**Supplementary material for:**

**Rapid increases in infant adiposity and overweight/obesity in childhood are associated with higher central and brachial blood pressure in early adulthood.**

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**Details of measurement of height and weight at research clinics**

At the clinics between four months and five years, crown-heel length for children aged 4 to 25 months was measured using a Harpenden Neonatometer and from 25 months onwards standing height was measured using a Leicester Height Measure; weight was measured using Fereday 100kg combined scale (4 month clinic), Soenhle scale or Seca scale model 724 (8 month clinic), Seca 724 or Seca 835 (12 month clinic), Seca 835 (18 months onwards). From age seven years upwards, all children were invited to annual clinics, at which standing height was measured to the last complete mm using the Harpenden Stadiometer and weight was measured to the nearest 0.1kg using the Tanita Body Fat Analyser (Model TBF 305).

**Supplementary Table 1. Comparing participants who did and did not attend the 17 year research clinic**

Vales are mean (SD) or number (percent). Note that missing data result in different Ns for each variable.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Attended research clinic** | **Did not attend research clinic** | **P value for comparison** |
|  | *N* |  | *N* |  |  |
| Maternal education | 4,604 |  | 7,891 |  |  |
|  Less than O-Level |  | 877 (19.1%) |  | 2,877 (36.5%) |  |
|  O-Level |  | 1,572 (34.1%) |  | 2,759 (35.0%) |  |
|  A-Level |  | 1,289 (28.0%) |  | 1,514 (19.2%) |  |
|  Degree or above |  | 866 (18.8%) |  | 741 (9.4%) | <0.001 |
| Maternal pre-pregnancy BMI (kg/m2) | 4,330 | 22.8 (3.7) | 7,340 | 23.0 (3.9) | 0.06 |
| Maternal age (years) | 4,767 | 29.2 (4.6) | 9,330 | 27.4 (5.0) | <0.001 |
| Maternal parity | 4,615 | 0.8 (0.9) | 8,490 | 0.9 (1.0) | <0.001 |
| Birth weight (kg) | 4,715 | 3.41 (0.55) | 9,199 | 3.36 (0.60) | <0.001 |
| BMI at birth (kg/m2)\* | 4,966 | 13.09 (1.47) | 9,347 | 13.04 (1.52) | 0.04 |
| BMI at 3 months (kg/m2)\* | 4,966 | 16.23 (1.44) | 9,347 | 16.25 (1.47) | 0.43 |
| BMI at 1 year (kg/m2)\* | 4,966 | 17.58 (1.36) | 9,347 | 17.64 (1.42) | 0.01 |
| BMI at 3 years (kg/m2)\* | 4,966 | 16.09 (1.11) | 9,347 | 16.14 (1.15) | 0.01 |
| BMI at 7 years (kg/m2)\* | 4,966 | 15.65 (1.53) | 9,347 | 15.74 (1.53) | 0.001 |
| BMI at 10 years (kg/m2)\* | 4,966 | 17.68 (2.59) | 9,347 | 17.81 (2.27) | 0.002 |

**Supplementary Table 2. Comparing participants included in our analyses with those excluded due to missing data on child growth or confounders**

Vales are mean (SD). Note that BP was measured on fewer individuals than BMI, due to the BP equipment being unavailable at the start of the clinic.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Included in our analyses, N=3,154** | **Excluded from our analyses due to missing data on child growth or confounders** | **P value for comparison** |
|  |  | *N* |  |  |
| BMI at 17 year clinic (kg/m2) | 22.67 (3.96) | 1,910 | 23.23 (4.59) | <0.001 |
| Age at 17 year clinic (years) | 17.76 (0.36) | 1,927 | 17.87 (0.49) | <0.001 |
| Central systolic BP at 17 year clinic (mmHg) | 97.0 (9.3) | 820 | 96.7 (0.3) | 0.51 |
| Central diastolic BP at 17 year clinic (mmHg) | 65.9 (7.7) | 820 | 66.0 (7.8) | 0.88 |
| Diastolic BP at 17 year clinic (mmHg) | 64.6 (7.5) | 820 | 64.7 (7.6) | 0.81 |

**Supplementary Table 3. Mean predicted growth patterns and model fit for growth trajectories for all cohort members with one or more growth measurement**

|  |  |  |
| --- | --- | --- |
|  | Average patterns of growth | Model fit |
|  | Mean (SD) predicted growth rates in females\* | Mean (SD) predicted growth rates in males\* | Mean observed measure (SD)\*\* | Mean predicted measure (SD)\*\* | Mean difference (SD)\*\* |
| *Length/height models, N=14,326:* | *N=6,946* | *N=7,380* |  |  |  |
| Birth length | 50.37 (1.54) | 51.09 (1.66) | 50.61 (2.36) | 50.74 (1.52) | -0.13 (1.42) |
| >0 to ≤3 months | 3.54 (0.14) | 3.83 (0.14) | 57.24 (3.10) | 57.11 (1.38) | 0.14 (1.38) |
| >3 months to ≤1 year | 1.65 (0.13) | 1.67 (0.13) | 69.89 (4.78) | 70.03 (1.39) | -0.07 (1.39) |
| >1 year to ≤3 years | 0.81 (0.06) | 0.77 (0.06) | 83.53 (5.56) | 83.48 (5.01) | 0.16 (1.50) |
| >3 years to <7 years | 0.56 (0.05) | 0.56 (0.05) | 106.16 (9.10) | 106.21 (8.57) | -0.03 (1.79) |
| >7 years to ≤10 years | 0.48 (0.03) | 0.47 (0.03) | 131.55 (7.85) | 131.75 (7.63) | -0.06 (1.01) |
| *Weight models, N=14,520:* | *N=7,037* | *N=7,483* |  |  |  |
| Birth weight | 3.32 (0.47) | 3.42 (0.54) | 3.39 (0.56) | 3.38 (0.56) | 0.02 (0.10) |
| >0 to ≤3 months | 0.87 (0.15) | 1.02 (0.18) | 4.61 (0.91) | 4.64 (0.88) | -0.03 (0.16) |
| >3 months to ≤1 year | 0.46 (0.08) | 0.47 (0.09) | 8.50 (1.48) | 8.44 (1.44) | 0.06 (0.30) |
| >1 year to ≤3 years | 0.19 (0.03) | 0.18 (0.03) | 11.77 (1.74) | 11.82 (1.60) | -0.05 (0.42) |
| >3 years to ≤7 years | 0.19 (0.05) | 0.18 (0.04) | 18.15 (3.49) | 18.13 (3.30) | 0.02 (0.87) |
| >7 years to ≤10 years | 0.32 (0.10) | 0.30 (0.09) | 29.49 (6.50) | 29.50 (6.34) | -0.01 (0.78) |

\* Units are cm for birth length and cm/month for length/height growth, kg for birth weight and kg/month for weight growth

\*\* Units are cm for length/height and kg for weight

**Supplementary Table 4. Gender-specific associations between childhood BMI and blood pressure at age 17; minimally adjusted and additionally adjusted for BMI at age 17**

|  |  |  |  |
| --- | --- | --- | --- |
| **BMI z-scores at each age** | **Brachial systolic BP (mmHg)** | **Central systolic BP (mmHg)** | **Diastolic BP (mmHg)** |
|  | *Females* | *Males* | *P value\** | *Females* | *Males* | *P value\** | *Females* | *Males* | *P value\** |
|  | *N=1,733* | *N=1,421* |  | *N=1,733* | *N=1,421* |  | *N=1,733* | *N=1,421* |  |
| *Adjusted for child’s age at outcome assessment*  |
| Birth | -0.6 (-1.0 to -0.1) p=0.01 | -0.4 (-0.9 to 0.0) p=0.07 | 0.85 | -0.5 (-1.0 to 0.0) p=0.03 | -0.6 (-1.2 to 0.0) p=0.04 | 0.70 | -0.3 (-0.7 to 0.1) p=0.11 | -0.2 (-0.6 to 0.2) p=0.26 | 0.80 |
| 3 months | 0.0 (-0.5 to 0.5) p=0.95 | 0.3 (-0.2 to 0.9) p=0.20 | 0.73 | 0.2 (-0.4 to 0.7) p=0.50 | 0.5 (-0.2 to 1.1) p=0.14 | 0.36 | 0.0 (-0.4 to 0.5) p=0.83 | 0.0 (-0.4 to 0.5) p=0.95 | 0.99 |
| 1 year | 0.1 (-0.4 to 0.7) p=0.58 | 0.0 (-0.6 to 0.5) p=0.98 | 0.84 | 0.4 (-0.2 to 0.9) p=0.23 | 0.3 (-0.4 to 1.0) p=0.35 | 0.86 | 0.0 (-0.5 to 0.4) p=0.85 | -0.3 (-0.7 to 0.2) p=0.27 | 0.52 |
| 3 years  | 0.0 (-0.7 to 0.7) p=0.99 | 0.5 (-0.3 to 1.3) p=0.20 | 0.51 | 0.4 (-0.3 to 1.2) p=0.28 | 1.1 (0.1 to 2.0) p=0.03 | 0.54 | -0.1 (-0.7 to 0.5) p=0.79 | 0.2 (-0.4 to 0.9) p=0.53 | 0.92 |
| 7 years | 1.8 (1.2 to 2.3) p<0.001 | 2.3 (1.7 to 2.9) p<0.001 | 0.04 | 2.0 (1.3 to 2.7) p<0.001 | 2.9 (2.1 to 3.7) p<0.001 | 0.08 | 1.3 (0.8 to 1.8) p<0.001 | 1.4 (0.9 to 2.0) p<0.001 | 0.59 |
| 10 years | 2.8 (1.7 to 3.8) p<0.001 | 4.3 (3.2 to 5.4) p<0.001 | 0.005 | 2.9 (1.7 to 4.1) p<0.001 | 5.0 (3.6 to 6.4) p<0.001 | 0.02 | 2.2 (1.3 to 3.1) p<0.001 | 2.6 (1.7 to 3.6) p<0.001 | 0.42 |
| *Adjusted for child’s age at outcome assessment, confounders\*\* including previous BMI measures and BMI at age 17* |
| Birth | -0.9 (-1.3 to -0.5) p<0.001 | -0.7 (-1.1 to -0.2) p=0.004 | 0.88 | -0.9 (-1.4 to -0.4) p<0.001 | -0.8 (-1.4 to -0.3) p=0.002 | 0.44 | -0.5 (-0.9 to -0.2) p=0.01 | -0.4 (-0.7 to 0.0) p=0.07 | 0.59 |
| 3 months | -0.4 (-0.8 to 0.1) p=0.12 | 0.0 (-0.5 to 0.5) p=0.99 | 0.31 | -0.2 (-0.8 to 0.3) p=0.39 | 0.0 (-0.6 to 0.6) p=0.95 | 0.11 | -0.2 (-0.6 to 0.2) p=0.26 | -0.1 (-0.6 to 0.3) p=0.51 | 0.65 |
| 1 year | -0.5 (-1.0 to 0.0) p=0.05 | -0.7 (-1.2 to -0.1) p=0.02 | 0.33 | -0.4 (-0.9 to 0.2) p=0.17 | -0.5 (-1.1 to 0.2) p=0.16 | 0.36 | -0.5 (-1.0 to -0.1) p=0.01 | -0.7 (-1.1 to -0.2) p=0.005 | 0.91 |
| 3 years  | -1.1 (-1.8 to -0.5) p=0.001 | -0.4 (-1.1 to 0.4) p=0.31 | 0.05 | -0.9 (-1.6 to -0.1) p=0.02 | 0.0 (-0.9 to 0.9) p=0.99 | 0.06 | -1.0 (-1.5 to -0.4) p=0.001 | -0.3 (-0.9 to 0.3) p=0.36 | 0.40 |
| 7 years | -0.5 (-1.2 to 0.1) p=0.11 | -0.7 (-1.5 to 0.1) p=0.08 | 0.006 | -0.6 (-1.3 to 0.2) p=0.13 | -0.6 (-1.5 to 0.3) p=0.21 | 0.02 | -0.5 (-1.0 to 0.1) p=0.10 | -0.3 (-1.0 to 0.3) p=0.34 | 0.38 |
| 10 years | 0.8 (-0.2 to 1.9) p=0.12 | 2.1 (0.9 to 3.2) p<0.001 | 0.002 | 0.8 (-0.4 to 2.0) p=0.20 | 2.3 (0.9 to 3.7) p=0.001 | 0.01 | 0.8 (-0.2 to 1.7) p=0.11 | 1.4 (0.3 to 2.4) p=0.01 | 0.43 |

\* P values test the null hypothesis that associations are the same in males and females

\*\*Confounders are maternal age, education, pre-pregnancy BMI, and parity

**Supplementary Table 5. Association between childhood BMI and blood pressure measured at age 17, using observed BMI measurements rather than those predicted by the multilevel model**

Adjusted for age and gender at the time of outcome assessment, confounders, and previous BMI measurements

Data used are birth measures and measured between 1-4 months (3 months), 8-16 months (1 year), 32-40 months (3 years), 72-96 months (7 years), and 102-120 months (10 years), and the measurement from the 17 year clinic, converted to age- and gender-specific z-scores

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Brachial systolic BP (mmHg)** | **Central systolic BP (mmHg)** | **Diastolic BP (mmHg)** |
|  | **N** |  | **N** |  | **n** |  |
| BMI at birth (z-scores) | 2,539 | -0.7 (-1.1 to -0.3) p=0.001 | 2,539 | -0.6 (-1.0 to -0.3) p=0.001 | 2,539 | -0.4 (-0.7 to -0.1) p=0.01 |
| BMI at 3 months (z-scores) | 2,074 | 0.4 (-0.1 to 0.8) p=0.12 | 2,074 | 0.1 (-0.3 to 0.5) p=0.58 | 2,074 | -0.03 (-0.4 to 0.3) p=0.86 |
| BMI at 1 year (z-scores) | 1,612 | 0.4 (-0.1 to 1.0) p=0.14 | 1,612 | 0.1 (-0.3 to 0.6) p=0.57 | 1,612 | -0.3 (-0.7 to 0.2) p=0.20 |
| BMI at 3 years (z-scores) | 369 | 0.2 (-1.1 to 1.5) p=0.76 | 369 | 0.1 (-1.0 to 1.2) p=0.85 | 369 | -0.1 (-1.0 to 0.9) p=0.88 |
| BMI at 7 years (z-scores) | 340 | 1.7 (0.2 to 3.2) p=0.02 | 340 | 1.6 (0.4 to 2.9) p=0.01 | 340 | 1.4 (0.3 to 2.5) p=0.01 |
| BMI at 10 years (z-scores) | 313 | 0.5 (-1.9 to 2.9) p=0.67 | 313 | 0.2 (-1.8 to 2.2) p=0.82 | 313 | -0.1 (-1.9 to 1.6) p=0.89 |
| BMI at 17 years (z-scores) | 3,806 | 3.62 (3.32 to 3.92)P<0.001 | 3,806 | 1.93 (1.68 to 2.17)P<0.001 |  | 3.48 (3.12 to 3.85)P<0.001 |

**Supplementary Table 6. Life course models for the association between trajectories of body size and brachial systolic blood pressure at age 17. N=3,154**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Trajectory of body size\*** | **N** | **Mean (SD) BMI kg/m2** | **Mean (SD) observed brachial systolic BP (mmHg)** | ***Predicted mean (SE) brachial systolic BP (mmHg)*** |
| *Birth* | *2 years* | *17 years* | *Accumulation, equal effects*  | *Accumulation, differing effects* | *critical period at 17 years*  | *Mobility birth – 2 years* | *Mobility birth – 17 years* | *Persistent risk* |
| N | N | N | 1,498 | 21.0 (2.0) | 115.2 (11.0) | 115.2 (0.3) | 115.3 (0.3) | 115.4 (0.2) | 115.5 (0.2) | 115.4 (0.2) | 115.4 (0.2) |
| L | N | N | 737 | 20.8 (2.1) | 116.0 (11.9) | 117.6 (0.2) | 115.8 (0.4) | 115.4 (0.2) | 115.5 (0.2) | 115.4 (0.2) | 115.4 (0.2) |
|  |  |  |  |  |  |  |  |  |  |  |  |
| N | N | O | 352 | 28.6 (3.4) | 121.9 (11.4) | 117.6 (0.2) | 121.7 (0.5) | 121.8 (0.4) | 121.8 (0.4) | 121.7 (0.5) | 121.7 (0.5) |
| L | N | O | 157 | 28.6 (3.1) | 121.8 (11.0) | 120.1 (0.4) | 122.2 (0.6) | 121.8 (0.4) | 121.8 (0.4) | 122.1 (0.8) | 121.7 (0.5) |
|  |  |  |  |  |  |  |  |  |  |  |  |
| N | O | O | 125 | 29.3 (4.4) | 120.9 (12.1) | 120.1 (0.4) | 121.5 (0.7) | 121.8 (0.4) | 121.8 (0.4) | 121.7 (0.5) | 121.7 (0.5) |
| L | O | O | 32 | 28.3 (3.5) | 123.5 (12.3) | 122.5 (0.7) | 121.9 (0.7) | 121.8 (0.4) | 120.5 (1.2) | 122.1 (0.8) | 123.5 (2.0) |
|  |  |  |  |  |  |  |  |  |  |  |  |
| N | O | N | 196 | 22.2 (1.8) | 116.1 (11.7) | 117.6 (0.2) | 115.0 (0.6) | 115.4 (0.2) | 115.5 (0.2) | 115.4 (0.2) | 115.4 (0.2) |
| L | O | N | 57 | 22.0 (1.7) | 112.5 (8.5) | 120.1 (0.4) | 115.5 (0.7) | 115.4 (0.2) | 114.1 (1.2) | 115.4 (0.2) | 115.4 (0.2) |
|  |  |  |  |  |  |  |  |  |  |  |  |
| *P value against the null hypothesis that the model has the same fit as the fully saturated model:* | *<0.001* | *0.11* | *0.17* | *0.16* | *0.11* | *0.14* |
| *RMSE* | *11.5* | *11.3* | *11.3* | *11.3* | *11.3* | *11.3* |

\* L represents the lowest third of birth weight at birth and O represents overweight or obese (defined on age- and gender-appropriate cut-offs using the UK 1990 growth reference) at 2 and 17 years. N represents the middle or top third of birth weight, and normal or low BMI at 2 and 17 years.

**Supplementary Table 7. Life course models for the association between trajectories of body size and diastolic blood pressure at age 17. N=3,154**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Trajectory of body size\*** | **N** | **Mean (SD) BMI kg/m2** | **Mean (SD) observed brachial diastolic BP (mmHg)** | ***Predicted mean (SE) brachial diastolic BP (mmHg)*** |
| *Birth* | *2 years* | *17 years* | *Accumulation, equal effects*  | *Accumulation, differing effects* | *critical period at 17 years*  | *Mobility birth – 2 years* | *Mobility birth – 17 years* | *Persistent risk* |
| N | N | N | 1,498 | 21.0 (2.0) | 63.6 (7.1) | 63.5 (0.2) | 62.6 (0.2) | 63.7 (0.2) | 63.7 (0.2) | 63.7 (0.2) | 63.7 (0.2) |
| L | N | N | 737 | 20.8 (2.1) | 64.0 (7.8) | 65.1 (0.2) | 69.9 (0.2) | 63.7 (0.2) | 63.7 (0.2) | 63.7 (0.2) | 63.7 (0.2) |
|  |  |  |  |  |  |  |  |  |  |  |  |
| N | N | O | 352 | 28.6 (3.4) | 67.9 (7.2) | 65.1 (0.2) | 67.9 (0.3) | 67.9 (0.3) | 67.9 (0.3) | 67.9 (0.3) | 67.9 (0.3) |
| L | N | O | 157 | 28.6 (3.1) | 67.9 (7.2) | 66.7 (0.3) | 68.2 (0.4) | 67.9 (0.3) | 67.9 (0.3) | 68.1 (0.5) | 67.9 (0.3) |
|  |  |  |  |  |  |  |  |  |  |  |  |
| N | O | O | 125 | 29.3 (4.4) | 67.9 (8.5) | 66.7 (0.3) | 67.5 (0.4) | 67.9 (0.3) | 67.9 (0.3) | 67.9 (0.3) | 67.9 (0.3) |
| L | O | O | 32 | 28.3 (3.5) | 68.6 (7.5) | 68.3 (0.5) | 67.8 (0.5) | 67.9 (0.3) | 67.7 (0.8) | 68.1 (0.5) | 68.6 (1.3) |
|  |  |  |  |  |  |  |  |  |  |  |  |
| N | O | N | 196 | 22.2 (1.8) | 63.1 (6.6) | 65.1 (0.2) | 63.2 (0.4) | 63.7 (0.2) | 63.7 (0.2) | 63.7 (0.2) | 63.7 (0.2) |
| L | O | N | 57 | 22.0 (1.7) | 62.9 (7.4) | 66.7 (0.3) | 63.5 (0.4) | 63.7 (0.2) | 63.4 (0.8) | 63.7 (0.2) | 63.7 (0.2) |
|  |  |  |  |  |  |  |  |  |  |  |  |
| *P value against the null hypothesis that the model has the same fit as the fully saturated model:* | *<0.001* | *0.84* | *0.71* | *0.60* | *0.60* | *0.63* |
| *RMSE* | *7.4* | *7.3* | *7.3* | *7.3* | *7.3* | *7.3* |

\* L represents the lowest third of birth weight at birth and O represents overweight or obese (defined on age- and gender-appropriate cut-offs using the UK 1990 growth reference) at 2 and 17 years. N represents the middle or top third of birth weight, and normal or low BMI at 2 and 17 years.