DOI: 10.1590/1413-81232018238.13972016

Determinants of low birth weight in the children of adolescent mothers: a hierarchical analysis

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Abstract *This study aimed to identify the determinants of low birth weight (LBW) amongst children of adolescent mothers through a hierarchical approach in a cross-sectional study of 751 adolescents attended at a public hospital in Rio de Janeiro. Sociodemographic data, prenatal care, and biological and maternal obstetric conditions were analyzed. Possible determinants of LBW were identified in the bivariate analysis and then hierarchical logistic regression models were tested, considering as taggered hierarchy of distal, intermediate, and proximal levels. Variables with $p < 0.05$ at each level of analysis were kept in the model, and the adjusted odds ratio (OR) and 95% confidence interval (CI) were estimated. The prevalence of low birth weight was 10%. The determinants of LBW were: distal level – non-acceptance of pregnancy (OR = 10.19, 95% CI = 1.09 to 39.53); intermediate level – having fewer than six prenatal consultations (OR = 4.29; 95% CI = 1.55 to 11.83) and not having standardized nutritional care (OR = 3.18; 95% CI = 1.18 to 8.55); and proximal level – preterm delivery (OR = 10.19, 95% CI = 2.12 to 49.01). The determinants of LBW were maternal characteristics, prenatal care, and birth conditions, which contain certain modifiable social characteristics.*

Key words *Newborn Low birth weight, Teenage pregnancy, Prenatal care*

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Introduction

According to the World Health Organization (WHO)[1], low birth weight (LBW), defined as weight at birth of less than 2,500 grams, is a determinant of fetal and neonatal mortality and morbidity, developmental deficit, cognitive impairment, and increased risk of chronic noncommunicable diseases in adulthood.[2]

Overall estimates indicate that the prevalence of LBW is about 15%, with 96.5% of cases occurring in developing countries, especially among the most vulnerable populations.[1]The main causes of this outcome are preterm birth, intrauterine growth retardation, and fetal malnutrition.[1] In Brazil, there are significant regional variations in the prevalence of low birth-weight infants. In 2013, 9.5% of the live births of Brazilian adolescent mothers were low weight, while in the city of Rio de Janeiro this percentage was 10.1%.[3]

Conditions at birth result from a complex interrelationship of factors of various dimensions. Studies have focused on the relationship between undesirable gestational outcomes and genetic, constitutional, demographic, socioeconomic, nutritional, obstetric, and prenatal care conditions.[1,4-6] For example, LBW amongst the children of adolescent mothers has been associated with low income and inadequate housing conditions, generally measured by the type of housing and access to clean water and sanitation.[6] These conditions are not directly responsible for the outcome, but can influence certain determinants. Thus, the study of LBW amongst the infants of adolescent mothers calls for complex hierarchical models to study its determinants and interrelationships.

Monteiro et al.[7] present a model of LBW determination in which they hierarchically interrelate the potential risk factors already identified in the literature. The variables that appear at the first level of this model are duration of gestation and intrauterine growth rate (proximal determinants); at the second level, the variables are nutritional status of the pregnant woman at the beginning of and during pregnancy, diseases, smoking, pregnancy stress, prenatal adequacy, maternal age, and parity (intermediate determinants). Finally, at the third level, the variables are two socioeconomic conditioners, income and education (distal determinants).

A study by Nascimento[8] of women who gave birth at the University Hospital of Taubaté (São Paulo, Brazil) found the following gestational variables (proximal determinants): gestational hypertension, vaginal bleeding in any trimester, and insufficient weight gain during pregnancy. The demographic and reproductive factors (intermediate determinants) they identified were gestation in adolescence, previous underweight births, and previous miscarriage, and the socioeconomic factors (distal determinants) were found to be family income and low maternal schooling.

Hierarchical analyses have been used in national epidemiological studies to elucidate the risk factors associated with diseases related to maternal and infant health.[9] These analyses incorporate differentiated hierarchical levels of determination for a given outcome.[10] In this model, the distal determinants (environmental and sociodemographic factors) influence the intermediate determinants (behavioral and health/disease factors), which in turn influence the proximal determinants.[10] This enables the complexity of the outcome to be observed, either through the force of the influence that each of the factors exerts on its occurrence, or through the interrelationships and interdependencies of these different factors in triggering episodes that favor the development of the outcome.[10]

This type of analysis allows us to identify the influence of the social determinants of health, defined as the social conditions in which people live and work, and which are shaped by "social, economic, cultural, ethnic/racial, behavioral factors, on the occurrence of health problems and their risk factors in the population,"[11] which are still little investigated in Brazil. Even when they are included in certain analyses, the social determinants of health are not highlighted because they do not have the same strength as biological variables. However, hierarchical analysis brings to light the interrelationships and mediation effects between these determinants and the ones traditionally known to be involved in the occurrence of LBW in the children of adolescent mothers, while also enabling the identification of when it is that they have the greatest impact on LBW. As such, it can demonstrate the relationship between inequalities and social inequities in perinatal health.

In the present research, hierarchical modeling was used to identify the factors that determine the occurrence of low birth weight amongst children of adolescent mothers attended at a public maternity hospital in Rio de Janeiro.

Ciência & Saúde Coletiva, 23(8):2609-2620, 2018

Methods

Study Design

This cross-sectional study was carried out in a public maternity hospital in the city of Rio de Janeiro, Brazil, using the databases from two studies, the Prenatal Nutritional Monitoring Program for Pregnant Adolescents and Gestational Weight Gain in Adolescents Associated with the Best Perinatal Outcome, developed under the responsibility of the Research Group on Maternal and Infant Health at the Josué de Castro Nutrition Institute (Instituto de NutriçãoJosué de Castro, INJC), Federal University of Rio de Janeiro. This maternity hospital is specialized in healthcare for pregnant adolescents. The prenatal care rate for adolescents aged under 19 is around 17.4% (base in May / 2015; http: //www.maternidade.ufrj .br / portal / images / stories / pdfs / indicators / 2015 / indicador_geral_maio.pdf).

Study population and inclusion criteria

The study population consisted of pregnant adolescents who received prenatal, delivery, and postpartum care at the maternity hospital in question between 2004 and 2010 and also in 2013. The selection criteria for this case history were: mother less than 20 years old at conception; mother having received prenatal care; having a single fetus gestation; having no chronic diseases; and availability of information on birth weight in the medical records.

Calculation of sample size

As the required information for this study was available on fewer adolescents than in the total sample of the original study, post-hoc sample size calculations were performed. Assuming a 10% prevalence of LBW and a significance level of 5% for the sample of around 700 women, with an 80% power to detect differences of at least 6% in the prevalence of LBW between the groups (GI/GIII and GII), the minimum sample estimated for the present study was 530 women.

Data collection

Data was collected by a trained and supervised team by consulting the records of the adolescent girls and newborns and in interviews conducted during prenatal nutrition consultations. The dependent variable (low birth weight) was classified according to the WHO definition (birth weight <2,500g)[1]. The independent variables studied were: sociodemographic data, regular and nutritional prenatal care, and maternal biological and obstetric characteristics. Based on the literature review,[4,12-14] a hierarchical conceptual model was proposed.

Maternal anthropometric evaluation and gestational complications

The anthropometric evaluation was based on pre-gestational weight or weight measured up to the 13th gestational week, height, and pre-natal weight or at the last prenatal visit. Nutritional status was determined from the pre-gestational body mass index (BMI), according to the WHO recommendation for individuals aged 5 to 19 years, according to sex and age in months, by means of which the percentile referring to pre-gestational BMI was found.[15] Next, the subjects were classified according to their nutritional status as underweight, normal weight, overweight, or obese, according the Food and Nutrition Surveillance System standards[15] proposed by the Brazilian Ministry of Health.[16] Gestational weight gain was calculated and evaluated according to the recommendations of the Institute of Medicine[17] .

Based on the Ministry of Health[18] recommendations, the gestational complications studied were anemia (hemoglobin <11g/dl) and hypertensive pregnancy syndromes (gestational hypertension, preeclampsia, eclampsia). The occurrence of gestational night blindness and gestational diabetes was also investigated, according to specific criteria,[19-21] as was the occurrence of any other complications during pregnancy. The newborns' weight and gestational age were evaluated at birth.

Hierarchical model

In the present study, the variables of interest were based on current knowledge about LBW, followed by a classic classification of hierarchical levels,[10] in which the model is structured with three levels of hierarchy – distal, intermediate, and proximal – in order to discriminate the relationships amongst the determinants and between the determinants and LBW in children of adolescent mothers (Figure 1).

Sanitation was defined as adequate when there was piped water, garbage collection, and sewage treatment, and as inadequate when one of these services was missing.[22]

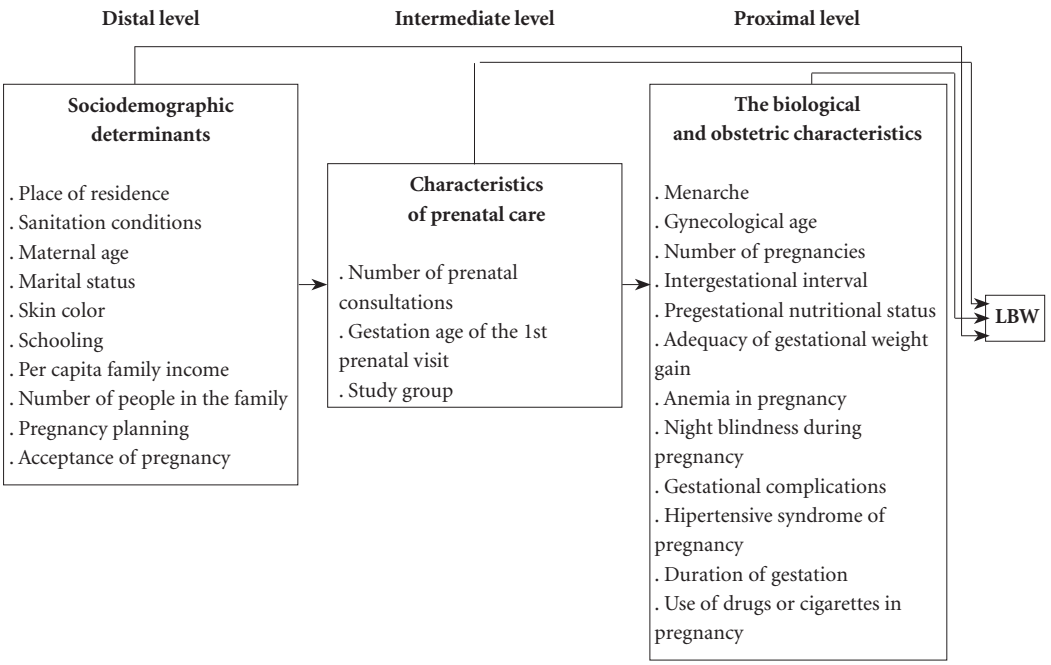

Figure 1. Description of the independent variables according to the hierarchical model. Rio de Janeiro, 2013.

The variable "study group" was created to represent the nutritional supervision the women received during their prenatal care. Group II (GII – 2007–2010) received differentiated nutritional assistance, in which follow-up with a nutritionist began at an early stage as part of their prenatal care regimen and included at least four consultations with a nutritionist, interspersed with group consultations, where surveillance actions, actions designed to prevent clinical complications, and individualized nutritional assessments were provided. Groups I (GI – 2004–2006) and III (GIII - 2013) were referred to a nutritionist at any gestational age and they did not attend a minimum of four consultations.

Regarding pre-gestational nutritional status, the variables were classified according to pre-gestational BMI (kg/m^2): low weight = BMI less than the 3rd percentile; normal weight = BMI from the 3rd percentile to less than the 85th percentile; overweight = BMI between the 85th percentile and less than the 97th percentile; and obese = BMI 97th percentile or greater). The evaluation compared low weight individuals with the other classifications, since low pre-gestational weight may be related to LBW.[23]

Data analysis

The association between the possible determinants of LBW and adolescent pregnancy was evaluated through a bivariate analysis of all the variables at each hierarchical level. Gross odds ratios (OR) with 95% confidence intervals (CI) were estimated using simple logistic regression. To design the final hierarchical model, the variables were introduced into the model at the distal, intermediate, and proximal levels. A criterion of inclusion of the variables in the model was $p < 0.20$ in the bivariate analysis. For the model adjustment at the hierarchy level, the variables with a value of $p < 0.05$ at each level of analysis were kept in the model.

In the final model, adjusted ORs were estimated with their respective 95% CI using hierarchical logistic regression and according to each level of hierarchy. The chi-squared test was used to evaluate the association between LBW determinants and sample characteristics, and Student's t-test was used for comparing the mean values. The analyses were carried out with the aid of the statistical program SPSS (Statistical Package for Social Sciences), version 21.0.

Ethical issues

The study was conducted in compliance with the ethical considerations contained in National Health Council resolutions 196/96 and 466/2012 and approved by the Research Ethics Committee of the Maternity School of the Federal University of Rio de Janeiro (Maternidade Escola da UFRJ; CAAE - 1758.0.000.361-07; 07/07/2007 and CAAE: 25438113.8.0000.5275). Only the participants in group III signed an Informed Consent Form, since the data on the other groups were collected from medical records and the researcher was responsible for its reliability.

Results

Ten percent of the newborns had LBW and 13% were born premature; 751 adolescents and their respective children were included in the study. The original study population (n = 845) was reduced in number by 94: 37% caused by miscarriages and 59% due to lack of information on birth weight. The comparative analysis between the adolescents excluded from the study at this stage and those included in the study showed no statistical difference (p >0.05) in relation to maternal age at birth, schooling, acceptance of the pregnancy by the adolescent, and number of prenatal consultations.

The mean age of the adolescent mothers at birth was 17.5 years ± 1.6; 64% had completed their elementary education, 52% did not work, 68% were single, 62% declared themselves to be non-white, 64% had a per capita income that was below the minimum wage, 52% were residents of the south zone of Rio de Janeiro, and 89% had access to adequate sanitation. Although just 22% of the subjects had planned their pregnancy, 95% of them reported they accepted it.

Seventy-two percent of the adolescents had six or more prenatal visits and 80% received prenatal nutritional care. Eighty-one percent started pregnancy with an adequate nutritional status, but 66% had inadequate weight gain. Twenty-six percent had some gestational complication, with anemia being the most frequent complaint. The most frequent hypertensive syndrome of pregnancy was gestational hypertension (n = 20), and night blindness was also reported by 36 adolescents.

The bivariate analysis identified the factors associated with LBW (p <0.20) at all three levels of the hierarchy. Table 1 shows the association between the dimensions that make up the level referring to socioeconomic characteristics (distal level) and LBW. Maternal age, marital status, acceptance of pregnancy, and schooling were all associated with LBW. Non-acceptance of the pregnancy (OR = 5.7, 95% CI = 1.67–19.84) and the absence of a partner (OR = 2.28, 95% CI = 1.04–5.02) were both identified as contributory factors at this level. We identified an association between acceptance of pregnancy and planning of pregnancy and fewer than six prenatal consultations (p = 0.01). Prenatal care was also found to be commenced later by those who did not accept their pregnancy (mean = 17.6 gestational weeks versus 16 gestational weeks for those who accepted their pregnancy) and non-acceptance was found to be more frequent in the adolescents under 16 (6.7% versus 5.1% for over-16s).

The characteristics of prenatal care (intermediate level) that were associated with the outcome were: number of prenatal consultations and study group (Table 2). Having fewer than six prenatal consultations was related to the lowest educational level (p <0.001).

The biological and obstetric characteristics (proximal level) associated with the outcome were: gender, pregestational nutritional status, adequacy of gestational weight gain, and duration of gestation (Table 3). The highest impact factor at this level was duration of gestation (OR = 36.6, 95% CI = 19.60–68.55), followed by adequacy of gestational weight gain (OR = 2.94, 95% CI, = 1.39–6.24). Student's t-test showed that the adolescents from GI and GIII had a lower average number of consultations with a nutritionist (2.6 ± 1.6 visits versus 3.8 ± 1.7 visits for GII, p <0.001).

In the final model, after adjustments, it was observed that not accepting the pregnancy (distal level, adjusted OR = 6.56, 95% CI = 1.09–39.53), having fewer than six prenatal consultations (95% CI = 1.56–11.83), belonging to study group I or III (intermediate level, adjusted OR = 3.18, 95% CI = 1.18–8), and having a gestation of less than 37 weeks (proximal level, adjusted OR = 10.19, 95% CI = 2.12–49.01) were the determinants of LBW (Table 4).

Discussion

The prevalence of LBW in this study was 10%. This indicator varies greatly across the different regions of Brazil, with surveys of pregnant women under 20 years of age in the southeast

Table 1. Sociodemographic (distal) determinants of low birth weight amongst the children of adolescents attended at a public maternity hospital in Rio de Janeiro. Rio de Janeiro, Brazil (2004-2010 and 2013).

Variables	Sample n	Low birth weight n (%)	p[a]	OR (CI95%)
Place of residence	**750**			
Do not lives in the South Zone	361	38 (10.5)	0.64	1.12 (0.70-1.81)
Lives in the South Zone	389	37 (9.5)		1
Sanitation conditions	**458**			
Inadequate	48	4 (8.3)	0.75	1.19 (0.40-3.56)
Adequate	410	29 (7.1)		1
Maternal age	**749**			
< 16 years	112	16 (14.3)	0.10	1.63 (0.90-2.95)
> 16 years	637	59 (9.3)		1
Marital status	**538**			
Lives without a partner	367	37 (10.1)	0.04	2.28 (1.04-5.02)
Lives with his partner	171	8 (4.7)		1
Skin color	**586**			
Not white	363	33 (9.1)	0.81	1.07 (0.59-1.94)
White	223	19 (8.5)		1
Scholling	**662**			
Fundamental incomplete	240	32 (13.3)	0.02	1.87 (1.12-3.15)
Fundamental complete	422	32(7.6)		1
Per capita family income	**201**			
< 1 minimum wage	129	8 (6.2)	0.85	1.12 (0.33-3.87)
> 1 minimum wage	72	4 (5.6)		1
Number of people in the family	**254**			
> 4	70	6 (8.6)	0.46	1.47 (0.52-4.15)
≤ 4	184	11 (6.0)		1
Pregnancy planning	**385**			
No	300	21 (7.0)		1.20 (0.44 -3.29)
Yes	85	5 (5.9)	0.72	1
Acceptance of pregnancy by the adolescent	**308**			
No	16	4 (25.0)		5.70 (1.67-19.84)
Yes	292	16 (5.5)	0.01	1

Legend: OR = odds ratio; 95% CI = 95% confidence interval; [a] bivariate logistic regression.

and northeast of the country having identified prevalences of 15.1% and 11.9%, respectively.[24,25] When Lima and colleagues[26] studied the variability of this prevalence in Brazil, they found that the LBW rate was related to the mother's social environment and inequality of access to health services. Also, the shortage of resources for hospital medical care and the non-recording of birth weight in less developed regions contributes to these lower rates, in contrast to the more developed regions, which offer better quality prenatal care, leading to lower infant mortality and more birth weight records.

In a survey carried out in low- and middle-income countries, Ganchimeget al.[27] found a higher prevalence of LBW (12.3%) among the children of adolescents. This may be related to the worse socio-demographic and prenatal care conditions in some of the countries in Africa and Asia included in the study, which had a higher number of adolescents with low pre-gestational BMI and lower levels of schooling than the Latin American countries evaluated. However, the LBW rate found in this study was on the threshold of the United Nations recommendation, which proposes that the prevalence of children with LBW should not exceed 10%.[28] According to the WHO.[1] in 2000 the prevalence of LBW in developed countries was around 7%, while in South America it was around 9.6%. In 2014, this rate in Latin America was 9%,[2] reflecting the difficulty of controlling this negative outcome.

Table 2. Association between characteristics of prenatal care and low birth weight of children of adolescents attended at a maternity school in Rio de Janeiro, Brazil (2004-2010 and 2013).

Variables	Sample n	Low birth weight n (%)	p[a]	OR (CI95%)
Number of prenatal consultations	**679**			
< 6	192	33 (17.2)	< 0.001	3.40 (1.99-5.81)
≥ 6	487	28 (5.7)		1
Gestational age of the 1st prenatal visit	517			
≤ 16	200	18 (9.0)	0.95	1.02 (0.55-1.90)
> 16	317	28 (8.8)		1
Study group	**751**			
GI and GIII	555	66 (11.9)	< 0.001	2.80 (1.37-5.74)
GII	196	9 (4.6)		1

Legend: OR = odds ratio; 95% CI = 95% confidence interval; [a] Bivariate logistic regression.

The hierarchical model used in this investigation found just one sociodemographic factor (distal level) as a determinant of LBW: the non-acceptance of the pregnancy. This may be related to family planning, since it was verified that all those who did not accept their pregnancy were adolescents who had not planned to get pregnant, unlike those who had planned their pregnancy. Another factor that could be attributed to the acceptance of pregnancy is maternal age, which affects psychological maturity. In the present study, most of the subjects who did not accept their pregnancy were under 16 years of age.

However, in another study of pregnant Brazilian adolescents, Moreira et al.[29] found other determinants for not accepting pregnancy, such as the negative reaction of the parents, denial of support for the pregnant women, and low socioeconomic level, related to low health and education conditions, corroborating the occurrence of unwanted pregnancies.

Phipps and Nunes,[30] who evaluated the association of intention to conceive with maternal and child health risks, found that adolescents' lack of emotional preparation at conception was associated with the inadequacy of prenatal care (OR = 2.7, 95 % = 1.27–5.72). Meanwhile, according to a meta-analysis by Shah et al.,[31] unwanted pregnancies may increase the chances of LBW by 1.4 times (OR = 1.36, 95% CI = 1.25–1.48).

Non-acceptance of the pregnancy in this study was associated with the late initiation of prenatal care and fewer than six prenatal consultations overall, confirming findings from other studies that suggest that unwanted pregnancies are associated with inadequate prenatal care.[32]

Starting prenatal care late and attending fewer consultations are recognized characteristics of this population[33] and are associated with negative perinatal outcomes such as prematurity and LBW.[8] In a Canadian study, it was found that not only did young women start prenatal care late, but they also presented worse health, less folic acid use, lower rates of initiation and duration of breastfeeding, and children with a lower health status than the adult women.[34]

According to Brazilian Ministry of Health guidelines, at least six prenatal consultations must be provided to ensure maternal and neonatal well-being.[17] Our findings are consistent with this, insofar as attending fewer than six prenatal consultations was determinant for LBW among the children of the adolescents, as observed in the Santos et al. study (OR = 2.7; 95% CI = 1.48–5.05).[8] Another study of pregnant women and adolescents that involved proposing a hierarchical model for LBW found that the lowest number of prenatal consultations (<6 - intermediate level) increased the chances of LBW 1.7 times [25].

In our study, it was also observed that a lower number of prenatal consultations was associated with lower levels of education, and in the bivariate analysis, schooling was associated with LBW, confirming an influence of this social indicator (distal level) on care characteristics (intermediate level). According to Viner et al.,[35] access to education is a strong social determinant of adolescent health, and school is a crucial institution for supporting the process of maturation and biopsychosocial development so that the young person can make a healthy transition into adult life.

Table 3. Association between maternal proximal characteristics (biological, obstetric, and clinical) and low birth weight of the children of adolescents attended at a maternity school in Rio de Janeiro, Brazil (2004-2010 and 2013).

Variables	Sample n	Low birth weight n (%)	p[a]	OR (CI95%)
Menarche	**347**			
< 13 years	222	19 (8.6)	0.47	1.37 (0.58-3.22)
≥ 13 years	125	8 (6.4)		1
Gynecological age	**421**			
≤ 2 years	60	5 (8.3)	0.76	1.17 (0.43-3.18)
> 2 years	361	26 (7.2)		1
Number of pregnancies	**751**			
Not primiparous	171	21 (12.3)	0.26	1.36 (0.80-2.33)
Primiparous	580	54 (9.3)		1
Intergestational interval	**70**			
< 24 months	47	5 (10.6)	0.80	1.25 (0.22-6.99)
≥ 24 months	23	2 (8.7)		1
Pregestational nutritional status	**452**			
Underweight	62	8 (12.9)	0.09	2.70 (0.42-2.46)
Normal/ Overweight	390	26 (6.7)		1
Adequacy of gestational weight gain	**409**			
Below	122	16 (13.1)	<0.001	2.94 (1.39-6.24)
Appropriateorabove	287	14 (4.9)		1
Anemia in pregnancy	**569**			
Yes	234	21 (11.5)	0.44	1.23 (0.72-2.12)
No	335	32 (9.6)		1
Night blindness during pregnancy	**330**			
Yes	36	4 (11.1)	0.22	2.04 (0.65-6.43)
No	294	17 (5.8)		1
Gestational complications	**715**			
With complications	188	23 (12.2)	0.25	1.36 (0.80-2.30)
Without complications	527	49 (9.3)		1
Hipertensive syndrome of pregnancy	**751**			
No	719	72 (10.0)	0.91	1.08 (0.32-3.62)
Yes	32	3 (9.4)		1
Duration of gestation	**667**			
< 37 weeks	85	47 (55.3)	<0.001	36.6 (19.60-68.54)
≥ 37 weeks	582	19 (3.3)		1
Use of cigarettes in pregnancy	**448**			
Yes	43	5 (11.6)	0.30	1.71 (0.62-4.66)
No	405	29 (7.2)		1
Use of drugs in pregnancy	**449**			
Yes	12	1 (8.3)	0.94	1.08 (0.13-8.60)
No	437	34 (7.8)		1

Legend: OR = odds ratio; 95% CI = 95% confidence interval; [a] bivariate logistic regression.

However, although school is the primary space for the development of socialization and transmission of norms, values, and knowledge, it is not provided in an egalitarian way, often reinforcing social, class, and gender inequalities. Allied to this, there are conditions of poverty and family fragility that promote school dropout, increasing the proportion of adolescents whose life prospects are restricted to an immediate future, with low expectations and very low self-esteem[36].

Table 4. Final hierarchical model with crude and adjusted ORs to estimate the determinants of low birth weight in the children of adolescents attending a public maternity hospital in Rio de Janeiro, Brazil (2004-2010 and 2013).

		p[c]	OR	CI 95%	*p*[c]	Adjusted OR	CI95%
Distal model							
Acceptance of pregnancy	No	0.01	5.70	1.67 – 19.84	0.04	6.56	1.09 – 39.53
	Yes	...	1.00	...		1.00	...
Intermediate model[a]							
Nº of PNC consultations	< 6	< 0.001	3.40	1.99 – 5.81	< 0.001	4.29	1.55 – 11.83
	6 or +	...	1.00	...	...	1.00	...
Study group	GI and GIII	< 0.001	2.80	1.37 – 5.74	0.02	3.18	1.18 – 8.55
	GII	...	1.00	...	...	1.00	...
Proximal model[b]							
Duration of gestation	< 37 weeks	< 0.001	36.6	19.60 – 68.54	< 0.001	10.19	2.12 – 49.01
	≥ 37 weeks	...	1.00	...	...	1.00	...

[a] Adjusted by the acceptance of the pregnancy by the pregnant woman.[b] ajusted by study group and number of prenatal consultations. [c] hierarchical logistic regression. Legend: No. - number; PNC - Prenatal care; OR = odds ratio; 95% CI = 95% confidence interval.

These may be some of the factors that determine the low levels of prenatal care and their consequent negative impact on perinatal outcomes.

Regarding skin color, no association was found with the outcome, although in a Brazilian study of pregnant women and adolescents,[37] it was observed that the participants with black skin had fewer prenatal consultations and a higher frequency of zero prenatal care, which, as already mentioned, are both determinants of LBW. According to Meyer et al.,[38] skin color seems to interfere with perinatal outcomes because access to education is related to racial disparities, referring to the same consequences pointed out in the previous paragraph.

In our study, sanitation was not found to be a determinant of LBW. However, it is reported in the literature that poor housing conditions, including access to basic sanitation, can influence the occurrence of LBW and prematurity.[6]This social indicator of health is related to poverty, which in turn can be a proxy for health, so it was selected as a variable to be tested at the distal level[6] .

Regarding prenatal nutritional care, it was observed that this kind intervention, when provided on a regular basis, may help reduce LBW, as well as to gestational diabetes, preeclampsia, and prematurity, as described by Vitolo et al.[39] In another Brazilian study of pregnant adolescents, it was found that the absence of nutritional care resulted in a 3.5 times higher chance of LBW.[22]

The importance of prenatal nutritional care has been elucidated in studies that have demonstrated the importance of adequacy of weight gain and healthy dietary intake during gestation on perinatal outcomes. Guerra et al.'s[40] study of the impact of the nutritional status of pregnant adolescents on newborns found a positive correlation between gestational weight gain and birth weight ($r = 0.41$, $p = 0.00$). Meanwhile, Padilha et al.'s[23] study found that weight gain during pregnancy ($p = 0.00$) and pre-gestational BMI ($p = 0.04$) are predictors of birth weight.

Inadequate gestational weight gain, as found in some studies of adolescents, was also observed in the majority of participants in this study.[12,40] Indeed, according to the latest population-based study of the Brazilian Institute of Statistics and Geography[41] on food consumption, most adolescents consume a high proportion of ultraprocessed foods and a low proportion of fresh and minimally processed foods, producing nutritional deficiencies of vitamins A, E, D, C in particular, as well as calcium, phosphorus, and magnesium. There is a widely accepted association between vitamin A and vitamin D deficiency and low birth weight[42,43] .

The new Food Guide for the Brazilian Population[44] recommends reducing the consumption of ultraprocessed products (manufactured foods, which are nutritionally unbalanced and are often rich in sugar, sodium, and fat and poor in fiber) and increasing the intake of minimally processed and fresh foods (obtained directly from nature and consumed without alteration or after minimal processing, which are considered

good sources of fiber, vitamins, minerals, and proteins).

Thus, it is suggested that prenatal nutritional care could protect against LBW, demonstrating that nutritional guidance is essential to correct food inadequacies and control weight gain, which are factors associated with a healthy pregnancy and the prevention of chronic diseases during the child's life. According to Barker,[45] deficient nutrition during gestation and early childhood results in permanent metabolic and/or structural adaptation in the intrauterine environment, which increases the risk of developing coronary heart disease and other associated diseases such as hypertension, diabetes, and strokes in adulthood.

In addition to the social determinants that act indirectly on the outcome and allow greater possibilities of intervention, it is important to identify maternal biological factors that are directly related to the development of the outcome, in order to obtain the greatest possible control of LBW. In the literature it is recognized that a gestation of less than 37 weeks (preterm delivery) is related to LBW[1] and that adolescence is characterized as an independent risk for premature birth – a risk that may be 1.7 times higher in adolescents younger than 15 years of age than in adults.[46] This predisposition may be due to maternal biological immaturity and the consequent greater risk for gestational complications associated with premature birth.

Although the odds of LBW were ten times higher among the preterm infants, prematurity in this study showed less determination on the dependent variable than is reported in the literature. In a study[25] carried out in the northeast of Brazil designed to find the determinants of LBW from a hierarchical model, prematurity (proximal level) increased the odds of LBW by 21.8 times. In another study of pregnant women and adolescents from southern Brazil that aimed to identify the factors associated with LBW, it was found that prematurity increased the chances of low birth weight up to 37 times.[13] We suggest that the result found in this research is due to the fact that the health unit in question is a reference in prenatal care for pregnant adolescents, offering specialized care, which means most of them have over six prenatal consultations and receive some type of prenatal nutritional care.

The gaps in the socio-demographic data (absent from the medical records), such as per capita family income and number of people in the family, was a limitation of the research, causing the quantitative for these variables to be reduced, which was reflected in high CIs. However, despite the higher CI, non-acceptance of pregnancy by the adolescent mother (which constituted one quarter of our sample) resulted in an underweight infant, and this variable was related to the poorer quality of the prenatal care. It was also observed that other sociodemographic characteristics demonstrated an association with the outcome at the distal level, reinforcing the importance of these factors. However, filling out the medical records of adolescents in such circumstances is not an easy task for health professionals, constituting a limitation of the study of this influence of the social determinants of health.

Conclusions

The hierarchical analysis employed in the present study identified one sociodemographic determinant, the non-acceptance of pregnancy, which in turn may exert an influence on prenatal care ("lower frequency of prenatal consultations"), the non-receipt of prenatal nutritional care ("do not receive prenatal nutritional care") and premature delivery, with these variables acting directly on the outcome studied. In addition, an association between the variables under study and the moment when they exert the greatest impact was also elucidated.

We would suggest that the human resources offering prenatal care to pregnant adolescents should be trained to offer emotional support and encouragement to family members to assist the pregnant woman and to encourage them to ensure an adequate nutritional status throughout pregnancy through the provision of differentiated and quality nutritional care, beginning concurrently with prenatal care. There is a need to increase access to information on pregnancy prevention and development of pregnancy in this age group, including the importance of prenatal care and its early initiation.

Collaborations

GPB, MMAS, and CS worked on designing the study, analyzing and interpreting the data, and writing and reviewing the manuscript. LSP, JRD, and SPH contributed to writing and reviewing the manuscript.

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Article submitted 20/01/2016
Approved 16/08/2016
Final version submitted 18/08/2016