Cognitive development and overweight in preschool children: a birth cohort study

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Introduction

- Childhood overweight and obesity has significantly increased within the last 20 years  

- Obesity in childhood has been associated with long term risk of health problems  
  (Aggoun Y. Pediatr Res. 2007;61:653-9)

- Growing evidence that obesity or overweight may be associated with poor neurocognitive outcomes including general cognitive function, executive function, memory and verbal abilities, or attention at all ages  

- These findings are mainly based on cross-sectional studies → the direction of the association is uncertain
Objective

- To assess the influence of cognitive development, social behavior and ADHD symptoms on overweight in preschool children in a birth cohort

- To elucidated the direction of the association
Methods

• **Design**
  - Population-based birth cohort from Menorca
  ⇒ INMA (INFancia y Medio Ambiente) project

• **Study population**

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
<th>Participants</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997-1998</td>
<td>Pregnancy (n=482)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1998-1999</td>
<td>At birth (n=482)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004-2005</td>
<td>6 years old (n=421)</td>
<td></td>
<td>(87.3%)</td>
</tr>
<tr>
<td></td>
<td>4 years old</td>
<td></td>
<td>(only 261 (62%) have BMI)</td>
</tr>
</tbody>
</table>
Methods

Variables

- Education level
- Social class
- BMI
- Height
- Mediterranean Diet

- Age
- Tobacco use

- Gender
- Gestational age
- Birth weight
- Birth height
- Parity
- Breastfeeding

4 years old

- Mc Carthy Scales
- Social Competence Scale
- ADHD (DSM-IV)

BMI z-score
BMI groups (CDC classification)
- Healthy weight
- At risk of overweight
- Overweight

6 years old

- Age
- Psychologist
- School grade
- Child’s diet

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## Results

### Neurodevelopment scores at age 4 by BMI groups at age 6

<table>
<thead>
<tr>
<th>NEURODEVELOPMENT SCORES AT AGE 4</th>
<th>Healthy weight n=183</th>
<th>At risk overweight n=43</th>
<th>Overweight n=30</th>
<th>p-trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global cognitive (MCSA) †</td>
<td>100 (91;112)</td>
<td>99 (90;105)</td>
<td>91 (80;99)</td>
<td>0.002</td>
</tr>
<tr>
<td>Verbal†</td>
<td>101 (93;112)</td>
<td>98 (87;112)</td>
<td>91 (77;100)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Perceptual-performance†</td>
<td>100 (92;110)</td>
<td>98 (88;108)</td>
<td>99 (84;106)</td>
<td>0.110</td>
</tr>
<tr>
<td>Quantitative†</td>
<td>96 (89;109)</td>
<td>99 (93;109)</td>
<td>89 (86;99)</td>
<td>0.127</td>
</tr>
<tr>
<td>Memory†</td>
<td>100 (89;108)</td>
<td>98 (92;115)</td>
<td>95 (93;102)</td>
<td>0.181</td>
</tr>
<tr>
<td>Motor skills†</td>
<td>100 (91;114)</td>
<td>98 (91;104)</td>
<td>98 (89;104)</td>
<td>0.083</td>
</tr>
<tr>
<td>Executive function†</td>
<td>100 (92;111)</td>
<td>100 (92;109)</td>
<td>89 (81;96)</td>
<td>0.661</td>
</tr>
<tr>
<td>Social Competence (CPSCS) †</td>
<td>96 (86;102)</td>
<td>94 (84;99)</td>
<td>89 (75;99)</td>
<td>0.116</td>
</tr>
<tr>
<td>Attention-Deficit Hyperactivity Symptoms (DSM-IV) †</td>
<td>0.0 (0.0;5.0)</td>
<td>1.0 (0.0;4.0)</td>
<td>2.5 (0.0;6.5)</td>
<td>0.850</td>
</tr>
</tbody>
</table>

CPSCS = California Preschool Social Competence Scale; DSM-IV = Diagnostic and Statistical Manual of Mental Disorders-IV; MCSA = McCarthy Scales of Children’s Abilities

*MCAS’s and CPSCS’s data were standardized (Mean: 100, SD: 15)
†median (interquartile range)
*mean (standard deviation)
# Results

**Association between cognitive development scores at age 4 and BMI z-score at ages 4 and 6**

<table>
<thead>
<tr>
<th></th>
<th>BMI z-score at age 4 years (n=256)</th>
<th>β</th>
<th>SE</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global cognitive</td>
<td></td>
<td>-0.003</td>
<td>0.005</td>
<td>0.540</td>
</tr>
<tr>
<td>Verbal</td>
<td></td>
<td>-0.001</td>
<td>0.005</td>
<td>0.857</td>
</tr>
<tr>
<td>Executive function</td>
<td></td>
<td>-0.005</td>
<td>0.005</td>
<td>0.394</td>
</tr>
<tr>
<td>Quantitative</td>
<td></td>
<td>-0.002</td>
<td>0.005</td>
<td>0.211</td>
</tr>
<tr>
<td>Memory</td>
<td></td>
<td>-0.004</td>
<td>0.005</td>
<td>0.475</td>
</tr>
</tbody>
</table>

Adjusted for age, psychologist, school grade, BMI z-score and square of BMI z-score at age 4, child’s gender, birth weight and height, gestational age, maternal smoking, adherence to Mediterranean Diet during pregnancy, maternal social class, level of education, maternal age, pre-pregnancy height and BMI, breastfeeding, mother’s parity and smoking at child’s age of 4, child’s consumption of sugar beverages, sweet and meat at age 4.
# Results

## Association between cognitive development scores at age 4 and BMI groups at age 6

<table>
<thead>
<tr>
<th>BMI groups at age 6 years</th>
<th>At risk of overweight (OR (95% CI))</th>
<th>Overweight (OR (95% CI))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n=256)</td>
<td></td>
</tr>
<tr>
<td>Global cognitive</td>
<td>0.98 (0.94-1.02)</td>
<td>0.87 (0.80-0.94)</td>
</tr>
<tr>
<td>Verbal</td>
<td>0.99 (0.95-1.02)</td>
<td>0.86 (0.79-0.93)</td>
</tr>
<tr>
<td>Executive function</td>
<td>0.99 (0.96-1.03)</td>
<td>0.87 (0.80-0.94)</td>
</tr>
<tr>
<td>Quantitative</td>
<td>1.00 (0.97-1.03)</td>
<td>0.91 (0.85-0.98)</td>
</tr>
<tr>
<td>Memory</td>
<td>1.00 (0.97-1.03)</td>
<td>0.91 (0.85-0.98)</td>
</tr>
</tbody>
</table>

Reference group was those children with healthy weight

Adjusted for age, psychologist, school grade, BMI z-score and square of BMI z-score at age 4, child’s gender, birth weight and height, gestational age, maternal smoking, adherence to Mediterranean Diet during pregnancy, maternal social class, level of education, maternal age, pre-pregnancy height and BMI, breastfeeding, mother’s parity and smoking at child’s age of 4, child’s consumption of sugar beverages, sweet and meat at age 4.
Results

Cognitive development scores at age 4 for each weight status change between ages of 4 and 6 compared with those who maintained healthy weight

Reference group was those who maintained healthy weight

Adjusted for age, psychologist, school grade, BMI z-score and square of BMI z-score at age 4, child’s gender, birth weight and height, gestational age, maternal smoking, adherence to Mediterranean Diet during pregnancy, maternal social class, level of education, maternal age, pre-pregnancy height and BMI, breastfeeding, mother’s parity and smoking at child’s age of 4, child’s consumption of sugar beverages, sweet and meat at age 4

* p<0.005
Limitations

- Nearly 40% of weight and height data at age 4 was lost because of a flood → selection bias, probably non-differential

- Rapid weight gain during first months of life not recorded → inclusion of intermediate variables as birth weight or growth during first years of life measured as BMI at age 4

- Parental IQ or mental health not evaluated → inclusion of education level and social class could reduce residual confounding
Conclusions

• First longitudinal study assessing influence of cognitive development on overweight at early childhood

• Low general cognitive abilities at age 4, specifically executive function and verbal skills, were associated with an increase of BMI in preschool children at age 6, after adjusting for all available pregnancy and child data
Thank you very much for your attention
Results

- Relationship between **BMI z-score at age 4** and **BMI z-score at age 6**: 

  ![Graph showing the relationship between BMI z-scores at age 4 and age 6.](image)

  → Both linear and quadratic components of BMI at age 4 were introduced in models

- Relationship between **general cognitive scores at age 4** and **BMI z-score at age 6** was linear (P for gain of linearity > 0.1)