

## Review Article

# Current calcium recommendations in North America

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Calcium recommendations in North America set in 1997 were determined as the intake for maximal retention in age groups for which these data were available. Because there is a linear relationship between bone density and fracture risk and because 99% of calcium resides in the bone, it was thought that maximizing calcium retention is an optimal goal for bone health. Typically, data for only one gender and race were available in an age group. Recent evidence suggests that calcium intakes for maximal retention may not vary by subgroup even if calcium retention is vastly different at any given intake. Issues that are receiving attention currently include possible catch up growth, dairy vs. calcium intake, and how to establish optimal intakes.

**Key Words:** calcium, recommended intakes, race, adolescents, children

## INTRODUCTION

Calcium recommendations for children and adolescents in North America set in 1997 were determined as the intake for maximal retention in age groups for which these data were available.<sup>1</sup> Because there is a linear relationship between bone density and fracture risk and because 99% of calcium resides in the bone, it was thought that maximizing calcium retention is an optimal goal for bone health. Data from calcium balance studies were used to determine the intake where a plateau in calcium retention occurs. The data for adolescents was plotted as shown in Figure 1. The point where the 95% confidence interval crosses the 100% maximal retention line (A in the figure) extrapolated to 1300 mg/d which became the calcium recommendations for adolescents for North American. There are many questions surrounding this approach.

Typically, data for only one gender and race were available in an age group. For adolescents, data were available in white girls.<sup>2</sup> Would the intake for maximal retention be the same for boys and other races or subgroups? Recommendations are the same for children aged 9-18 years. The data available were in 12-14 y old girls. But are true requirements consistent across this wide age span? Balance studies were not available in younger children to use the intake for maximal retention approach for other age groups. Does a short term balance study reflect long term bone accretion? Although great effort was taken to prove steady state on assigned calcium intakes by demonstrating unchanging Ca:PEG ratios using the nonabsorbable polyethylene glycol fecal marker,<sup>2</sup> perhaps homeostatic regulatory mechanisms compensate intakes for prolonged exposure to calcium intakes that would alter requirements. Some would argue that 100% of maximal retention should not be the goal for the population, but rather some lower amount as demonstrated by B in Figure 1. A discussion of some of these issues is presented here.

## NEWER EVIDENCE FOR CALCIUM RECOMMENDATIONS

Recent evidence suggests that calcium intakes for maximal retention may not vary by subgroup even if calcium retention is vastly different at any given intake. Since the current recommendations for North America were released in 1997, there have been studies of calcium requirements in black adolescent girls<sup>3</sup> (Figure 2) and adolescent boys (Figure 3).<sup>4</sup> Black girls and boys retained more calcium than white girls across a wide range of intakes, but the calcium intake for optimal retention was not significantly different from white girls. Figure 2 does not demonstrate a plateau because black girls were not studied at sufficiently high levels for a nonlinear regression model to effectively find a plateau.

Therefore, linear regression was conducted only to intakes as high as black girls were studied. Calcium intake explained 12.3% and race explained 13.7% of calcium retention in this study. Boys retained 171 mg calcium/d more than girls at any calcium intake. The higher bone mass achieved by black compared to white women and men compared to women are due to greater efficiency of utilization of calcium rather than higher calcium requirements. Studies of other races and populations are needed. Genetics and environment including dietary and physical activity habits may influence requirements.

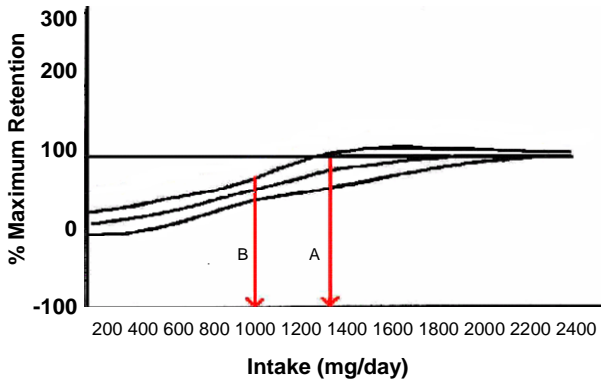
Calcium retention as a function of intake has also been reported in children aged 1-4 y.<sup>5</sup> The authors concluded that skeletal growth needs were achieved at an intake of 470 mg/d, an intake approximating the Adequate Intake set at 500 mg/d in 1997.<sup>1</sup> Studies are needed in children aged 5-12 y.

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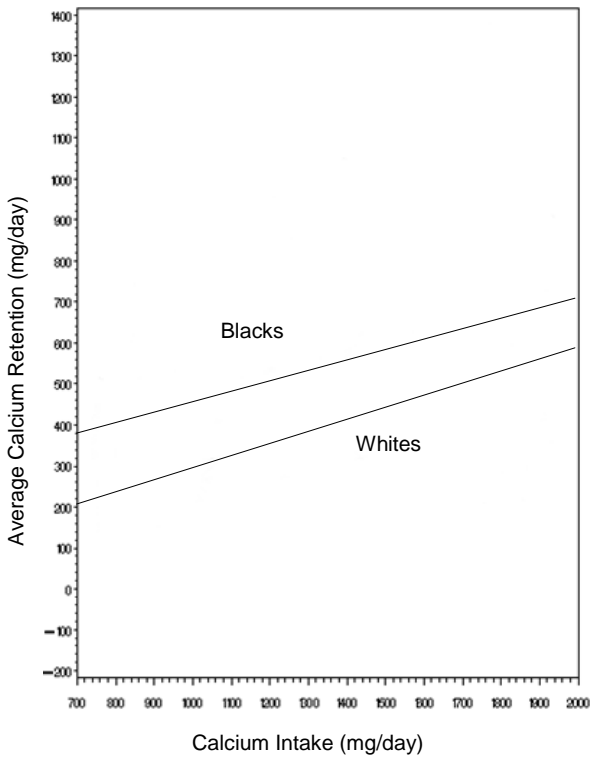
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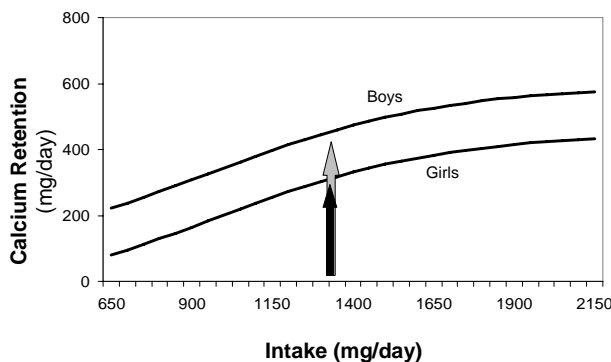
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**Figure 1.** Maximal retention of calcium as a function of calcium intake for adolescents. The three curves represent the mean and standard deviations for data taken from Jackman et al.<sup>2</sup> A shows current calcium requirements at 100% maximal retention B estimates intakes for 70% maximal retention



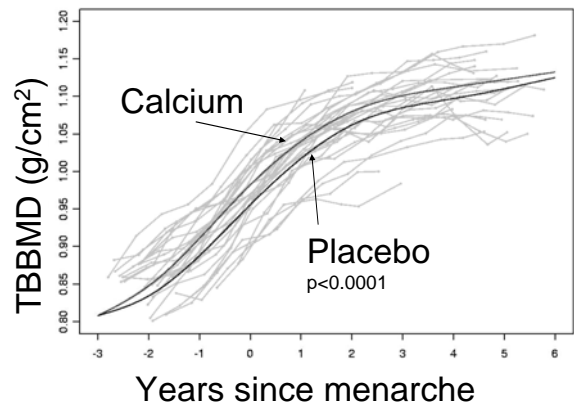
**Figure 2.** Comparison of calcium retention as a function of calcium intakes between white and black adolescent girls. Data taken from Braun et al.<sup>3</sup>



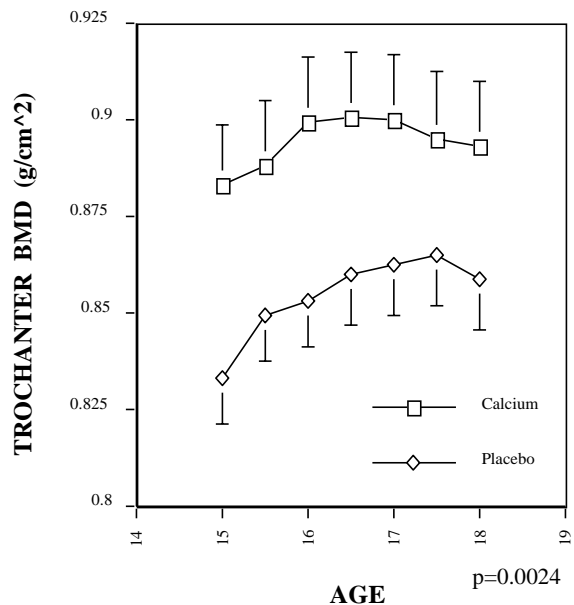
**Figure 3.** Comparison of calcium intakes for maximal retention between white adolescent boys and girls. Data taken from Braun et al.<sup>4</sup>

**CURRENT ISSUES**

Issues that are receiving attention currently include possible catch up growth and how to establish optimal calcium intakes. The only long term randomized controlled trial of calcium supplementation that spanned pre-puberty through the pubertal growth spurt to achievement of peak bone mass was by Matkovic et al.<sup>6</sup> The effect of supplementation on total body (Figure 4) and several skeletal sites was a significant advantage overall, but analysis of the final measurement showed nonsignificant group differences, except for trochanter BMD<sup>7</sup> (Figure 5), or for taller girls at age 18 for many sites<sup>6</sup>. It is difficult to determine whether this was due to a biological phenomenon known as catch-up growth or if it was due to poor retention and dietary compliance in the study. BMD of the hip was different at the end of the study<sup>7</sup>. This is an important site, but hip measurements were not taken in the first years of the trial which raises the possibility that the two groups were not similar at the start. Even if catch up growth were possible, the period in which BMD was reduced is a period of increased risk of fracture. Goulding et al.<sup>8</sup> reported that fracture risk in children is associated



**Figure 4.** Total body BMD in randomized controlled trial of 1 g calcium vs. placebo in white girls<sup>6</sup>



**Figure 5.** Hip BMD in trial of 1 g Ca vs. placebo daily in white girls<sup>7</sup>

with low bone density. Mean calcium intake in the Matkovic et al. study<sup>6</sup> was approximately 800 mg/d. Catch up growth, if possible may not occur at lower calcium intakes. More evidence is needed to understand possible catch up growth.

When the Dietary Recommended Intakes for calcium were released in 1997, some questioned why the goal was to achieve 100% of maximal calcium retention. It was deemed that something lower would be more practical and achievable. There is considerable discussion that more emphasis should be placed on those consuming very low calcium intakes than on those consuming >800 mg calcium per day. Abrams et al.<sup>9</sup> demonstrated failure to adapt to low calcium intakes. Pubertal girls on average retained only 131 mg/d on their habitual dietary calcium intakes of about 386 mg/d compared to 587 mg/d on intakes of over 1200 mg/d. Perhaps they would not sustain this high level of calcium accretion for prolonged periods, but it would certainly remain higher than on their usual low intakes. In conclusion, increasing calcium intakes to the current recommended levels is a prudent goal with potential benefit and little risk.

#### AUTHOR DISCLOSURES

Connie M Weaver was a member of the IOM Panel that determined Dietary Recommended Intakes for North America for calcium released 1997. She has served on Boards and Grant Review Panels or received grants from several organizations which market calcium products: Dairy Management Inc., Wyeth, Pharmavite, Glaxo Smith Kline.

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