LETTER

Weighing the evidence for a body mass-regulating gravitostat

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The intriguing paper by Jansson et al. (1) reports the identification of a body mass-regulating homeostat that operates in rodents independently of leptin. In response to implantation of capsules weighing 15% of body weight the authors observed that ∼80% of this load was offset by a reduction in biological body weight. This interesting effect was attributed to a reduction in fat mass and explained by decreased food intake. Based upon studies of osteocyte-depleted mice, the authors propose that the lower extremities harbor an osteocyte-dependent gravitostat that regulates body weight. According to this model, elevations in body weight are sensed by osteocytes as an increased strain and, in response, an unknown anorexigenic factor is secreted from the weight-bearing bones.

If this proposed gravitostat responds to alterations in body load then exposure to hypergravity would be expected to cause hypophagia and weight loss, whereas a microgravitational environment should promote hyperphagia and weight gain. Along these lines, it is very interesting to note that rodents have previously been reported to respond to hypergravity (2G) by an acute decrease in food intake and a lowering of total body and fat mass (2). Furthermore, when exposed to microgravity, the lipid content of adipose tissue has been observed to increase (2). Thus, gravitational alterations seem to produce effects that agree with the gravitostat model of body weight regulation, at least in rodents. But what about humans? Data from space missions show that astronauts experience a decrease in body mass while in the microgravitational environment (3–5) and that this is due to a 23–43% decrease in caloric intake (4). It must be emphasized that space travel is not a controlled experiment and that astronauts also experience an altered light–dark cycle and an increased exposure to ionizing radiation, both of which are factors that have been proposed to initiate a physiological stress response that decreases appetite, perhaps to an extent that it overrules reduced secretion of an anorexigenic factor from osteocytes. Thus, studies using bed rest, a ground-based model of microgravity (4), might provide more definitive answers, but such studies also reported a decrease in body weight (6, 7) and indicated that increased time spent in bed might decrease appetite (7). These findings contradict the existence of a gravitostat in humans.

As a final note, it is important to highlight that the proposal made by Jansson et al. (1) is in line with what has previously been stated by Ravussin et al. (8), namely that "a stress signal derived from an organ distinct from adipose tissue could drive expression of a catabolic factor." Given that microgravity does not seem to increase appetite in humans, it could be speculated that leptin and the proposed gravitostat are two complementary systems, with leptin being a signal that acts preferentially to defend against starvation (8, 9), whereas the unknown catabolic signal produced by the gravitostat might act primarily as a defense against adiposity. Whether or not this is true should be tested by human intervention studies.

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