

The Deleterious Effect of Obesity on Bone Mineral Density in Korean Adolescent Girls

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OBJECTIVES

Several studies have suggested that obesity has a detrimental effect on bone mass accrual and fractures in adolescence, although this issue remains controversial. The beneficial effect of hormonal changes during puberty may be attenuated by obesity. We evaluated the effect of obesity, as measured by body mass index (BMI) and fat mass (FM), on bone density and examined whether obesity reduced the beneficial effects of hormonal changes on bone parameters in adolescent girls.

METHODS

We analyzed data from 946 subjects (aged 10–19 years) from the Korea National Health and Nutrition Examination Survey (2008–2011). In these subjects, the entire body, excluding the head, was examined using dual-energy X-ray absorptiometry in order to measure bone mineral content, bone area, and fat mass. The effects of obesity on bone parameters were evaluated according to FM and BMI categories in pre-menarcheal and post-menarcheal subjects.

| Independent variable | Dependent variable: TBLH bone parameters | | | | | | | | | | | | | | | | | |
|--|--|--------|-----|---------|--------|-----|-----------------------|--------|-------|---------|--------|-------|-----------------------|--------|-------|--|--|--|
| | aBMD (g/cm ³) | | | BMC (g) | | | BA (cm ²) | | | BMC (g) | | | BA (cm ²) | | | | | |
| | b | p | VIF | b | p | VIF | b | p | VIF | b | p | VIF | b | p | VIF | | | |
| BMI [*] < 5 th (n = 66) | | | | | | | | | | | | | | | | | | |
| TBLH BMC (g) | | | | | | | | | | | | | | | | | | |
| TBLH BA (cm ²) | | | | | | | | | | | | | | | | | | |
| Age (years) | 0.0112 | 0.071 | | 28.28 | <0.001 | | 12.70 | 0.164 | 5.011 | 19.35 | 0.034 | 5.174 | -1.20 | 0.877 | 5.575 | | | |
| Menarcheal status [*] | -0.0129 | 0.740 | | -108.95 | 0.115 | | -102.99 | 0.076 | 4.374 | -36.57 | 0.524 | 4.608 | -49.43 | 0.302 | 4.557 | | | |
| Lean mass (kg) | 0.0107 | 0.002 | | 30.48 | <0.001 | | 21.73 | <0.001 | 2.839 | 15.21 | 0.007 | 3.790 | 6.74 | 0.160 | 4.149 | | | |
| Fat mass (kg) | 0.0035 | 0.440 | | 24.74 | 0.004 | | 26.72 | <0.001 | 2.434 | 4.97 | 0.496 | 3.088 | 15.04 | 0.011 | 2.795 | | | |
| Adjusted R ² | 0.561 | | | 0.759 | | | 0.673 | | | 0.840 | | | 0.782 | | | | | |
| 5 th ≤ BMI [*] < 85 th (n = 693) | | | | | | | | | | | | | | | | | | |
| TBLH BMC (g) | | | | | | | | | | | | | | | | | | |
| TBLH BA (cm ²) | | | | | | | | | | | | | | | | | | |
| Age (years) | 0.0063 | <0.001 | | 19.04 | <0.001 | | 10.33 | <0.001 | 2.130 | 11.25 | <0.001 | 2.189 | -2.25 | 0.198 | 2.305 | | | |
| Menarcheal status [*] | 0.0351 | <0.001 | | 68.52 | <0.001 | | 51.90 | 0.001 | 2.115 | 29.40 | 0.016 | 2.148 | 6.62 | 0.565 | 2.165 | | | |
| Lean mass (kg) | 0.0105 | <0.001 | | 31.05 | <0.001 | | 19.00 | <0.001 | 2.345 | 16.72 | <0.001 | 2.924 | -1.52 | 0.245 | 3.689 | | | |
| Fat mass (kg) | 0.0001 | 0.117 | | 12.39 | <0.001 | | 15.35 | <0.001 | 1.713 | 0.81 | 0.501 | 1.981 | 7.17 | <0.001 | 1.866 | | | |
| Adjusted R ² | 0.614 | | | 0.782 | | | 0.677 | | | 0.891 | | | 0.838 | | | | | |
| 85 th ≤ BMI [*] < 95 th (n = 118) | | | | | | | | | | | | | | | | | | |
| TBLH BMC (g) | | | | | | | | | | | | | | | | | | |
| TBLH BA (cm ²) | | | | | | | | | | | | | | | | | | |
| Age (years) | 0.0020 | 0.507 | | 2.94 | 0.663 | | 0.88 | 0.886 | 1.847 | 2.41 | 0.626 | 1.847 | -0.87 | 0.859 | 1.851 | | | |
| Menarcheal status [*] | 0.0323 | 0.119 | | 54.21 | 0.194 | | 19.89 | 0.629 | 1.505 | 42.14 | 0.209 | 1.508 | -12.24 | 0.713 | 1.528 | | | |
| Lean mass (kg) | 0.0093 | <0.001 | | 35.40 | <0.001 | | 22.99 | <0.001 | 1.397 | 21.45 | <0.001 | 2.051 | 2.01 | 0.584 | 2.912 | | | |
| Fat mass (kg) | 0.0020 | 0.304 | | 26.98 | <0.001 | | 28.34 | <0.001 | 1.527 | 9.79 | 0.012 | 2.237 | 12.35 | 0.001 | 2.155 | | | |
| Adjusted R ² | 0.399 | | | 0.745 | | | 0.633 | | | 0.835 | | | 0.763 | | | | | |
| BMI [*] ≥ 95 th (n = 69) | | | | | | | | | | | | | | | | | | |
| TBLH BMC (g) | | | | | | | | | | | | | | | | | | |
| TBLH BA (cm ²) | | | | | | | | | | | | | | | | | | |
| Age (years) | 0.0107 | 0.002 | | 20.25 | 0.024 | | 2.67 | 0.809 | 1.354 | 18.57 | 0.001 | 1.355 | -17.56 | 0.015 | 1.468 | | | |
| Menarcheal status [*] | 0.0590 | 0.054 | | 230.90 | 0.005 | | 196.78 | 0.056 | 1.591 | 107.01 | 0.039 | 1.685 | -33.86 | 0.610 | 1.797 | | | |
| Lean mass (kg) | 0.0095 | <0.001 | | 15.57 | 0.007 | | -3.35 | 0.636 | 1.558 | 17.68 | <0.001 | 1.564 | -18.90 | <0.001 | 1.747 | | | |
| Fat mass (kg) | -0.0043 | 0.015 | | 12.20 | 0.010 | | 23.35 | <0.001 | 1.474 | -2.50 | 0.434 | 1.846 | 11.16 | 0.004 | 1.635 | | | |
| Adjusted R ² | 0.475 | | | 0.580 | | | 0.331 | | | 0.842 | | | 0.748 | | | | | |

Abbreviations: aBMD, areal bone mineral density; BA, bone area; BMC, bone mineral content; BMI, body mass index; TBLH, total body less head; VIF, variance inflation factor

RESULTS

Approximately one-quarter (n=213) of the participants were in pre-menarche. The mean age of menarche in the post-menarcheal adolescents (n = 733) was 12.2 ± 1.3 years. Multiple regression analysis showed that FM had no effect on bone mineral density (BMD), but that lean mass was positively related to BMD in adolescent girls. When BMI was categorized into four groups by percentiles, the positive effect of hormonal changes in puberty appeared only in healthy-weight group (5th percentile ≤ BMI < 85th percentile). In the obese group (BMI ≥ 95th percentiles), FM was negatively related to BMD.

CONCLUSIONS

This study demonstrated that the beneficial effects of hormonal changes during puberty were significantly attenuated in overweight and obese Korean adolescent girls. Moreover, FM was found to have a negative effect on BMD in obese Korean adolescent girls.

References

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