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Research Article

Does Low Birth Weight Influence Overweight in Late Adolescence? A Cohort Study in Northeast Brazil

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Abstract

Introduction: To born with low birth weight is associated to weight excess all life long and is considered a risk factor to many diseases.

Objective: To evaluate the association of low birth weight with parameters of adiposity in adolescence.

Methods: Cohort study, started in 1993, included 69 term new-borns with low birth weight (exposure group) and 135 term new-borns with birth weight between 3,000g and 3,499g (control group) recruited in adolescence, on 2012. The explanatory variable was birth weight; the outcome was body mass index, waist circumference, waist-to-height ratio, waist-hip ratio, neck circumference, triceps skinfold thickness, percentage of body fat, and fat weight, and the covariates were catch-up growth, duration of breastfeeding, poverty level, consumption of fat and sugar, and physical activity level.

Results: At the beginning of the cohort, the exposure group had major risk of catch-up growth (RR = 1.94; 95%CI 1.21 - 3.10), less breastfeeding (RR = 0.87; 95%CI 0.56 - 1.35), and was poorer (RR = 1.86; 95%CI 1.02 - 3.47) than the control group. Within adolescence, there was no statistical difference between the groups related to anthropometric evaluation, but the major poverty condition was maintained (RR = 1.47; 95%CI 1.01 - 2.15). The body mass index was highly correlated to anthropometric indices and with fat weight.

Conclusion: Although the exposure group had accelerated catch-up growth, it did not differ from the control group and did not show weight excess, which could be explained by the high levels of poverty, restricting the excess of obesogenic supply.

Keywords: *Birth Weight; Infant; Low Birth Weight; Obesity; Risk Factors*

Abbreviations

IUGR: Intrauterine Growth Restriction; BMI: Body Mass Index

Introduction

Obesity is a major health problem [1] occurring at all age groups and associated with multiple co-morbidities such as hypertension, type 2 diabetes, dyslipidaemia, cardiovascular disease, increased insulin resistance and some types of cancer [2]. Surveys conducted in the late twentieth century seeking the origin for adults' cardiovascular diseases showed obesity as an important risk factor and prompted the formulation of a set of hypotheses linking events occurring during intrauterine life and first postnatal months to the genesis of the process [3].

Thus, a new conceptual framework emerged: the developmental origins of health and disease [4]. The occurrence of injuries during intrauterine development, such as growth restriction (IUGR), would lead to structural and metabolic changes in the foetus, altering fetal programming [5]. However, several factors could enlarge or minimize the effect of early events throughout life, leading to a wide phenotype variation [5]. Exposure to environmental and occupational pollutants, diets, behaviours and psychic experiences, among several other factors linked to the concept of exposoma [5] would act in vulnerable periods - windows of opportunity - possibly through epigenetic mechanisms. The developmental plasticity would contribute to the self-organization of organic systems, therefore, breaking the deterministic nature suggested by Waddington's canalization theory [6].

The nutrition provided to pregnant women has a direct role in the fetus' metabolic processes, particularly in leptin activity, thus determining the deposition and scheduling of white and brown adipose tissue [7]. The restriction of intrauterine nutrition, particularly in late pregnancy, hinders the natural accumulation of fat and leads to low birth weight new-borns. In developmental process [8], when the body is exposed to abundant supply, there will be an excessive compensatory growth (catch-up growth) [9] and adaptive responses in the course of life [10]. These conceptual approaches motivated the creation of this cohort from the opportunity to recruit an uniform population, from a socio-economic and environmental point of view, in order to pair the risk of underweight new-borns and follow up on them, analysing changes in lifestyle that might explain the nutritional status in late adolescence.

The purpose of this article was to evaluate the association of low birth weight to adiposity parameters, at the end of adolescence.

Material and Methods

The study was conducted in urban areas in the towns of Agua Preta, Catende, Joaquim Nabuco, Ribeirão and Palmares, located in the southern forest of the state of Pernambuco. These municipalities share an agricultural economic activity, in which the seasonal production and processing of sugar cane prevails, thereby leading to much of the local unemployment, in the off-season periods [11].

This is the third phase of a cohort study started in 1993. Full-term new-borns were recruited from local hospitals and formed two groups - one with low birth weight and the other group presenting proper weight. They were followed over the first two years of life (phase 1) and reassessed at ages 8 (phase 2) and 18 (phase 3).

The exposed group comprised full-term new-borns with low birth weight, i.e. between 1,800g and 2,499g; and the unexposed group was composed of full-term newborns with birth weight between 3,000g and 3,499g. Each of the newborns of the unexposed group was included because he/she was born shortly after a low birth weight baby integrating the exposed group and because they were of the same gender, at the proportion of 1 (exposed group): 2 (unexposed group) [12].

Exclusion criteria in both groups were: multiple births, prematurity (gestation < 37 weeks), presence of congenital infections, congenital malformations and genetic syndromes, as well as the need for intensive treatment in the immediate neonatal period.

The current stage of the research, conducted in the period from May to December 2012, included 204 members of the initial cohort, being 69 of the exposed group (underweight) and 135 of the unexposed group (adequate weight), recruited in adolescence for new anthropometric measurements, with inquiries about dietary habits and physical activity and determination of body constitution through bioelectrical impedance.

The variables were grouped as explanatory (birth weight), outcome (body mass index, waist circumference, waist-to-height ratio, waist-hip ratio, neck circumference, triceps skinfold thickness, percentage of body fat) and covariates (catch growth-up, duration of breastfeeding, poverty level, consumption of fat and carbohydrates, level of physical activity).

To determine body mass index (BMI), we used the weight measured on a digital balance Filizola® previously calibrated with a capacity of 150 kg and an accuracy of 0.1 kg; height was measured with a stadiometer scale mobile (*Leicester Height Measure® - Child Growth Foundation*), with an accuracy of 0.1 cm, with measurements taken in duplicate. The hip, neck and abdomen circumferences were measured with non-distensible measuring tape (*Lasso-Child Growth Foundation®*), with 200 cm in length and precision of 0.1 cm [13,14]. For the measurement of triceps skinfold, a calliper (CESCORF Científico®) was used, with pressure support of 10 g/mm^2 and 0.1 mm sensitivity. The measurement methods and cut-off points to characterize larger than normal values, for the variables in use, were based on the recommendation of the International Federation for Diabetes [15]. All equipment was calibrated by a skilled technician.

The percentage of body fat was calculated as the ratio between fat weight and body weight, expressed as a percentage. The fat weight was calculated by subtracting the body weight and lean mass, determined by bioelectrical impedance analysis in body composition analyser (Maltron tetrapolar®, model BF-906) provided with adhesive electrodes. The interpretation of body fat percentage was based on the values presented by Lohan [16], according to age class.

Data on birth weight, catch-up growth, duration of breastfeeding and poverty score at birth were obtained from the database built in the first phase of the cohort.

For accelerated growth recovery (catch-up growth), we considered the variation in body weight between birth and six months of life, converted to z scores, assuming value equal to or greater than 0.67 as indicative of the rise of a channel on the body weight growth curve [17].

The period of breastfeeding for more than 40 days was considered a protective factor against health problems in childhood, when breast milk was the predominant source of nutritional food, compared to supplements compatible with the infant age [18]. When infants' complete weaning was reported in less than 40 days of life period, the duration of breastfeeding was considered a risk factor for such injuries. The limit of 40 days was adopted in the first phase of the research, on identifying that breastfeeding was early replaced by mixed breastfeeding, in this population.

We used the score of poverty proposed by Alvarez., *et al*. [19], composed of 13 variables scored from zero to four, making a total of 52 points, which conversion percentile allowed us to determine a cut-off less than 0.66 to classify socioeconomic status in very poor (≤ 0.66 percentile) and poor (> 0.66 percentile).

The consumption of fat and carbohydrates was obtained by dietary survey to characterize the daily, weekly, monthly and annual frequency of consumption of standard food for the region, converting the frequencies into weekly equivalent. In the group of foods with higher fat content, whole dairy products (yogurt, cheese), animal fats (mayo, butter), vegetable fats (margarine), fried foods (potatoes, pastries, snacks, kebab, chips), meat (poultry, beef or pork), derivative products (sausages, sausage, hamburger, preparations of meat) and eggs were included.

The following items took part of the group of predominantly carbohydrate foods: cereals and cereal products (rice, breads, crackers, flour), ice cream, popsicles, sugar, candy, chocolate powder or bar, pudding or sweet stuffs, soda normal or light, artificial juices, beer, wine and other alcoholic beverages. A weekly consumption greater than the average frequency of consumption of the research subjects was considered excessive, while a weekly consumption smaller or equal to the frequency of consumption of the research subjects was considered suitable.

To determine the level of physical activity two categories were considered: active (encompassing the "very active" and "active" categories) and sedentary (including "irregularly active" and "inactive" categories), according to the International Physical Activity Questionnaire [20].

The database was constructed using double entry in Epi-Info 6.04 (CDC, Atlanta, USA) program. Statistical analyses were performed with the Statistical Package for Social Sciences (SPSS®), version 20.0. The variables were analysed as continuous and dichotomized for contingency analysis. We used the histogram to assess the symmetry of such variables in order to define the statistical test to be used. The Chi square test or Fisher's exact test was used for comparison between the exposed and unexposed groups, at a significance level of 0.05. We also calculated relative risks and confidence intervals at confidence level of 95%, as well as the linear correlation coefficients of anthropometric variables or fat weight and body mass index.

This study was approved by the Research Ethics Committee of the Health Sciences Centre of the Federal University of Pernambuco, under CAAE nº. 0328.0.172.000 - 08. Parents or guardians signed informed consent forms authorizing the participation of adolescents in research. In the case of teenagers who had come of age, they signed the term themselves.

Results and Discussion

Table 1 presents the relationship between the explanatory variable, defining the exposed and unexposed groups, and the covariates catch-up growth and duration of breastfeeding. The group of low birth weight was exposed to greater risk of developing catch-up growth (RR = 1.94, 95% CI 1.21 to 3.10) in the first six months of life.

Variables	Total (n = 204) n (%)	Birth weight		RR (IC95%)	p
		Low (n = 69) n (%)	Suitable (n = 135) n (%)		
Assessment between 0 - 6 months of life					
Catch-up growth*					0,005
≥ 0.67 DP	61 (39.9)	27 (56.2)	34 (32.4)	1.94 (1.21 - 3.10)	
< 0.67DP	92 (60.1)	21 (43.8)	71 (67.6)	1.00	
Breastfeeding (days)†					0.325
≤ 40	49 (27.7)	17 (25.0)	32 (29.4)	0.87 (0.56 - 1.35)	
> 40	128 (72.3)	51 (75.0)	77 (70.6)	1.00	
Assessment between 17 - 19 years of life					
Carbohydrate consumption					0.009
Excessive	79 (38.7)	35 (50.7)	44 (32.6)	1.63 (1.12 - 2.38)	
Suitable	125 (61.3)	34 (49.3)	91 (67.4)	1.00	
Fat consumption					0.153
Excessive	86 (42.2)	33 (47.8)	53 (39.3)	1.26 (0.86 - 1.84)	
Suitable	118 (57.8)	36 (52.2)	82 (60.7)	1.00	
Physical activity					0.510
Sedentary	114 (55.9)	38 (55.1)	76 (56.3)	0.98 (0.66 - 1.44)	
Active	90 (44.1)	31 (44.9)	59 (43.7)	1.00	
Score of poverty					0.035
Very poor	70 (34.3)	30 (43.5)	40 (29.6)	1.47 (1.01 - 2.15)	
Poor	134 (65.7)	39 (56.5)	95 (70.4)	1.00	

Table 1: *Social characteristics, catch-up growth and habits of life according to birthweight.*

*Caption: * - the catch-up growth of 51 infants was not determined*

† - the follow-up of 27 breastfeeding infants was lost.

The group of low birth weight was 1.49 times (95% CI 1.02 to 2.18) poorer than the proper weight group, with a significant difference (p = 0.032). In Table 1, we observe that the score of poverty has not changed after 17 to 19 years since the group of low birth weight had a chance 1.47 times (95% CI 1.01 to 2.15) greater to be poorer than the non-exposed group and this difference was significant (p = 0.035).

We observed that the risk of carbohydrates intake in the exposed group was 1.63 times greater than the non-exposed group. By comparing the groups, both of them often consumed less or equal fat than what the research subjects consumed on average; and the difference was not significant. From the frequency distribution of anthropometric data according to birth weight, expressed in Table 2, no significant difference between the groups of adequate weight and low birth weight was found, considering all parameters.

Anthropometric data between ages 17 and 19	**Total (n = 204) n (%)**	**Birth weight**		**p**
		Low (n = 69) n (%)	**Suitable (n = 135) n (%)**	
BMI				
High (≥ 25kg/m^2)	36 (17.6)	14 (20.3)	22 (16.3)	0.300
Suitable	168 (82.4)	55 (79.7)	113 (83.7)	
Abdominal circumference				
High	35 (17.2)	8 (11.6)	27 (20.0)	0.093
Suitable	169 (82.8)	61 (88.4)	108 (80.0)	
Neck circumference				
High	16 (7.8)	3 (4.3)	13 (9.6)	0.146
Suitable	188 (92.2)	66 (95.7)	122 (90.4)	
Waist-height ratio				
High	44 (21.6)	15 (21.7)	29 (21.5)	0.550
Suitable	160 (78.4)	54 (78.3)	106 (78.5)	
Waist-hip ratio				
High	17 (8.3)	4 (5.8)	13 (9.6)	0.257
Suitable	187 (91.7)	65 (94.2)	122 (90.4)	
Triceps skinfold				
High	12 (5.9)	4 (5.8)	8 (5.9)	0.620
Suitable	192 (94.1)	65 (94.2)	127 (94.1)	
% body fat				
High	93 (45.8)	29 (42.0)	64 (47.8)	0.265
Suitable	110 (54.2)	40 (58.0)	70 (52.2)	

***Table 2**: Anthropometric data according to birthweight in adolescents.*

In Table 3, the excess fat in the abdomen was more frequent in female adolescents; with the presence of greater catch-up growth; increased consumption of carbohydrates and fat, as well as among those belonging to families with low poverty level at birth, but none of these differences was statistically significant.

Variables	Total	Waist circumference		RR (CI 95%)	p
		High	Suitable		
	n	n (%)	n (%)		
Assessment from 0 to 6 months of life					
Gender					
Female	119	24 (20.2)	95 (79.8)	1.56 (0.81 - 3.01)	0.122
Male	85	11 (12.9)	74 (87.1)	1.00	
Birth weight					
Low weight	69	8 (11.6)	61 (88.4)	0.58 (0.28 - 1.21)	0.093
Suitable	135	27 (20.0)	108 (80.0)	1.00	
Score of poverty					
Very poor	64	9 (14.1)	55 (85.9)	0.76 (0.38 - 1.52)	0.281
Poor	140	26 (18.6)	114 (81.4)	1.00	
Catch-up growth*					
≥ 0,67 DP	61	13 (21.3)	48 (78.7)	1.22 (0.64 - 2.36)	0.344
< 0,67DP	92	16 (17.4)	76 (82.6)	1.00	
Breastfeeding (days)†					
≤ 40	49	8 (16.3)	41 (83.7)	0.95 (0.45 - 1.99)	0.544
> 40	128	22 (19.5)	106 (80.5)	1.00	
Assessment from 17 to 19 years old					
Physical activity					
Low	114	20 (17.5)	94 (82.5)	1.05 (0.57 - 1.94)	0.511
Suitable	90	15 (16.7)	75 (83.3)	1.00	
Fat consumption					
Excessive	98	19 (19.4)	79 (80.6)	1.28 (0.70 - 2.35)	0.265
Suitable	106	16 (15.1)	90 (84.9)	1.00	
Carbohydrate consumption					
Excessive	79	15 (19.0)	64 (81.0)	1.19 (0.65 - 2.18)	0.356
Suitable	125	20 (16.0)	105 (84.0)	1.00	
Score of poverty					
Very poor	70	13 (18.6)	57 (81.4)	1.13 (0.61 - 2.11)	0.419
Poor	134	22 (16.4)	112 (83.6)	1.00	

Table 3: *Social characteristics, catch-up growth and habits of life according to waist circumference.*

*Caption: * the catch-up growth of 51 infants was not determined*

† - the follow-up of 27 breastfeeding infants was lost

Similarly, to the lack of significance on waist circumference, the body mass index - an outcome variable related to central and peripheral obesity - showed no association with any of the covariates that could differentiate the two groups (exposed and unexposed) (Table 4).

Variables	Total (n = 204)	Body Mass Index		RR_{Bruta} (CI 95%)	p
		High (n=36) n (%)	Suitable (n=168) n (%)		
Birth to 6 months					
Gender					
Female	85	15 (17.6)	70 (82.4)	1.00 (0.55 - 1.82)	0.571
Male	119	21 (17.6)	98 (82.4)	1.00	
Birth weight					
Low weight	69	14 (20.3)	55 (79.7)	1.24 (0.68 - 2.28)	0.300
Suitable	135	22 (16.3)	113 (83.7)	1.00	
Score of poverty					
Very poor	64	12 (18.8)	52 (81.2)	1.09 (0.58 - 2.05)	0.461
Poor	140	24 (17.1)	116 (82.9)	1.00	
Catch-up growth*					
≥ 0,67 DP	61	15 (24.6)	46 (75.4)	1.41 (0.76 - 2.64)	0.189
< 0,67DP	92	16 (17.4)	76 (82.6)	1.00	
Breastfeeding (days)†					
≤ 40	49	8 (16.3)	41 (83.7)	0.84 (0.40 - 1.72)	0.400
> 40	128	25 (19.5)	103 (80.5)	1.00	
17 to 19 years old					
Physical activity					
Low	90	15 (16.7)	75 (83.3)	0.90 (0.50 - 1.65)	0.446
Suitable	114	21 (18.4)	93 (81.6)	1.00	
Fat consumption					
Excessive	86	18 (20.9)	68 (79.1)	1.37 (0.76 - 2.48)	0.193
Suitable	118	18 (15.2)	100 (84.8)	1.00	
Carbohydrate consumption					
Excessive	79	17 (21.5)	62 (78.5)	1.42 (0.78 - 2.58)	0.167
Suitable	125	19 (15.2)	106 (84.8)	1.00	
Score of poverty					
Very poor	70	15 (21.4)	55 (78.6)	1.37 (0.75 - 1.48)	0.202
Poor	134	21 (15.7)	113 (84.3)	1.00	

Table 4*: Social characteristics, catch-up growth and habits of life according to BMI.*

*Caption: * the catch-up growth of 51 infants was not determined*

† - the follow-up of 27 breastfeeding infants was lost

When examining the association between low birth weight and adequate weight, it was found that BMI kept a significant and strong linear correlation with other anthropometric indices related to waist circumference, waist-to-height ratio and fat weight in adolescents (Figure 1).

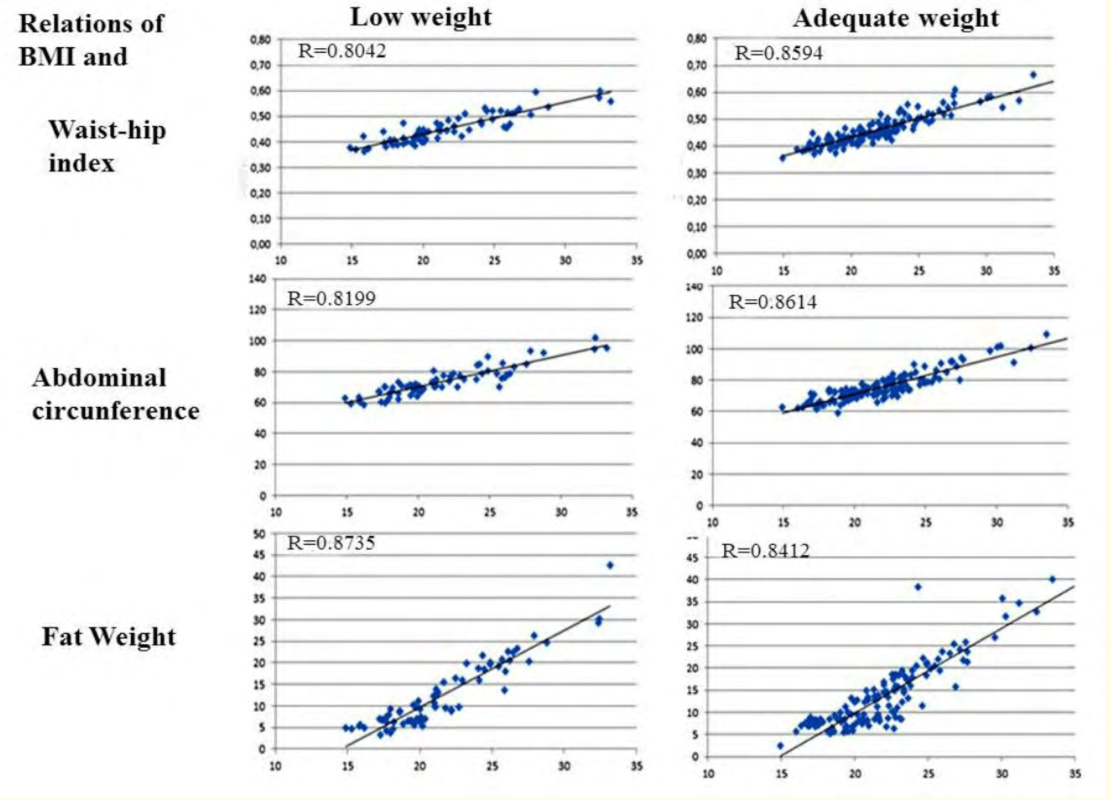

Figure 1: *Correlation between BMI and the ratio waist-to-height, waist circumference and fat weight.*

The model of health development in the course of life examines the influence of multiple risks and protective factors during life from a development perspective, including the importance of early relationships during pregnancy, as well as aspects of different stages of post-natal life, incorporating the ideas emerging from biological systems theories. When admitting that health follows a continuum throughout life, these theories have in common the central idea that health stems from environmental, social, economic, epigenetic transformations [21]. Fetal programming is not deterministic and thus we found that low birth weight new-borns from this study, although had an increased risk for obesity - exacerbated by rapid catch-up growth - did not differ from their peers born with adequate weight and had no higher overweight frequency in adolescence.

The assessment of obesity has been identified as essential for determining the risk for metabolic syndrome, cerebrovascular and coronary diseases that contribute to an increased mortality [22,23]. A single type of measurement does not make it possible to determine the body fat distribution, which is essential to analyse the risk factors related to adiposity, requiring the analysis of several anthropometric parameters. Among the reviews we find the body mass index, of widespread use, but with low sensitivity for diagnosing excess body fat and the nutritional state [24], which is why there's an indication for complementary evaluation with the determination of corporal bio-impedance [25]. Waist circumference has been employed as a simple, cheap and effective measure for assessing central adiposity with excellent correlation with imaging and association with high risk of cardiovascular disease and mortality, as well as neck circumference [26].

Hip circumference, although alone is not a significant predictor of morbidity and mortality, when associated with waist circumference, constitutes the waist-hip ratio, adding value as a risk for cardiovascular disease [27]. Also, the waist-height index has shown a useful measure in predicting the incidence of metabolic problems in middle-aged adults, related to obesity [28].

In the present study, the use of multiple measurements for the determination of excess general and central adiposity conferred a greater reliability to the assertion that there is no association between birth weight and overweight, despite the evidence of a rapid catch-up growth among infants with low birth weight. The statement seemed suitable on noting that the percentage of body fat as well as waist circumference behaved similarly in both groups. So, we may assume that nutrition, physical activity and socioeconomic conditions did not favour the determinism between accelerated catch-up growth and obesity.

Breastfeeding is a protective factor against obesity for life. The cohort including 847 new-borns followed up to three years of age showed that the introduction of complementary foods before four months of age increases by six times the risk of obesity [29]. Similarly, a meta-analysis of cohort showed that the decrease in obesity in adulthood also depends on the duration of breastfeeding, either as sole or partial food, since each month of breastfeeding was associated with a decreased risk of obesity in 4% [30].

When identifying, in the first phase of the study with new-borns in the South of Pernambuco, that the introduction of complementary feeding was given early, before four months of age, regardless of birth weight, we assumed, for analysis, a breastfeeding period of 40 days, which, although not unique, had a protective effect. This finding would suggest that adolescents are exposed to a higher risk of obesity due to less time breastfeeding. However, the duration of breastfeeding was not associated with increased BMI or waist circumference in adolescence, independent of birth weight, suggesting that the combination of a number of demographic and nosographic events characterizing the epidemiological and nutritional transition had a similar impact on both groups [31].

A second nutritional factor that may contribute to excess weight with an accelerated catch-up growth is providing obesogenic diet or a food supply which is higher than the energetic needs, as admitted by the thrifty phenotype hypothesis [32]. Individuals born with low weight make use of different mechanisms of adaptation to extra-uterine environment, among which is the increase of carbohydrate metabolism and subsequent increase in adiposity, increasing the future risk of chronic diseases such as insulin resistance, obesity and type 2 diabetes [33]. These mechanisms lead to high levels of leptin in conjunction with the resistance to its action, which is associated with lack of satiety in early life, obesity and metabolic disorders in adolescence and adulthood, when these infants are exposed to an abundant nutritional environment [34].

However, when exposed to stringent nutritional conditions or high-power consumption, the phenotypic plasticity favours the development of adaptation, contributing to survival [35]. The "predictive adaptive response" can be understood as an interaction between the organism and its environment during its development, making frequent adjustments in order to become more suitable for the environment where it will live until reproductive age. These adjustments will represent an adaptive advantage when the "prediction" on the environment is correct and will be a disadvantage when this prediction is wrong [35], featuring the plasticity of "metabolic capacity." This allows that body has a better development to increase the potential for phenotypic variation, optimizing the phenotype for a particular environment, increasing their survival and reproductive success, when responses are well integrated, i.e. have the suitable expressions of genes key to environmental stimuli, regulating subsequent patterns of tissue arrangement [36].

The lack of significant differences in the consumption of carbohydrates and fats and of anthropometric measures between groups suggests that the food supply was sufficient for proper growth and development, yet not excessive for manifesting obesity in the group of adequate weight. Thus, the food supply behaved like a levelling factor between the groups, although they had a different fetal programming.

This finding reinforces the developmental theory of health and disease, since it demonstrates that suitable nutritional conditions, among other factors, can lead to beneficial effects, independent of birth condition, however the risk of obesity can manifest in adulthood.

Considering that catch-up growth depends on the genetic constitution of the individual, but also on the nutritional supply, environmental stimuli, social stress and health sufficient opportunities, for the low birth weight group, a diet rich in carbohydrates and fats, associated with an early catch-up growth, favour obesity [37,38], which was not observed in the present study. So, we should consider the socioeconomic status of these adolescents. By identifying that the two groups encompassed an uniform population, with similar low socioeconomic status at birth and remaining throughout the adolescence, based on the theory of metabolic programming and on the epigenetic theory, we may assume that this factor contributed, at that stage of life, for the non-development of obesity, contradicting the fetal programming expressed by the catch-up growth. The socioeconomic restriction, present in the population studied in the whole cohort, may have contributed to restrict the excessive consumption of food, acting as a restrictor factor for obesity [31,39].

Intervention studies aimed at analysing the relationship between physical activities, BMI and waist circumference in children with low birth weight have not shown consistent results, although admittedly the greatest expenditure of energy can help reduce the risk of excess weight [40]. A study conducted in the United States in 2010, with the implementation of 30 minutes daily exercises for students between eight and 12 years old, identified a reduction in BMI and waist circumference in the non-exposed group only, not subjected to such exercises [41]. The lack of relationship between intensity of physical activity and indicative parameters of overweight, as evidenced by our results, motivated the first study in cohort, population-based, initiated in 2010, which investigated the relationship between birth weight, growth trajectories, physical fitness and physical activity versus sedentary behaviour in 8 - 9 years old children [42]. The guiding premise of this study is to admit that physical activity does not act in isolation but is part of a larger context with factors whose collective action can lead on health and sickness [42].

Since gestational age is an important factor in the relationship of low birth weight with fat distribution in adult [43] and that the method used in determining intrauterine growth retardation and gestational age may have brought inaccurate low birth weight diagnoses as a proxy for intrauterine malnutrition, this may be a bias in our results. However, the evidence of the plasticity theories enables us to consider overcoming risk factors and adapting during the life cycle of these adolescents, given the relative organic balance presented by them.

Another possibility for not finding a higher frequency of overweight among low birth weight was the insufficient sample size to observe a biological standard. This research has provided inconclusive data about the relationship between rapid weight gain in infants with low birth weight and overweight in adolescence, also because it has adopted a reductionist model in relation to the multiple factors that may mediate this relationship.

Despite these limitations, when finding no significant differences in anthropometric measures among the low birth weight group, showing a catch-up growth in the first six months of life when compared to adequate weight group, the study seems to reaffirm the adaptability of these individuals during the course of life, leading to a non-manifestation of an initial programming favouring obesity, which can contribute to reducing cardiovascular diseases and metabolic syndrome in adulthood.

Conclusions

The results of this study corroborate the findings of the analysis of this cohort, conducted when children were eight years old, in which the nutritional status at birth had no influence on the corporal composition [44]. Therefore, this study should alert paediatricians to consider the non-determinism of accelerated catch-up growth in low birth weight, guiding parents and caregivers about the importance of nutrition and of encouraging the physical activity in early life, contributing to the quality of life when their children reach adulthood.

In addition, these results point to the importance of systematically measuring the BMI because, despite the criticism about its lack of specificity in separating the peripheral visceral fat, it is, undoubtedly, an important indicator for clinical guidance, as demonstrated in this study, since it identifies the significant and strong correlation with other anthropometric parameters. The importance of such finding lies in the possibility of its use in evaluating excess weight by means of a simple measuring method, easier than the other determinations.

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Conflict of Interest

The authors declare no conflict of interest.

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