Influence of term gestational age on weight: cohort study

Influência da idade gestacional no termo sobre o peso: estudo de coorte

Influencia de la edad gestacional a término sobre el peso: estudio de cohorte

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Abstract

Objective: Identify the effect of term gestational age on birth weight and its evolution in the first year of the child's life.

Method: Single cohort, concurrent, with prospective follow-up of one year, performed in Botucatu/SP. Data were collected at three moments in the child's first year of life. To analyze the weight at birth, at six and at twelve months, in function of the gestational age, including potential confounding variables, regression models with normal response were adjusted after identifying bivariate associations with $p<0.20$. The analyses were developed using SPSS V22.

Results: Independently, early-term children were, on average, 161 g lighter at birth (β=-161.6; 95% CI= -236.1 - -87.2; $p<0.001$), 350 g heavier at six months (β=0.35; 95% CI= 0.16-0.53; $p<0.001$) and 290 g heavier at twelve months (β= 0.29; 95% CI= 0.04-0.50; $p=0.019$) than full-term children. Secondary findings: mothers of older age and who attended a larger number of antenatal consultations had heavier babies at birth; longer children at birth were heavier at six and twelve months and infants breastfed longer were lighter at twelve months.

Conclusion: Full-term gestational age was associated with birth weight, at six and twelve months. Early-term children independently showed a lower birth weight and higher weight than full-term infants at six and twelve months of age.

Resumo

Objetivo: Identificar o efeito da idade gestacional no termo sobre o peso ao nascer e sua evolução no primeiro ano de vida da criança.

Método: Coorte única, concorrente, com seguimento prospectivo de um ano, realizado em Botucatu/SP. A coleta de dados foi realizada em três momentos no primeiro ano de vida da criança. Análise do peso ao nascer, aos seis e doze meses, em função da idade gestacional, incluindo potenciais variáveis de confusão foi realizada, ajustando modelos de regressão com resposta normal, após identificação das associações bivariadas com $p<0,20$. Análises executadas com o software SPSS v22.

Resultados: De maneira independente, crianças nascidas de termo precoce tinham, em média, 161 g a menos no peso ao nascer (β=-161,6; IC 95%= -236,1- -87,2; $p<0,001$), 350g a mais no peso aos seis meses (β=0,35; IC 95%= 0,16-0,53; $p<0,001$) e 290 g a mais no peso aos doze meses (β= 0,29; IC 95%= 0,04-0,50; $p=0,019$) que aquelas nascidas de termo completo. Achados secundários: mães com mais idade e número de consultas pré-natal tiveram bebês com maior peso ao nascer; crianças com maior comprimento ao nascer tiveram maior peso aos seis e doze meses e aquelas com maior tempo de aleitamento materno tiveram menor peso aos doze meses.

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Conflicts of interest: nothing to declare.

Conclusão: Houve associação entre idade gestacional no termo e peso ao nascer, aos seis e doze meses. Crianças nascidas de termo precoce tiveram, de maneira independente, menor peso ao nascer e maior peso que as nascidas de termo completo aos seis e doze meses de vida.

Resumen

Objetivo: Identificar el efecto de la edad gestacional a término sobre el peso al nacer y su evolución en el primer año de vida del niño.

Método: Cohorte única, concurrente, con seguimiento prospectivo de un año, realizado en Botucatu, estado de São Paulo. La recolección de datos se realizó en tres momentos durante el primer año de vida del niño. El peso fue analizado al nacer, a los seis y a los doce meses, en función de la edad gestacional, que incluyó potenciales variables de confusión, con el ajuste de modelos de regresión con respuesta normal, luego de la identificación de las relaciones bivariadas con p<0,20. Los análisis se realizaron con el software SPSS v22.

Resultados: De manera independiente, los niños nacidos antes de término tenían, en promedio, 161 g menos de peso al nacer (β=-161,6; IC 95 %= -236,1--87,2; p<0,001), 350 g más de peso a los seis meses (β=0,35; IC 95 %= 0,16-0,53; p<0,001) y 290 g más de peso a los doce meses (β= 0,29; IC 95 %= 0,04-0,50; p=0,019) que los niños nacidos a término. Descubrimientos secundarios: madres con más edad y número de consultas de atención prenatal tuvieron bebés con más peso al nacer; niños con mayor longitud al nacer tuvieron más peso a los seis y doce meses, y los que tuvieron más tiempo de lactancia materna tuvieron un peso menor a los doce meses.

Conclusión: Se encontró relación entre edad gestacional a término y peso al nacer, a los seis y a los doce meses. Niños nacidos antes de término tuvieron, de manera independiente, menos peso al nacer y más peso que los nacidos a término a los seis y doce meses de vida.

Introduction

Weight is a measure of child viability, being an important marker of neonatal morbidity and mortality.[1–4]

A cohort study conducted in Florianópolis-SC, involving 15,879 live births, found an association between birth weight and neonatal death.[5] In addition to the risk of early death, studies show repercussions of birth weight throughout childhood and adult life, with an increase in metabolic syndrome in children and adults associated with birth weight.[6–8]

This study focuses on infant weight, considering term births. The use of term birth tends to designate a homogeneous group of children, born between 37 and 41 full weeks of gestation. Five weeks is a long period though, which can lead to relevant differences in gestational outcomes. Thus, in 2013, the *American College of Obstetricians and Gynecologists* proposed a new classification for non-premature births, according to gestational age at the time of their occurrence. This definition departed from the joint proposal with the Society for Maternal-Fetal Medicine in the United States of America, dividing term birth into three categories: early term, between 37 weeks and 38 weeks and 6 days; full term, between 39 weeks and 40 weeks and 6 days) and late term, between 41 weeks and 41 weeks and 6 days, maintaining the classification postterm for children born after 42 weeks of gestation.[9]

According to the American College's Committee on Obstetric Practice, this change was made to clarify to the medical community as well as to patients that there is no uniformity between infants born after 37 weeks of gestation, as birth close to 39 weeks is important for full fetal development before delivery and, hence, for the start of a healthy life. Hence, childbirth before 39 weeks should only be planned when significant risk is identified for the mother or fetus, or in case of problems that cannot be controlled, such as premature labor or premature membrane rupture.[9]

Considering scientific evidence on the worse neonatal outcome related to low birth weight and the classification proposed for term newborns by the American College of Obstetricians and Gynecologists, this study is proposed to identify the effect of term gestational age on birth weight and its evolution in the child's first year of life.

Methods

This is a single and concurrent cohort with an observational design, in which the participants are classified as exposed and not exposed, being followed to monitor the occurrence of the outcome in a certain period of time, in this case, one year.[10] It is part of a larger study funded by São Paulo Research Foundation (FAPESP), entitled "Child Health in the first year of life: prospective cohort study in the interior of São Paulo". Both the main research and this excerpt received approval from the Research Ethics Committee of the Faculty of Medicine of Botucatu/SP, number 103348/2017.

The study was conducted in Botucatu-SP, located in the Central South of São Paulo, with an estimated population of 127,328 inhabitants for 2018 and part of Regional Health Department VI (DRS VI), Bauru, with 67 other cities. At the time of data collection, the city had a teaching hospital for birth care in the Unified Health System, as well as a private hospital for care to pregnant women with an without a health insurance.[10] Eight traditional primary care services, 12 family health services and one neonatal service are available for outpatient care, aiming to assist all children born in the city in the first days of life, before they are linked to the primary care services of reference.[11]

The presumed study population consisted of mother-infant pairs living in Botucatu. Supposing simple random sampling, type I and II errors equal to 0.05 and 0.20, respectively, absence of confounding variables and an estimated 20% of losses, the final sample proposed was 520 women.

The inclusion criteria were term birth and living in Botucatu. Considering the established period for inclusion in the study (between July 2015 and February 2016), in total, 650 mothers and 656 children were collected. After excluding cases of premature birth, stillbirth and twins, the initial sample consisted of 608 pairs. At the end of the first year of life, however, 541 children (9.9% losses) concluded the follow-up.

With a view to inclusion in the cohort, the mothers were approached and invited to participate in the waiting room, when they arrived for neonatal care at the primary care service where the recruiting took place. After further information about the research objectives and procedures, in case of agreement, they signed a Free and Informed Consent Form.

A trained and remunerated team collected the data for the main study at three moments in the child's first year of life: personally, during the first, sixth and twelfth months of life.

The interview for inclusion in the cohort took place in a private room that was comfortable for the interviewee and her child. Identification data were collected for the mother and infant, as well as sociodemographic, background gestational history, current gestational history, delivery and birth data. The interviews at six and twelve months took place at the mothers' homes or at the primary health service of reference, at the mother's preference. Among other, the child's anthropometric data were collected.

The data collection tools were specifically constructed for this study. They were pretested until reaching a version the involved researchers found satisfactory.

The independent variable, gestational age, was treated as a categorical, polytomous variable (37-38 weeks, 39-40 weeks, and 41 weeks). To calculate the gestational age, an early ultrasound was used, performed in the first trimester of pregnancy or, if no such ultrasound was available, the gestational age was calculated from the date of the last menstruation, provided that the mother indicated being sure about that date.

The research outcomes were weight at birth (g), and weight at six and twelve months of life (Kg).

Potential confounding variables included maternal sociodemographic and obstetric variables: age (years); education (years of school approval); marital status (with partner/without partner); self-reported skin color (white/non-white); per capita household income (≤ one minimum wage/ > one minimum wage); number of pregnancies; number of antenatal appointments and type of delivery (vaginal/cesarean section). To calculate the per capita family income, initially, we added the total family income in reais and divided the value obtained by the total number of people dependent on this income. Then, considering the value of the minimum wage at the time (R$ 788.00), we estimated the per capita family income in minimum wages.

The following data were collected for the newborn: length (centimeters at birth, at six and twelve months of life); head circumference (centimeters at birth, at six and twelve months of life); low weight (<2500G) at birth (yes/no); small newborn for gestational age at birth[12] (yes/no); exclusive breastfeeding at six months (yes, no) and duration of breastfeeding (days).

To analyze the weight at birth, at six and at twelve months, in function of the gestational age, including potential confounding variables, regres-

sion models with normal response were adjusted after identifying bivariate associations with p<0.20. The analyses were developed using SPSS V22.

Results

In this study, 608 women who gave birth to their children at a gestational age between 37 and 41 full weeks were included. The personal characteristics of the women and infants are shown in table 1.

Most of the women were young, with a median age between 25-28 years; high level of education, with a median 11 years of school approval; lived with a partner (87.0% -87.6%) and were white (57.1% -65.6%). Cesarean birth was more frequent in the early term group (64.1%), the median weight of newborns ranged from 3,095 g to 3,480 g, low birth weight was more frequent among early term births (4.4%) and small newborns for gestational age were more often in the late term group (7.8%) (Table 1). Table 2 relates to the gross and adjusted analyses between research variables and birth weight.

The variables maternal age, lives without a partner, number of antenatal consultations, early term and late term, presented p< 0.20 in the gross analysis and were included in the adjusted analysis. Independently, early-term children were, on average, 161 g lighter at birth than full-term children (β=-161.6; 95% CI= -236.1 - -87.2; p<0.001) and late-term children were, on average, 148 g heavier at birth than full-term children (β=148.7; 95% CI= 44.2-253.0; p=0.005). Also independently, for each year of the mother's life, the newborn was, on average, 6g heavier at birth (β=5.84; 95% CI = 0.62-11.0; p=0.029) and, for each antenatal consultation, the newborn was 30g heavier at birth: β=30.0; 95% CI= 15.4-44.6; p<0.001 (Table 2). Table 3 refers to the infant's weight at six months of life.

The variables newborn small for gestational age, length at birth, early term and late term presented p< 0.20 in the gross analysis and were included in the adjusted analysis. Independently, early-term children were, on average, 350g heavier at six months than full-term children (β= 0.35; 95% CI = 0.16-0.53; p<0.001). Also independently, length at birth was associated with weight at six months of life. For each additional centimeter at birth, the children were, on average, 200g heavier at the age of six months: β = 0.20; 95% CI= 0.16-0.53; p<0.001 (Table 3). Table 4 relates to the child's weight at the age of 12 months.

Table1. Characteristics of the mothers and infants who participated in the study, considering the early-term (N=250), full-term (N=281) and late-term (N=77) groups

Characteristics	Early Med. (min-max)**	Full term Med. (min-max)**	Late Med. (min-max)**
Maternal age (years)	28 (15-42)	27 (14-42)	25 (16-39)
School approval (years)	11 (1-18)	11 (1-23)	11 (2-21)
Number of pregnancies	1 (0-6)	1 (0-7)	1 (0-5)
Number of antenatal consultations	8 (1-15)	9 (1-17)	11 (1-15)
Birth weight (grams)	3095 (1990-4295)	3280 (2020-4700)	3480 (2285-4725)
Length at birth (cm)	48 (42.5-52)	49 (40.5-57)	50.5 (45-54.5)
Head circumference at birth (cm)	34 (30-40)	34.5 (31-42)	35 (31-41.5)
	N(%)	N(%)	N(%)
Per capita income ≤ 1MW*	12(4.8)	21(7.5)	6 (7.8)
Lives with partner	219(87.6)	246(87.5)	67 (87.0)
White skin color	164(65.6)	169(60.1)	44 (57.1)
Birth weight <2500g	11(4.4)	4(1.4)	1 (1.3)
Small/gestational age	10(4.0)	21(7.4)	6 (7.8)
Cesarean delivery	159(64.1)	119(42.3)	34 (44.2)
Exclusive breastfeeding at 6 months of age	7(2.8)	7(2.5)	2 (2.6)

* MW-minimum wage; * * Med (min-max) - Median (minimum value-maximum value)

Table 2. Gross and adjusted analysis with research variables and birth weight

Variables	Gross analysis			Adjusted analysis*		
	β	95% CI	p-value	β	95% CI	p-value
Maternal age (years)	6.1	0.7-11.5	0.028	5.8	0.62-11.0	0.029
School approval (years)	5.9	-7.5-19.3	0.390			
Lives without partner	-88.8	-198.4-20.9	0.113	-40.9	-145.6-63.7	0.443
Non-white skin color	25.1	-48.7-98.9	0.505			
Per capita family income	0.09	-47.9-48.1	0.997			
Number of pregnancies	-17.8	-254.2-218.6	0.883			
Number of antenatal consultations	46.3	32.2-60.4	<0.001	30.0	15.4-44.6	<0.001
Full term	0					
Early term	-191.5	-256.6- -117.4	<0.001	-161.6	-236.1- -87.2	<0.001
Late term	176.4	70.9-218.8	<0.001	148.7	44.2-253.0	0.005

* Regression model with normal response

Table 3. Gross and adjusted analysis with research variables and weight of the baby at six months of life

Variables	Gross analysis			Adjusted analysis*		
	β	95% CI	p-value	β	95% CI	p-value
Maternal age (years)	0.0	-0.0-0.1	0.836			
School approval (years)	0.0	-0.0-0.1	0.267			
Lives without partner	0.1	-0.1-0.4	0.324			
Non-white skin color	0.0	-0.2-0.2	0.978			
Per capita family income	0.02	-0.09-0.14	0.643			
Small newborn for gestational age	-0.79	-1.16- -0.42	<0.001	-0.20	-4.7-0.04	0.054
Length at birth	0.1	0.1-0.2	<0.001	0.20	0.16-0.53	<0.001
Duration of breastfeeding	0.0	-0.001-0.002	0.680			
Full term	0					
Early term	0.1	-0.1-0.3	0.165	0.35	0.16-0.53	<0.001
Late term	0.3	0.1-0.6	0.021	0.13	-0.12-0.40	0.310

* Regression model with normal response

Table 4. Gross and adjusted analysis of the research variables and weight of the child at twelve months

Variables	Gross analysis			Adjusted analysis*		
	β	95% CI	p-value	β	95% CI	p-value
Maternal age (years)	0.0	-0.1-0.0	0.726			
School approval (years)	0.0	-0.1-0.1	0.106	0.028	-0.01-0.06	0.156
Lives without partner	0.0	-0.3-0.4	0.896			
Non-white skin color	-0.1	-0.3-0.2	0.685			
Per capita family income	0.06	-0.08-0.21	0.372			
Small newborn for gestational age	-0.85	-1.3- -0.40	<0.001	-0.16	-0.61-0.27	0.497
Length at birth	0.2	0.1-0.3	<0.001	0.24	0.18-0.30	<0.001
Duration of breastfeeding	-0.002	-0.003-0.0003	0.114	-0.002	-0.004- -0.001	<0.001
Full term	0					
Early term	0.1	-0.2-0.3	0.451	0.29	0.04-0.50	<0.019
Late term	0.2	-0.2-0.5	0.320	-0.06	-0.37-0.25	0.707

* Regression model with normal response

Education, small newborn for gestational age and length at birth presented p< 0.20 in the gross analysis and were included in the adjusted analysis, as well as the research variables: early term and late term. Independently, early-term children were, on average, 290g heavier at 12 months than full-term children (β= 0.29; 95% CI = 0.04-0.50; p = 0.019). Also independently, length at birth was associated with the duration of breastfeeding and weight at 12 months. For every additional centimeter at birth, the children were, on average, 240g heavier at 12 months: β=0.24; 95% CI= 0.18-0.30; p<0.001 and for each additional day of breastfeeding, the children were, on average, 2g lighter: β= -0.002; 95% CI= -0.002; 0.004--0.001; p<0.001 (Table 4).

Discussion

Independently, at birth, early-term children were, on average, 161g lighter than full-term children, while late-term children were 148g heavier than full-term children. Also independently, early-term children were, on average, 350g heavier at six months and 290g heavier at twelve months of life when compared to full-term children.

Regarding the birth weight, the results obtained are in line with the scientific literature, and there is evidence of the relevance of each additional week of gestation to increase the newborn's weight, [12,13] which also explains the higher weight of late-term newborns when compared to full-term infants. A population-based study that evaluated fetal growth and newborn length in eight countries showed that the curves for birth weight are directly proportional to the gestational age.[12] In Brazil, in a study using data from the Live Birth Information System (SINASC), between 2001 and 2010, the proportion of low-weight newborns decreased as the duration of pregnancy increased.[13]

In this study, the low-weight rate tended to be low, as expected because the infants were born full-term. Among the early-term newborns, however, this was three times higher than that observed

among full-term or late-term births, which indicates the importance of term pregnancies evolving into delivery only after 39 weeks.

It is known that low birth weight is a risk condition for children in general. Nevertheless, the weight should be considered in relation to the gestational age, as the prognosis better in case of infants born in the appropriate term, even when in low-weight conditions. The explanation lies in the compensatory postnatal growth, in response to the deceleration in the rate of the child's weight gain during pregnancy because, insofar as the cause of the problem is corrected and under appropriate environmental conditions, the organism starts to grow at a higher speed than expected for age, so that these children reach the normal weight for age still in the first year of life.[14] In a study involving preterm newborns, which investigated breastfeeding patterns and the evolution of weight gain, it was demonstrated that the lower the gestational age and/or birth weight, the greater the postnatal weight gain.[15]

Unlike the birth weight, weight at six and twelve months was found to be independently higher among early-term infants than among full-term or late-term newborns, indicating acceleration in weight gain among children born at term, but with a lower gestational age and weight. This finding leads us back to the already mentioned discussion about the acceleration in weight gain after birth in conditions of prematurity and/or of small children for gestational age.[14] The situation found among early-term infants is inverse, insofar as they have reached between 37-38 weeks of gestational age and because this group contains proportionally half of the cases of children classified as small for gestational age when compared to the late and full-term groups.

Although the explanation about the compensatory acceleration of the weight gain is specifically focused on premature children and low-weight children for their gestational age thus far, it can apply to early-term newborns, also because some researchers appoint that the responses in this group are closer to those of late premature infants than to those of full-term infants. In this context, in a cross-sectional study conducted in France in 2010, the risk factors for late premature and early-term children were investigated, taking full-term infants as a reference. The authors concluded that both groups had the same associated risk factors and should therefore have shared prevention strategies.[16]

Therefore, other studies should be conducted, with larger samples, in order to confirm whether the weight increase of early-term newborns is truly more accelerated than that observed among other full-term newborns, a relevant condition according to the evidence in the scientific literature concerning the association between low birth weight and the development of metabolic syndrome in adults.[6–8,17,18]

The following are secondary findings of this study: independently, there was a directly proportional association between maternal age and the number of antenatal consultations and the weight at birth. The association between length at birth and weight at six and twelve months was also directly proportional, but the association between the duration of breastfeeding and weight at twelve months was inverse.

With regard to the birth weight, the results obtained in relation to the maternal age are in accordance with the scientific literature, because studies on this theme relate the children's weight gain with the increase in maternal age, with an inverse relationship only at the age extremes.[19–21] Regarding the number of antenatal consultations, it may be related to the longer duration of pregnancy as, the longer the pregnancy, the more appointments are scheduled and, as from 36 weeks of pregnancy, at least weekly returns are indicated.[22]

As for the weight at six and twelve months, the positive association with the length at birth was also found in two studies conducted in the state of Minas Gerais, in which children who had a longer length at birth had a higher rate of weight gain in the first six[23] or twelve months of life.[24] About the fact that children who were breastfed longer present less weight at twelve months, it can derive from the longer use of infant milk formulas, as these may contain excessive fat and carbohydrate levels.[25]

One limitation of this study was the fact that the pairs who participated in the cohort were col-

lected at a neonatal screening service in primary care, which attends to children in the first month of life. Therefore, the presence of mothers and children who experienced problems that could affect the research outcomes may have been small.

Conclusion

This study evidenced the influence of gestational age of early-term children on the birth weight, at six and twelve months: the weight was 161g lower at birth, 350g higher at six months and 290g higher at twelve months of life when compared to full-term children. Studies with this focus are scarce though. Therefore, further research is necessary to promote a broad discussion on this topic.

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