that they take the position that percentage body fat (BF) is an inappropriate index of adiposity. We elected to use percentage BF as an index of adiposity rather than body mass index (BMI) because of the limitations associated with BMI (2) and, more importantly, because it is the excess fat, not the excess weight, that predisposes metabolic disorders (3–7).

Using percentage BF cutoffs associated with cardiovascular disease risk factors (3) was the basis for grouping our participants. Cole et al did not take into consideration or comment on the group comparisons; however, our conclusion that “excess weight in the form of fat mass does not provide additional benefits, and may potentially be negative, for adolescent bone” was derived primarily from the group comparisons. Although no differences were found between the normal- and high-fat groups in mean values of fat-free soft-tissue mass, statistically significant differences were detected between mean levels of fat mass. This additional 9-kg of fat mass in the high-fat group provided no advantage in the peripheral quantitative computed tomography–derived bone measurements at the tibia and radius.

In addition to the group comparisons, we sought to determine relations between the bone measurements and percentage BF and fat mass. Whereas Cole et al state the limitations of using the ratio, fat mass/body weight × 100, as an index of adiposity in denoting meaningful relations with other health outcomes, their same argument can be applied to the ratio, weight/height² (8), which is the most commonly used index of adiposity. Nevertheless, in Table 3 of our article, if we had just reported fat mass adjusted for muscle cross-sectional area and limb length, the negative relations with cortical bone area and cortical bone mineral content at the tibia and radius still provide important information and support our conclusion.

The issue of normalization of body composition for body size is complex and controversial; accordingly, there is no universal agreement on the correct choice of statistical adjustment. Our decision, however, for adjustments of body size, was based on functional biological mechanisms related to bone strength (9, 10). More specifically, the study’s conclusion stems from “adjustments” relative to mechanical loading generated by muscle forces at the site of bone measurement. Our findings are consistent with the theory that bone adapts its strength mainly to dynamic (muscle), rather than to static (fat), loads. We acknowledge the points of caution made by Cole et al with respect to the use of percentage BF as a proxy for adiposity when examining relations with health outcomes. Our data collectively, however, support the study conclusion.

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REFERENCES

Mineral balance and mineral requirement

Dear Sir:

Recently, Hunt and Johnson (1) suggested, on the basis of a sophisticated analysis of calcium balance studies in 155 individuals accumulated over the years at their unit, that the calcium requirement may be substantially lower than current recommendations (2). This balance-based approach is in contrast with the one used to set those requirements by the Calcium and Related Nutrients Panel of the Food and Nutrition Board (FNB) (2). The FNB approach involved the determination of what was termed maximal calcium retention, ie, the threshold value at which balance does not further improve as intake increases. That criterion, as must be evident, is very different from the neutrality of balance itself. The authors give us no justification for their approach nor for not using the approach taken by the FNB.

Generally speaking, neutral balance is not a reliable way of ascertaining nutrient requirements, as a moment’s reflection will demonstrate. For example, the energy requirement to maintain balance is substantially lower in a famine victim than the requirement needed to restore lost body mass or sustain a healthy body mass. Similarly, the vitamin D intake needed to maintain a constant concentration of serum 25-hydroxyvitamin D in a rachitic child is not an indication of the vitamin D requirement to restore or maintain health. The same is true for most, and perhaps all, nutrients.

To use neutral balance as an indicator of adequacy, one must first be assured that the study subjects are in a state of optimal nutrition with respect to the nutrient concerned. Unfortunately, for calcium,
we have no validated, independent means of establishing optimal nutritional status. It might seem as if inadequate nutrition would be reflected in negative balance, but that would be true only in the transition from health to deficiency, not in the deficient steady state itself. Thus, an output equal to intake means only that the deficiency is not getting worse. To use neutral balance as an indicator of optimal nutrition is essentially circular and cannot be relied on to provide a valid estimate of the requirement.

That the approach taken by Hunt and Johnson is incorrect is also supported by the very large body of literature demonstrating substantial calcium-related health benefits produced by higher intakes than those needed to ensure neutral balance (eg, 3).

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REFERENCES

Reply to RP Heaney

Dear Sir:

Heaney questioned our use of a “balance”–based approach instead of a “maximal calcium retention”–based approach to estimate the calcium requirements for American adults aged 19–75 y (1). The maximal retention approach was not used by the Food and Nutrition Board (FNB) (2) for adults in their final report on the grounds that the proposed statistical model could not include 100% maximal retention, regardless of calcium intake. In addition, some of the estimates obtained with the use of this method are not biologically justifiable. In their final report, the FNB (2) used classic metabolic studies of calcium balance to obtain data on the relation between calcium intake and retention, from which a regression model was developed. From this relation, they derived an intake of calcium that would be adequate to attain a predetermined desirable calcium retention. Our data, which covered a broad range of intakes, did not exhibit nonlinearity and, therefore, did not justify the use of a more complex nonlinear model such as the one used by the FNB. The FNB model was based on data either combined from multiple laboratories (for persons aged 18–30 y) or limited to 6 discrete intakes (for persons aged ≥31 y). The FNB chose neutral calcium balance as desirable calcium retention for adults aged ≥31 y; we applied this criterion for all adults, which is consistent with our observation that calcium balance was unaffected by age in adults aged 19–75 y. For all age groups, the FNB made an adjustment for assumed significant whole-body surface calcium losses. Our data on whole-body surface mineral loss indicate that calcium surface losses are negligible.

Our data are consistent with the earlier observations by Heaney (3) that calcium has a threshold value for retention in bone such that further increases in calcium intake are simply excreted. Recently, Heaney (4) concluded from calcium balance studies with premenopausal women that a calcium intake in the range of 800–1000 mg/d is adequate to support bone health in mature women. Our values for a presumptive Estimated Average Requirement (741 mg/d) and Recommended Dietary Allowance (1035 mg/d) encompass that range.

The zone of safety between calcium balance and calcium toxicity may be relatively narrow. Our data also show a slow but inexorable increase in positive calcium balance with increasing calcium intake above the point of neutral balance. A new exhaustive meta-analysis of prospective cohort studies and randomized controlled trials (5) shows an increase in hip fracture rate with calcium supplementation. Furthermore, in a recent, large, 7-y study with 36 282 healthy postmenopausal women, supplementation with 1000 mg Ca/d and 400 IU vitamin D/d significantly increased the risk of kidney stones and did not significantly reduce hip fracture rates (6). Also, in a separate study with women with no history of kidney stones, intake of supplemental calcium was associated with an increased risk of kidney stones after adjustment for age (7). For renal stone patients, a regression equation predicted hypercalciuria when calcium intakes reach 1685 and 866 mg for men and women, respectively (2). Because there is mounting evidence that calcium supplementation may be detrimental to bone and kidney health, and there is a clear indication that menopausal bone loss cannot be substantially influenced by diet (4), we suggest a reevaluation of the rationale for advocating calcium intakes higher than those needed to ensure balance.

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