Sibling Inequalities in Overweight and the Role of Mother's Education: Evidence From the Indonesian Family Life Survey

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Abstract

Background: Previous studies have shown that sibling inequalities in overweight vary across contexts. Furthermore, research on the extent to which parental factors such as mother's education can compensate for or reinforce such disparities is considerably rare.

Objective: This study analyzes to what extent and how the chances of overweight among children (0-19 years of age) vary systematically by gender, birth order, and number of siblings. We also look at whether mother's education buffers or aggravates sibling inequalities in overweight.

Methods: Data were from the fifth wave of the Indonesian Family Life Survey-5 2014/2015, which comprised 6723 children born in 4784 families. We applied within-family centered birth order dummies to disentangle the effects of birth order from those of number of siblings. Cluster-robust logistic regressions were conducted.

Results: Overweight occurred more in eldest and youngest children, and in children of smaller families. Mother's education amplified sibling inequalities. Odds of overweight in children increased along with more years of education the mothers had. This was greater for boys and eldest children. Further analyses indicated that boys whose mothers spent more years in school consumed high-calorie foods more often.

Conclusion: The overall results indicate that mother's education aggravates sibling inequalities in overweight. Nutrition interventions to reduce overweight in children should target the eldest and the youngest children and children of smaller families. Mothers who had more school years, and particularly their sons, should also be in the target group. Boys should be advised to consume high-calorie foods less often.

Keywords

gender, birth order, number of siblings, mother's education, overweight, Indonesia

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Introduction

Overweight compromises human capital accumulation and increases the risks of noncommunicable diseases (NCDs) over the life course. Schwimmer et al[1] found that being overweight in childhood and adolescence reduced functioning in the physical, emotional, social, and school domains. These may result in lower skill attainment that likely limits individual contributions to the economy later in life.[2-4] Overweight children might also experience a lower quality of life in adulthood because of cardiovascular diseases, diabetes, and certain types of cancer.[5] This evidence underlines how critical it is to understand and address the causes of overweight before children enter adulthood.

So far, most of scientific debates on risk factors of overweight have revolved around socioeconomic status (SES) and spatial location (urban vs rural).[6-9] This study, however, takes a different approach, by diving deeper into the household, examining sibling inequalities in overweight and the role of mother's education therein. Previous studies have shown that overweight in children differs by gender, birth order, and number of siblings.[10-14] However, results indicating which children in the sibling set (eg, the eldest, youngest etc) have higher odds of overweight diverge across contexts. Contradictory results are found both in developed and developing countries, and with respect to different population subgroups.[15] Hence, it is unclear what mechanisms explain sibling inequalities in overweight under what particular circumstances. Moreover, in contrast to the literature on undernutrition, that is, stunting and wasting, in which the role of mother's education in improving children's nutritional status has received ample attention,[16,17] there has been hardly any research about the association between mother's education, sibling differences, and the risk of overweight in children, particularly in developing countries.

This study contributes to the growing literature on child obesity in 3 ways. First, we examine not only how gender, birth order, and the number of siblings affect overweight during childhood and adolescence but also whether mother's education plays a role in these inequalities. Second, we investigate the moderating effects of mother's education on sibling inequalities in overweight. Third, we test whether the role of mother's education in adjusting the risk factors of overweight might overlap with the effects of SES. This is in response to critics that the effects of mother's education on children's nutritional status could be spurious, because mothers who had more school years are usually from high SES families.[18,19]

Our study uses data from the fifth wave of the Indonesian Family Life Survey (IFLS) 2014/2015, which comprised 6723 children (0-19 years of age) born in 4784 families. Aside from multiple health indicators, IFLS also collected SES-related information,[20] which enables controlling for potential confounders of health outcomes. Since IFLS is a household survey, it is possible to construct an analytical sample of household data that link the mother, children, and siblings. The IFLS-5 (2014/2015) introduced a new food consumption module, which collected data on the consumption of high-calorie foods by household members.[21] This unlocked possibilities to examine overconsumption of high-calorie foods as a potential channel through which children may develop overweight.

The Indonesian context enhances this study's societal relevance since, with more than 250 million inhabitants, Indonesia is the world's fourth largest country. Furthermore, Indonesia's emerging economy has experienced vast economic growth. The Gross National Income per capita has grown 6-fold from US$580 in 2000 to US$3540 in 2017.[22] This has increased the purchasing power of Indonesian families. In 2017, spending on prepared food and beverages counted for 17.2% of the total monthly average per capita expenditure, which is nearly twice the percentage (9.5%) in 1999.[23] It has been estimated that 5.9 (16.7%) million Indonesian boys and 4.8 (14.4%) million girls aged 5 to 19 years were either overweight or obese in 2016, which jointly nearly triples the 2010 figure.[24,25] This suggests that Indonesia is in the fourth stage of the global nutrition transition, which is marked by a change toward high-calorie diets (ie, high total fat, high sugar, and processed foods) and an increasing risk of overweight.

Background and Hypotheses

The global nutrition transition framework of Popkin[26] and Popkin et al[27] aims to understand how overweight may develop into a global threat to the health of populations. It describes 5 stages of shifting trends in nutrition and lifestyle, starting from: (1) hunter-gatherers: varied diet, physically active lifestyle; to (2) famine: less varied diet, agricultural settlement; (3) receding famine: less varied diet continued, industrial revolution; (4) the emergence of NCDs: increasing consumption of high-calorie foods, physically a less active lifestyle; and lastly (5) behavioral changes: increasing public awareness of healthy diets and lifestyle. Most of today's populations are in 1 of the last 3 stages. In the third stage of receding famine, economic conditions have improved and families have become more food secure, and thus are less likely to be undernourished. At the same time, economic change and the introduction of new technologies have reduced physical activity. Furthermore, globally, a diet that is high in saturated fat, sugar, and refined foods (often low in fiber) is gaining ground.[26] The fourth stage is characterized by the rise of overweight, due to the combination of overconsumption of high-calorie foods and a sedentary lifestyle, resulting in an energy imbalance. This may induce NCDs and premature mortality.[5,24] At the fifth stage, public awareness propels behavioral changes that result in healthier diets and a physically active lifestyle.

Although useful, the global nutrition transition framework is a macro-level framework,[28,29] which renders many micro-level aspects of overweight invisible. These aspects include sibling inequalities (ie, differences by gender, birth order, and number of siblings). To investigate these aspects further, we used resource dilution theory as our point of departure. This theory has been used to explain intrahousehold inequalities in life course outcomes with regard to sibling dynamics in various settings.[30] It is based on the assumption that family resources are finite and that the more children there are in a family, the smaller the share of family resources per child would be. Children with many siblings usually have, for example, a lower educational attainment[31,32] and a lower nutritional status than children with fewer siblings.[33] Interestingly, in relation to overweight, having more siblings can be positive. Smaller food shares and more physical activity, that is, via group play, may help children to balance their energy levels and could prevent them from being overweight.[34]

Most studies based on resource dilution theory start with the hypothesis that the allocation of family resources diminishes with higher birth order. This might not necessarily apply to overweight in children. The "neglected middle-child" hypothesis that is popular in psychology, for example, suggests that parents, because of diverse reasons, give attention and family resources to the eldest and the youngest child more than to the middle child.[35,36] As shown by Ochiai et al,[11] this hypothesis may also apply to overweight in children. They found that among Japanese school-children, the eldest and the youngest are at higher odds of being overweight than middle children. In contrast, in a study in a low-income community in the United States, only the youngest had higher risks of being overweight.[10] It was suggested that this resulted from food resources benefitting the youngest, while elder siblings were often working and had a higher energy expenditure. These examples show the mixed evidence on birth order effects on overweight in children and their differences across contexts.[15]

Family resources might also be distributed unequally among sons and daughters. Discrimination in food allocation against girls places them at a risk of low nutritional status, particularly in societies with a patrilineal and patrilocal tradition.[33,37-39] However, modernization of norms and values may shift the situation to the benefit of girls. In Indonesia, for example, the growing economy and the existence of egalitarian gender norms induce equal food access for girls and boys.[40] Related to overweight, globally the norm for girls that "being slim is being beautiful" is gaining ground,[41] which could motivate girls and their parents to adjust girls' diets in order to comply with the norm. On the other hand, the lack of a similar norm for boys leaves them more vulnerable to overconsumption of foods, resulting in a higher risk of overweight.

The role of the mother on her children's life outcomes is critical. A study by LaFave and Thomas in Indonesia,[42] for example, strongly suggest that mother's influence on child's health (eg, nutritional status and cognitive capacity) was significantly greater than that of the father and extended family members, including grandparents. In Indonesia context, the greater influence of the mothers was perhaps due to the family planning program under The New Order Regime (1968-1998). The program has transformed the society to be more conjugal in family structure, reducing that of the influence of extended family members. Furthermore, within the program, there was also a "social engineering" to place the mother as a nurturer and more as the primary caregiver for children.[43]

A number of studies have suggested that mothers who spent more years in school often have more opportunities than fathers to practice their agency in managing family resources to benefit their children.[44-47] This can be indirect, through expansion of her chance to participate in the labor market and earn money in order to provide more food security to her children.[47] Another channel is more direct and relates to the educated mother's ability to access and use nutrition information.[44] It suggests that mothers who had more school years are more open to new diets and nutrition innovations which may improve the nutritional status of their children.[45,46] Studies in developed countries seem to confirm that and show that children of educated mothers—mothers who had more school years—are less often overweight.[12,48,49] The relation may however be different in the developing world. A small-scale study in Bogor–Indonesia found that children of educated mothers were more susceptible to overweight.[50] The study found that these children received more pocket money, which was mostly spent on high-calorie foods at school.

Whereas the role of mother's education in compensating or aggravating inequalities in overweight by birth order and the number of siblings is understudied, the positive role of mother's education in reducing gender inequality in undernutrition is well-documented.[51,52] However, this should be interpreted cautiously; Kunto and Bras[16] found evidence that, in Indonesia, the more years of formal education the mothers had would compensate for boys' deficit in body mass, but in unhealthy ways. This was done most likely by unintentionally allowing boys to consume high-calorie foods more often.

Informed by the studies reviewed above, we formulated 2 hypotheses. First, sibling inequalities (ie, in terms of gender, birth order, and number of siblings) and mother's education influence overweight in children (H1). Although the effects of birth order may vary, boys and children of smaller families are expected to be more at risk of overweight, irrespective of mother's education. Second, mother's education plays a moderating role in sibling inequalities in overweight (H2). We expect these moderating effects of mother's education to apply at least to gender. We hypothesize that boys whose mothers spent more years in school consumed high-calorie foods more often than girls and, thereby, are more likely to be overweight.

Methods

We derived our data from the IFLS, the largest ongoing household panel survey, which collects multiple indicators of socioeconomic and health information in Indonesia. The first wave of IFLS was in 1993/1994 and, since then, 4 follow-up surveys have been carried out in 1997/1998, 2000, 2007/2008, and 2014/2015. Details of the IFLS can be found in Strauss et al.[20]

Analytical Sample

In order to produce a recent picture of overweight among Indonesian children, we based this study on the latest wave, IFLS-5 (2014/2015). The fifth IFLS featured improvements to previous waves by including more health and psychological indicators, among other elements, and importantly for this study, data on the weekly consumption frequency of high-calorie foods. New data on the consumption of high-calorie foods enable us to examine the overconsumption of high-calorie foods as the channel through which children might develop overweight. Our analytical sample consisted of 6723 children (0-19 years of age) born in 4784 families.

Ethical Consideration

Indonesian Family Life Survey data are open access for registered users and can be downloaded from the RAND Corporation website. Institutional review boards (IRBs) in the United States (at RAND) and in Indonesia at the University of Gadjah Mada have reviewed and approved IFLS-5 (2014/2015) survey instruments and procedures. Prior to fieldwork, all requirements for consent by adults and children had been met and approved by the 2 IRBs.

Outcome Variables

Two outcome variables were developed: "overweight" as the main outcome variable and "consumption of high-calorie foods" as a secondary outcome variable. We used the latter variable to analyze sibling inequalities and the role of mother's education in regulating overconsumption of high-calorie foods.

We assigned a dummy variable to record overweight (0 = nonoverweight, 1 = overweight). In IFLS, trained nurses used calibrated tools to collect data on height and weight of all present household members. We used these data to evaluate overweight in children (0-19 years of age). As children are still growing and have not yet attained their final stature, measuring overweight in children differs from that of adults. Instead of using the body mass index (BMI), which is commonly used to evaluate adult overweight, we used the World Health Organization (WHO) BMI for age z-scores. The BMI for age z-scores are standardized BMI by sex and age.[53,54] We are aware that WHO recommends weight for length z-scores to evaluate healthy weight of children younger than the age of 5. However, a recent article found that, even for children of this age, BMI for age z-scores perform similar to, if not better than, weight for length z-scores in identifying overweight children.[55] We therefore used BMI for age z-scores for all children in our sample (0-19 years of age). A cutoff value ≥ 1 SD (standard deviation) for BMI for age z-scores was used to classify children into "overweight."[53,54] Since those who were obese (BMI for age z-scores ≥ 2 SD) only constituted a small

percentage, we classified them as overweight children. This simplified the analyses and ensured that this study had sufficient statistical power to test the hypotheses.

Indonesian Family Life Survey-5 (2014/2015) surveyed the weekly consumption of 17 food items.[21] Five of these can be classified as high-calorie foods: instant noodles, fast foods, carbonated beverages, fried snacks, and sweet snacks. Each household member was asked how many days during the week prior to the interview (s)he consumed a specific food item. The mother was usually the person who answered these questions for children younger than the age of 11.[20] We computed "consumption of high-calorie foods" as the sum of weekly consumption frequency of the 5 high-calorie foods, which yielded a scoring range of 0 to 35. This score provides only a qualitative assessment of intake because it does not assess the portion and the exact nutrients the foods consisted of. Therefore, any analytical result of this variable should be interpreted carefully. Only scores for children aged 2 to 19 were computed, because of the different feeding patterns of children younger than the age of 2.

Explanatory Variables

Four explanatory variables were used: "sex", "birth order," "number of siblings," and "mother's education." We used sex as a dummy variable for gender (0 = girls, 1 = boys). Recent studies on overweight in children indicate that the effects of birth order on overweight are most likely nonlinear.[10,11,13,15] Hence, we grouped children who currently lived in the household into 3 categories: eldest, mid-child, and youngest. Unfortunately, assigning these type of birth order dummies cannot convincingly disentangle the effects of birth order from that of number of siblings.[31] Therefore, we applied within-family centered birth order dummies to better address the problem. The transformation process is as follows:

Suppose n_i is "number of siblings" for child i and d_{im} is the birth order dummy for child i born to family m; we computed the within-family mean of each birth order dummy $\bar{d}_i = 1/n_i \times \sum d_{im}$. We then subtracted $\bar{d}_i$ from

d_{im}, such that the within-family centered birth order dummy became $d_{im}^* = d_{im} - \bar{d}_i$. We did the transformation for all 3 birth order dummies. For families with an "only child" or without a sibling, the 3 transformed birth order dummies are null. In families with 2 children, only the transformed mid-child dummy is null. The approach therefore emulates within-family fixed effects, but without the need to exclude families with 2 children or less.[56] It also avoids assigning "only child" as "eldest," which was problematic in previous studies.[15]

"Mother's education" is measured by the number of years the mother spent in school at the time of interview. This could take a value of between 0 (never went to school) and 12 years (of at least high school graduate). We assigned 12 years of education for mothers who had some years of tertiary education or hold a degree. In the multivariate analyses, we centered mother's education between families to better guide the interpretations and to reduce multicollinearity, particularly with number of siblings.

Control Variables

We followed previous studies in including "child's age" (in years), "birth weight" (5 groups: <2.5 kg, 2.5-<3 kg, 3-<3.5 kg, 3.5-<4 kg, ≥4 kg), and "maternal overweight" (0 if BMI < 25, 1 if BMI ≥ 25) as control variables.[11,57,58] Birth weight need to be included to control for prenatal biological factors (eg, maternal weight at time of gestation and weight gain during gestation) that might confound the risk of overweight in children. We further used quintile dummies of nominal personal consumption expenditure (PCE) to control for confounding effects of household SES on overweight in children. The procedure to develop PCE for these SES dummies was taken from Witoelar.[59] In addition, we included residential area of urban versus rural and also Java-Bali vs outside Java-Bali. Java-Bali areas are more developed than other areas in Indonesia. Lastly, we included month of interview (bimonthly fixed-effects). These last 2 control variables used to control for unobserved spatial (residential area) and temporal effects (bimonthly

fixed-effects) of nutrient intake and energy expenditure.

Analyses

The analyses were structured in 4 steps. We started with model 1, which is a basic logistic regression model analyzing the main effects of the explanatory variables on overweight. Model 1 tested sibling inequalities and the direct effects of mother's education on overweight (H1). A simplified notation for model 1 is as follows:

$$
\begin{aligned}
\text{logit}(p_{im}) = {} & \beta_0 + \beta_1 \text{sex}_{im} + \beta_2 \text{border}_{im} \\
& + \beta_3 \text{nsib}_m + \beta_4 \text{medu}_m \quad (1) \\
& + \beta_5 X_{im} + \varepsilon_{im}
\end{aligned}
$$

where $\text{logit}(p_{im})$ is the logit function of overweight for child i born in family m, sex_{im} is gender dummy, border_{im} are within-family centered birth order dummies, nsib_m is the number of siblings, medu_m is mother's education, X_{im} is a vector of control variables, and the residuals ε_{im}.

In the following, models 2 to 4, we sequentially added interactions of mother's education with gender, birth order, and number of siblings. Models 2 to 4 tested the role of mother's education in explaining sibling differences in overweight (H2). The models tested whether there were different effects of gender, birth order, and number of siblings on overweight according to maternal education. These "moderating effects analyses" thus evaluated whether more years spent in school by mothers buffered, aggravated or did not change the effect of gender, birth order, and number of siblings on overweight.

$$
\begin{aligned}
\text{logit}(p_{im}) = {} & \beta_0 + \beta_1 \text{sex}_{im} + \beta_2 \text{border}_{im} \\
& + \beta_3 \text{nsib}_m + \beta_4 \text{medu}_m \\
& + \beta_5 (\text{sex}_{im} \times \text{medu}_m) \quad (2) \\
& + \beta_6 X_{im} + \varepsilon_{im}
\end{aligned}
$$

$$
\begin{aligned}
\text{logit}(p_{im}) = {} & \beta_0 + \beta_1 \text{sex}_{im} + \beta_2 \text{border}_{im} \\
& + \beta_3 \text{nsib}_m + \beta_4 \text{medu}_m \\
& + \beta_5 (\text{sex}_{im} \times \text{medu}_m) \quad (3) \\
& + \beta_6 (\text{border}_{im} \times \text{medu}_m) \\
& + \beta_7 X_{im} + \varepsilon_{im}
\end{aligned}
$$

$$\begin{aligned}
\text{logit}(p_{im}) = \; & \beta_0 + \beta_1 \text{sex}_{im} + \beta_2 \text{border}_{im} \\
& + \beta_3 \text{nsib}_m + \beta_4 \text{medu}_m \\
& + \beta_5 (\text{sex}_{im} \times \text{medu}_m) \\
& + \beta_6 (\text{border}_{im} \times \text{medu}_m) \\
& + \beta_7 (\text{nsib}_m \times \text{medu}_m) \\
& + \beta_8 X_{im} + \varepsilon_{im}
\end{aligned} \quad (4)$$

We considered a model among models 1 to 4 as parsimonious, if the model had the lowest AIC (Akaike Information Criterion), while retaining the smallest number of parameters.[60] We added 2 additional analyses. The first is to analyze the role of mother's education in differing consumption of high-calorie foods within siblings, while the second is to compare moderating effects of mother's education to those of SES on sibling inequalities in overweight. Results for these 2 analyses were based on the most parsimonious models of models 1 to 4.

In the first set of the additional analyses, we examined sibling inequalities and the role of mother's education in the consumption of high-calorie foods. We carried out the analyses by substituting the dependent variable of the most parsimonious model with the consumption of high-calorie foods score. We used multivariate linear regressions for these analyses.

The second set of additional analyses was carried out to settle concerns that the effects of mother's education on children's nutritional status could be spurious.[18,19] This is because mothers who had more years in school are mostly from high SES families. The concerns can be difficult to test in setups where mother's education and SES are only placed as main effects. However, as shown in models 2 to 4, our foremost interest was in the moderating effects of mother's education. Therefore, by substituting interactions of mother's education with SES, we could evaluate whether the moderating effects of mother's education differed from those of SES. We used 2 specifications of SES for this second additional analyses: linear specification of SES and *ln*(PCE).

All multivariate analyses that we applied used cluster-robust standard errors at the family level. This is to correct for estimation bias, due to clustering involving within-family unobserved correlations.

Results

Table 1 presents bivariate analyses of children's characteristics and overweight. The results indicate that the proportion of boys in the "overweight" group was significantly higher than that of girls (odds of boys vs girls: 0.19 vs 0.17). There were also significant differences between the "nonoverweight" and the "overweight" groups in terms of birth order, child's age, and birth weight. Compared to being a middle child, being the eldest or the youngest was associated with higher odds of overweight (odds of eldest vs mid-child vs youngest: 0.18 vs 0.12 vs 0.20). As indicated by the mean age, younger children were more likely to be overweight than older children. This can be interpreted in 2 ways. First, children were less likely to be overweight when they grew up (age effects) and second, children of the younger cohorts, for any cohort-related reason (ie, greater adherence to high-calorie diets, and being less physically active), had higher odds of being overweight than children from older cohorts (cohort effects). Table 1 suggests that heavier babies have increasing odds of being overweight as a child (eg, <2.5 kg vs ≥4 kg: 0.14 vs 0.24). This evidence concurs with other studies, which found a positive link between birth weight and overweight in children.[58]

Table 1 shows that there was no significant difference in the consumption of high-calorie foods between the "nonoverweight" and the "overweight" groups ($P = .667$). A reverse causality might disguise the expected link between consumption of high-calorie foods and overweight. Perhaps overweight children reduce how often they consume high-calorie foods, including the portion, in order to manage their weight. The empirical verification of this reverse causality requires future study. For the current study, we assume that consuming high-calorie foods increases the odds of overweight.

Table 2 shows bivariate analyses of family characteristics and overweight. The table suggests that those who had fewer siblings, were children of mothers with more school years, and

Table 1. Bivariate Analyses of Children's Characteristics and Overweight.

Children's Characteristics	Nonoverweight N = 5696	n (%)	Overweight N = 1027	n (%)	Odds[a]	P value[b]
Sex						
Boys	2847	49.9	550	53.5	0.19	.035
Girls	2849	50.1	477	46.5	0.17	
Birth order						
Eldest	3100	54.5	562	54.8	0.18	.001
Mid-child	605	10.6	71	6.9	0.12	
Youngest	1991	34.9	394	38.3	0.20	
Age[c]	8.0	5.12	7.4	5.09		.001
Birth weight						
<2.5 kg	461	8.1	62	6.0	0.13	<.001
2.5-<3 kg	1335	23.5	203	19.8	0.15	
3-<3.5 kg	2360	41.5	423	41.1	0.18	
3.5-<4 kg	1155	20.2	247	24.1	0.21	
≥4 kg	385	6.7	92	9.0	0.24	
Consumption of high calorie[c,d]	9.8	5.39	9.9	5.31		.667

Abbreviation: SD, standard deviation.
[a]Odds of overweight for each category: odds = N overweight/N nonoverweight.
[b]χ^2 test for categorical variables or *t* test for continuous variables.
[c]Mean with SD in parentheses.
[d]Children older than 2 years of age, N nonoverweight = 4996, N overweight = 847.

were children whose mother were overweight—a proxy for the unhealthy lifestyle of the mother—were more often found to be overweight. This also applied for children of higher SES families (eg, odds Q1 vs Q5: 0.14 vs 0.40). The results also reveal that those who lived in rural areas or in less developed areas outside Java-Bali were less likely to be overweight. Perhaps the manual labor activities that characterize life in these areas require high-energy expenditure by its inhabitants, including children. The regions outside Java-Bali are largely remote, meaning that market infiltration of high-calorie foods is probably less intense. More overweight children were found in the March to August interviews. This could be an indication of seasonal effects on overweight. Future studies have to fully uncover such seasonal effects, because the data that this study used are cross-sectional data from a single IFLS wave.

Table 3 consists of multivariate analyses of models 1 to 4. Adjusted for the control variables, the main effects in model 1 support the evidence of sibling inequalities in overweight of Tables 1 and 2, with the exception of gender. Although model 1 indicates that boys were at higher odds of overweight than girls, this was not significant (adjusted odds ratio [AOR] = 1.125). Gender differences in overweight emerged when an interaction with mother's education was introduced from model 2 onward. Model 2, for example, shows that boys whose mothers spent more years in school had higher odds of overweight than girls (AOR = 1.052, $P < .05$). In model 3, mother's education aggravated effects of birth order. This was shown in increased odds of overweight of the eldest by 16.6% for each additional year of mother's education (model 3: AOR = 1.166, $P < .05$). Multiway interactions of gender, birth order, and number of siblings were not significant—results are available upon request. Therefore, Table 3 only consists of models 1 to 4. Model 3 is the most parsimonious, because even though it has a marginally higher AIC (ΔAIC = 0.661), but has one parameter less than model 4: "number of siblings × mother's education," which was not significant either (AOR = 0.981). Model 3 therefore became the base model for further analyses.

Table 4 sums up the first additional analyses examining the consumption of high-calorie foods

Table 2. Bivariate analyses of Family Characteristics and Overweight.

Family Characteristics	Nonoverweight		Overweight		Odds[a]	P value[b]
	N = 5696	n (%)	N = 1027	n (%)		
Number of siblings[c]	2.1	0.01	2.0	0.03		.002
Sibling size						
1 (only child)	1617	28.4	322	31.4		.049
2	2561	44.9	464	45.2		
3 or more	1518	26.7	241	23.5		
Mother's education (years)[c]	8.8	3.22	9.5	3.16		<.001
Matenal overweight						
No	3177	55.9	445	43.4	0.14	<.001
Yes	2504	44.1	581	56.6	0.23	
SES dummies						
Q1	1460	25.7	206	20.1	0.14	<.001
Q2	1414	24.9	204	19.9	0.14	
Q3	1270	22.4	216	21.1	0.17	
Q4	1060	18.7	209	20.4	0.20	
Q5	477	8.4	191	18.6	0.40	
ln(PCE)	13.6	0.56	13.7	0.64	<0.001	
Residential area						
Urban	3493	61.5	722	70.4	0.21	<.001
Rural	2188	38.5	304	29.6	0.14	
Java-Bali	4155	73.1	815	79.4	0.20	<.001
Outside Java-Bali	1526	26.9	211	20.6	0.14	
Month of interview						
January-February	1366	24.1	240	23.4	0.18	<.001
March-April	890	15.7	200	19.5	0.22	
May-June	497	8.8	122	11.9	0.25	
July-August	257	4.5	74	7.2	0.29	
September-October	1030	18.1	153	14.9	0.15	
November-December	1641	28.9	237	23.1	0.14	

Abbreviations: PCE, personal consumption expenditure; SD, standard deviation; SES, socioeconomic status.
[a]Odds of overweight for each category: odds = N overweight/N nonoverweight.
[b]χ^2 test for categorical variables or t test for continuous variables.
[c]Mean with SD in parentheses.

as the channel through which mother's education may cause sibling inequalities in overweight. Models 3A to 3C are based on model 3, but we substituted "consumption of high-calorie foods" for "overweight" as the outcome variable. However, no interaction effects were significant in model 3A (2-19 years). Assuming that the age of children may play a role in when mothers allow their boys and girls to consume high-calorie foods, we developed models 3B to 3C, in which the same analysis is carried out, but for children older than 5 years old in model 3B, and older than 7 years old in model 3C.

The main effect consistently shows that boys consume high-calorie foods more often than girls (model 3A = 0.400, P < .01). Evidence emerged that the eldest consumes high-calorie foods more often, but the evidence for this is relatively weak since it was only significant in model 3B (b = 0.605, P < .05). Overall, children whose mothers had more school years consume high-calorie foods less often (eg, model 3B: b = –0.089, P < .01), but this did not apply to boys. Models 3B to 3C indicate that boys consume high-calorie foods more often for each additional year that the mother spent in school. This pattern seems to be significant from late childhood onward (model 3B: b = 0.102, P < .05) and increases visibly when children enter school age (model 3C: b = 0.132, P < .01). This is the only

Table 3. Main Effects and Moderating Effects of Explanatory Variables on Overweight.[a]

Explanatory Variables	Model 1		Model 2		Model 3		Model 4	
	AOR	SE	AOR	SE	AOR	SE	AOR	SE
Interaction effects								
Sex × mother's education[b]								
Girls			1.000	.	1.000	.	1.000	.
Boys			1.052	0.026[c]	1.053	0.026[c]	1.052	0.025[c]
Birth order[d] × mother's education[b]								
Eldest					1.161	0.071[c]	1.162	0.068[e]
Middle					1.000	.	1.000	.
Youngest					1.045	0.058	1.053	0.055
Number of siblings × mother's education[b]							0.981	0.014
Main effects								
Sex								
Girls	1.000	.	1.000	.	1.000	.	1.000	.
Boys	1.125	0.079	1.095	0.079	1.089	0.078	1.093	0.078
Birth order[d]								
Eldest	1.420	0.232[c]	1.419	0.234[c]	1.280	0.219	1.300	0.220
Middle	1.000	.	1.000	.	1.000		1.000	.
Youngest	1.560	0.245[e]	1.565	0.245[e]	1.533	0.242[e]	1.548	0.241[e]
Number of siblings	0.888	0.039[e]	0.887	0.039[e]	0.881	0.039[e]	0.884	0.039[e]
Mother's education[b]	1.033	0.014[c]	1.007	0.018	1.018	0.019	1.058	0.035
Control variables included?	Yes		Yes		Yes		Yes	
N of children	6723		6723		6723		6723	
N of families	4784		4784		4784		4784	
Pseudo-R^2	0.048		0.049		0.052		0.052	
AIC	5516.942		5513.932		5504.549		5504.113	

Abbreviations: AIC, Akaike Information Criterion; AOR, adjusted odds ratio; SES, socioeconomic status.
[a]AORs are odds ratio adjusted for control variables: child's age, birth weight, maternal overweight, SES dummies, residential area, and month of interview. Cluster-robust standard errors at family level in parentheses.
[b]Between-families centered mother's education.
[c]$P < .01$.
[d]$P < .05$.
[e]Within-family centered birth order dummies.

pattern we found that reflects the moderating effects of mother's education on sibling inequalities in overweight. Models 3A to 3C do not reveal a moderating effect of mother's education on birth order inequalities in the consumption of high-calorie foods.

Table 5 summarizes the second set of additional analyses, examining if the moderating effects of mother's education on sibling inequalities in overweight were different to those SES. Two specifications of SES were used in model 3D (linear specification of SES) and in model 3E (ln(PCE)). Table 5 shows that SES shared no similarity to that of moderating effects of mother's education on sibling inequalities in overweight. None of the interaction effects with

gender, birth order, or number of siblings were significant. Unlike model 3, we also observed that the main effects of birth order on overweight are not significant. Furthermore, Models 3D to 3E are also less meaningful than the parsimonious model 3, because these models have a substantially poorer goodness-of-fit (ΔAIC > 10, eg, model 3E vs model 3 = 5690.484-5504.549).

Discussion and Conclusion

We can now summarize our results in 2 groups of main findings. First, we found that the eldest and the youngest were more likely to be overweight than middle children. We also found that children who had fewer siblings were at higher odds of

Table 4. Main Effects and Moderating Effects of Mother's Education on Consumption of High-Calorie Foods.[a]

Explanatory Variables	Model 3A		Model 3B		Model 3C	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Interaction effects						
Sex × mother's education[b]						
Girls	Reference	.	Reference	.	Reference	.
Boys	0.034	0.043	0.106	0.050[c]	0.145	0.053[d]
Birth order[e] × mother's education[b]						
Eldest	0.049	0.081	0.01	0.089	0.039	0.094
Mid-child	Reference	.	Reference	.	Reference	.
Youngest	0.026	0.074	0.04	0.085	0.076	0.090
Main effects						
Sex						
Girls	Reference	.	Reference	.	Reference	.
Boys	0.400	0.139[d]	0.519	0.167[d]	0.589	0.185[d]
Birth order[e]						
Eldest	0.495	0.271	0.605	0.301[c]	0.547	0.317
Mid-child	Reference	.	Reference	.	Reference	.
Youngest	−0.026	0.260	0.215	0.303	0.243	0.328
Number of siblings	0.362	0.103[d]	0.368	0.110[d]	0.412	0.115[d]
Mother's education[b]	−0.083	0.033[c]	−0.089	0.038[c]	−0.117	0.041[d]
Control variables included?	Yes		Yes		Yes	
N of children	5827		4195		3534	
N of families	4255		3227		2765	
R^2	0.022		0.029		0.035	
R^2-adjusted	0.018		0.023		0.027	

Abbreviation: SES, socioeconomic status.
[a]Coefficients are coefficients adjusted for control variables: child's age, birth weight, maternal overweight, SES dummies, residential area, and month of interview. Cluster-robust standard errors at family level in parentheses. Model 4A (2-19 years), model 4B (5-19 years), and model 4C (7-19 years).
[b]Between-families centered mother's education.
[c]$P < .01$.
[d]$P < .05$.
[e]Within-family centered birth order dummies.

overweight. In addition, the more years of formal education the mother had would increase rather than reduced the chances of overweight. However, we did not find that overweight varied by gender. These results, except for gender, supported H1 that sibling inequalities and mother's education affect overweight in children. Second, we found evidence supporting H2 that mother's education aggravated sibling inequalities in overweight. When the interaction terms of mother's education and gender were introduced, gender inequality in overweight became evident. Unlike girls, boys whose mother spent more years in school were at higher odds of overweight than girls. This was also the case for eldest children.

Nevertheless, mother's education did not influence overweight for youngest children or for children with only a few siblings.

Two additional findings emerged. First, we demonstrated that mother's education aggravated gender inequality in the consumption of high-calorie foods. To a certain extent, this pattern reflected our second series of main findings (H2). We found that, overall, boys consumed high-calorie foods more often than girls, but boys whose mothers spent more years in school consumed high-calorie foods even more often. This appeared to increase from late childhood onward (>5-19 years of age). However, as opposed to our second series of main findings, evidence of birth

Table 5. Moderating Effects of Different Specification of SES on Overweight.[a]

Explanatory Variables	Model 3D		Model 3E	
	AOR	SE	AOR	SE
Interaction effects				
Sex × SES[b]				
Girls	1.000	.		
Boys	1.058	0.059		
Birth order[c] × SES[b]				
Eldest	1.088	0.138		
Middle	1.000	.		
Youngest	1.031	0.122		
Sex × ln(PCE)				
Girls			1.000	.
Boys			1.228	0.159
Birth order[c] × ln(PCE)[b]				
Eldest			1.310	0.402
Middle			1.000	.
Youngest			1.127	0.328
Main effects				
Sex				
Girls	1.000	.	1.000	.
Boys	0.953	0.170	0.067	0.119
Birth order[c]				
Eldest	1.091	0.444	0.035	0.145
Middle	1.000	.	1.000	.
Youngest	1.444	0.541	0.308	1.226
Number of siblings	0.883	0.039[d]	0.885	0.039[d]
SES[b]	1.152	0.049[d]		
ln(PCE)			1.345	0.137[d]
Other control variables included?	Yes		Yes	
N of children	6723		6723	
N of families	4784		4784	
Pseudo-R^2	0.044		0.045	
AIC	5696.279		5690.484	

Abbreviations: AIC, Akaike Information Criterion; AOR, adjusted odds ratio; PCE, personal consumption expenditure; SES, socioeconomic status.

[a]AORs are odds ratio adjusted for control variables: child's age, birth weight, maternal overweight, mother's education, residential area, and month of interview. Cluster-robust standard errors at family level in parentheses.

[b]Linear specification of SES in which SES quartile was treated as a continuous variable.

[c]Within-family centered birth order dummies.

[d]$P < .05$.

order inequalities in the consumption of high-calorie foods is weak. Furthermore, there was no convincing evidence that more educated mothers aggravated birth order effects in the consumption of high-calorie foods either. We found that, when adjusted for control variables (including SES), consumption of high-calorie foods increased with more siblings. This might indicate that more siblings reduce supervision of children's diet. Second, we showed that the moderating effects of mother's education are different from those of SES. This suggests that the moderating effects are likely to be associated with the extent of the agency of educated mothers had, that is, influencing children's diets and lifestyle, rather than purely SES background.[44,46]

Our main findings confirm previous studies on sibling inequalities in overweight, that is, by

gender—after being moderated by mother's education—birth order, and number of siblings.[10-15] On the main effects of mother's education, studies in developed countries suggest that children whose mother had more years school years are less likely to be overweight.[12,48,49] Most of these studies did not explicitly explain the mechanisms underlying this effect. For example, a study by Apouey and Geoffard in France[49] relied on Drewnowski and Specter,[7] and Baker et al[8] on using mother's education interchangeably with family SES—with which we cannot fully agree, based on Table 5. They inferred that French children whose mothers spent more years in school were less likely to be overweight, because they came from higher SES families, which were likely to have had better access to healthier nutrient-dense foods.

Literature from developing countries has, however, suggested the opposite. Given their phase in the nutrition transition, in developing countries, overweight is still more the problem of higher SES families rather than that of the poor.[6,61] Our study supports this. A small-scale study in Bogor, Indonesia, also found that children whose mothers spent more years in school were more often overweight.[50] This strongly suggests that the effects of mother's education on overweight in children differs across contexts, in this case across, that is, developed versus developing countries.

In both developed and developing countries, mothers who had more school years may share the same trait of being open to new diets and nutrition innovations,[45,46] but it might work out differently, depending on the stage in the global nutrition transition.[26,27] Developing countries are most likely in the fourth stage of the global nutrition transition. In this stage, high-calorie diets become increasingly popular. Perhaps openness to new diets and nutrition innovations place educated mothers in developing countries at the forefront in terms of adopting unhealthy diets for their children. This may work the opposite way in developed countries, which are mostly in the fifth stage of the global nutrition transition. At this stage, educated mothers might help their children to practice healthy eating habits and a more active lifestyle.

In our study, the odds of overweight were higher for boys whose mother spent more years in school. Our first additional findings provided an explanation for this, by signaling a much higher consumption of high-calorie foods by boys. Perhaps social norms accompanying the body image that girls should be slim is the reason behind these gender differences.[41] To conform with the norm, mothers might limit consumption of high-calorie foods by their daughters but, concurrently, be less restrictive with their sons. Our findings indicated that educated mothers, those who had more years of formal education, exercised this agency even more, and thereby produced a greater gender gap in overweight. This may be beneficial for girls of educated mothers, but it is certainly harmful to boys.

For birth order, our findings were similar to the study by Ochiai et al in Japan,[11] in that the eldest and the youngest had higher odds of overweight than middle children. However, a study in rural China showed results that differed from ours, that is, higher odds of overweight in later born children, but not in the eldest.[14] We cannot therefore firmly confirm that the "neglected middle-child hypothesis" applies universally. We examined birth order inequalities further and found that mother's education increased the odds of overweight for the eldest, but not for the youngest. This means that, while it was nonconditional for the youngest, certain characteristics linked to mother's education gave the eldest more exposure to overweight. Perhaps this was bound to the main activity of the eldest. As the role model for their younger siblings, educated mothers might encourage the eldest to stay in school longer, and enter employment at a much later age. A focus on school, with no need to enter employment early, probably lowers the eldest's physical activity and calorie expenditure. The opposite might apply to the eldest children of less-educated mothers. They might exit school earlier and immediately enter employment. This is not necessarily because they need to support the family economy, but this can also be because the family places less value on education. With their lower educational level, the eldest can only achieve intensive manual labor roles. These types of jobs burn more calories, thus preventing them from being overweight. These

are tentative hypotheses, which require further analyses that go beyond the scope of this study.

Without evidence of moderating effects of mother's education, the results on the relation between the number of siblings and overweight are easier to interpret. Having more siblings meant being less likely to be overweight, and vice versa (Table 3). This confirms previous studies, which found that children of small families—particularly those without siblings or who were an "only child"—were more often overweight.[10,11,13,15] Two mechanisms were suggested for this association, which link number of siblings and overweight. First, derived from resource dilution theory, more siblings signifies more mouths to feed. With finite parental resources, this means that children of larger families receive a smaller share of the food available than those of smaller families, but the positive side is that this could prevent children from being overweight. Second, more siblings mean more physical activity, that is, more group play.[34] A physically active lifestyle burns more calories and helps children maintain a healthy weight. In the Indonesian context, the second mechanism seems to be more applicable. This is because our study shows a negative association of number of siblings and overweight (see Table 3), but a positive association between number of siblings and consumption of high-calorie foods (see Table 4).

We acknowledge that this study has a number of limitations. Among these are, first of all, the fact that we relied on the cross-sectional design of IFLS-5 (2014/2015). This approach allowed us to portray the recent phenomena of overweight among Indonesian children, but limited us to disentangle age effects from those of cohort effects. Based on their study in France, Apouey and Geoffard[49] suggested that birth cohort might differentiate overweight in children. Future studies should therefore take this into consideration by, for example, by pooling additional data from multiple IFLS waves and exploiting its longitudinal design. This longitudinal design should also unlock the possibility to investigate changes in the relationships of mother's education, sibling inequalities, and other factors (eg, demographics, income, source of food purchase, and family dynamics) on overweight in children. Second,

we focused on analyzing the moderating effects of mother's education. To reduce complexity in interpreting the results, we assumed that the effects of mother's education were linear. Our results suggested that there were indeed linear main and moderating effects of mother's education. However, this was without examining non-linear specifications of mother's education, which could also be important.[12,48,49,62] This is another area on which future studies could shed more light. Third, although we identified the moderating effects of mother's education on gender inequality in overweight, as reflected in the consumption of high-calorie foods, our explanation of the social pressure that girls should be slim is rather tentative. This is a call for further studies, probably using more qualitative methods, to examine our proposed explanation. Fourth, similar to the third limitation, we explained the moderating effects of mother's education in overweight of the eldest based on rough theories. We proposed that the pressure to study and remain at school longer may expose the eldest children of educated mothers more to overweight. However, future studies are required to uncover the true mechanisms. Fifth, aside from the consumption of high-calorie foods, we included physical activity in our discussion. Unfortunately, even the latest IFLS-5 (2014/2015) does not have data or good proxies for calories burned through physical activities. It limited us to testing alternative channels from which overweight in children might develop. These analyses are critical for knowledge building on overweight issues in children. Therefore, we suggest that future studies should also collect and analyze data on physical activity and lifestyle. Sixth, the educational level of the father is completely absent in this study. It would be interesting for future studies to examine the role of father's education on overweight in children, and whether this is similar to the mother, or more closely mirrors that of SES. Lastly, we did not explicitly study the effects of mother's education in extended family settings, where grandparents might also participate in taking care of children, or in settings where employed mothers may delegate the caregiver roles to others. Indeed, a previous study in Indonesia suggested that the mother's influence on

child health was significantly greater than that of the father and grandparents.[42] However, the mother's influence in that particular study was proxied by household assets under the mother's authority. Would the same results hold for mother's education? This is a question that a future study must address.

In conclusion, we found that the eldest and youngest children, and children from small families, were more likely to be overweight in Indonesia. In contrast to evidence from developed countries that mother's education reduced the chance of overweight,[12,48,49] children of educated Indonesian mothers experienced the opposite. They were more often overweight. This effect was greater for boys and for eldest children. Overconsumption of high-calorie foods by boys of educated mothers, and a tentative explanation of adherence to a less physically active lifestyle among eldest children of educated mothers, might explain these phenomena. These results should inform governments, policy, and practice communities in developing countries, and particularly in Indonesia, that target groups for nutrition interventions to counteract overweight in children should not exclude educated mothers and their children, particularly boys. Stimulation of a more active lifestyle for the eldest and youngest children, and for children of small families should be integrated in programs. Educating mothers, including those who had more years of formal education, to better supervise their boys' diet should also be high on the agenda.

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