

High fat, high protein diet increases nonshivering thermogenesis and serum leptin but is deleterious to trabecular bone in cold- and warm-housed mice.

Maureen Devlin, Amy Robbins, Christopher Tom, Miranda Cosman, Lillian Shipp, Katarina Alajbegovic.

University of Michigan, United States

Previously we showed that chronic cold exposure impairs trabecular bone architecture despite increased nonshivering thermogenesis (NST) via uncoupling protein (UCP1) in mice. We hypothesize that a high fat, high protein diet, as was traditionally consumed by circumpolar humans, may protect against cold-induced bone loss by providing additional calories for NST. To test this hypothesis, we housed wildtype C57Bl/6J male mice in pairs at 26°C (close to thermoneutrality), 22°C (standard housing temperature), and 20°C (mild cold stress) from 3-6 wks of age. Mice were fed a purified normal diet (N) or high fat, high protein diet (HFHP) ad libitum (N=6-8/group). Outcomes included body mass, body length, %body fat and whole body bone mineral density (BMD) via pDXA, UCP1 mRNA and protein expression in brown adipose tissue (BAT), and cortical and trabecular microarchitecture via mCT. Results indicate that HFHP mice at 20°C and 22°C gained 31.3% more body mass from 3-6 wks of age and had 4.7% longer body length vs. N ($p<0.05$ for both), while HFHP mice at 26°C did not have significant changes vs. N. At all temperatures, serum leptin levels were 40-48% higher in HFHP vs. N at 6 weeks of age ($p<0.05$ for all). In interscapular BAT, HFHP mice had higher UCP1 mRNA and protein expression vs. N at 6 wks of age ($p<0.05$ for both). There were no differences in BMD, but HFHP mice had higher %body fat at 6 wks of age vs. N ($p<0.05$). In distal femur trabecular bone, HFHP mice had markedly lower Tb. N at all temperatures (-14-21%, $p<0.007$ for all) and lower Conn.D at 22°C and 26°C (-39-52%, $p<0.009$ for both). There were no significant differences in cortical bone thickness or cross sectional geometry in HFHP vs. N mice. These data demonstrate that high fat, high protein diet increases nonshivering thermogenesis, body fat, and leptin levels, but is deleterious to trabecular bone architecture both during cold exposure and at thermoneutrality. These findings do not support our hypothesis that a diet-induced increase in nonshivering thermogenesis protects against cold-induced bone loss, and suggest high fat, high protein diets may actually be detrimental to bone health in humans.