Early Human Development 91 (2015) 445–449

Contents lists available at ScienceDirect

Early Human Development

journal homepage: www.elsevier.com/locate/earlhumdev

Association between weight at birth and body composition in childhood: A Brazilian cohort study

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ARTICLE INFO

Article history:
Received 27 August 2014
Received in revised form 7 April 2015
Accepted 8 May 2015

Keywords:
Birth weight
Children
Fetal programming
Adiposity
Fat-free mass
Body composition

ABSTRACT

Background and aim: Previous studies have shown that the association between birth weight and obesity later in life apparently follows a U-shaped curve. However, due to the continuous increase of mean birth weight in several countries worldwide, it is expected that higher birth weight will play a more important role as a risk factor for further obesity than low birth weight. This study investigated the association between birth weight and body composition of children in order to establish their relationship in an earlier period of life.
Study design and subjects: Prospective cohort study carried out from 1997 to 2006 in Jundiai city, Brazil, involving 486 children at birth and from 5 to 8 years of age. The following anthropometric measurements were determined: birth weight, weight, height, waist circumference and triceps skinfold thickness. Fat mass percentage, fat mass and fat-free mass were measured by electrical bioimpedance analysis by the 310 Body Composition Analyzer, Biodynamics®. Five multiple linear regression models were developed considering waist circumference, triceps skinfold thickness, fat mass percentage, fat mass and fat-free mass as markers of body composition, and outcomes.
Results: Significant positive associations were observed between birth weight and waist circumference ($p < 0.001$), triceps skinfold thickness ($p = 0.006$), fat mass ($p = 0.007$) and fat-free mass ($p < 0.001$). Approximately 10% of the children presented excess body fat assessed by bioimpedance, and 27.6% of them had central adiposity (waist circumference ≥95th percentile).
Conclusions: Intrauterine growth, assessed by weight at birth, was positively associated with body composition of children aged 5–8 years, indicating that those with the highest birth weight are more at risk for obesity, and probably to chronic diseases in adulthood.

1. Introduction

A worldwide increase in the prevalence of childhood overweight and obesity has been seen over the past few decades [1], even in developing countries like Brazil. In addition to psychosocial consequences, children with excess weight are at an increased risk of developing metabolic and endocrine diseases later in life [2].

According to the "Developmental Origins of Health and Disease Hypothesis" disturbances during critical windows of development, such as growth in the intrauterine period has long-term effect on the physiology, structure and functions of the organism [3,4]. Hyperplasia and/or hypertrophy of adipose cells result in an exacerbated expansion of adipose tissue, a characteristic of obesity, which tends to persist in childhood and adulthood [5].

Birth weight is a proxy of intrauterine growth and appears to be associated with body adiposity, not only in childhood [6], but also throughout an individual's life [7].

Previous studies have shown that the association between birth weight and obesity later in life apparently follows a U-shaped curve [8]. However, due to the continuous increase, in the last two decades, of mean birth weight in several countries worldwide [9,10], it is expected that higher birth weight will play a more important role as a risk factor for further obesity [5,11,12] than low birth weight.

The present study investigated the association between birth weight and body composition of Brazilian children in order to establish their relationship in an earlier period of life.

2. Materials and methods

This study is derived from a cohort, carried out between 1997 and 2000, initially composed of 865 low-income pregnant women from Jundiai city, São Paulo state, Brazil. The women were recruited from all health units and hospitals in the city and were followed before the

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http://dx.doi.org/10.1016/j.earlhumdev.2015.05.004
0378-3782/

16th week of pregnancy to the birth of their babies. All women were insured by the National Health Service (SUS) and were apparently healthy, considering that those who present any problem in pregnancy are usually reported to specialized antenatal services. Women with chronic infectious diseases, metabolic diseases, cardiopathy, mental diseases, hypertension/pre-eclampsia/eclampsia, vaginal bleeding and multiple deliveries were excluded from the study. Details of the cohort have been published previously [13].

Data on anthropometry and physical examination of the newborn babies were collected per protocol, from the hospital records, and checked on the next day after birth by a pediatrician. Gestational age (GA) was determined by a combination of ultrasonography performed up to the 20th week of gestation, the Capurro method [14] determined between 12 and 48 h of birth, and information on the date of the last menstrual period. When there was less than or a week discrepancy between at least two of the GA determinations, assessed by the three different methods, one of them was chosen, giving preference to the order of the methods cited above.

The present prospective cohort study was carried out between November 2004 and December 2006, and consisted of two phases. In the first phase, information from the questionnaire of the first cohort study was taken into account, and the mothers who at that time were living in Jundiai city and nearby municipalities were located. The mothers were invited to participate in the present study through telephone contact or by visiting their homes if they did not have a telephone. Next, a home visit was made, during which the objectives of the study were explained, and the ethical consent form was signed by the child's parents or guardians. At the time of this home visit, a general questionnaire was applied in order to assess demographic and socioeconomic factors, and information on breastfeeding and morbidity of the children. In the second phase of the study, the participants were contacted again by telephone to arrange to collect anthropometric measurements (weight, height, waist circumference, and triceps/subscapular skinfold thickness) and body composition data.

Out of the 865 mother–infant pairs from the previous cohort, 745 women and their children were located and invited to participate in the study, resulting in a sample of 649 children, whose parents signed a free informed consent form and answered a general questionnaire. However, 163 children had incomplete data or did not participate in the second phase of the study, resulting in a final sample of 486 children.

The anthropometric measurements (weight, height, waist circumference—WC, triceps and subscapular skinfold thickness) were obtained in accordance with the recommendations of Jelliffe and Jelliffe [15]. The children and respective mothers were weighed, after fasting for 10–12 h, by a portable electronic scale (Sohnle®, model 7500, Murrhardt, Germany), with accuracy of 100 g. Their height was measured using a SECA® stadiometer (Leicester Portable Height measure model, Hamburg, Germany), with accuracy of 0.1 cm. The nutritional status of the children and respective mothers was determined by the body mass index (BMI), and classified according to the WHO Growth Reference for children and teenagers: (<3rd) underweight; (3rd–85th) normal weight; (85th–97th) overweight; (97th–99th) obesity [16], and the WHO standards for adults [17]. Waist circumference measurements were obtained using a SECA® measuring tape (Hamburg, Germany) of accuracy 0.1 cm. Mean values of waist circumference were compared with a British standard [18]; children with WC <95th percentile were classified as non-obese and those ≥95th percentile as obese. Triceps and subscapular skinfold thickness measurements were determined by a Harpenden® skinfold caliper (Baty International, West Sussex, UK) of accuracy 1 mm. Triceps skinfold thickness, which is an indirect measure of body fat, was classified according to gender and age using the cut-off values proposed by Frisancho [19].

Fat mass percentage, fat mass and fat-free mass were measured by electrical bioimpedance analysis utilizing the *BIA 310e Body Composition Analyzer* (Biodynamics Corporation®, USA). The variable fat mass percentage was classified according to Lohman [20].

Table 1
Characteristics of the children and respective mothers ($n = 486$).

Variables	*n*	%	Mean (SD)
Birth weight (g)			3219.53 (470.82)
<2500	25	5.2	
2500–2999	123	25.3	
3000–3499	208	42.8	
3500–3999	107	22.0	
≥4000	23	4.7	
Gestational age (weeks)			39.20 (1.32)
Preterm	15	3.1	
Term	464	95.5	
Posterm	7	1.4	
Gender			
Male	227	46.7	
Female	259	53.3	
Child's age (months)			78.82 (7.99)
60–71.99	102	21.0	
72–83.99	254	52.3	
84–97	130	26.7	
Per capita income (MBW)			0.95 (0.81)
0–0.5	139	28.7	
0.5–1	191	39.3	
1–1.5	83	17.1	
1.5–2	42	8.6	
>2	31	6.3	
Persons per household			4.33 (1.4)
Breastfeeding (months)			12.23 (12.0)
<3	112	23.0	
4–6	87	17.9	
7–12	122	25.1	
13–18	63	13.0	
19–24	50	10.3	
>24	52	10.7	
Child's BMI			16.00 (2.47)
Underweight	16	3.3	
Normal weight	354	72.8	
Overweight	78	16.1	
Obesity	38	7.8	
Waist circumference*			56.72 (6.84)
Not obese (<95th percentile)	352	72.4	
Obese (≥95th percentile)	134	27.6	
Triceps skinfold thickness**			10.13 (3.29)
Thin	18	3.7	
Below average	34	7.0	
Average	309	63.6	
Above average	46	9.5	
Excessive fat	79	16.2	
Subscapular skinfold thickness (mm)			7 (3.25)
Fat mass percentage***			15.81 (6.28)
Very low	58	11.9	
Low	107	22.0	
Optimum	271	55.8	
Moderately high	36	7.4	
High	11	2.3	
Very high	3	0.6	
Fat mass (kg)			4.03 (2.45)
Fat-free mass (kg)			20.19 (3.69)
≤15	20	4.1	
15.1–26	431	88.7	
26.1–40.7	35	7.2	
Mother's marital status			
Single	116	23.9	
Married	334	68.7	
Separated/Divorced	31	6.4	
Widow	5	1.0	
Mother's age (years)			30.68 (6.04)
Mother's BMI^{+}			27.49 (4.13)
Eutrophic	115	23.8	
Overweight	246	50.9	
Obese grade I	92	19.1	
Obesity grade II	24	5.0	
Obesity grade III	6	1.2	

MBW — minimum Brazilian wage (R$ 350.00 = USD 77.00); BMI = body mass index (kg/m^2) — WHO (2007); *McCarthy et al. (2001); **Frisancho (1990); ***Lohman (1992); $^{+}n = 483$.