

Plasma Adipokines, Bone Mass, and Hip Geometry in Rural Chinese Adolescents

Supplemental Materials

Definition of the grade of physical activity

Physical activity was assessed with the short version of the international physical activity questionnaire (IPAQ-short) (<http://www.ipaq.ki.se>), which has been validated in multiple countries, including China. Briefly, the IPAQ-short collects information on 3 types of physical activity (walking, moderate-intensity activities and vigorous -intensity activities) across various physical activity domains using the “last 7 days” as the reference period. Each type of activity was weighted by its metabolic equivalent (MET) level and a score in MET minutes (MET-min) was produced for each subject. “High” physical activity level was defined as (1) vigorous-intensity activity on ≥ 3 days and accumulating ≥ 1500 MET-min/week”, or (2) ≥ 7 days of any combination of walking, moderate-intensity or vigorous-intensity activities, achieving ≥ 3000 MET-min/week. “Moderate” physical activity level was defined if one of the following criteria was met; (1) ≥ 3 days of vigorous-intensity activity of ≥ 20 minutes/day; (2) ≥ 5 days of moderate-intensity activity or walking of at least 30 minutes/day; (3) ≥ 5 days of any combination of walking, moderate-intensity, or vigorous intensity activities achieving ≥ 600 MET-min/week. Those individuals who did not meet criteria for high or moderate physical activity were considered to have a “Low” physical activity level.

Supplemental Table S1. Association of log-transformed adipokine with bone mineral density in 1250 Chinese adolescents aged 13-21 years, with adjustment of different body compositions.

| Regression Models | Male | | | Female | | |
|---|----------------------------|---------------------------|----------------------------|-------------------------|-------------------------|-------------------------|
| | WB-BMD | L2L4-BMD | TH-BMD | WB-BMD | L2L4-BMD | TH-BMD |
| Log-transformed adiponectin as the predictor | | | | | | |
| Basic model ^a | -0.02+0.00 ^{****} | -0.05+0.00 ^{***} | -0.04+0.00 ^{****} | -0.01+0.00 | -0.02+0.00 [*] | -0.01+0.01 |
| Basic model+LM | -0.02+0.00 ^{***} | -0.03+0.01 ^{***} | -0.03+0.01 ^{***} | -0.01+0.00 | -0.01+0.01 | -0.01+0.01 |
| Basic model+BW | -0.02+0.00 ^{***} | -0.02+0.00 ^{**} | -0.03+0.01 ^{***} | -0.01+0.00 | -0.01+0.01 | 0.00+0.00 |
| Basic model+BMI | -0.02+0.00 ^{***} | -0.02+0.00 ^{**} | -0.02+0.00 ^{***} | 0.00+0.00 | -0.01+0.01 | 0.00+0.00 |
| Basic model+LM+FM | -0.02+0.00 ^{***} | -0.02+0.01 ^{**} | -0.03+0.01 ^{***} | 0.00+0.00 | -0.01+0.01 | 0.00+0.01 |
| Log-transformed Leptin as the predictor | | | | | | |
| Basic model ^a | 0.01+0.00 ^{**} | 0.00+0.01 | 0.01+0.01 | 0.01+0.00 ^{**} | 0.02+0.01 [*] | 0.01+0.01 [#] |
| Basic model+LM | 0.01+0.00 ^{**} | 0.00+0.01 | 0.01+0.00 | 0.00+0.00 | 0.01+0.01 | 0.00+0.01 |
| Basic model+BW | -0.01+0.00 ^{**} | -0.02+0.01 ^{**} | -0.02+0.01 ^{**} | -0.01+0.01 [*] | -0.01+0.01 | -0.02+0.01 [#] |
| Basic model+BMI | -0.01+0.00 ^{**} | -0.01+0.00 ^{**} | -0.02+0.01 [*] | -0.01+0.00 [*] | -0.01+0.01 | -0.02+0.01 [#] |
| Basic model+LM+FM | 0.00+0.00 | -0.01+0.01 | 0.00+0.01 | 0.00+0.00 | 0.00+0.01 | -0.01+0.01 |

Beta (parameter estimate) ±standard error was shown in the Table.

LM: whole-body Lean mass; FM: whole-body fat mass; BW: body weight; BMI: body mass index; WB-BMD: whole-body less head bone mineral density (BMD); L2L4-BMD: Lumbar-spine BMD; TH-BMD: total-hip BMD.

^aBasic model adjusted for age, Tanner stage, height, menarche status (no menarche/menarche at ≤13 years/ menarche at 14 years / menarche at ≥15 years) physical activity, active or passive smoking (yes/no), and student/non-student.

[#]p<0.07; * p<0.05; ** p<0.01, *** p<0.001, **** p<0.0001

Supplemental Table S2. Association of log-transformed adiponectin Z-score with bone phenotypes Z-scores in 1250 Chinese adolescents aged 13-21 years, with adjustment of different body compositions.

| Regression Models | WB-BA ^b | L2L4-BA ^b | TH-BA ^b | WB-BMC ^b | L2L4-BMC ^b | TH-BMC ^b | CSA ^b | SM ^b |
|-----------------------------------|--------------------------|----------------------|------------------------------|--------------------------------|---------------------------------|---------------------------------|--------------------------|-------------------------|
| Males | | | | | | | | |
| Basic model ^a | -0.08+0.03 ^{**} | -0.01+0.03 | -0.01+0.03 | -0.04+0.02^{**} | -0.09+0.02^{***} | -0.12+0.03^{***} | -0.10+0.04 ^{**} | -0.07+0.04 [*] |
| Basic model+LM Z-score | -0.04+0.02 [*] | 0.02+0.03 | 0.03+0.03 | -0.04+0.02^{**} | -0.07+0.02^{***} | -0.09+0.03^{**} | -0.05+0.03 | -0.03+0.03 |
| Basic model+BW Z-score | -0.03+0.02 | 0.02+0.03 | 0.02+0.03 | -0.04+0.02^{**} | -0.07+0.02^{***} | -0.09+0.03^{**} | -0.05+0.03 | -0.04+0.03 |
| Basic model+BMI Z-score | -0.03+0.02 | 0.02+0.03 | 0.02+0.03 | -0.04+0.02^{**} | -0.07+0.03^{***} | -0.09+0.03^{**} | -0.05+0.03 | -0.04+0.03 |
| Basic model+LM Z-score+FM Z-score | -0.03+0.02 | 0.02+0.03 | 0.03+0.03 | -0.04+0.02^{**} | -0.07+0.02^{***} | -0.08+0.03^{**} | -0.05+0.03 | -0.03+0.03 |
| Females | | | | | | | | |
| Basic model ^a | -0.03+0.03 | -0.01+0.04 | 0.06+0.04 | -0.01+0.01 | -0.04+0.03 | 0.00+0.04 | -0.04+0.05 | -0.02+0.04 |
| Basic model+LM Z-score | -0.02+0.03 | 0.00+0.03 | 0.07+0.04[*] | -0.01+0.01 | -0.04+0.03 | 0.02+0.03 | -0.03+0.04 | -0.02+0.04 |
| Basic model+BW Z-score | -0.01+0.02 | 0.00+0.03 | 0.08+0.04[*] | -0.01+0.01 | -0.04+0.03 | 0.02+0.03 | -0.03+0.04 | -0.01+0.04 |
| Basic model+BMI Z-score | -0.01+0.02 | 0.00+0.03 | 0.08+0.04[*] | -0.01+0.01 | -0.04+0.03 | 0.02+0.04 | -0.02+0.04 | -0.01+0.04 |
| Basic model+LM Z-score+FM Z-score | 0.00+0.02 | 0.00+0.03 | 0.08+0.04[*] | -0.02+0.01 | -0.04+0.03 | 0.03+0.03 | -0.02+0.04 | -0.01+0.04 |

Beta (parameter estimate) ±standard error was shown in the Table.

LM: whole-body Lean mass; FM: whole-body fat mass; BW: body weight; BMI: body mass index; WB-BA: whole-body less head bone area (BA); L2L4-BA: Lumbar-spine BA; TH-BA: total-hip BA; WB-BMC: whole-body less head bone mineral content (BMC); L2L4-BMC: Lumbar-spine BMC; TH-BMC: total-hip BMC; CSA: Cross-sectional area; SM: Section modulus

^aBasic model adjusted for age, Tanner stage, height Z-score, menarche status (no menarche/menarche at ≤13 years/ menarche at 14 years / menarche at ≥15 years), physical activity, active or passive smoking (yes/no), student/non-student, and corresponding bone area (for BMC only).

^bThe corresponding Z-score for each bone phenotype was applied as the outcome.

* p<0.05, ** p<0.01, *** p<0.001

Supplemental Table S3. Association of log-transformed letpin Z-score with bone phenotype Z-scores in 1250 Chinese adolescents aged 13-21 years, with adjustment of different body compositions.

| Regression Models | WB-BA ^b | L2L4-BA ^b | TH-BA ^b | WB-BMC ^b | L2L4-BMC ^b | TH-BMC ^b | CSA ^b | SM ^b |
|-----------------------------------|----------------------------------|----------------------------------|----------------------------------|---------------------|-------------------------------|--------------------------------|----------------------------------|---------------------------------|
| Males | | | | | | | | |
| Basic model ^a | 0.10+0.03 ^{***} | -0.02+0.03 | -0.05+0.03 | 0.01+0.01 | 0.01+0.02 | 0.04+0.03 | 0.01+0.04 | -0.02+0.04 |
| Basic model+LM Z-score | 0.09+0.02 ^{****} | -0.02+0.02 | -0.06+0.03 [*] | 0.01+0.01 | 0.01+0.03 | 0.03+0.03 | 0.00+0.03 | -0.02+0.03 |
| Basic model+BW Z-score | -0.09+0.02^{****} | -0.12+0.03^{****} | -0.18+0.03^{****} | -0.01+0.02 | -0.06+0.02[*] | -0.09+0.03^{**} | -0.17+0.04^{****} | -0.16+0.04^{***} |
| Basic model+BMI Z-score | -0.08+0.02^{****} | -0.12+0.03^{****} | -0.19+0.04^{****} | -0.01+0.02 | -0.05+0.02[*] | -0.09+0.03^{**} | -0.17+0.04^{****} | -0.16+0.04^{***} |
| Basic model+LM Z-score+FM Z-score | -0.02+0.02 | -0.03+0.03 | -0.07+0.03 [*] | 0.00+0.02 | -0.05+0.03 | -0.02+0.03 | -0.04+0.04 | -0.06+0.04 |
| Females | | | | | | | | |
| Basic model ^a | 0.21+0.03 ^{****} | 0.01+0.04 | 0.07+0.04 | -0.02+0.02 | 0.05+0.03 | 0.08+0.04 | 0.09+0.05 [*] | 0.07+0.04 |
| Basic model+LM Z-score | 0.13+0.03 ^{****} | -0.03+0.04 | 0.01+0.04 | -0.02+0.02 | 0.02+0.03 | 0.01+0.04 | 0.01+0.05 | 0.00+0.04 |
| Basic model+BW Z-score | -0.07+0.02^{***} | -0.11+0.04^{**} | -0.11+0.04^{**} | -0.03+0.02 | -0.03+0.03 | -0.11+0.04[*] | -0.13+0.05[*] | -0.13+0.05^{**} |
| Basic model+BMI Z-score | -0.08+0.02^{****} | -0.11+0.04^{**} | -0.11+0.04^{**} | -0.02+0.02 | -0.03+0.03 | -0.12+0.04^{**} | -0.13+0.05^{***} | -0.13+0.05^{**} |
| Basic model+LM Z-score+FM Z-score | -0.08+0.02^{***} | -0.10+0.04[*] | -0.06+0.04 | 0.00+0.02 | -0.03+0.04 | -0.06+0.04 | -0.08+0.05 | -0.10+0.05 |

Beta (parameter estimate) ±standard error was shown in the Table.

LM: whole-body Lean mass; FM: whole-body fat mass; BW: body weight; BMI: body mass index; WB-BA: whole-body less head bone area (BA); L2L4-BA: Lumbar-spine BA; TH-BA: total-hip BA; WB-BMC: whole-body less head bone mineral content (BMC); L2L4-BMC: Lumbar-spine BMC; TH-BMC: total-hip BMC; CSA: Cross-sectional area; SM: Section modulus

^aBasic model adjusted for age, Tanner stage, height Z-score, menarche status (no menarche/menarche at ≤13 years/ menarche at 14 years / menarche at ≥15 years), physical activity, active or passive smoking (yes/no), student/non-student, and the corresponding bone area (for BMC only).

^bThe corresponding Z-score for each bone phenotype was applied as the outcome.

* p<0.05; ** p<0.01, *** p<0.001, **** p<0.0001

Supplemental Table S4. Association of log-transformed adipokine Z-score with bone mineral density Z-score in 1250 Chinese adolescents aged 13–21 years, with adjustment of different body compositions.

| Regression Models | Male | | | Female | | |
|---|----------------------------------|----------------------------------|---------------------------------|-------------------------------|-------------------------|-------------------------------|
| | WB-BMD ^b | L2L4BMD ^b | TH-BMD ^b | WB-BMD ^b | L2L4BMD ^b | TH-BMD ^b |
| Log-transformed Adiponectin Z-score as the predictor | | | | | | |
| Basic model ^a | -0.17+0.04^{****} | -0.16+0.04^{****} | -0.17+0.04^{***} | -0.06+0.04 | -0.07+0.04 [#] | -0.01+0.04 |
| Basic model+ LM Z-score | -0.12+0.03^{***} | -0.13+0.04^{***} | -0.13+0.04^{***} | -0.05+0.04 | -0.07+0.04 | 0.00+0.04 |
| Basic model+BW Z-score | -0.11+0.03^{***} | -0.13+0.04^{***} | -0.13+0.04^{***} | -0.04+0.04 | -0.06+0.04 | 0.00+0.04 |
| Basic model+BMI Z-score | -0.12+0.03^{***} | -0.13+0.04^{***} | -0.13+0.04^{***} | -0.04+0.04 | -0.06+0.04 | 0.00+0.04 |
| Basic model+LM Z-score+FM Z-score | -0.11+0.03^{***} | -0.12+0.04^{***} | -0.12+0.04^{**} | -0.04+0.04 | -0.06+0.04 | 0.00+0.04 |
| Log-transformed Leptin Z-score as the predictor | | | | | | |
| Basic model ^a | 0.10+0.04 ^{**} | 0.02+0.04 | 0.05+0.04 | 0.13+0.05 ^{**} | 0.10+0.04 [*] | 0.08+0.05 |
| Basic model+ LM Z-score | 0.09+0.03^{**} | 0.02+0.04 | 0.05+0.04 | 0.05+0.05 | 0.05+0.04 | 0.01+0.05 |
| Basic model+BW Z-score | -0.10+0.04^{**} | -0.12+0.04^{**} | -0.10+0.04[*] | -0.10+0.05[*] | -0.06+0.05 | -0.10+0.05[#] |
| Basic model+BMI Z-score | -0.09+0.04[*] | -0.12+0.04^{**} | -0.10+0.04[*] | -0.11+0.05[*] | -0.07+0.05 | -0.10+0.05[#] |
| Basic model+LM Z-score+FM Z-score | -0.01+0.04 | -0.06+0.04 | -0.01+0.04 | -0.05+0.05 | -0.04+0.05 | 0.05+0.05 |

Beta (parameter estimate) ±SE was shown in the Table.

LM: whole-body Lean mass; FM: whole-body fat mass; BW: body weight; BMI: body mass index;

WB-BMC: whole-body less head bone mineral density (BMD); L2L4-BMD: Lumbar-spine BMD; TH-BMD: total-hip BMD;

^a Basic model adjusted for age, Tanner stage, height Z-score, menarche status (no menarche/menarche at ≤13 years/ menarche at 14 years / menarche at ≥15 years), physical activity, active or passive smoking (yes/no), and student/non-student.

^bThe corresponding Z score of BMD was applied as the outcome

[#] p<0.08; * p<0.05; ** p<0.01, *** p<0.001, **** p<0.0001

Supplemental Table S5 Model-fitting results for the univariate models of each trait in Chinese twin pairs aged 13-21 years.

| Models ^a | Adiponectin | | Leptin | | TH-BMC | |
|---------------------|----------------------|----------------------|---------------------|----------------------|----------------------|----------------------|
| | $\Delta\chi^2$ | ΔAIC^b | $\Delta\chi^2$ | ΔAIC^b | χ^2 | ΔAIC^b |
| Males | | | | | | |
| ACE model | | | The reference model | | | |
| AE model | 13.14 ^{***} | 11.14 | 1.52 | -0.48 | 0.51 | -1.49 |
| CE model | 2.14 | 0.14 | 2.08 | 0.08 | 38.13 ^{***} | 36.13 |
| Females | | | | | | |
| ACE model | | | The reference model | | | |
| AE model | 3.01 | 1.01 | 0.65 | -1.35 | 0.00 | -2.00 |
| CE model | 10.54 ^{**} | 8.54 | 2.14 | 0.14 | 50.20 ^{***} | 48.20 |

TH-BMC: total-hip bone mineral content.

^a**ACE model:** allowing for an additive genetic component(a^2), shared (c^2) and unique (e^2) environmental components; **AE model:** the shared environmental component(c^2) was set to zero; **CE model:** the additive genetic component (a^2) was set to zero.

^bThe best-fitted model (in bold) was the one not having a significant worse fit compared with the full ACE model (chi-square test is not statistically significant with p-value > 0.05) and with the lowest Akaike Information Criteria (AIC).

p<0.01, *p<0.001

Supplemental Figure S1. Plots of adipokines and bone phenotypes against age of menarche in 509 Chinese post-menarche females aged 13-21 years.

