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

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Osteoporosis and low bone mineral density are major health problems affecting more than 25 million older Americans. Some eighty percent of sufferers are women.[1,2] A number of factors contribute to osteoporosis risk, including genetics, exercise habits, and nutrition.[1] In particular, adequate dietary intakes of calcium, magnesium, and vitamin D are essential for building strong bones.[3] Scientists now consider osteoporosis to be, in part, a pediatric disease, because failure to build adequate bone density during childhood and adolescence is a primary risk factor for developing the disease later in life.[4] Consequently, an effective strategy for reducing osteoporosis risk is improving bone mineral density in children and adolescents.

The purpose of this year-long randomized clinical trial was assessing 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, 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, where they received a chewable vitamin-mineral supplement (USANA's Active Calcium Chewable product). 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 also delivered boron and silicon, two 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 twelve 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 significant differences

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in age, weight, height, or body mass index (BMI) existed 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 twelve months.

Throughout the course of the study, no significant differences occurred between each group's average dietary patterns. 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 use of the supplied dietary supplement.

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 placebo (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 mineral 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 show that use of a calcium, magnesium, and vitamin D dietary supplement improved bone mineralization in preadolescent girls. After 12 months of treatment, girls in the active group showed significantly greater gains in trabecular bone mass when compared to placebo.

The results of this study support those of previous calcium supplementation trials involving children and adolescents.[5,6,7] Furthermore, these results support the strategy of supplementing calcium, magnesium, and vitamin D during critical formative years in order to build and maintain healthy bone mineral density and reduce the risk of osteoporosis.

This is also the first randomized clinical trial, to our knowledge, that 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 the major impact of supplementation on bone mass in metabolically active trabecular (as opposed to cortical) bone.

Acknowledgments

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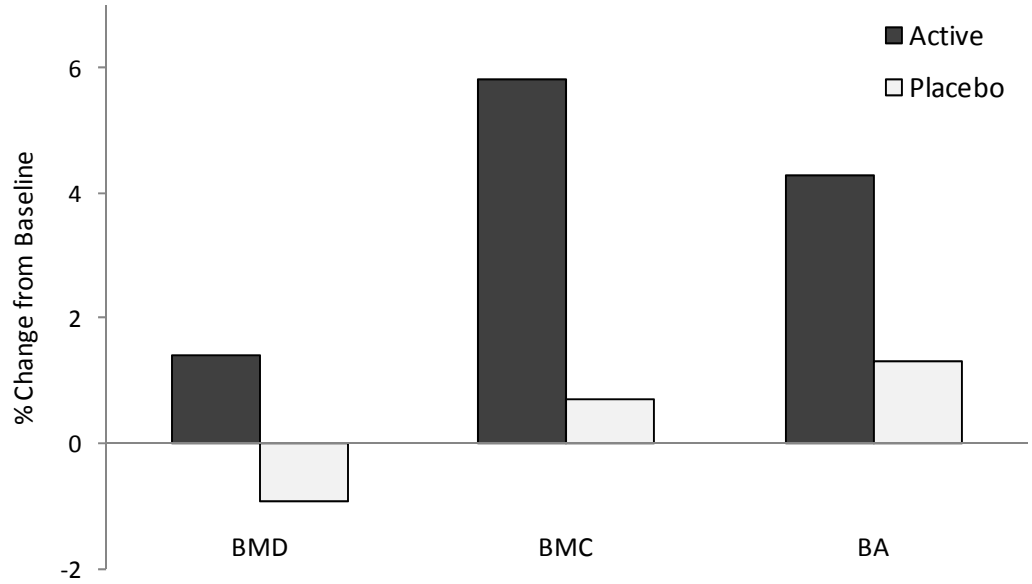
Figure 1

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



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