lower linoleic acid concentrations than did the control subjects. The experimental subjects also had significantly higher concentrations of linolenic and eicosapentaenoic acids than did the control subjects. Because the study was not designed to test the n–6 hypothesis, linoleic acid concentrations (and thus the ratio of polyunsaturated to saturated fatty acids) were not expected to differ between the experimental and control groups. In the free-living populations that we studied, the ratio of polyunsaturated to saturated fatty acids captured healthy trends in ingested lipids and was strongly associated with the risk of ischemic heart disease (10). Inclusion of α-linolenic acid in the AHEI score might have improved our prediction of cardiovascular disease, but again, we chose to include only those factors with longer, more established relations.

As we learn more about the relation between diet and health, scores such as the AHEI can continue to be refined and improved, and diet patterns being recommended to the US public can become more precise. For now, advice that emphasizes the intake of unsaturated fats and the restriction of saturated and trans fats and that encourages the consumption of fish, nuts, and whole grains clearly represents an improvement in recommendations to reduce chronic disease risk.

Marjorie L McCullough

Epidemiology and Surveillance Research
American Cancer Society
1599 Clifton Road, NE
Atlanta, GA 30329
E-mail: marji.mccullough@cancer.org

Walter C Willett

Department of Nutrition
Harvard School of Public Health
665 Huntington Avenue
Boston, MA 02115

REFERENCES

Bone mineral content, not bone mineral density, is the correct bone measure for growth studies

Dear Sir:

In a recent issue of the Journal, Lehtonen-Veromaa et al (1) reported important findings with respect to the apparent effect of basal vitamin D status on the attainment of peak bone mass in peripubertal girls living at a latitude at which solar vitamin D synthesis in the skin is minimal and in a country (Finland) in which vitamin D fortification of milk is too low as to be nearly negligible. The importance of their findings, although statistically significant, is minimized by an unfortunate choice of outcome variable, i.e., areal bone mineral density (BMD). This is precisely the wrong measurement during growth, because it factors out most of the component of bone accumulation that is associated with change in bone size. What is important in a growth experiment is bone mass (measured as bone mineral content, BMC), not bone density. The authors’ title captures that truism, even if their data do not.

The positive correlation between 25-hydroxyvitamin D [25(OH)D] and BMD gain, depicted in Figure 1 in the article (1), could have been due to the fact that vertebral size was expanding more in the girls with low 25(OH)D values than in the girls with higher 25(OH)D values. With a larger denominator, the BMD value would have increased less. I doubt that that is the case, but without the critical data there is no way to tell.

BMD should never be used in a growth study (2, 3). There is no mechanical reason why true density should change appreciably with growth, and Matkovic et al (4) showed that, in fact, it did not. Bone mineral apparent density is an even less appropriate measure under these circumstances, because it represents an empirical method of adjusting to account for differences in the third dimension that BMD does capture.

My guess is that the reported change in BMD in these girls was almost surely less than the actual change in bone mass, and that, had the authors used BMC as their outcome variable, the association with vitamin D would have been even stronger than the association they report. What Lehtonen-Veromaa et al should provide are the BMC and area values (and their corresponding 3-y changes). Only these are capable of capturing the variable in the

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<table>
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<th>TABLE 2</th>
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<td>Unsaturated fatty acid intakes by quintile (Q) of Alternate Healthy Eating Index score in 67271 women who participated in the Nurses’ Health Study</td>
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<tr>
<td>P:S</td>
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<td>PUFAs (g/d)</td>
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<td>MUFAs (g/d)</td>
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<td>Linoleic acid (g/d)</td>
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<td>Linolenic acid (g/d)</td>
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1 P:S, polyunsaturated-to-saturated fatty acid ratio; PUFAs, polyunsaturated fatty acids; MUFAs, monounsaturated fatty acids. For all of the variables, P for trend < 0.001.

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BMD reflects not only bone density but also bone size and that models (1). We agree that it is evident that bone mineral density mass in growing girls as measured with the use of new statistical our results concerning vitamin D and the attainment of peak bone eating the opportunity for additional discussion and further analysis of the Journal.

Robert P Heaney

Creighton University
601 North 30th Street, Suite 4841
Omaha, NE 68131
E-mail: rheaney@creighton.edu

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Reply to RP Heaney

Dear Sir:

We thank RP Heaney for his interest in our work and for generating the opportunity for additional discussion and further analysis of our results concerning vitamin D and the attainment of peak bone mass in growing girls as measured with the use of new statistical models (1). We agree that it is evident that bone mineral density (BMD) reflects not only bone density but also bone size and that the outcome variable bone mineral content (BMC) may generally reflect peak bone mass better than does BMD. However, our main results regarding the changes in the BMD of the lumbar spine in the girls who were in the same phase of growth (decelerating with age) and sexual maturation but who had different vitamin D status were convincing. The changes in BMD in growing girls were controlled accurately by the use of several covariates (ie, baseline reproductive years, baseline bone mineral values, increases in height and weight, mean intake of calcium, and mean amount of physical activity during the study) to adjust the changes in bone size. However, it is true that the use of a method with BMC as a dependent variable and with adjustment for bone area (BA) is an interesting way of avoiding pitfalls in the assessment of real changes in bone density in the growing bone (2). Thus, we reanalyzed our main results with the use of this recommended principle.

In our 3-y prospective study of 171 peripubertal girls, the correlation between the 3-y changes (Δ) in BMD and BMC was highly significant (r = 0.969), and the degree of relation between baseline 25-hydroxyvitamin D [25(OH)D] and ΔBMD (r = 0.35, P < 0.001) was quite similar to that between baseline 25(OH)D and ΔBMC (r = 0.33, P < 0.001). The mean (±SD) crude values of 3-ΔBMC in the lumbar spine were significantly different in the vitamin D tertiles (11.0 ± 8.0, 10.9 ± 9.6, and 16.1 ± 7.9 g, respectively; P = 0.006), whereas the ΔBA did not differ significantly between the vitamin D tertiles. In the girls with advanced sexual maturation at baseline (n = 129), the difference in 3-y BMC accumulation from baseline (adjusted for baseline reproductive years, baseline bone mineral values, ΔBA, increases in height and weight, mean intake of calcium, and mean amount of physical activity) between the girls with severe hypovitaminosis D [25(OH)D concentration < 20 nmol/L] and those with normal vitamin D status [25(OH)D concentration ≥37.5 nmol/L] was 6.4% (P = 0.007) in the lumbar spine. In addition, when this method was used (Table 1), ΔBMC was 1.839 g greater (95% CI: 0.436 g, 3.242 g) in the highest vitamin D tertile than in the lowest tertile. ΔBMC values obtained after various other adjustments are also given in Table 1. These values for the femoral neck did not differ significantly, except when ΔBMC values were adjusted only for increases in BA, height,

<table>
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<td>Three-year changes (∆) in the bone mineral density (BMD) and the bone mineral content (BMC) of the lumbar spine (L1–L4) and at the femoral neck (FN) analyzed after various adjustments in peripubertal girls with advanced sexual maturation (n = 129) according to tertiles of baseline serum 25-hydroxyvitamin D [25(OH)D] concentration</td>
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<tr>
<td>Serum 25(OH)D tertiles</td>
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<td>ΔBMD, L1–L4 (g/cm²)</td>
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<td>ΔBMC, L1–L4 (g)</td>
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1 x ± SE.
2 Adjusted for baseline reproductive year, baseline value of BMD, increases in height and weight, mean intake of calcium, and mean amount of physical activity.
3 Δ x ± SE relative to baseline.
4 Δ t, 95% CI in parentheses.
5 Adjusted for baseline reproductive year; baseline value of BMC; increases in bone area, height, and weight; mean intake of calcium; and mean amount of physical activity.
6 Adjusted for increases in bone area, height, and weight; mean intake of calcium; and mean amount of physical activity.
7 Adjusted for increases in bone area, height, and weight.

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