Exercise Complements Calorie Cutting for Healthy Bones

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ST. LOUIS, Dec. 12 -- Exercise can counteract the bone-mineral density loss that is triggered by calorie restriction, according to a small study.

For a similar weight loss over 12 months, calorie restriction decreased total hip bone mineral density by 2.2% while exercise increased it by 1.2% (*P*=0.02), said Dennis T. Villareal, M.D., of Washington University here, and colleagues, in the Dec. 11 issue of the *Archives of Internal Medicine*.

Bone mineral density at the intertrochanter showed the same pattern, with reductions of 2.1% for the calorie-cutting group and 1.7% for the exercise group (*P*=0.009).

"These data suggest that exercise should be an important component of a weight-loss program to offset adverse effects of calorie restriction on bone," the authors wrote.

The trial looked at regional bone mineral density at clinically important sites of fracture among 48 overweight middle-age adults (mean age 57, mean BMI 27 km/m^2). All 30 women in the study were postmenopausal. Participants were excluded if their weight was unstable over the three months prior to baseline or if they regularly exercised, took bone-acting drugs such as bisphosphonates or glucocorticoids in the prior year, or smoked.

Ten participants were randomized to a healthy lifestyle control group in which they were offered information about a healthy diet and given a multivitamin with calcium and cholecalciferol. They had minor body weight changes over the yearlong study reduction (1.2%, or 0.9 kg).

Another 19 patients were randomized to calorie restriction with a goal of 16% reduction in the first three months followed by 20% reduction. Each week, they met individually with a dietitian and attended group meetings. After one year, the mean body weight decrease was 10.7%, or 8.2 kg.

The exercise group consisted of 19 participants who were to achieve the same calorie deficit with exercise alone. They met with exercise trainers and used heart rate monitors to measure energy expenditure. At the end of the trial, they had lost an average of 8.4% of their body weight, or 6.7 kg.

Although the dieters restricted their energy intake (mean reduction 382±404 kcal/d), the exercisers and control groups did not, according to self-reported dietary intakes on seven-day food diaries (mean increase 9.6±213 kcal/d and 67±237 kcal/d, respectively). Likewise, the exercisers increased their metabolic equivalents from 10.4±2.5 to 14.1±4.4 MET hours a day though the diet and control groups did not (11.0±2.9 versus 10.1±1.3 MET hours per day and 9.8±1.9 versus 10.9±3.4 MET hours per day, respectively).

These changes were reflected in regional bone-mineral density, measured with dual-energy x-ray absorptiometry. The one-year findings were:

For the calorie restriction group, significant decreases in lumbar spine (2.2%±3.3%), total hip (2.2%±3.1%), and intertrochanter (2.1%±3.4%) bone-mineral density compared with baseline,

Significant bone-mineral density changes for the calorie restriction group compared with the control group in the total hip (-2.2%±3.1% versus +1.2%±2.1%, *P*=0.02) and intertrochanter (-2.1%±3.4% versus 1.7%±2.8%),

For the exercise group, no significant changes in any bone-mineral density measurements compared with baseline or with the control group, and

No significant changes for any group in spine bone-mineral density, a primary outcome measure along with hip bone-mineral density.

To look at mechanisms for the differences between groups, the researchers also measured bone markers and hormones in venous blood samples taken at baseline and at six and 12 months.

One suggested mechanism for bone loss induced by weight reductions is the decline in bone-active hormones, such as leptin, that are produced by fat cells. The researchers found that leptin levels decreased in both intervention groups to a similar extent at one year compared with baseline (13.7 versus 8.3 U/L for dieters and 15.4 versus 9.6 U/L for exercisers).

"However, leptin changes did not correlate with bone-mineral density changes [all *P*>0.10], and the exercise group did not have a decrease in bone-mineral density despite reduced leptin concentrations," the authors wrote. "Therefore, our results do not support an important role for leptin."

A better explanation may be that exercise tricks the body into making more bone as muscles pull on the skeleton, producing strains that are perceived by bone cells as osteogenic.

The researchers found that changes in bone-specific alkaline phosphatase levels, a marker of bone formation, were greater in the exercise group than the calorie restriction group (1.1 versus 0.7 U/L at one year, *P*=0.03) though none of the changes were significant compared with baseline. There were no significant changes in osteocalcin, another marker of bone formation, but levels of the bone resorption marker C-telopeptide of type I collagen were increased in both intervention groups (0.575 versus 0.551 ng/mL for calorie reduction and 0.554 versus 0.529 ng/mL).

The researchers said the study was limited in that the method used to measure bone-mineral density does not provide information on bone quality, such as its microarchitecture, which also helps determine fracture risk.

They said further studies will be needed to evaluate these changes with diet- and exercise-induced weight loss as well as to look at sex differences. Also, the findings should be "cautiously extended to nonoverweight populations" since most participants were overweight, they added.

Dr. Villareal and colleagues suggested that exercise alone is not the most practical approach to weight loss since such a large amount would be required to achieve clinically meaningful weight loss.

"A more practical approach for weight reduction is a combination of calorie restriction and exercise," they wrote. "Our results suggest that regular exercise should be included as part of a comprehensive weight loss program to offset the adverse effects of calorie restriction on bone."

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Villareal DT, et al "Bone Mineral Density Response to Caloric Restriction-Induced Weight Loss or Exercise-Induced Weight Loss: A Randomized Controlled Trial" *Arch Intern Med* 2006; 166:2502-2510