

Low calcium intake aggravates the deleterious effects of an isocaloric low protein diet on bone material level properties during growth

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Objective:

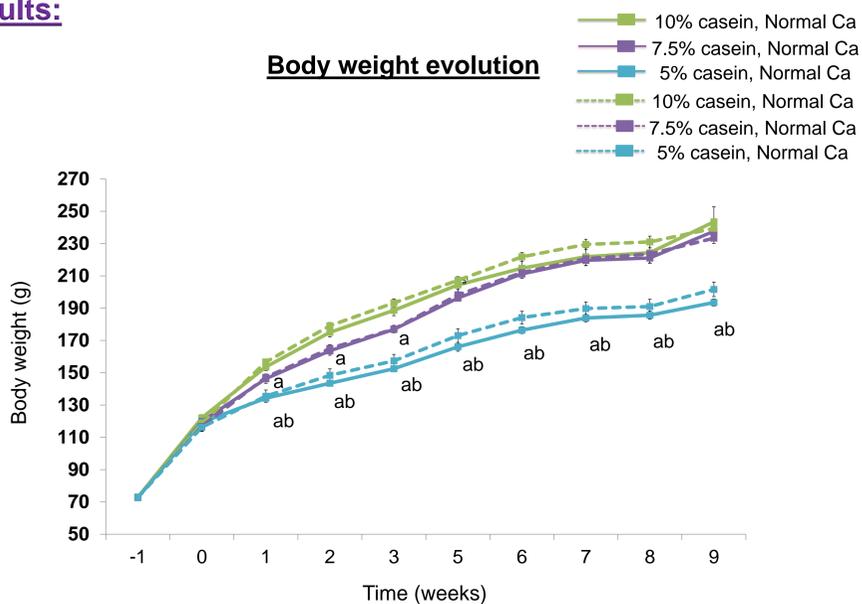
Low protein or low calcium intakes are known to impair bone growth, but their combined effects on determinants of bone strength are not well understood. We investigated the influence of various protein and calcium intakes on determinants of bone strength in growing rats.

Material & Methods:

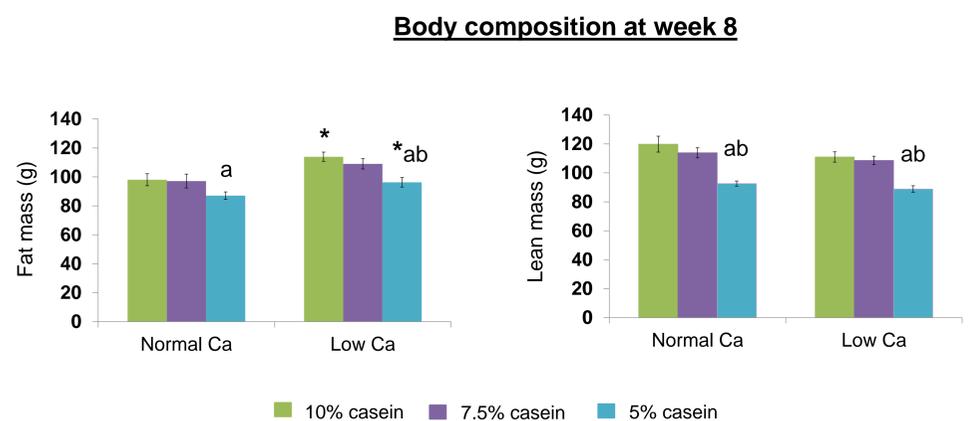
One-month old female rats were fed isocaloric diets containing 10, 7.5 or 5% casein, with 1.1% (normal) or 0.2% calcium (low) during 8 weeks. Body weight was weekly assessed. Body composition was measured by DXA. Tibia midshaft geometry (outer-diameter) was measured by a caliper, bone mineral content (BMC) by DXA, and cortical tissue hardness by nanoindentation. Blood analyses were performed with ELISA or colorimetric assays.

Results are expressed as means +/- SEM. The significance of difference between groups was evaluated using a two-way analysis of variance (ANOVA) or repeated measures ANOVA for the evolution of body weight, followed by a Fisher's test. A p -value <0.05 was considered as statistically significant.

Results:



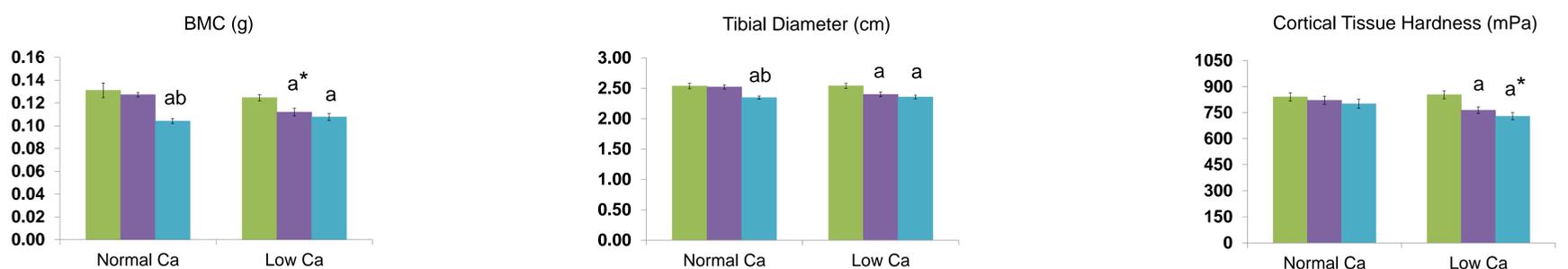
Independently of the Ca intake, only the 5% casein diet led to a lower body weight gain over time.



a, $p < 0.05$ vs 10% casein; b, $p < 0.05$ vs 7.5% casein; *, $p < 0.05$ vs normal Ca

Independently of the Ca intake, the 5% casein diet led to lower lean and fat masses while the low Ca intake led to a higher fat mass.

Tibia midshaft analysis at week 8



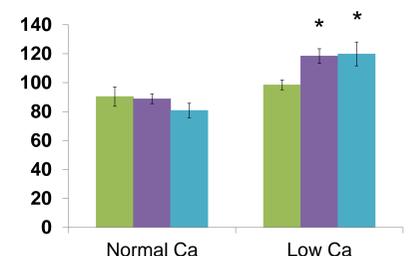
For normal Ca intake, BMC and tibial diameter were reduced by the 5% casein diet while for low Ca intake these parameters were already decreased with the 7.5% casein diet. Cortical tissue hardness was significantly decreased when the reduced protein intake was combined to a low Ca diet.

Blood analysis at week 8

	10% Casein		7.5% Casein		5% Casein	
	Normal Ca	Low Ca	Normal Ca	Low Ca	Normal Ca	Low Ca
Calcium (mg/dl)	12.5 ± 0.2	12.6 ± 0.2	12.3 ± 0.2	13.2 ± 0.4	12.4 ± 0.4	12.5 ± 0.3
Phosphorus (mg/dl)	6.2 ± 0.2	5.3 ± 0.2	6.6 ± 0.3	5.7 ± 0.7	6.3 ± 0.4	6.5 ± 0.7
PTH (pg/ml)	60.1 ± 12.0	48.4 ± 11.3	92.4 ± 17.6	41.5 ± 10.1	99.3 ± 36.1	76.4 ± 20.1
Calcitriol (pmol/L)	71.9 ± 14.1	147.3 ± 18.0*	82.8 ± 6.1	164.0 ± 19.1*	56.5 ± 4.5	123.9 ± 12.1*
Osteocalcin (ng/ml)	25.4 ± 4.5	35.3 ± 3.0	30.7 ± 5.0	32.7 ± 8.0	28.4 ± 5.5	33.6 ± 4.7
IGF-1 (ng/ml)	534.7 ± 43.6	531.4 ± 28.7	542.7 ± 15.2	563.6 ± 46.1	404.7 ± 29.2 ^{ab}	470.9 ± 25.3 ^{b,p=0.06}

Calcemia, phosphatemia and circulating PTH were not significantly changed by the various diets after 8 weeks of treatment. Serum Calcitriol was increased by the low Ca intake and serum IGF-1 was reduced by the 5% casein intake independently of the Ca diet. Urinary deoxyridinolines were raised by the low Ca intake while serum osteocalcin was not modified by either the protein or the Ca diet.

Urinary deoxyridinoline (nM/mM creatinine) at week 8



Conclusion:

These results obtained in growing rats indicate that lowering calcium intakes during an isocaloric low protein diet has some additive deleterious effects on material level properties. Altogether these results point out the important role of adequate protein and calcium intakes to optimize bone development during growth.