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Calcium-Magnesium-Vitamin D Supplementation Improves Bone Mineralization in Preadolescent Girls

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Introduction

Osteoporosis and low bone mineral density are major health problems affecting more than 25 million older Americans. Eighty percent or more of sufferers are women (1,2). While a number of factors including genetics and exercise contribute to defining the risk of osteoporosis, nutrition remains a key determinant (1). In particular, adequate dietary intakes of calcium, magnesium, and vitamin D are essential for building strong mineral-rich bones (3). Scientists now consider osteoporosis to be, in part, a pediatric disease in the sense that failure to build strong, mineral-rich bones during childhood and adolescence is a primary risk factor for developing the disease later in life (4). They further propose that one of the most effective strategies for preventing osteoporosis is to build strong mineral-rich bones during childhood and adolescence. The purpose of this year-long randomized clinical trial was to assess the impact of a daily calcium, magnesium, and vitamin D supplement on bone development and bone mineralization in preadolescent girls.

Methods

One hundred preadolescent girls (age 12 years, Tanner Stage 2) of European American descent were enrolled in this double blind, placebo-controlled clinical study. Half were assigned at random to the active treatment and received a chewable vitamin-mineral supplement (Active Calcium Chewable produced by USANA Health Sciences). The recommended dose of four tablets per day provided 800 mg/d elemental calcium (as calcium citrate and carbonate), 400 mg/d elemental magnesium (as magnesium citrate and oxide), and 400 IU/d vitamin D3. The formula delivered boron and silicon, two additional minerals thought to be essential for bone health, in trace amounts (1.33 mg/d and 9 mg/d respectively). The remaining girls received a placebo supplement containing no vitamins or minerals. Three-day food intake records were completed every three months. Body weight, height, pubertal status, and physical activity records were obtained at enrollment, and again after six and 12 months of treatment. At these same six-month intervals, bone scans at the distal tibia were performed to measure bone mass and mineral content. A new scanning technique, peripheral quantitative computed tomography (pQCT), was employed allowing independent evaluation of trabecular and cortical bone.

Results

Eighty-one girls (38 active, 43 placebo) completed this one-year study. No differences in age, weight, height, or body mass index were found between groups at enrollment, or after six or 12 months of treatment. Tanner Stage, menarche status, and reported physical activity were also similar between groups at enrollment and 12 months.

There were no significant differences in dietary patterns between groups throughout the study. Compliance with the supplement regimes averaged 74% and 69% in the active and placebo groups respectively. As such, girls in the active treatment group consumed on average an additional 592 mg calcium, 296 mg magnesium, 296 IU vitamin D3, 1.0 mg boron, and 6.7 mg silicon per day through supplement use.

Cross sectional pQCT measurements of total, trabecular, and cortical bone mass at the distal tibia were similar between the two treatment groups at baseline. After 12 months of supplementation, however, girls receiving the calcium, magnesium, and vitamin D supplement showed a net gain in trabecular bone mineral density of 1.41% over baseline while girls in the placebo group showed a net decline of -0.94% (Figure 1). This difference was statistically significant ($p=0.005$). Percent gains in trabecular bone mineral content after 12 months of supplementation were also greater in the active treatment group than in the placebo group (5.83% versus 0.69% respectively) as were percent gains in trabecular bone cross sectional area (4.28% versus 1.30% respectively) (Figure 1). Gains in total and cortical bone mineral content, bone area, and bone min-

eral density did not differ between groups from baseline to study completion. Tests of correlation between baseline body weight, height, BMI, and menarche status with total, cortical, and trabecular bone parameters were significant. Weight-bearing physical activity was weakly linked to total bone mineral density.

Discussion

Results from this study clearly demonstrate that supplementation with a high quality calcium, magnesium, and vitamin D formula can improve bone mineralization in preadolescent girls. After 12 months of treatment, girls in the active group showed significantly greater gains in trabecular bone mass than did girls in the placebo group.

The results of this study support those of previous calcium supplementation trials run with children and adolescents (5,6,7). Furthermore, they underscore the strategy of using high-quality calcium, magnesium, and vitamin D supplements during the formative years (as well as throughout life) to build and maintain strong, mineral rich bones and reduce the risk of osteoporosis.

Importantly, this is the first randomized clinical trial that, to our knowledge, used the pQCT technique to evaluate the impact of vitamin/mineral supplementation on bone development in preadolescent girls. This advance is significant because pQCT allowed independent evaluation of different bone compartments. This in turn enabled investigators to demonstrate that the major impact of supplementation on bone mass was realized in metabolically active trabecular (as opposed to cortical) bone.

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Figure 1. Percent increases over baseline in mineral density (BMD), mineral content (BMC), and cross sectional area (BA) of trabecular bone in active versus placebo groups.