**Association between healthy lifestyle pattern and early onset of puberty: based on a longitudinal follow-up study**

**Supplementary Figure 1** The selection process of participants and follow-up flowchart

**Supplementary Table 1** Lifestyle components and determination of favorable lifestyle factors

|  |  |
| --- | --- |
| **Component** | **Definition of favorable lifestyle factors** |
| Dietary behavior | Meet 6-8 ideal dietary factors: |
| * Breakfast: every day |
| * Milk: every day |
| * Fruits: ≥2 servings per day |
| * Vegetables: ≥3 servings per day |
| * SSBs: zero consumption |
| * Meat and its product: 1-2 cups per day |
| * High-energy food: ≤3 days per week |
| * Eating out: ≤2 times per week |
| Physical activity | Moderate intensity and vigorous intensity ≥1 hours per day |
| Sleep duration | ≥9 hours per day |
| Smoking and drinking behavior | No cigarette and alcohol consumption |
| Sedentary behavior | ≤6 hours per day |

SSBs: sugar-sweetened beverages.

One serving of fruit or vegetable is approximately 100g, and one cup of meat is about 50g.

**Supplementary** **table 2** Comparison of basic information between the included group and the missing group

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Characteristics | Included | Excluded | *t/x2* | *P* |
| Baseline age, year | 8.4±0.6 | 8.3±0.7 | 0.89 | 0.37 |
| Age of puberty onset, year | 10.0±1.1 | 9.9±1.1 | 1.62 | 0.11 |
| Baseline BMI, kg/m2 | 16.3±2.8 | 16.2±2.5 | 0.93 | 0.35 |
| Birth weight, kg | 3.3±0.5 | 3.3±0.4 | 1.32 | 0.19 |
| Paternal BMI, kg/m2 | 24.0±2.8 | 24.0±2.9 | 0.56 | 0.58 |
| Maternal BMI, kg/m2 | 21.1±2.4 | 21.1±2.2 | 0.40 | 0.69 |
| Boys, % | 739(57.1%) | 291(55.4%) | 0.43 | 0.51 |
| Breastfeeding, % | 1055(83.9%) | 418(83.4%) | 0.33 | 0.95 |
| Cesarean delivery, % | 579(45.2%) | 214(41.6%) | 2.02 | 0.16 |
| Early onset of puberty, % | 289(22.3%) | 134(25.5%) | 2.13 | 0.14 |

BMI: body mass index.

**Supplementary** **Table 3** The Log-binomial regression analysis of the association between prepubertal lifestyle and risk of early onset of puberty

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Lifestyle factors | | Boys | | | | |  | Girls | | | | |
| N(%) | Model 1 | | Model 2 | |  | N(%) | Model 1 | | Model 2 | |
| RR (95%CI) | *P* | RR (95%CI) | *P* |  | RR (95%CI) | *P* | RR (95%CI) | *P* |
| Dietary behavior | Unideal | 131(22.8) | 1 (Reference) |  | 1 (Reference) |  |  | 98(22.2) | 1 (Reference) |  | 1 (Reference) |  |
| Ideal | 38(23.0) | 1.01(0.74,1.39) | 0.96 | 1.06(0.73,1.56) | 0.75 |  | 22(19.3) | 0.87(0.57,1.31) | 0.50 | 0.84(0.51,1.36) | 0.47 |
| Physical activity | Unideal | 119(26.3) | 1 (Reference) |  | 1 (Reference) |  |  | 95(22.0) | 1 (Reference) |  | 1 (Reference) |  |
| Ideal | 50(17.4) | 0.66(0.49,0.89) | 0.006 | 0.69(0.48,0.97) | 0.04 |  | 25(20.2) | 0.91(0.62,1.35) | 0.66 | 0.90(0.56,1.44) | 0.66 |
| Sleep duration | Unideal | 109(23.8) | 1 (Reference) |  | 1 (Reference) |  |  | 82(22.3) | 1 (Reference) |  | 1 (Reference) |  |
| Ideal | 60(21.4) | 0.90(0.68,1.18) | 0.44 | 0.80(0.57,1.13) | 0.20 |  | 38(20.2) | 0.90(0.64,1.27) | 0.57 | 0.94(0.63,1.41) | 0.76 |
| Smoking and drinking behavior | Unideal | 4(12.9) | 1 (Reference) |  | 1 (Reference) |  |  | 6(27.3) | 1 (Reference) |  | 1 (Reference) |  |
| Ideal | 165(23.3) | 1.81(0.72,4.55) | 0.21 | 1.63(0.60,4.41) | 0.34 |  | 114(21.4) | 0.78(0.39,1.58) | 0.50 | 0.75(0.31,1.77) | 0.50 |
| Sedentary behavior | Unideal | 119(26.3) | 1 (Reference) |  | 1 (Reference) |  |  | 74(21.0) | 1 (Reference) |  | 1 (Reference) |  |
| Ideal | 50(17.4) | 0.66(0.49,0.89) | 0.006 | 0.60(0.42,0.86) | 0.005 |  | 46(22.8) | 1.09(0.79,1.50) | 0.62 | 0.95(0.65,1.40) | 0.80 |
| Healthy lifestyle pattern | Poor | 51(28.8) | 1 (Reference) |  | 1 (Reference) |  |  | 41(23.6) | 1 (Reference) |  | 1 (Reference) |  |
| Unfavorable | 61(23.5) | 0.81(0.59,1.12) | 0.21 | 0.78(0.55,1.09) | 0.14 |  | 40(19.2) | 0.82(0.55,1.20) | 0.30 | 0.77(0.49,1.22) | 0.26 |
| Intermediate healthy | 40(20.6) | 0.72(0.50,1.03) | 0.07 | 0.72(0.49,1.05) | 0.08 |  | 32(26.0) | 1.10(0.74,1.65) | 0.63 | 1.01(0.62,1.64) | 0.96 |
| Healthy | 17(15.7) | 0.55(0.33,0.90) | 0.02 | 0.47(0.27,0.80) | 0.006 |  | 7(14.0) | 0.59(0.28,1.24) | 0.17 | 0.52(0.22,1.24) | 0.14 |
| *P* for trend |  |  | 0.83(0.72,0.95) | 0.008 | 0.81(0.69,0.96) | 0.01 |  |  | 0.95(0.80,1.12) | 0.54 | 0.91(0.74,1.12) | 0.39 |

Model 1 did not adjust for any variables; Model 2 adjusted for baseline BMI, birth weight, feeding patterns, type of delivery, parental BMI and education levels.

**Supplementary Table 4** The Log-binomial regression analysis of the association between prepubertal lifestyle and risk of early onset of puberty, stratified by baseline nutritional status



Model adjusted for birth weight, feeding patterns, type of delivery, parental BMI and education levels.

**Supplementary** **table 5** The modification of lifestyle on the association between baseline BMI and early onset of puberty

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Baseline BMI | | Boys | |  | Girls | |
| RR (95%CI) | *P* |  | RR (95%CI) | *P* |
| All | Baseline BMI | 0.96(0.91,1.01) | 0.10 |  | 1.17(1.07,1.28) | 0.001 |
| Unhealthy lifestyle | Baseline BMI | 0.97(0.91,1.02) | 0.23 |  | 1.18(1.08,1.30) | <0.001 |
| Healthy lifestyle | Baseline BMI | 0.87(0.70,1.08) | 0.20 |  | 1.20(0.72,1.99) | 0.49 |

**Supplementary** **table 6** The population attributable risk and incidence of early onset of puberty if people maintained a healthy lifestyle

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | | Incidence of early onset of puberty | PAR | *P* |
| Boys | all observed | 21.79(18.91,24.98) | 8.54(2.34,14.67)# | 0.007 |
| healthy lifestyle | 13.25(8.02,21.10) |  |  |
| poor lifestyle | 28.42(22.00,35.86) | 15.18(5.59,24.48)$ | 0.002 |
| Girls | all observed | 21.66(17.92,25.94) | 8.80(-1.51,18.92)# | 0.09 |
| healthy lifestyle | 12.87(5.52,27.18) |  |  |
| poor lifestyle | 24.88(17.72,33.74) | 12.01(-1.32,24.93) $ | 0.08 |

PAR: population attributable risk.

Adjusting for bseline BMI, birth weight, feeding patterns, type of delivery, parental BMI and education levels.

# All observed was used as the baseline scenario.

$ Poor lifestyle was used as the baseline scenario.

**Supplementary table 7** Prevalence of different lifestyle combinations and incidence of early onset of puberty

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Lifestyle combinations | Boys | |  | Girls | |
| Prevalence (N, %) | Incidence (N, %) |  | Prevalence (N, %) | Incidence (N, %) |
| hl2\_1 | 78(10.6%) | 12(15.4%) |  | 33(5.9%) | 7(21.2%) |
| hl2\_2 | 79(10.7%) | 21(26.6%) |  | 49(8.8%) | 7(14.3%) |
| hl2\_3 | 159(21.5%) | 37(23.3%) |  | 112(20.2%) | 22(19.6%) |
| hl2\_4 | 69(9.3%) | 13(18.8%) |  | 42(7.6%) | 8(19.0%) |
| hl2\_5 | 129(17.5%) | 22(17.1%) |  | 47(8.5%) | 7(14.9%) |
| hl2\_6 | 271(36.7%) | 47(17.3%)\*\* |  | 119(21.4%) | 24(20.2%) |
| hl2\_7 | 130(17.6%) | 15(11.5%)\*\* |  | 49(8.8%) | 9(18.4%) |
| hl2\_8 | 269(36.4%) | 58(21.6%) |  | 182(32.8%) | 36(19.8%) |
| hl2\_9 | 119(16.1%) | 19(16.0%)\* |  | 75(13.5%) | 20(26.7%) |
| hl2\_10 | 271(36.7%) | 47(17.3%)\*\* |  | 193(34.8%) | 42(21.8%) |
| hl3\_1 | 46(6.2%) | 8(17.4%) |  | 13(2.3%) | 1(7.7%) |
| hl3\_2 | 75(10.1%) | 12(16.0%)\* |  | 33(5.9%) | 7(21.2%) |
| hl3\_3 | 32(4.3%) | 3(9.4%)\* |  | 13(2.3%) | 3(23.1%) |
| hl3\_4 | 75(10.1%) | 20(26.7%) |  | 49(8.8%) | 7(14.3%) |
| hl3\_5 | 31(4.2%) | 5(16.1%) |  | 21(3.8%) | 2(9.5%) |
| hl3\_6 | 66(8.9%) | 12(18.2%) |  | 42(7.6%) | 8(19.0%) |
| hl3\_7 | 123(16.6%) | 21(17.1%)\* |  | 46(8.3%) | 7(15.2%) |
| hl3\_8 | 68(9.2%) | 9(13.2%)\*\* |  | 21(3.8%) | 4(19.0%) |
| hl3\_9 | 122(16.5%) | 13(10.7%)\*\* |  | 47(8.5%) | 8(17.0%) |
| hl3\_10 | 114(15.4%) | 17(14.9%) |  | 74(13.3%) | 19(25.7%) |
| hl4\_1 | 44(6.0%) | 8(18.2%) |  | 13(2.3%) | 1(7.7%) |
| hl4\_2 | 21(2.8%) | 2(9.5%) |  | 6(1.1%) | 1(16.7%) |
| hl4\_3 | 31(4.2%) | 3(9.7%)\* |  | 13(2.3%) | 3(23.1%) |
| hl4\_4 | 30(4.1%) | 4(13.3%) |  | 21(3.8%) | 2(9.5%) |
| hl4\_5 | 66(8.9%) | 8(12.1%)\* |  | 21(3.8%) | 4(19.0%) |
| hl5\_1 | 21(2.8%) | 2(9.5%) |  | 6(1.1%) | 1(16.7%) |

hl2\_1: Having good dietary behavior and active physical activity;

hl2\_2: Having good dietary behavior and adequate sleep duration;

hl2\_3: Having good dietary behavior and not smoking and drinking;

hl2\_4: Having good dietary behavior and low sedentary behavior;

hl2\_5: Having active physical activity and adequate sleep duration;

hl2\_6: Having active physical activity and not smoking and drinking;

hl2\_7: Having active physical activity and low sedentary behavior;

hl2\_8: Having adequate sleep duration and not smoking and drinking;

hl2\_9: Having adequate sleep duration and low sedentary behavior;

hl2\_10: Having not smoking and drinking and low sedentary behavior;

hl3\_1: Having good dietary behavior, active physical activity and adequate sleep duration;

hl3\_2: Having good dietary behavior, active physical activity and not smoking and drinking;

hl3\_3: Having good dietary behavior, active physical activity and low sedentary behavior;

hl3\_4: Having good dietary behavior, adequate sleep duration and not smoking and drinking;

hl3\_5: Having good dietary behavior, adequate sleep duration and low sedentary behavior;

hl3\_6: Having good dietary behavior, not smoking and drinking and low sedentary behavior;

hl3\_7: Having active physical activity, adequate sleep duration and not smoking and drinking;

hl3\_8: Having active physical activity, adequate sleep duration and low sedentary behavior;

hl3\_9: Having active physical activity, not smoking and drinking and low sedentary behavior;

hl3\_10: Having adequate sleep duration, not smoking and drinking and low sedentary behavior;

hl4\_1: Having good dietary behavior, active physical activity, adequate sleep duration and not smoking and drinking;

hl4\_2: Having good dietary behavior, active physical activity, adequate sleep duration and low sedentary behavior;

hl4\_3: Having good dietary behavior, active physical activity, not smoking and drinking and low sedentary behavior;

hl4\_4: Having good dietary behavior, adequate sleep duration, not smoking and drinking and low sedentary behavior;

hl4\_5: Having active physical activity, adequate sleep duration, not smoking and drinking and low sedentary behavior;

hl5\_1: Having good dietary behavior, active physical activity, adequate sleep duration, not smoking and drinking and low sedentary behavior.

The asterisk indicated that the differences in the incidence of early onset of puberty within each lifestyle combination group were statistically significant by using the Chi-square test (\* *P*<0.05, \*\* *P*<0.01).

**Supplementary table 8** The distribution and consistency of healthy lifestyle pattern in two surveys

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Healthy lifestyle pattern in May 2017 | | Healthy lifestyle pattern in October 2017 | | | | Consistency | Kappa |
| Poor | Unfavorable | Intermediate healthy | Healthy |
| Boys | Poor | 93 | 3 | 4 | 1 | 88.7% | 0.83 |
|  | Unfavorable | 9 | 132 | 9 | 0 |  |  |
|  | Intermediate healthy | 1 | 6 | 44 | 0 |  |  |
|  | Healthy | 0 | 1 | 2 | 13 |  |  |
| Girls | Poor | 76 | 3 | 1 | 0 | 88.6% | 0.83 |
|  | Unfavorable | 3 | 91 | 4 | 0 |  |  |
|  | Intermediate healthy | 5 | 9 | 43 | 1 |  |  |
|  | Healthy | 1 | 0 | 1 | 7 |  |  |