and phosphorus requirement is increased in rapidly growing premature infants. The use of human milk with low phosphorus and other nutrient contents is suboptimal for normal growth and tissue accretion in preterm infants with birth weights <1500 g, and the use of human milk fortifier is indicated. However, human milk has numerous advantages over infant formulas, and its use is recommended for all infants.

The consensus for achieving bone health and preventing bone disease at all life stages is to optimize achievement of peak bone mass by appropriate lifestyle measures, in particular adequate physical activity and adequate dietary intake. Certain physical activities—especially weight-bearing exercises—are best for the development and maintenance of bone mass. However, exercise in any form can provide many benefits, including weight control and improved cardiorespiratory health, and should be encouraged.

References