plotted on centile charts. These provide clinicians with an informative assimilation of paediatric bone densitometry and anthropometric data, which is easy to interpret. We are in the process of implementing data for assessing bone mineral content in relation to lean muscle mass in our reports, to further improve the diagnosis of bone diseases in children.

Example 1:
Bone densitometry report for a male of age 15.7
Height (176.5 cm) (z = 0.6), weight (69.8 kg) (z = 1.0), BMI (22.4 kg/m²) (z = 0.1)¹
pQCT trabecular vBMD 84.8 mg/cm³ Reduced (z = −6.2)
pQCT total vBMD 212.0 mg/cm³ Reduced (z = −3.2)
DXA Lumbar spine BMAD 0.153 g/cm³ Reduced (z = −3.5)
DXA left femoral neck BMAD 0.236 g/cm³ Reduced (z = −2.2)²
Moigaard (1997) calculations for LS DXA:
Are bones short for age? NO (z = 0.6); Are bones narrow for height? NO (z = 0.3); Are bones under mineralised for their size? YES (z = −2.2)

**Conclusion:** Osteopaenia confirmed by pQCT, DXA femoral neck and lumbar spine. Based on Moigaard calculations, bones are normal for age and height, but undermineralised.

¹Calculated from (Cole et al., 1990; Freeman et al., 1990).
²Calculated from Manchester normative reference data (Ward et al., 2007).

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### The effect of socioeconomic status upon bone geometry and bone mineral density at different skeletal sites in healthy children


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**Background:** Studies indicate children from socially deprived backgrounds have higher fracture rates in comparison to those from more affluent areas (Stark et al., 2002). However, the effect of socioeconomic status upon bone geometry and bone mineral density (BMD) is not well studied (Clark et al., 2005).

**Aim:** The aim of this study was to assess the effect of socioeconomic status upon bone parameters of the whole body (WB), lumbar spine (LS), femoral neck (FN), distal and midshaft radius in a cohort of healthy children.

**Participants and methods:** A total of 435 (235 male; age 12.0 ± 3.1, range 5–18 years) healthy Caucasian children from the Greater Manchester region (United Kingdom [UK]) were studied. Height (cm) and weight (kg) were measured; body mass index (BMI [kg/m²]) was calculated. The Hologic QDR Discovery DXA scanner measured WB, LS and FN bone area (BA, cm²) and bone mineral content (BMC, g). Bone mineral apparent density (BMAD, g/cm³) of the LS and FN was calculated. The Stratec XCT-2000 pQCT scanner measured total and trabecular volumetric BMD (vBMD, mg/mm³) and BA (mm²) of the 4% distal radius and BA, cortical area, medullary area, cross-sectional muscle area (mm²), cortical BMC (mg/mm), cortical vBMD and cortical thickness (mm) of the 50% midshaft radius. Standard deviation scores (SDS) for anthropometric measurements and all bone parameters were calculated. Participants postcodes were used to determine the Townsend Deprivation Score (TDS) as an indicator of socioeconomic status, using data from the UK 2001 Census.

**Results:** The TDS was determined for the locality of 382 participants. The median TDS was −0.38, close to the population average (interquartile range −2.5 to 2.6). Forty-three percent of participants had TDS > 0; the distribution was skewed towards higher deprivation (more deprived) scores (range −4.8 to 13.9). There was a significant positive association between the TDS and weight (r = 0.11, p = 0.036) and BMI (r = 0.10, p = 0.056) SDS. Distal radius BA increased with the TDS (r = 0.21, p < 0.001), as did trabecular vBMD (r = 0.09, p = 0.089), while total vBMD decreased (r = −0.17, p < 0.001). There were no significant associations for any parameters at the WB, LS, FN or midshaft radius.

**Conclusion:** These data indicate children from socially deprived backgrounds have greater BA and trabecular vBMD, but reduced total vBMD at the distal radius; this may be due to greater body weight and BMI. However, we cannot ascertain from these data whether the TDS and associated lifestyle factors also have an effect; this requires further investigation.

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### Influence of body composition and weight-bearing physical activity in BMD of pre-pubertal children


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The main purpose of this study was to analyze the influence of mechanical factors such as body composition and physical activity on bone mineral density (BMD) of pre-pubertal girls and boys, accounting for bone age, a common confounding variable. Of the 141 starting participants 117 completed all assessments and were included in this study, namely 53 girls (G) (chronological age, 8.5 ± 0.5 years; bone age 8.5 ± 1.3 years; height, 131.8 ± 5.3 cm; weight, 30.2 ± 6.5 kg) and 64 boys (B) (chronological age, 8.5 ± 0.5 years; bone age, 8.9 ± 1.1 years; height, 133.4 ± 7.0 cm; weight, 32.3 ± 7.3 kg). Evaluation of body weight, total lean and fat mass, and BMD of lumbar spine (L1–L4), femoral neck, and radius were performed with DXA.
Physical activity (PA) was assessed with a uni-axial accelerometer. Maturation level was determined by the TW3 method (Tanner et al., 2001). Calcium intake was calculated from a semi-quantitative Food Frequency Questionnaire assessing regular intake of a wide set of typical Portuguese foods. Comparisons by t-test revealed that boys have higher values than girls for BMI (18.2 ±3.4 vs. 17.2±2.4 kg/m², p=0.031), lean mass (23.9±3.2 vs. 21.6±2.6 kg, p<0.001), moderate plus vigorous PA (87±27 vs. 60±25 min/day, p<0.001), femoral neck BMD (0.714±0.082 vs. 0.648±0.050 g/cm², p<0.001), and radius BMD (0.424±0.032 vs. 0.407±0.029 g/cm², p=0.002). No difference was found between genders for fat mass, spine BMD, sedentary and light PA, calcium intake, and bone age (p>0.05). Regression analysis using total lean body mass, moderate plus vigorous PA, and bone age as predictors showed that total lean body mass explained 25% of the variance of radius BMD (β=0.497, p<0.001), 11% of the variance of lumbar spine BMD (β=0.338, p<0.001), and 23% of the variance of femoral neck BMD (β=0.417, p<0.001). Moderate plus vigorous PA also explained 10% of the variance of femoral neck BMD (β=0.318, p<0.001). Comparisons between genders adjusted for these predictors indicated that BMD differences were eliminated on lumbar spine and radius and only persisted on femoral neck. For this bone site, boys continued to show higher values than girls (0.697±0.09 vs. 0.664±0.010 g/cm², p=0.027). In conclusion, lean body mass, but not fat or body weight, was the most important predictor of radius, femoral neck, and lumbar spine BMD. Habitual weight-bearing physical activity appears to positively impact femoral neck BMD; however, it did not explain all the difference between pre-pubertal girls and boys.

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Bone mineral accrual and age of attainment of adult bone mass: A 15-year-longitudinal study from pre-adolescence into adulthood

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Maximizing bone mass during adolescence may protect against osteoporosis in later life. The purposes of this study were to identify the age when bone mass plateaued and to assess the amount of bone mass accrued during the adolescence period. Data were from the Saskatchewan Pediatric Bone Mineral Accrual Study (PBMAS), a mixed longitudinal study of 197 subjects who were measured on at least two occasions between 1991 and 1997. Between 2002 and 2006, 167 subjects were reassessed. Peak height velocity (PHV) was obtained and individual bone mass measurements (DXA HOLOGIC 2000) were aligned by a biological age (years from PHV). Sigmoidal curves were fitted and age where bone mass plateaued was interpolated. Data were analyzed with repeated measures ANOVA. Males reached PHV significantly later than females, 13.5±1.0 and 11.8±1.0 years respectively (p<0.05). Relative to plateau values, at PHV, subjects had attained: 91% of stature; 93% of FNarea and 75% of FNBMC; 76% of LSarea and 54% of LSBMC; 74% of Tbarea; and 62% of TBBMC. The table shows the years from PHV when plateau was reached for each site. There was no site by gender interaction or gender effect (p>0.05), but there were significant differences in age of attainment between sites (p<0.05). Between 1 year after PHV and the attainment of the plateau, another 0% FNarea, 13% FNBMC, 14% LSarea, 30% LSBMC, 16% Tbarea and 26% TBBMC, were respectively added to the skeleton. In conclusion when controlling for maturation, site specific differences were found in age of attainment of adult values; area attainment always preceded BMC; no gender differences were found. A significant portion of the skeletal mass was laid down over a 6- to 8-year period of growth. Therefore, attention to modifiable determinants of bone mineral accrual during this period of growth would seem warranted and have implications with regards to maximizing adult bone mass.

<table>
<thead>
<tr>
<th></th>
<th>FNarea</th>
<th>FNBMC</th>
<th>LSarea</th>
<th>LSBMC</th>
<th>Tbarea</th>
<th>TBBMC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>1.4±1.0</td>
<td>3.2±1.6</td>
<td>4.1±1.3</td>
<td>5.7±1.9</td>
<td>4.7±1.2</td>
<td>5.9±1.2</td>
</tr>
<tr>
<td>Female</td>
<td>1.0±0.9</td>
<td>3.0±1.2</td>
<td>4.0±1.1</td>
<td>5.3±1.6</td>
<td>4.2±1.2</td>
<td>5.4±1.3</td>
</tr>
</tbody>
</table>

Values mean±SD years from PHV; bone mineral content and area at femoral neck (FNBMC and area), lumbar spine (LSBMC and area) and total body (TBBMC and Tbarea).

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Bone geometry normalizes with age in children and adolescents with Type 1 diabetes mellitus

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Objective: To establish whether type 1 diabetes mellitus (T1DM) has a long-term effect on bone development in children and adolescents.

Methods: Bone characteristics and muscle cross-sectional area (CSA) were measured in 41 (19f/22 m) patients and reevaluated after a mean of 5.56±0.4 years using peripheral quantitative computed tomography (pQCT). At first measurement, 9 patients had altered bone geometry (group 2, 4f) and were compared with the remaining patient cohort (group 1, n=32, 19f) longitudinally.

Results: At first evaluation mean age was 9.87±2.3 years and mean disease duration 4.31±2.9 years. Bone geometry parameters were reduced in the whole patient group. At