Do differences in nutrient intake predict differences in bone mass in boys: a co-twin control study

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Genetic factors determine a large proportion of the variance in bone traits such as size, mass and volumetric density. The proportion of variance attributable to genetic factors can be determined using the classic twin model, in which it is assumed that similarities in life style factors, such as diet, are the same within monozygotic (MZ) pairs as they are within dizygotic (DZ) pairs. The effects of home environment, however, may differ less within MZ pairs than within DZ pairs, and this may account in part for their greater resemblance. This assumption has not been rigorously tested in young males. Protein and calcium intakes are important nutrients for bone mass accrual. Protein insufficiency during growth is associated with delayed skeletal maturity, and reduced cortical and trabecular bone (1). Calcium supplementation has been associated with increased bone mass accrual in children (2). Using data from male twins, we determined the similarity in nutrient intake within MZ and DZ pairs, and the extent to which within pair differences in bone mass and anthropometry could be explained by within pair differences in nutrient intake.

We studied 36 MZ and 39 DZ male twin pairs aged 11.3 ± 2.9 years (range 7–20 years). Bone mass and body composition were measured using dual energy x-ray absorptiometry (DXA). Dietary intake was assessed using 3-day weighed food diaries, and analysed using FoodWorks Nutrition Program (Version 2.10). Anthropometry was measured using standard methods. Similarities within pairs were assessed using Pearson's correlation. The extent to which within pair differences in bone mass could be accounted for by within pair differences in nutrient intake was determined using multiple linear regression through the origin. Data was analysed using StatView (version 4.51).

MZ and DZ twins did not differ in mean age, bone mass, anthropometry or nutrient intake. Age-adjusted correlations for height, sitting height, leg length and bone mass ranged from r = 0.86-0.96 for MZ pairs and r = 0.68-0.78 for DZ twins (all $P < 0.01$). Age-adjusted correlations for calcium, protein and energy intakes were r = 0.89, r = 0.77 and r = 0.84 for MZ pairs and r = 0.43, r = 0.43 and r = 0.52 for DZ pairs, respectively (all $P < 0.01$). Within pair differences in protein intake were marginally significant predictors of within pair differences in total body ($\beta = 0.3$) and leg BMC ($\beta = 0.3$) ($P < 0.08$), but not axial BMC. Within pair differences in calcium and energy intake did not predict differences in bone mass. Within pair differences in nutrient intake did not predict differences in height, sitting height or leg length.

MZ pairs differ less in their dietary intake than do DZ pairs. These data suggest that about 9% of the variance in within pair differences in BMC at several sites was explained by within pair differences in protein intake. Dietary calcium intake did not appear to be an independent predictor of bone mass, but this could be a type 2 error due to lack of power. Protein intake may be a more important factor in bone mass accrual at the legs than the spine. The importance of dietary protein intake in relation to bone mass accrual is becoming more apparent.

1. Adams P, Berridge FR. Effects of Kwashiorkor on cortical and trabecular bone. Ar Dis Childh 1969; 44: 705–709.
2. Johnston CC, Miller JZ, Slemenda C et al. Calcium supplementation and increases in bone mineral density in children. N Engl J Med 1992; 327: 82–87.