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1 **Socioeconomic inequalities in weight, height and body mass index from birth to 5 years**

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17

18 **Short running title:** Socioeconomic inequalities in early growth

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24 None of the authors had a conflict of interest.

25

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37 study sponsors were not involved in the study design, data collection, or data analyses.

38 **Abbreviations:** Body Mass Index (BMI); Ponderal Index (PI); Overweight (OW)

39

40 **Abstract**

41 **Background/Objectives:** Studies in high income countries show that despite the positive  
42 association of weight with socioeconomic position at birth, an inverse socioeconomic gradient  
43 in overweight (OW) appears later in childhood. The objectives were to understand the natural  
44 history of socioeconomic inequalities in weight, height and body mass index (BMI), by  
45 investigating their associations with maternal educational level between birth and five years,  
46 separately in boys and girls.

47 **Subjects/Methods:** A published work of growth modelling between birth and 5 years allowed  
48 us to calculate predicted weight, height and BMI at 1 month, 6 months, 1, 3 and 5 years for  
49 1735 children from the French EDEN mother-child cohort. Associations between maternal  
50 education and predicted measures of body size were analysed with marginal linear and  
51 logistic models, stratified by sex.

52 **Results:** In girls, despite a positive association between maternal education and birthweight,  
53 an inverse socioeconomic gradient was observed as early as 1 month for BMI. Girls whose  
54 mothers had low education levels were shorter on the whole than their counterparts with  
55 better-educated mothers, despite their similar weights. In boys, no socioeconomic gradient in  
56 BMI was observed at any age, including birth, but positive associations were found as early as  
57 1 month for both weight and height.

58 **Conclusion:** The emergence of an inverse socioeconomic gradient in BMI and OW  
59 apparently results from a complex pattern of socioeconomic inequalities in weight and height  
60 from 1 month onwards. The very start of life thus appears to be an important window of  
61 opportunity for addressing socioeconomic inequalities in growth.

62

63

## 64 INTRODUCTION

65 Childhood overweight (OW) and obesity are an important public health concern worldwide  
66 because of their relations to a range of short- and long-term health issues.<sup>1-3</sup> Moreover, OW  
67 children are more likely to remain OW in adulthood.<sup>4</sup> Childhood is therefore a critical  
68 window for preventing the development of excessive adiposity and its associated negative  
69 health outcomes, which are likely to accumulate across the life course.

70 The prevalence of OW in children has sharply increased worldwide since the 1970s, although  
71 evidence suggests that it has stabilized in some industrialized countries in recent years.<sup>5-9</sup> An  
72 inverse association between socioeconomic position and child adiposity has been identified,<sup>10,</sup>  
73 <sup>11</sup> and its gradient is reported to widen with age<sup>12-14</sup> as well as with time, since stronger  
74 gradients have been observed in more recent studies.<sup>15-17</sup> This inverse socioeconomic gradient  
75 in the body mass index (BMI) of children seems paradoxical in view of the positive  
76 association between socioeconomic position and weight observed at birth.<sup>18, 19</sup> Given the  
77 switch from lower weight at birth to greater adiposity during childhood in more disadvantaged  
78 children, growth history from birth, including the effects of changes in weight and height or  
79 length on BMI gradient, is an interesting topic. Various studies have examined the age at  
80 which this inverse socioeconomic gradient in BMI or OW appears, with findings of around 4  
81 years in England,<sup>13</sup> before 4-5 years in Australia,<sup>14</sup> between 2 and 7 years in Germany<sup>20</sup>,  
82 before 7 years in Denmark<sup>21</sup> and around 6 years in Holland.<sup>12, 22</sup> This gradient may operate  
83 differently according to sex, in view of the steeper socioeconomic inequalities in BMI and  
84 OW<sup>13, 23, 24</sup> or in length<sup>25, 26</sup> that have been reported in girls. However, most of the studies that  
85 have explored the age of onset of the inverse socioeconomic gradient in BMI or OW are  
86 limited by both ages at data collection and the methods used, which do not take the non-linear  
87 shape of the BMI or z-score BMI growth trajectories into account accurately.

88 In France, separate cross-sectional studies have demonstrated an inverse relation between  
89 socioeconomic position and OW at both 5-6 years<sup>27-29</sup> and at 2 years.<sup>30</sup> Given this  
90 background, we hypothesised that this inverse relation with socioeconomic position was  
91 likely to be apparent by 2 years of age. Our objectives were to understand the natural history  
92 of socioeconomic inequalities in weight, height and BMI, by investigating their associations  
93 with maternal education levels between birth and five years, separately in boys and girls.

## 94 **SUBJECTS AND METHODS**

### 95 **Study design and participants**

96 The EDEN mother-child cohort aimed to assess pre- and post-natal determinants of child  
97 growth, health and development. This cohort included 2002 pregnant women recruited in two  
98 maternity hospitals (in Poitiers and Nancy, France) between 2003 and 2006. Exclusion criteria  
99 were multiple gestation, known diabetes, illiteracy and intention to deliver outside the  
100 maternity hospitals or to move outside the region within 3 years. Details of the study protocol  
101 have been published elsewhere.<sup>31</sup> Written consent was obtained from both parents. The study  
102 was approved by the ethics committee of Kremlin-Bicêtre and declared to the national  
103 commission for data protection and liberties (CNIL).

### 104 **Measurements**

105 Data were collected from obstetric and paediatric records at birth and then from self-reported  
106 questionnaires completed by the mothers and clinical examinations undertaken at different  
107 stages of follow-up.

#### 108 *Socioeconomic position*

109 Maternal education was used as a proxy for socioeconomic position, as it is the indicator most  
110 consistently and strongly associated with child adiposity in the literature<sup>10</sup> and is less likely to  
111 be affected by childbearing – unlike income and occupation. Mothers were asked to self-  
112 report their highest educational attainment at inclusion. Educational level was categorized as

113 low (failed to complete high school), intermediate (high school diploma to 2-year university  
114 degree, reference category) and high (3-year university degree or more).

#### 115 ***Weight and length or height***

116 Weight was measured by previously trained midwives at birth, 1 year, 3, and 5 years using an  
117 electronic scale (Seca Ltd or Terraillon SL-351). At 1 year, mothers were weighed both alone  
118 and holding the child, whose weight was obtained by subtracting the two measurements.  
119 Length was measured at birth and 1 year with a somatometer (Testut, NMMedical), and  
120 height at 3 and 5 years with a stadiometer (Seca Ltd). For simplicity's sake, height will be  
121 used to qualify length throughout the paper. Additionally, mothers filled in self-administered  
122 questionnaires at 4 months, 8 months and 1, 2, 3, 4 and 5 years. They were asked to report  
123 measured growth data available in their child's health booklet: one per month until one year,  
124 and two or three per year until five year. Of note, the latter were measured by primary care  
125 pediatricians or general practitioners during routine health monitoring.

#### 126 ***Preliminary statistical treatment of growth data***

127 Using all available collected data (on average 16 measurements per child, measured either by  
128 midwives or primary care pediatricians/general practitioners), predicted weight and height  
129 were calculated using previously modelled trajectories from the Jemss-Bayley model.<sup>32, 33</sup>  
130 These trajectories were calculated in children with at least two measurements of weight  
131 (excluding birthweight) or two measurements of height.<sup>32, 33</sup> In total, we were able to predict  
132 weight and height between birth and 5 years for 1764 children. Predicted weight growth did  
133 not include birthweight because the model assumes a monotonic shape and infants normally  
134 lose weight immediately after birth. Instead, the minimum weight recorded during the first 4  
135 days was used. Given that studies are not consistent regarding the use of either BMI or  
136 ponderal index (PI) to identify fat mass differences,<sup>34-36</sup> we calculated both predicted BMI and  
137 PI as predicted weight (kg) divided by predicted height (m) squared and cubed, respectively.

138 Predicted weight, height, BMI and PI were calculated at 1 month and 6 months to characterise  
139 early growth and at 1 year, 3 and 5 years to facilitate sensitivity analysis between predicted  
140 and collected data (the latter coming from either the clinical examinations or the health  
141 booklets). OW was defined at 2, 3, 4, and 5 years according to the International Obesity Task  
142 Force (IOTF) definition, which provides thresholds from 2 years onwards.<sup>37</sup>

#### 143 ***Other variables***

144 Gestational age and maternal age were reported at birth. Preterm birth (yes/no) was defined  
145 based on gestational age <37 weeks of gestation.

146

#### 147 **Population studied**

148 Among the 1907 children included in the EDEN cohort, 143 were excluded because they had  
149 fewer than two weight or height measurements between birth and 5 years, and 29 more due to  
150 missing values for maternal education. The sample in this analysis thus includes 1735  
151 children (838 girls and 897 boys).

152

#### 153 **Statistical analysis**

154 Characteristics of the study population (namely, mother's age, child's weight, length, BMI, PI  
155 and preterm birth) were described at birth according to maternal education and sex. Chi-  
156 square tests and ANOVA analyses were used for statistical comparisons as appropriate.

157 Linear and logistic marginal models were used to investigate the association between  
158 maternal education and repeated BMI, PI, weight and height data from 1 month to 5 years and  
159 OW from 2 years to 5 years, respectively. Child age was included as a categorical variable,  
160 defined based on 5 values in the linear models (i.e., 1 month, 6 months, 1 year, 3 and 5 years)  
161 and 4 values in the logistic model (i.e., 2, 3, 4 and 5 years). An interaction term involving  
162 child age and maternal education was included in each model to allow the association



163 between maternal education and BMI (or PI, OW, weight or height) to change according to  
 164 child age. Models were adjusted for centre (i.e., Nancy or Poitiers). Therefore, the model  
 165 equation for the  $i^{\text{th}}$  subject at the  $j^{\text{th}}$  measurement, with  $y$  the BMI (or PI, weight or height),  $k$   
 166 the level of education and  $\varepsilon_{ij}$  the error measurement, can be written as follows:

$$(1) \quad y_{ij} = \beta_0 + \beta_1 \times \text{sex}_i + \beta_2 \times \text{centre}_i + \beta_3 \times \text{age}_{ij} + \beta_4 \times \text{education}_{ik} + \\ \beta_{5jk} \times \text{age}_{ij} \times \text{education}_{ik} + \varepsilon_{ij}$$

167 A hypothesis underlying this model is that the pattern of association with age and education is  
 168 the same for both sexes. To test specifically whether the educational level was associated with  
 169 the different growth trajectories differently in boys and girls, we computed two nested models  
 170 (2 and 3), described below. The difference between these two models was assessed and tested  
 171 through the interaction terms  $\text{sex}_i \times \text{education}_{ik}$  and  $\text{sex}_i \times \text{age}_{ij} \times \text{education}_{ik}$ .

$$(2) \quad y_{ij} = \beta_0 + \beta_1 \times \text{sex}_i + \beta_2 \times \text{centre}_i + \beta_3 \times \text{age}_{ij} + \beta_4 \times \text{education}_{ik} + \\ \beta_{5jk} \times \text{age}_{ij} \times \text{education}_{ik} + \beta_{6j} \times \text{age}_{ij} \times \text{sex}_i + \beta_{7k} \times \text{sex}_i \times \text{education}_{ik} + \\ \beta_{8jk} \times \text{sex}_i \times \text{age}_{ij} \times \text{education}_{ik} + \varepsilon_{ij}$$

$$(3) \quad y_{ij} = \beta_0 + \beta_1 \times \text{sex}_i + \beta_2 \times \text{centre}_i + \beta_3 \times \text{age}_{ij} + \beta_4 \times \text{education}_{ik} + \beta_{5jk} \times \text{age}_{ij} \times \text{education}_{ik} + \\ \beta_{6j} \times \text{age}_{ij} \times \text{sex}_i + \varepsilon_{ij}$$

172 We compared models (2) and (3) using the likelihood ratio test, or the quasi-likelihood under  
 173 the independence model criterion (QIC) for OW. Given that the tests were significant for 4 of  
 174 the 5 outcomes, all analyses were stratified by sex. The choice of the best matrix of  
 175 covariance of residuals, among the unstructured, autoregressive heterogeneous, Toeplitz and  
 176 compound symmetry matrices, relied on the convergence of the model and the minimization  
 177 of the Akaike Information Criterion (AIC) or the QIC. An unstructured matrix was chosen for  
 178 models of all continuous outcomes, except for models of height in girls, where a Toeplitz  
 179 matrix was chosen. For OW, the autoregressive heterogeneous (order 1) matrix was selected.

180 In a first sensitivity analysis, we investigated the impact of the 29 missing data items for  
181 maternal educational level on the results. Because these data were unlikely to be missing at  
182 random, we reran the analyses with two imputed databases, one with all missing data set at  
183 the low level of education, and the other with all missing data set at the high level of  
184 education. In a second sensitivity analysis, we used the observed values of BMI, PI, weight,  
185 and height (in place of the predicted ones) and further adjusted for exact age at clinical  
186 examination.

187 The population included in the analysis was compared to the population not included using  
188 chi-square tests and ANOVA analyses as appropriate. All analyses were conducted with  
189 SASv9.3 (SAS, Cary, NC, US). Graphics were plotted with R software. The level for  
190 significance of two-sided test was set at  $P \leq 0.05$ .

## 191 **RESULTS**

### 192 **Population characteristics**

193 The more highly educated mothers were older than the less educated mothers (**Table 1**). Girls  
194 born to mothers with high educational levels had higher measured birth weights and birth  
195 lengths than girls whose mothers had low educational levels, while no significant difference  
196 was observed in boys. A trend towards a positive association between maternal education and  
197 BMI and PI at birth was observed in boys only ( $P < 0.10$ ).

### 198 **Maternal education and BMI and PI**

199 In girls, an inverse socioeconomic gradient in BMI was observed from 1 month to 5 years  
200 (**Figure 1**). Consistent results were found with PI. In boys, the association between education  
201 and BMI changed along the age range in a non-monotonic fashion ( $P$  for age  $\times$  education  
202 interaction = 0.02), but no significant socioeconomic gradient in BMI was observed at any  
203 age (**Figure 1**). A significant negative association was however observed with PI at 1 month  
204 and at 5 years (**Supplementary Figure 1**).

### 205 **Maternal education and OW**

206 At 2 years, the risk of OW in girls was already inversely associated with maternal education  
207 (**Figure 2**). This inverse gradient was consistent across all ages studied, as reflected by the  
208 non-significant interaction between age and maternal education ( $P$  for age  $\times$  education  
209 interaction = 0.28). In boys, the risk of OW did not differ according to maternal education  
210 from 2 to 5 years and there was no interaction between age and maternal education ( $P$  for age  
211  $\times$  education interaction = 0.68, **Figure 2**).

### 212 **Maternal education and weight**

213 Girls born to mothers with a low educational level had a lower birthweight (**Table 1**) but the  
214 pattern of the relation between maternal education and children's postnatal weight then  
215 seemed to shift. This change had already started at 1 month and was also observed at  
216 subsequent ages but we did not observe any significant gradient in weight at any age (**Figure**  
217 **3**,  $P$  for age  $\times$  education interaction  $< 0.01$ ). In boys, there was no significant gradient at birth  
218 or at 1 month, but a positive socioeconomic gradient in weight was observed between 6  
219 months and 3 years. The change in the association across ages was reflected by the  
220 significance of the interaction test ( $P$  for age  $\times$  education interaction  $< 0.01$ , **Figure 3**).

### 221 **Maternal education and height**

222 Girls whose mothers had low educational levels were significantly shorter than their  
223 counterparts whose mothers had more education at birth, 1 month and 5 years (**Figure 4**). In  
224 boys, this association remained significant as early as 1 month through 5 years (**Figure 4**,  $P$   
225 for age  $\times$  education interaction = 0.06 for both girls and boys).

### 226 **Sensitivity analyses**

227 Results were on the whole consistent when analyses were performed on the databases with  
228 imputed maternal education as low or high (results not shown but available on request). When  
229 we used observed instead of predicted data, the overall pattern of the relations between

230 maternal education and continuous outcomes (BMI, PI, weight or height) was consistent  
231 regarding effect size, in both sexes (results not shown but available on request).

### 232 **Comparison of included to excluded population**

233 Mothers excluded from the analysis (n=172) were younger and less educated than those  
234 included (mean age (SD): 27.6 (5.3) vs. 29.7 (4.8) years; low education level: 52.2% vs.  
235 26.9%). The proportion of boys and preterm births was higher in children excluded from the  
236 analysis (boys: 61.3% vs. 51.7%; preterm: 9.4% vs. 5.4%). No significant difference was  
237 observed in length and weight measured at birth among those included and excluded  
238 respectively (length: 49.3 (2.7) vs. 49.6 (2.3) cm; weight: 3.23 (0.57) vs. 3.28 (0.51) kg).

### 239 **DISCUSSION**

240 Using a large French mother-child cohort with repeated measurements of height and weight  
241 on 1735 children between birth and 5 years, this study provides original and comprehensive  
242 insights into the socioeconomic patterning of BMI and OW, in light of the socioeconomic  
243 inequalities in weight and height growth.

#### 244 ***BMI, PI and OW***

245 Our results show that, in girls, whereas birthweight was lower in newborns of women with  
246 low educational levels, an inverse socioeconomic gradient in BMI and PI was already visible  
247 at 1 month of age. Similarly, a socioeconomic gradient was observed for OW from 2 years,  
248 the earliest age for which cut-off points are available. Socioeconomic inequalities in BMI,  
249 OW and PI in girls were therefore observed even earlier than in previous studies.<sup>12, 14, 20-22, 38</sup>

250 Although an inverse association with PI was observed in boys at 1 month and 5 years, we did  
251 not find any significant association between maternal education and their BMI or OW during  
252 the first 5 years of life.

253 Other studies have also suggested stronger or earlier associations between socioeconomic  
254 position and adiposity measures in girls compared to boys. Apouey et al. showed an inverse

255 socioeconomic gradient in OW from 2-3 years in girls and only from 4-5 years in boys,<sup>24</sup>  
256 while Howe et al. found an inverse socioeconomic gradient in BMI at 8 years and fat mass at  
257 9 years in girls but nothing in boys.<sup>13, 25</sup> Differences in body composition between sexes have  
258 been described from infancy,<sup>36, 39, 40</sup> with a higher proportion of BMI (or PI) variability  
259 explained by fat mass in girls. This relatively better reflection of body fat mass variability by  
260 BMI (or PI) in girls could partly explain the sex differences found in all these studies.

### 261 *Weight and height*

262 Socioeconomic gradients in weight and height were also observed very early in life. In girls,  
263 although weight did not differ according to maternal education from 1 month of age onwards,  
264 we observed that those born to mothers with low educational levels were shorter on the  
265 whole. This difference in height but not in weight seemed to drive the inverse socioeconomic  
266 gradient in both BMI and OW from 1 month and 2 years onwards, respectively. In boys, while  
267 height was related to maternal education at each age, the parallel positive relation between  
268 maternal education and weight meant that neither BMI nor OW varied according to maternal  
269 education at any age.

270 Although the emergence of socioeconomic inequalities in BMI across childhood has so far  
271 mainly been addressed with a focus on weight, our findings shed light on the potential  
272 importance of height in the early development of such disparities. Socioeconomic patterning  
273 of height in childhood was also observed by Howe et al. in the Avon Longitudinal Study of  
274 Parents and Children (ALSPAC),<sup>25, 26</sup> Finch et al. in US children<sup>41</sup> and Matijasevich et al. in  
275 Brazilian children.<sup>42</sup> This trend has not, however, been observed in all studies.<sup>43, 44</sup> Besides the  
276 methodological differences between studies (e.g. cross-sectional vs. longitudinal design,  
277 statistical models used, ages studied), discrepancies between findings could come from  
278 differences in the choice of the proxy of socioeconomic position or in the way that  
279 socioeconomic position affects weight-related behaviours in different populations. It is also

280 possible that socioeconomic patterning of growth and BMI takes place earlier in life in the  
281 most recent generations, given the increase of adiposity<sup>3</sup> and socioeconomic inequalities in  
282 recent decades.<sup>45</sup>

### 283 **Potential explanations for socioeconomic inequalities in growth**

284 Although our focus was a description of the socioeconomic gradient in growth over time, it is  
285 worth considering the biological mechanisms that may underpin our findings. Weight and  
286 height may be transmitted across generations through both genetic and environmental  
287 influences.<sup>46-49</sup> Smaller babies, exposed to an obesogenic environment, are perhaps more  
288 vulnerable to overconsumption (and thus energy imbalance), than their taller counterparts. It  
289 has also been suggested that babies born in disadvantaged backgrounds are more often  
290 exposed to suboptimal parental feeding styles. In particular, mothers of smaller infants are  
291 more likely to use pressuring styles, which could also contribute to overfeeding.<sup>50</sup> There is  
292 also evidence showing a positive socioeconomic gradient in breastfeeding at the population  
293 level in industrialized countries,<sup>51</sup> along with a slower growth during the first year of life in  
294 breastfed babies<sup>52</sup> and lower risk for overweight or obesity later in childhood.<sup>53</sup> Overall,  
295 suboptimal health, diet and growth from birth could be considered to be indicators of a more  
296 global vulnerability transmitted from the mother to the child.

297 Our results add to the evidence that socioeconomic inequalities take root before birth, before  
298 and during pregnancy, and continue into childhood. In the background of this  
299 intergenerational transmission of inequality, our findings confirm that the window of  
300 opportunity for combatting non-optimal growth and/or OW begins very early in life. Future  
301 research into the early and modifiable risk factors involved in the socioeconomic patterning of  
302 both height and weight growth in girls and boys is clearly a priority.

### 303 ***Limitations and strengths***

304 Limitations of the study include the fact that the predicted data were based on a mixture of  
305 measured data and data collected from health booklets. The latter, likely more subject to  
306 measurement errors, may have affected the accuracy of the predicted data and decreased the  
307 statistical power. Modelling was performed on the assumption that children lost to follow-up  
308 had experienced the same growth curve compared to children with a complete follow-up and  
309 a similar initial growth. This hypothesis, although possible, could not be verified, and we  
310 cannot be certain of the validity of the growth modelling of children who dropped out. In  
311 addition, prevalence of OW at 5 years was rather low in the Eden cohort, especially in boys  
312 (5.7% vs. 9.8% in girls),<sup>54</sup> compared to findings from the 2006-07 INCA2 national dietary  
313 survey, which reported a prevalence of 13.5% in children aged 3-6 years.<sup>55</sup> The presence of  
314 selection bias at inclusion, as is often the case in cohort studies, is therefore possible and may  
315 have implications for generalisation of the findings. Specifically, only including literate  
316 women at baseline may have resulted in an underrepresentation of disadvantaged families,  
317 which might have weakened our ability to compare mothers according to their education  
318 level. We also acknowledge that, consistent with the literature, we used maternal education  
319 level as a proxy for socioeconomic position. Given the complexity in accurately assessing  
320 socioeconomic position, we cannot be certain that the results relating to disadvantage in our  
321 analysis would not change if a different indicator were used. It is also possible that BMI is not  
322 the most appropriate indicator of adiposity as it has been shown to underestimate the  
323 socioeconomic gradient in obesity and body fatness.<sup>56, 57</sup> Under these circumstances,  
324 however, our findings, which suggest early socioeconomic inequalities in weight, height and  
325 BMI even in this rather low-risk sample, make the public health arguments even stronger. A  
326 clear strength of our study is that data are from a birth cohort, making it possible to address  
327 the link between maternal education and the various outcomes prospectively, using marginal  
328 models to account for repeated measurements. Growth modelling was the preferred method as

329 it allowed us to estimate accurate predicted weight and height at any age despite measurement  
330 error and missing values across the follow-up and thus reducing mis-classification and  
331 attrition biases.

332

333 In conclusion, these findings showed that the emergence of an inverse socioeconomic gradient  
334 in BMI and OW apparently results from a complex pattern of socioeconomic inequalities of  
335 weight and height from 1 month onwards. The very start of life thus appears to be an  
336 important window of opportunity for addressing socioeconomic inequalities in growth.

337

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344 B. de Lauzon-Guillain, P. Ducimetière, M. de Agostini, B. Foliguet, A. Forhan, X. Fritel, A.  
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351 MAC. MB analyzed the data with advice from BH, JB and SL. MB, BH and SL drafted and  
352 revised the manuscript. All authors interpreted the data and criticized the manuscript for  
353 important intellectual content. MAC and BH designed and led the EDEN mother-child cohort.



354 AF is responsible for the EDEN data management. JB and SC have fitted weight and height  
355 growth trajectories using the Jenss-Bayley nonlinear model and provided the relevant data.  
356 All authors have read and approved the final version of the manuscript. This article is the  
357 work of the authors. MB serves as guarantor for the contents of this article. All authors had  
358 full access to all of the data (including statistical reports and tables) in the study and take the  
359 responsibility for the integrity of the data and the accuracy of the data analysis. All  
360 researchers are independent of the funding bodies. All members in the EDEN mother-child  
361 cohort study group designed the study and revised the draft manuscript.

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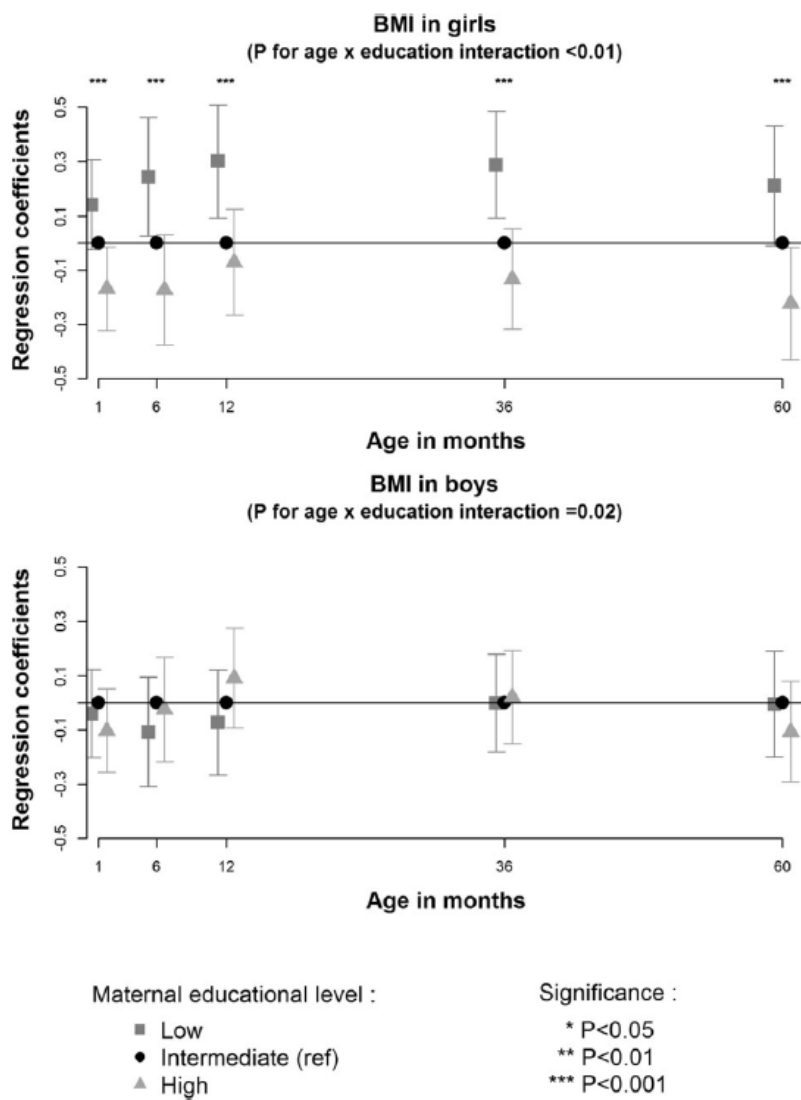
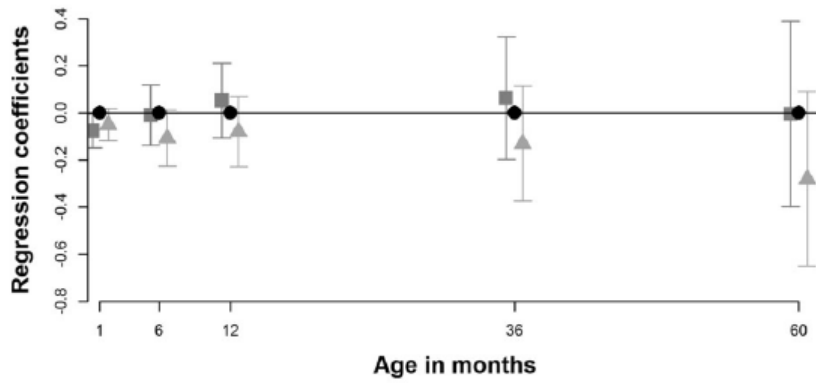


Figure 1: Linear regression coefficients [95%CI] for association between maternal education and BMI, adjusted for centre, in girls (n=838) and in boys (n=897). P for sex interaction <0.05.



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**Weight in girls**  
(P for age x education interaction with age<0.01)



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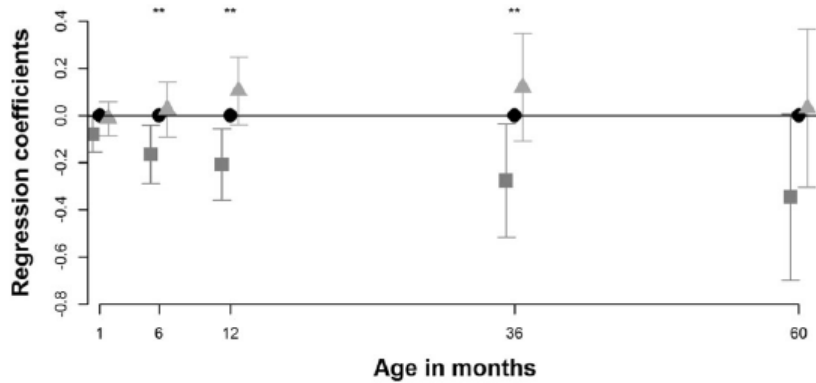
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**Weight in boys**  
(P for age x education interaction with age<0.01)



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Maternal educational level :  
 ■ Low  
 ● Intermediate (ref)  
 ▲ High

Significance :  
 \* P<0.05  
 \*\* P<0.01  
 \*\*\* P<0.001

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569 Figure 3: Linear regression coefficients [95%CI] for association between maternal education and

570 weight, adjusted for centre, in girls (n=838) and in boys (n=897). P for sex interaction <0.01.

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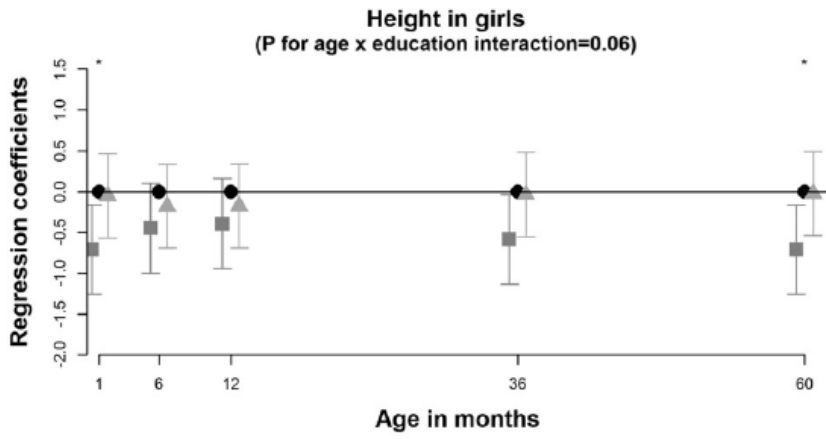
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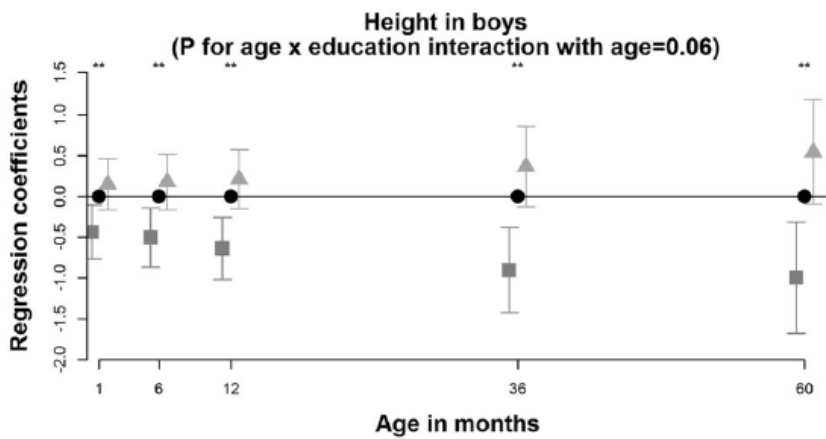
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Maternal educational level :  
 ■ Low  
 ● Intermediate (ref)  
 ▲ High

Significance :  
 \* P<0.05  
 \*\* P<0.01  
 \*\*\* P<0.001

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589 Figure 4: Linear regression coefficients [95%CI] for association between maternal education and

590 height, adjusted for centre, in girls (n=838) and in boys (n=897). P for sex interaction >0.05.

591