The association between an unhealthy childhood diet and body composition depends on prenatal experience

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Introduction

• The prevalence of obesity is rising in children and is associated with both childhood ill health and an increased risk of subsequent adult obesity
• Intrauterine life may be a critical period for the programming of later obesity
• The developmental mismatch hypothesis proposes that risk of diseases such as obesity is increased when impaired prenatal nutrition and growth, is followed by an unhealthy childhood diet.
Southampton Women’s Survey

12,583 non-pregnant Southampton women aged 20-34, interviewed about diet, physical activity, social circumstances and lifestyle.

3,158 live-born singleton births.

Offspring followed through pregnancy, infancy and beyond.
Abdominal circumference was measured at 11 weeks, 19 weeks, 34 weeks, birth, 6 months, 1 year, 2 years, 3 years, 6-7 years and 9 years.
AC size z-scores

Lines are mean, ±2 SDs and ±3 SDs
The broad pattern of 6 year diet has been characterised by the use of a prudent diet score.
## Principal component analysis

<table>
<thead>
<tr>
<th></th>
<th>Weighting</th>
<th>Frequency (per week)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green vegetables</td>
<td>0.33</td>
<td>× 7</td>
<td>2.3</td>
</tr>
<tr>
<td>Salad vegetables</td>
<td>0.25</td>
<td>× 4.5</td>
<td>1.1</td>
</tr>
<tr>
<td>White bread</td>
<td>-0.20</td>
<td>× 0.3</td>
<td>-0.1</td>
</tr>
<tr>
<td>Crisps</td>
<td>-0.21</td>
<td>× 0.5</td>
<td>-0.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>3.2</strong></td>
</tr>
</tbody>
</table>
### Median frequency per week food intake by quarters of the 6 year prudent diet score

<table>
<thead>
<tr>
<th>Food</th>
<th>Least prudent quarter</th>
<th>Most prudent quarter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salad vegetables</td>
<td>0.8</td>
<td>6</td>
</tr>
<tr>
<td>Green vegetables</td>
<td>2.3</td>
<td>6.5</td>
</tr>
<tr>
<td>Root vegetables</td>
<td>2</td>
<td>4.3</td>
</tr>
<tr>
<td>Other vegetables</td>
<td>0.5</td>
<td>2</td>
</tr>
<tr>
<td>Crisps</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Processed meat</td>
<td>7</td>
<td>4.8</td>
</tr>
<tr>
<td>White bread</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Chips and roast potatoes</td>
<td>3</td>
<td>1.5</td>
</tr>
</tbody>
</table>
Outcomes

- Dual-energy X-ray Absorptiometry (DXA) was used to assess body composition at 9 years; fat, lean and bone mass were derived using paediatric software.

- 592 children included in the analysis.
Directed Acyclic Graphs

• An analysis can stand or fall on the choice of confounders

• A Directed Acyclic Graph (DAG) or causal diagram describes a model of the associations between all variables that could influence the exposure-outcome association.
• Adjust for: 9 year height, sex, breastfeeding duration, maternal BMI, education, smoking in pregnancy, late pregnancy vitamin D and pregnancy weight gain
## Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal education ≥ A-levels, n (%)</td>
<td>376 (63.6%)</td>
</tr>
<tr>
<td>Pre-conception BMI, kg/m² [median (IQR)]</td>
<td>24.0 (22.1 to 27.0)</td>
</tr>
<tr>
<td>Female, n (%)</td>
<td>303 (48.8%)</td>
</tr>
<tr>
<td>Age at DXA scan, years [mean (SD)]</td>
<td>9.2 (0.3)</td>
</tr>
<tr>
<td>9 year total fat, kg [median (IQR)]</td>
<td>7.6 (5.7, 10.0)</td>
</tr>
<tr>
<td>9 year total lean, kg [mean (SD)]</td>
<td>22.7 (3.3)</td>
</tr>
<tr>
<td>9 year total BMC, kg [mean (SD)]</td>
<td>1.0 (0.1)</td>
</tr>
</tbody>
</table>
Main effects - fat mass

9 year total fat (SDs)

Regression coefficient (95% CI)

n = 199
Main effects – percentage fat

9 year percentage fat (SDs)

Regression coefficient (95% CI)

11 week size
11-19 week growth
19-34 week growth
34 week-birth growth
Birth-6 month growth
6-12 month growth
12 month-2 year growth
2-3 year growth
3-6 year growth
9 year percentage fat (SDs)

n = 199
Main effects – total lean

9 year total lean (SDs)

Regression coefficient (95% CI)

11 week size
11-19 week growth
19-34 week growth
34 week-birth growth
Birth-6 month growth
6-12 month growth
12 month-2 year growth
2-3 year growth
3-6 year growth
9 year total lean (SDs)

n = 199
Main effects – total BMC

9 year total BMC (SDs)

Regression coefficient (95% CI)

-11 week size
-11-19 week growth
-19-34 week growth
-34 week-birth growth
-6-12 month growth
-6-12 month growth
-12 month-2 year growth
-2-3 year growth
-3-6 year growth
-9 year total BMC (SDs)

n = 199
Interaction – total fat

P-value for interaction = 0.006

Conditional AC growth 34 weeks to birth (SDs)

9 year total fat (SDs)

Prudent diet score (SDs)

-0.7 -0.2 0.2 0.7
Interaction – percentage fat

P-value for interaction = 0.005

9 year percentage fat (SDs)

Conditional AC growth 34 weeks to birth (SDs)

Prudent diet score (SDs)

-0.7  -0.2  0.2  0.7
Interaction – total lean

P-value for interaction = 0.97

9 year total lean (SDs)

Conditional AC growth 34 weeks to birth (SDs)

Prudent diet score (SDs)

-0.7, -0.2, 0.2, 0.7
Interaction – total BMC

P-value for interaction = 0.94

9 year total BMC (SDs)

Conditional AC growth 34 weeks to birth (SDs)

Prudent diet score (SDs)

-0.7
-0.2
0.2
0.7
Strengths and weaknesses

• Strengths

Detailed anthropometric measurement and conditional growth analyses enabled description of abdominal circumference growth.

Dietary patterns describe broad patterns of diet, with greater potential for public health intervention.

Directed acyclic graphs provide an objective method to determine confounders, aiming to describe causality.

• Weakness

The conditional growth method only provides measures of fetal growth for participants with abdominal circumference data at all time points.
Conclusions

• Individuals showing late gestation faltering of fetal growth who then had an unhealthy childhood diet had greater adiposity, while childhood diet was less influential on adiposity in individuals whose fetal growth had not faltered.

• There were no similar interactions for lean and BMC outcomes.

• The result for adiposity provides some evidence in support of the mismatch hypothesis.
Acknowledgements

12,583 SWS study participants

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