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Birth weight and body composition in 6-to-8 years old Maya children

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ABSTRACT

Objective: To test the hypothesis that fetal growth, indexed by birth weight (BW), induce metabolic adjustments in the fetus that will be reflected in differences in body composition in a sample of 6-to 8-years old urban Maya children from Yucatan, Mexico.

Methods: We measured height (cm), weight (kg) and triceps skinfold (mm) in 260 children (boys: 132, girls: 128), and height (cm) and weight (kg) in their mothers. Body composition was estimated in children through bioelectrical impedance analysis. Outcome variables were fat free-mass index (FFMI= fat-free mass [kg]/height [m]²) and fat mass index (FMI= fat mass [kg]/height [m]²). The main independent variable was BW z-scores. Multiple linear regression models were used to analyze the association between BW z-scores and outcome variables measured during childhood. Separate analyses were done for boys and girls. Complementary models were run using outcomes as z-scores. Models were adjusted for location, children's and mothers' age, mother's body mass index and household overcrowding index.

Results: BW in boys was positively associated with FFMI and FMI. FFMI increase 0.34 kg/m² per 1-SD increase in BW and FMI increase 0.40 kg/m² per 1-SD increase in BW. When outcomes were used as z-scores, FFMI increase 0.24 SD and FMI increase 0.18 SD per 1-SD increase in BW, respectively.

Conclusion Our results are in contrast with previous findings that birth weight is more consistently associated with subsequent lean mass than with fat mass. Associations, detected only in boys, may be explained by sex differences in sensitivity to early life environments.

Key words: birth weight, body composition, phenotypic induction, Maya

INTRODUCTION

Phenotypic induction, also known as programming, has been defined as the capacity of any environmental stimuli, present during critical stages of early development, to generate long-term effects on the structure or physiology of the organism (Bateson, 2001). Phenotypic induction has been recognized as a process that links early life experiences with cardiometabolic diseases in adulthood (Wells, 2012), and elements of body composition (e.g. lean and body fat mass) seem to play an important role shaping disease susceptibility in individuals (Calella, Galle, Fornelli, Liguori, & Valerio, 2020; Latt, Mäestu, & Jürimäe 2018).

Conditions experienced during intrauterine development are particularly relevant in the induction or programming of body composition and metabolism during postnatal life (Wells, Chomto, & Fewtrell, 2007). Birth weight, a crude parameter for fetal growth, has been commonly used as a proxy measure of the quality of nutritional conditions experienced by the organism during gestation. During the first months of pregnancy, the mother provides the nutrients and oxygen required for the formation and growth of vital and metabolically relevant organs, as well as muscle tissue development (Bogin, 1999). During the last stage of pregnancy, nutrients transferred to the fetus start to be accumulated in fat deposits to prepare for the several challenges of postnatal life, including termoregulation and the transition from placental to oral nutrition (Kuzawa, 1998).

Several studies have analyzed the relationship between birth weight and body composition at different stages of postnatal life. Studies have consistently shown positive associations between birth weight and subsequent lean body mass and a smaller number of studies have shown associations (both positive and negative) with body fat mass (Wells et al., 2007). Some studies have found that birth weight is associated with body fat only in females (Li, Stein, Barnhart, Ramakrishnan, & Martorell, 2003; Sachdev et al., 2005; Rogers et al., 2006). Most of studies associating size at birth with body composition during childhood have been conducted in populations from high-income countries, mainly in the UK and the USA (Okosun, Liao, Rotimi, Dever, & Cooper, 2000; Fewtrell, Lucas, Cole, &

Wells, 2004; Rogers et al., 2006). Fewer studies have addressed the link between birth weight and body composition outcomes among indigenous populations in low- and- middle income countries (Bavdekar et al., 1999; Li et al., 2003), whose chronic disadvantaged living conditions strongly impact maternal nutritional phenotype and their offspring size at birth.

The period of growth during which the organism is exposed to a given environment appear to be important in the induction of body composition outcomes. The intrauterine stage seems to be particularly important in the induction of lean body mass given that organogenesis occurs during this period. In contrast, the first years of postnatal growth are relevant in the induction of fat mass due to exposure to greater number of environmental factors that impact metabolism (Wells, 2007a). However, nutritional environment during gestation may induce variability in body fatness in postnatal life through long term changes in the regulation of several components of energy balance (Metges, 2009).

Whitin the framework of human biology, the rationale for this study is to contribute to the understanding of how conditions experienced at early stages of development shape variation in phenotype during childhood, in populations with a long history of poverty and who are currently experiencing abrupt changes in their lifestyle, such as the Maya.

The Maya are the largest indigenous group in the American continent (CDI, 2017). The Yucatan Peninsula, in Mexico, is home to a great number of Maya people resident in urban and rural communities (INEGI, 2015a). The Maya population of Yucatán has lived, since Colonial times, in conditions of serious poverty and oppression. During the European domination, the Maya lived under a political system that functioned on the basis on a slave-like payment tribute system and forced labor. Following the Mexican Independence, during the 19th century and up to the 1920's, a large number of Maya were employed in the production of sugar cane, livestock and the sisal agro-industry, but their living conditions did not improve (Bracamonte, 2007). Since the second half of the 20th century, a considerable proportion of Maya people moved into very low paid jobs in urban

settings, due to the collapse of the sisal industry and government policies relating to national and global economy (Ramírez-Carrillo, 2020). Recent estimations suggest that almost 70% of Maya families live in conditions of poverty (Bracamonte & Lizama, 2006). In urban locations, the Maya work mostly in construction, manufacturing, domestic, commercial and transport jobs, as low-wage employees. Their long history of marginalization and poverty have contributed to the presence of high rates of chronic undernutrition (Dickinson, Cervera, Murguía & Uc, 1990) and their recent integration into the national and global consumer market has increased the rates of overweight and obesity in children and adults (Bogin, Avila-Escalante, Castillo-Burguete, Azcorra, & Dickinson, 2020). Besides, Maya infants from Yucatan show lower mean values of birth weight than their non-Maya counterparts (Azcorra, Vázquez-Vázquez, Méndez, Salazar, & Datta Banik, 2016).

In this study we aim to test the hypothesis that fetal growth, indexed by birth weight, induce metabolic adjustments in the fetus that will be reflected in differences in body composition during childhood. We test this hypothesis in a sample of 6-to 8-years old urban Maya children from Yucatan. This study also aims to contribute to the debate about the factors that may explain the high rates of adiposity among the Maya. We have previously reported that around 30% of children of this sample met the criteria for excessive values of body mass index (BMI), waist circumference and triceps, suprailiac and subscapular skinfolds (Azcorra et al., 2019). We now add other body composition measures to further the discussion on early factors involved in the programming of body composition parameters during childhood.

METHODS

Data used in this study was withdrawn from a cross-sectional and intergenerational research project conducted between September 2011 and January 2014 in the state of Yucatan, in Mexico. This included 260 Maya children (6-to-8 years old) and their biological mothers from the cities of Merida (the capital city) and Motul. By 2015, Merida was inhabited by 892,363 people, with a Maya population of around 11%. Motul, located in the north-central region of the state, was, in 2015, inhabited

by 36,097 people; 25% of them were Maya (INEGI, 2015a). Merida and Motul differ in population size and in some aspects of economic activities, but children's families in our sample from both locations are not different in any relevant socioeconomic characteristics, such as mean family size (Merida: 5.14 vs Motul: 5.02), number of offspring (Merida: 2.42 vs Motul: 2.43) and mean of household overcrowding index (Merida: 3.01 vs Motul: 3.25). In both cities, the mother-child dyads were recruited in primary schools attended by the children. In Merida, participants were recruited in 47 schools from low-income neighbourhoods, with a high concentration of Maya families. In Motul, the mother-child dyads were recruited in the 12 public primary schools of the city. According to the National Institute of Geography and Statistics, 98.7% of children between 6 and 11 years of age in Yucatan attend primary school (INEGI, 2015b), and the percentage of attendance in urban setting, such as Merida and Motul is higher. Therefore, we are certain that all children meeting the inclusion criteria similar had the same chances to be included in the study. The presence of maternal and paternal Maya surnames in children and their mothers was used as the criteria to attribute Maya ancestry. This is a common way to attribute ancestry and has been explained in details elsewhere (Colantonio, Lasker, Kaplan, & Fuster, 2003; Relethford, 1995).

Physical measurements and body composition

Children's height (cm), weight (kg) and triceps skinfold (mm), and their mothers' height (cm) and weight (kg) were measured following standardized procedures (Lohman, Roche, & Martorell, 1998). Bioelectric impedance analysis (BIA) was conducted in children using a portable Bodystat 1500 Monitoring Unit to estimate body composition indicators, using equations developed by Ramirez et al. (2012). We estimated fat-free mass (FFM) and fat mass (FM) and then converted to fat-free mass index ($FFMI = FFM [kg]/height [m]^2$) and fat mass index ($FMI = FM [kg]/height [m]^2$), respectively. We also calculated body fat percentage in children ($BF\% = FM [kg] \times 100/weight [kg]$) with the purpose of describing the level of adiposity, although there are no standards or references for BF% appropriate for Mexican children. We selected FFMI and FMI as outcome variables rather than

percentages or absolute mass because FFMI and FMI are adjusted for variation in body size.

The BIA equations used were:

$$(1) \text{ FFM (kg)} = 0.661 \times \text{height(cm)}^2 / \text{resistance(ohms)} + 0.200 \times \text{weight(kg)} - 0.320$$

$$(2) \text{ FM (kg)} = \text{weight(kg)} - \text{FFM(kg)}$$

Mothers were measured and interviewed during homevisits to obtain anthropometric, demographic and socioeconomic data. Mothers' BMI was used as a covariate in the analyses. Household crowding index (number of people living in the house/number of rooms used to sleep) was used as a proxy for living conditions in the family (Krieger & Higgins, 2002). Children's birth weight was obtained from birth certificates given to the mothers at the time of hospital discharge.

Data analyses

No significant differences were found in socioeconomic characteristics of the family, children's birthweight and maternal anthropometric characteristics between participants from Merida and Motul. Therefore, the data presented in this study derives from a combined sample from both locations. Student's independent *t*-tests were used to compare anthropometric, body composition and maternal characteristics between boys and girls. The association between birth weight and body composition was analysed through multiple linear regressions models. Separated models were performed for boys and girls. Birth weight, FFMI and FMI were transformed to internal sex-specific z-scores using sample statistics ($Z = (x - \mu) / \sigma$, where *Z* is z-score, *x* is size, μ is mean size and σ is the standard deviation of the size). This is because references or standards for FMI and FFMI are not available for Mexican populations. In the first set of regression models we chose FFMI (kg/m²) and FMI (kg/m²) as the outcome variables and birth weight z-scores

as the main independent variable. To complement this analysis, a second set of multiple linear regression models were performed with the z-scores of the outcome variables to analyse the absolute change in the outcome variables per 1-SD change in the predictor. These models are helpful to compare the magnitude of associations between predictors and each component of body composition. Children from Motul showed higher mean values than children from Merida (6.44 kg/m² [SD=2.28] vs 5.47 kg/m² [SD=2.08], $p<0.001$). Therefore, place of residence was introduced into the models as a co-variable. All models were adjusted for location (Merida and Motul), children's age (years), mothers' age (years), mother's BMI and household crowding index.

Ethical clearance

This research was approved by the Bioethics Committee for the Study of Human Beings of Cinvestav of Mexico and the Loughborough University Ethics Advisory Group (R11-P133). Participant mothers signed consent forms and the children gave their verbal assent.

RESULTS

The mean value for birth weight in the entire sample was 3,126 g (SD= 502) (boys: 3,144 g [SD = 506], girls: 3,108 g [SD = 501]). Both boys and girls showed high levels of adiposity. The mean value for body fat mass, in all sample, was 8.6 kg (SD=3.9), which corresponds to 31.3 units in body fat percentage (29.9% in boys and 32.7% in girls). On average, body fat percentage increased in children at the rate of one percentual point per age group from six to eight years of age. In both boys and girls, the mean for triceps skinfold corresponded to 0.5 standard deviations above the median when compared with the Comprehensive Growth Reference data (Frisancho 2008). Boys and girls showed similar mean values in anthropometric characteristics except for the following body composition variables: i) girls showed greater values of triceps skinfolds and body fat percentage than boys; ii) boys showed greater values in fat-free mass and FFMI (Table 1). The mean number of offspring in the family was 2.4 (SD = 1.0); 48% percent of children

included in this study were the first born, 29% were the second and 23% were the third or higher. Sixty-nine percent of the mothers were below 150 cm in height, which corresponds to the nearest whole centimeter of the 5th percentile used to classify adults as short stature, and the mean value for their BMI was near to 30 kg/m², the cut-off point for obesity proposed by World Health Organization (De Onis & Lobstein, 2010). The vast majority of mothers (86%) met the criteria for excess body weight (42% overweight and 44% obesity). This means that these women suffer from the double-burden of malnutrition.

Birth weight was positively associated with FFMI and FMI, but only in boys (Table 2). After adjusting for maternal characteristics, children's age and household crowding index, boys' birth weight was positively associated with increases in FFMI of 0.34 kg/m² and increases in FMI of 0.40 kg/m² per 1-SD increase in birth weight, respectively. These associations correspond to increases of 0.24 SD in FFMI and 0.18 SD in FMI per 1-SD increase in boys' birth weight, which suggest that the magnitude of associations between size at birth and the two components of body composition are small and similar.

INSERT TABLE 1 HERE PLEASE

INSERT TABLE 2 HERE PLEASE

DISCUSSION

In this sample of pre-pubertal Maya children, birth weight was positively associated with FFMI and FMI, but only in boys. In boys, our results show that the magnitude of associations between size at birth and lean and body fat mass during childhood are similar, which contrast with findings that birth weight is more consistently associated with subsequent lean mass than with fat mass at different ages (Wells et al., 2007).

Several studies have addressed the association between birth weight and overweight/obesity at latter ages using BMI as a measure for adiposity (e.g. Parsons, Power, Logan, & Summerbell, 1999). However, it is well known that BMI

correlates with both lean and body fat mass (e.g. Wellens, Roche, Khamis, Jackson, Pollock, & Siervogel, 1996). In this study, we found that birth weight of boys is associated with both components of their body composition during childhood. This result, along with those reported by other studies, show the limitations of BMI when used to investigate the induction of fetal experience on later body composition.

The mean birth weight of children of our sample (3,126 g) is similar to that reported for the Maya population in the Yucatan state (Azcorra et al. 2016) but is, on average, 200 g lower than that of infants included in the International Standards for Newborns Weight INTERGROWTH-21st Project (Villar et al. 2014) and the WHO Multicentre Growth Reference Study. However, the mean birth weight of children in our sample is higher than that reported in samples of populations from low-and-middle income countries such as Brazil (Wells, Hallal, Wright, Singhal, & Victora, 2005), India (Bavdekar et al. 1999) and Jamaica (Walker, Gaskin, Powell, & Bennet, 2002), where the association between birth weight and body composition during childhood has been analysed. It is possible that higher mean birth weight in Yucatecan children may be explained by high levels of adiposity of mothers prior and during pregnancy, but we lack data to test this hypothesis. Furthermore, children in this sample show high levels of body fatness; the mean value for body fat percentage in all sample was 31.3%. Azcorra et al. (2019) reported that 37%, 32%, and 26% of these children showed excessive values of BMI, waist circumference and skinfolds, respectively, taking into account age and sex. In this study, size at birth was likewise related with lean and fat mass in boys. The relationship between size at birth and subsequent lean mass seems to be well understood. Intrauterine development is an important stage in the accretion of this component of body composition mainly due to organogenesis and muscle tissue development, dominated by hyperplastic processes, predominating during the first two trimesters of pregnancy (Bernstein, Goran, Amini, & Catalano, 1997). The relationship between birth weight and body fat later in life is more complex because fat mass accretion is present during the last trimester of pregnancy and weight gain during first years of postnatal life seems to be important for phenotype at mid-

childhood independently of size at birth (Wells et al. 2005; Norris et al., 2020). Studies in non-human animals have showed that the induction or programming of body fatness due to maternal nutritional imbalances during pregnancy are mediated through long term changes in neuroendocrine systems that regulate energy intake and expenditure in postnatal life. Candidates of these processes include the synthesis, secretion and action of hormones such as insulin and leptin (Chang, Gaysinskaya, Karatayev, & Leibowitz, 2008; McMillen, Muhlhausler, Duffield, & Yuen, 2004; Remacle, Bieswal, & Reusens, 2004).

Some studies have found an inverse association between birth weight and body fat but only after the statistical adjustments for weight or BMI are done (Malina, Katzmarzyk, & Beunen, 1996; Garnet et al., 2001). These results have been interpreted as evidence of adiposity induction under conditions of fetal growth deficit. This interpretation has been criticized by some authors arguing that growth patterns during postnatal life, particularly weight gain, and not necessarily birth weight, should be considered the main factor for body fatness (Wells et al., 2007). Our results contrast with those reported by Rogers et al. (2006) using data from the Avon Longitudinal Study of Parents and Children (ALSPAC). In the ALSPAC, where body composition was estimated through dual-energy X-ray absorptiometry, birth weight was positively associated with total fat mass at 9-10 years of age in both sexes. To give further context, the ALSPAC sample is slightly older than the Maya children of our study, and about 37% of girls were in Tanner stage 2 of puberty at the time of the assessment. Other studies have found positive associations between birth weight and fat mass only in adult women (Li et al., 2003; Sachdev et al., 2005).

Our study design and sampling strategy does not allow us to provide further explanations on why associations between birth weight and body composition were found only in boys. However, extensive evidence about how early environment shapes adult phenotype and metabolism in a sex specific manner is available (Dearden, Bouret, & Ozane, 2018). Studies on the effects of maternal obesity in their offspring's phenotype, conducted in human and non-human animals, have

shown that males tend to be more susceptible than females to accumulate body fat in response to maternal overnutrition during pregnancy (Andres et al., 2015; Pankey et al., 2017). Furthermore, some studies have found that infants born to overweight/obese mothers had more fat mass and less fat-free mass compared to infants born to normal weight mothers (e.g. Hull, Dinger, Knehans, Thompson, & Fields, 2008). Increased susceptibility of males against adverse early environments is not limited to conditions experienced during gestation. Some studies done with mice have found that males have higher absolute and relative weight gain and fat mass indexes than females when are exposed to high fat diets (Estrany, Proenza, Lladó, & Gianotti, 2011; Grove, Fried, Greenberg, Xiao, & Clegg, 2010). Our results on the association between birth weight and body composition in boys are in line with the notion about the strong influence of maternal phenotype on male offsprings' body composition, particularly in the context of the Maya population where women's overweight and obesity rates are very high (Azcorra, Varela-Silva, Rodriguez, Bogin, & Dickinson, 2013). Results of a previous study with this sample indicate that body fat percentage of children's mothers is about 45% (Azcorra et al., 2019). Besides, results of a study that aimed to investigate the quality of maternal diet during pregnancy in a sample of women from low to middle income groups from Merida and surrounded communities, found that 51% of women started the pregnancy with excess body weight ($BMI > 25 \text{ kg/m}^2$) (Romero Villanueva, 2020). The notion of an increased susceptibility of boys in this sample against adverse early conditions and intergenerational influences is supported by results of a previous study in which maternal height, a proxy measure for nutritional history, was inversely associated with fat mass index, waist circumference and skinfolds in boys (Azcorra, Dickinson, & Datta Banik, 2016).

Our results might be also explained by sex differences in body composition. It is known that sexual dimorphism regarding the amount and distribution of body fat and lean mass is established early in fetal life, and that by birth, females have less lean mass than males (Wells, 2007b). This sexual dimorphism, stable along infancy and childhood, increases at puberty. By puberty, girls tend to increase their fat mass content, both in absolute (kg) and relative (%) terms, while boys tend to

keep increasing lean body mass (Bogin, 1999). The girls from our sample show higher levels of body fat percentage (32.7% vs 29.9%) and lower values of fat-free mass than boys (11.8 kg/m² vs 12.5 kg/m²). However, as far as we know, there are no reports of sexual dimorphism in body composition of Maya children during childhood obtained from longitudinal studies. Differences in the development of adiposity and lean body mass between males and females may be associated to a major resistance on females to induction processes in the presence of adverse conditions experienced prenatally and postnatally. From an evolutionary point of view, our results might be interpreted as evidence of how unfavorable conditions experienced in early stages of development impact offspring's metabolism and phenotype in a sex specific manner; this biological process could increase reproductive fitness. Some studies have found positive associations between size at birth and body fat mass only in adult women (Li et al. 2003; Sachdev et al., 2005). These results have been interpreted as differential strategies established between males and females since intrauterine development to allocate somatic tissue and energy stores (lean mass in males and body fat in females) in preparation for reproductive cost (Wells et al., 2007).

To the best of our knowledge, there are no reports from ethnographic studies showing that Maya children from Yucatan receive gendered differential feeding and provision of health care. Our own experience of several decades working in the field also does not indicate that associations between birth weight and body composition found in boys are product of differential treatment by sex.

Overweight and obesity are health problems with a high cost in the well-being of indigenous populations, such as the Maya. On average, eight out of ten adult Maya women and four out of ten school-age children meet the criteria for excessive body weight. The actions implemented by Yucatec health institutions to reduce overweight figures among the Maya have focused, with very little success, on changing behaviors at the individual level and on building healthier environments. The results of our study show that phenotype observed in childhood, when several metabolic pathways have been established, is shaped by conditions experienced

at very early stages of development and by maternal nutritional history, including her prenatal and postnatal growth. Even though the magnitude of the associations between birth weight and body composition found in this study is small, our results indicate the need for early actions such as improving the growth and nutritional status of girls during infancy and reducing obesity among adult women before reproduction, taking into account that some positive results in the phenotype and health status will be observed in later generations. These actions must be framed in policies that seek to reduce the levels of poverty and discrimination and increase access to quality health services among the indigenous populations.

Limitations

Limitations in this study includes the lack of data about maternal characteristics before and during pregnancy. Statistical models on the association between children's birth weight and body composition were adjusted for maternal BMI at the time of the study, that is to say, 6 to 8 years after children's birth. Several factors may have influenced current maternal phenotype including reproduction and aging. Unfortunately, we lack of data on maternal body composition before conception and weight gain during pregnancy, factors that may help to understand more clearly process of induction of body composition.

Conclusion

The main results of this study show that urban Maya children of this sample exhibit high levels of adiposity and that size at birth was positively associated with lean and body fat mass in boys during childhood in contrast with previous findings that birth weight is more consistently associated with subsequent lean mass than with fat mass. Associations detected only in boys may be explained by sex differences in susceptibility to ecological conditions experienced in early stages of development and differences in the development of adiposity and lean body mass between males and females during mid-childhood. Our results indicate the need for

actions to be taken at very early stages of life in order to mitigate the burden of disease caused by overweight and obesity among the Maya.

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The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

HA formulated the research question, analyzed the data and wrote the first draft of the manuscript; MIVS and FD contributed to the first and subsequent drafts and provided input on all sections of the paper.

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Table 1 Anthropometric and body composition characteristics of participants

Characteristics	All sample	Boys (n=132) Mean (SD)	Girls (n=128) Mean (SD)	P
Children				
Age (years)	7.5 (0.8)	7.6 (0.8)	7.5 (0.8)	0.570
Birth weight (kg)	3126 (502)	3144 (506)	3108 (501)	0.569
Height (cm)	120.5 (7.1)	120.9 (7.0)	120.2 (7.1)	0.416
Weight (kg)	26.4 (6.9)	26.8 (7.0)	26.1 (6.9)	0.376
BMI (kg/m ²)	17.9 (3.1)	18.1 (3.2)	17.8 (3.1)	0.435
Triceps skinfold (mm)	12.2 (4.74)	11.4 (4.66)	12.9 (4.70)	0.006
Body composition – Bioelectrical impedance analysis				
Fat-free mass (kg)	17.9 (3.5)	18.5 (3.6)	17.2 (3.4)	0.005
Fat mas (kg)	8.6 (3.9)	8.3 (3.8)	8.8 (3.9)	0.326
%BF	31.3 (6.3)	29.9 (6.3)	32.7 (6.0)	<0.001
FFMI (kg/m ²)	12.2 (1.4)	12.5 (1.4)	11.8 (1.4)	<0.001
FMI (kg/m ²)	5.8 (2.1)	5.6 (2.1)	5.9 (2.1)	0.138
Mothers				
Age (years)	33 (5.5)	32.9 (5.2)	33.1 (5.8)	0.751
Height (cm)	147.8 (4.9)	147.4 (5.1)	148.3 (4.8)	0.153
Weight (kg)	65.1 (11.6)	65 (11.7)	65.2 (11.6)	0.926
BMI (kg/m ²)	29.7 (4.7)	29.9 (4.8)	29.6 (4.7)	0.603
Household				
Crowding index	3.1 (1.4)	3.1 (1.4)	3.1 (1.5)	0.970

FFMI: fat-free mass index; FMI: fat mass index; %BF: body fat percentage.

Independent t-test was applied to compare mean values of anthropometric variables and body composition parameters between boys and girls.

Table 2 Associations of birth weight (z-score) with fat-free mass index and fat mass index estimated from bioelectric impedance analysis.

Outcomes	Boys			Girls		
	B (SE)	95% CI	P	B (SE)	95% CI	P
Fat free mass index (kg/m ²)	0.34 (0.11)	0.11 0.56	0.003	0.18 (0.11)	-0.04 0.40	0.203
Fat mass index (kg/m ²)	0.40 (0.16)	0.07 0.71	0.018	0.15 (0.18)	-0.21 0.50	0.430

Each row represents a different model with children's FFMI and FMI in the left hand column as the dependent variables and birth weight (z-score) as the main independent variable. All models were adjusted for location, children's age and mothers' age and BMI and household overcrowding index.