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Housing conditions as a social determinant of low birthweight and preterm low birthweight

Condições de moradia como determinante social de baixo peso ao nascer e prematuro de baixo peso

ABSTRACT

OBJECTIVE: To assess the relationship between housing conditions and low birthweight and preterm low birthweight among low-income women.

METHODS: A case-control study was conducted with post-partum women living in the city of Rio de Janeiro, Southeast Brazil, in 2003-2005. Two groups of cases, low birthweight (n=96) and preterm low birthweight infants (n=68), were compared against normal weight term controls (n=393). Housing conditions were categorized into three levels: adequate, inadequate, and highly inadequate. Covariates included sociodemographic and anthropometric characteristics, risk behaviors, violence, anxiety, satisfaction during pregnancy, obstetric history and prenatal care.

RESULTS: Poor housing conditions was independently associated with low birthweight (inadequate – OR 2.3 [1.1;4.6]; highly inadequate – OR 7.6 [2.1;27.6]) and preterm low birthweight (inadequate – OR 2.2 [1.1;4.3]; highly inadequate – OR 7.6 [2.4;23.9]) and factors associated with outcomes were inadequate prenatal care and previous preterm birth. Low income and low maternal body mass index remained associated with low birthweight.

CONCLUSIONS: Poor housing conditions were associated with low birthweight and preterm low birthweight.

DESCRIPTORS: Housing. Premature Birth. Infant, Low Birth Weight. Risk Factors. Socioeconomic Factors. Case-Control Studies.

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RESUMO

OBJETIVO: Avaliar a relação entre condições de moradia e baixo peso ao nascer e prematuridade associada ao baixo peso ao nascer nos filhos de mulheres de baixa renda.

MÉTODOS: Foi realizado estudo caso-controle com mulheres no pós-parto residentes no município do Rio de Janeiro, RJ, em 2003–2005. Dois grupos de casos foram comparados com controles a termo e com peso normal (n = 393): baixo peso ao nascer (n = 96) e prematuridade associada ao baixo peso ao nascer (n = 68). As condições de moradia foram consideradas nos níveis: adequadas, inadequadas e muito inadequadas. As covariáveis investigadas foram características sociodemográficas, antropométricas, hábitos de risco, violência, ansiedade, satisfação com a gravidez, história obstétrica e cuidados pré-natais.

RESULTADOS: Condições de moradia inadequadas foram independentemente associadas com baixo peso ao nascer (Inadequadas – OR = 2,3 (1,1;4,6) e muito inadequadas – OR = 7,6 (2,1;27,6) e com prematuridade associada ao baixo peso ao nascer (inadequadas – OR = 2,2 (1,1;4,3) e muito inadequadas – OR = 7,6 (2,4;23,9). Fatores associados com os desfechos incluíram cuidados pré-natais inadequados e prematuridade prévia. Baixa renda e baixo índice de massa corporal materno foram associados com baixo peso ao nascer.

CONCLUSÕES: Condições de moradia inadequadas foram associadas com baixo peso ao nascer e prematuridade associada ao baixo peso ao nascer.

DESCRITORES: Habitação. Nascimento Prematuro. Recém-Nascido de Baixo Peso. Fatores de Risco. Fatores Socioeconômicos. Estudos de Casos e Controles.

INTRODUCTION

The conceptual framework of social determinants of health suggests that distal causes of diseases, i.e., "causes of the causes," should be addressed.[14] They include the nature of social conditions that affect health and mechanisms through which these conditions produce their effects.[14] Social determinants include unemployment, unsafe workplaces, poor urban living conditions, globalization and lack of access to health care.[23] Poor housing conditions reflect social deprivation and can be considered a cause and a consequence of poverty.

Low birth weight (LBW) preterm, defined as birth weigh <2,500 g and gestational age at birth <37 weeks, are an important cause of morbidity and mortality in newborns in Latin America. Developing countries have focused their efforts on maternal and child health issues. Despite extensive research on LBW etiology, it remains unknown in over 30% of clinical cases.[3] Studies have mainly focused on the relationship between undesirable pregnancy outcomes and parental education level, family income, father's occupational status and marital status.[1,2,8,10] Few studies on social determinants of pregnancy outcomes have been conducted, especially in developing countries. Most Brazilian studies have included women receiving care in both private and public hospitals with significantly different social factors.[2,10] Positive associations between social characteristics and pregnancy outcomes have been described;[2,10] however, no study has addressed the potential effect of inadequate social conditions on LBW of infants born to low-income women.

Differences in socioeconomic condition might affect health outcomes, even in deprived areas where people seem to be exposed to the same risks. This hypothesis is consistent with Wilkinson's theory, which suggests that, within societies, health is affect by social condition rather than extremes of wealth and poverty. There is a continuous gradient in health outcomes that runs across the whole society.[23] Studies in Britain[17] and US[15] have evidenced a gradient in health within countries.

A theoretical framework of LBW and preterm low birthweight (PTLBW) determinants is presented in Figure. Since housing conditions is a stable proxy measure of material status and social deprivation[16] we decided to categorize housing conditions into three levels based on its relationship with the following LBW and PTLBW covariates: level 1 – societal processes represented

by socioeconomic variables; level 2 – anthropometric characteristics, psychosocial factors and prenatal care; and level 3 – demographic characteristics, unhealthy behaviors and satisfaction during pregnancy, obstetric history and diseases during pregnancy.

The present study aimed to assess the relationship between housing conditions and LBW and PTLBW among low-income women.

METHODS

A case-control study was carried out including births recorded at four public maternity hospitals in the city of Rio de Janeiro, Southeastern Brazil, between July 2003 and June 2005. The research study was focused on determinants of undesirable pregnancy outcomes and related aspects of access to health care.

The power of the study was 75% based on the ratio of 1:3 case-controls to detect a 10% difference between groups at a 5% significance level. The sample size was estimated to allow comparing proportions in different-size samples[24] given a 15% rate of women living in poor housing conditions (non-urbanized area/no sewage system) in the reference population.[10]

The inclusion criteria included women aged 30 years or more who delivered a liveborn infant in the preceding three days. The criterion of 30 years of age was used based on the assumption that pregnant adolescents are often single and tend to move from their usual home during pregnancy; and thus the potential effect of housing condition on birth weight would be biased if they were included in the study. In addition, the prevalence of LBW and PTLBW are high among those younger than 18 and older than 30.

The exclusion criteria were: preterm births, HIV infection, and hypertension and diabetes mellitus before pregnancy.

Infants born before 37 completed weeks of pregnancy were considered preterm.[24] The estimated gestational age was assessed using the last menstrual period (LMP),[4] calculated by subtracting the last menstrual period from the delivery date reported by the mother. The Naegele's rule was applied by subtracting three months and adding seven days to the first day of the last menstrual period to calculate the expected date of delivery. Only full weeks were considered. When there was no information available on the last menstrual period, Capurro[6] score was used to estimate gestational age. The reliability analysis between LMP and Capurro score was tested by intraclass correlation coefficient. The intraclass correlation coefficient of agreement was 0.92.

LBW newborns were those weighing less than 2,500 g at birth. All newborns were weighed immediately after delivery using calibrated scales. Infant weight data were obtained from medical records. Two groups of cases were included: LBW and PTLBW infants.

A pre-test study was conducted including 40 puerperal women to test the study questionnaire. We decided to collect information on mother's income because most women were not able to provide information on family income. A pilot study was then carried out by six trained investigators to check the final version of the study questionnaire and to assess the feasibility of using the inclusion criteria set for the study in the same maternity hospitals.

The interviewers examined all medical records and those mothers eligible were invited to participate in the study. A questionnaire was applied to the mothers who accepted to participate to exclude those who did not meet the inclusion criteria.

Of 1,467 puerperal women assessed for eligibility, 172 (11.7%) refused to participate. Of 1,295 who agreed to participate, 806 were excluded for the following reasons: preterm births (N=110), HIV infection (N=26), chronic hypertension (N=574), and diabetes mellitus before pregnancy (N=96).

Data were collected on infants born to 489 mothers aged between 30 and 47 years: 96 LBW, 68 PTLBW, and 393 normal weight term. Around 45% of the sample were living in inadequate housing conditions (levels 1 and 2), which resulted in a statistical power greater than 75%.

We collected data from 489 puerperal women randomly selected among those who delivered liveborn infants in public maternity hospitals in Rio de Janeiro. The maternity units involved are referral centers for high-risk pregnancies and are managed by the Brazilian National Health System (SUS).

Housing conditions and covariate data were obtained from structured interviews and medical records. Housing conditions were categorized into three levels according to internal and external characteristics: adequate (reference level) – internal and external housing conditions were adequate; inadequate (level 1) – either internal or external housing conditions were inadequate; and highly inadequate (level 2) – both internal and external housing conditions were inadequate. Internal housing characteristics were inadequate when it included all the following: overcrowding; non-carpet floor covering; walls made of clay, straw, wood, plastic or metal; and no flush toilet in the bathroom. Inadequate external housing characteristics included no sewage system or pit and open sewage pit on the street.

Covariate data included sociodemographic and anthropometric characteristics, unhealthy maternal behaviors, violence during pregnancy, anxiety, satisfaction during pregnancy, obstetric history, prenatal care and diseases during pregnancy.

Sociodemographic and anthropometric characteristics included age, skin color, maternal schooling, marital status, work status, mother's income and body mass index (BMI). Skin color was self-referred by mothers. BMI was used to classify the mothers as low weight (BMI <18.5 kg/m^2) and non-low weight (BMI ≥18.5 kg/m^2). Self-reported smoking during pregnancy was recorded. Alcohol abuse during pregnancy was assessed using the Tolerance, Annoyed, Cut down and Eye-opener (T-ACE) questionnaire.[20]

Mothers were asked if they experienced physical violence during pregnancy. Anxiety was assessed with the Trait Anxiety Inventory,[21] and they were asked about their satisfaction during pregnancy and feelings about being pregnant.

Prenatal care attendance was assessed based on the number of prenatal care visits. Prenatal care was considered inadequate when women had less than four visits. Self-reported information on hypertension, anemia, gestational diabetes and infections during pregnancy was also collected. Obstetric history included parity and previous preterm.

All statistical analyses were carried out using SPSS 13.0. The significance level established for all analyses was 5%. Internal consistency for the anxiety scales were evaluated using Cronbach's alpha coefficient.

Covariates were assessed for each subject and then by group. Bivariate analysis was performed to identify significant associations of a series of independent variables with LBW and PTLBW through crude odds ratios.

Hierarchical multivariate logistic regression was performed to examine the association of poor housing conditions with LBW and PTLBW, adjusting for covariates. The covariates with $p \leq 0.20$ in the bivariate analysis were included in the logistic regression. The stepwise forward selection of risk factors in different blocks was used according to the theoretical framework presented in Figure. The first block included socioeconomic variables; the second block included anthropometric characteristics, psychosocial factors and prenatal care; and the third block included demographic characteristics, unhealthy behaviors and satisfaction during pregnancy, obstetric history and diseases during pregnancy. The significance of additional variables was tested at each stage and non-significant ones ($p>0.20$) were excluded to reduce discrepancy between the data and the model and reach an economic model with relatively few parameters.[9]

The study was approved by the Research Ethics Committee of the Escola Nacional de Saúde Pública Sérgio Arouca Fiocruz, protocol no. 78/02, 12/26/2002, and all participants signed an informed consent form.

RESULTS

The descriptive characteristics of housing conditions and covariates and the associations of those variables with LBW and PTLBW are presented in Tables 1 and 2. Most women had low income and low education level. The prevalence of women living in inadequate housing conditions was 43.5%. Inadequate housing conditions and being divorced/widowed were significantly associated with LBW.

Mean age of the sample population was 34.1 (SD 3.6) years and the predominant self-reported skin color was mixed. Few women reported alcohol abuse and physical violence during pregnancy. The majority of mothers were satisfied during the current pregnancy, but less than half of them were planned pregnancies. The LBW and PTLBW group had a significantly higher proportion of women smoking during pregnancy. The rates of alcohol abuse, physical violence, and contraceptive use were not statistically different between cases and controls.

Although few women were low weight at the beginning of their pregnancies (8.2%), low weight predominated among mothers who delivered LBW newborns. Higher anxiety scores and inadequate prenatal care were more common among mothers of LBW and PTLBW infants ($p<0.005$). The Cronbach's alpha coefficient for the anxiety questionnaire was 0.84.

Although parity was similar between cases and controls, LBW and PTLBW cases were more likely to have had previous preterm infants. There were no differences in the proportions of anemia, gestational diabetes and infections between LBW mothers and controls.

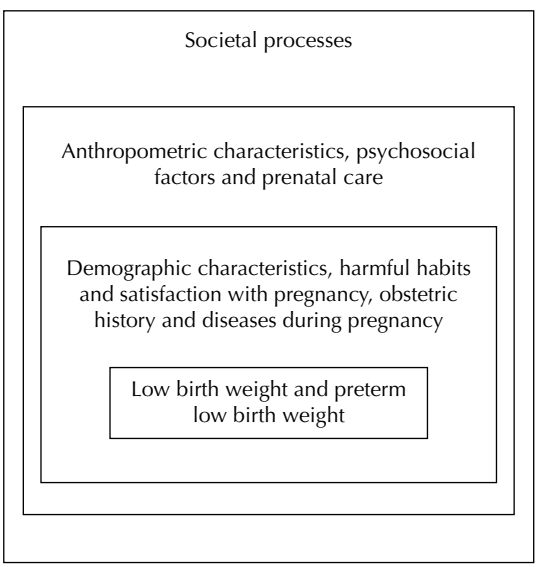

Figure. Theoretical framework of the determinants of low birth weight and preterm low birth weight. Rio de Janeiro, Southeastern Brazil, 2005.

The first characteristics included in the model were housing conditions, marital status, work during pregnancy and mother's income. The relationship between work during pregnancy and LBW was not significant when the variables from the first block were added. Housing conditions, marital status and mother's income remained significantly associated with LBW. At level 2, the positive associations of anxiety and marital status with LBW disappeared when socioeconomic variables, prenatal care and BMI were included in the model. However, prenatal care and BMI (low weight) remained positively associated with LBW after adjusting for variables at this level and the lower one. At level 3, previously significant variables remained associated with LBW. In addition, the positive association between previous preterm birth and LBW remained.

After adjustment for independent variables, the following variables were more strongly associated with LBW (95% CI): inadequate housing conditions level 1 (OR=2.3; 95% CI 1.1;4.6) and highly inadequate housing conditions level 2 (OR=7.6; 95% CI =2.1;27.6), mother's income (OR=2.3; 95% CI 1.1;4.9), mother's low weight (OR=2.6; 95% CI 1.1;6.8), inadequate prenatal care (OR=3.2; 95% CI 1.5;7.0) and previous preterm birth (OR=4.3; 95% CI 1.9;9.5) (Table 3).

At level 1, the variables housing conditions, marital status, work during pregnancy and mother's income

Table 1. Association of low birthweight with socioeconomic, anthropometric and anxiety and prenatal care characteristics. Rio de Janeiro, Southeastern Brazil, 2005.

Variable	Control		LBW		OR (95% CI)[a]	PTLBW		OR (95% CI)[a]
	n	%	n	%		n	%	
Socioeconomic characteristics								
Housing conditions								
Adequate	229	59.8	39	42.9	1	22	34.4	1
Inadequate level 1	140	36.5	41	45.0	1.7 (1.1;2.8)	32	50.0	2.4 (1.3;4.3)
Inadequate level 2	14	3.7	11	12.1	4.6 (2.0;10.9)	10	15.6	7.4 (3.0;18.7)
Maternal schooling (years)								
> 8 years	165	42.2	45	46.9	1	35	61.5	1
≤ 8 years	226	57.8	51	53.1	0.8 (0.5;1.3)	33	48.5	0.7 (0.4;1.2)
Marital status								
Married/living with a partner	320	82.3	73	76.1	1	51	75.0	1
Single	57	14.7	15	15.6	1.2 (0.6;2.2)	11	16.2	1.2 (0.6;2.5)
Divorced / Widowed	12	3.1	8	8.3	2.9 (1.2;7.4)	6	8.8	3.1 (1.1;8.7)
Work during pregnancy								
Employed/Homemaker	359	93.2	87	90.6	1	59	86.8	1
Unemployed	26	6.8	9	9.4	1.4 (0.7;3.2)	9	13.2	2.1 (0.9;4.7)
Mother's income (minimum wages)								
≥ ½	186	47.3	37	38.5	1	28	41.2	1
< ½	207	52.7	59	61.5	1.4 (0.9;2.3)	40	58.8	1.3 (0.8;2.2)
Anthropometric characteristics, anxiety and prenatal care								
Body mass index								
Normal/overweight	251	93.7	65	85.5	1	47	88.7	1
Low weight	17	6.3	11	14.5	2.5 (1.1;5.6)	6	11.3	1.8 (0.7;5.0)
Trait anxiety								
Score 20-37	139	35.4	23	24.0	1	15	22.1	1
Score 38-44	130	33.1	30	31.3	1.4 (0.8;2.5)	21	30.8	1.5 (0.7;3.0)
Score > 44	124	31.5	43	44.7	2.1 (1.2;3.7)	32	47.1	2.4 (1.2;4.6)
Prenatal visits								
≥ 5	348	88.5	69	71.9	1	48	70.6	1
0-4	45	11.5	27	28.1	3.0 (1.8;5.2)	20	29.4	3.2 (1.8;5.9)

LBW: Low birthweight; LBW/PT: Low birthweight and preterm; Control: Normal weight term.
[a] OR = odds ratio of LBW/normal weight term.

Table 2. Association of low birthweight with demographic, behavioral and clinical characteristics. Rio de Janeiro, Southeastern Brazil, 2005.

Variable	Control		LBW		OR (95% CI)[a]	PTLBW		OR (95% CI)[a]
Demographic, unhealthy behaviors and satisfaction during pregnancy								
Mothers' age (years)								
30-34	250	63.6	59	61.5	1	44	64.7	1
≥ 35	143	36.4	37	38.5	1.1 (0.7;1.7)	24	35.3	0.95 (0.6;1.6)
Skin color								
White	123	31.8	30	31.6	1	19	28.4	1
Mixed	185	47.8	46	48.4	1.0 (0.6;1.7)	33	49.3	1.2 (0.6;2.1)
Black	79	20.4	19	20.0	1.0 (0.5;1.9)	15	22.3	1.2 (0.6;2.6)
Alcohol abuse								
No	376	95.7	91	94.8	1	64	94.1	1
Yes	17	4.3	5	5.2	1.2 (0.4;3.4)	4	5.9	1.2 (0.4;3.4)
Smoked during gestation								
No	321	91.2	72	83.7	1	50	82.0	1
Yes	31	8.8	14	16.3	2.0 (1.0;4.0)	11	18.0	2.3 (1.1;4.8)
Physical violence during pregnancy								
No	379	96.7	91	94.8	1	65	95.6	1
Yes	13	3.3	5	5.2	1.6 (0.6;4.6)	3	4.4	1.4 (0.4;4.9)
Pregnancy intention								
Yes	357	93.2	84	89.4	1	61	91.0	1
No	26	6.8	10	10.6	1.6 (0.8;3.5)	6	9.0	1.4 (0.5;3.4)
Mother's feeling about pregnant								
She was trying to get pregnant	183	46.8	47	49.0	1	34	50.0	1
She would like to wait for a while	69	17.6	16	16.7	1.0 (0.6;2.0)	12	17.6	0.9 (0.5;1.9)
She did not want to get pregnant	139	35.5	33	34.4	1.0 (0.6;1.7)	22	32.4	0.9 (0.5;1.5)
Obstetric history and diseases during pregnancy								
Parity								
0-1	129	32.8	41	42.7	1	31	45.6	1
2	89	22.6	17	17.7	0.6 (0.3;1.2)	12	17.6	0.6 (0.3;1.2)
≥ 3	175	44.6	38	39.6	0.7 (0.4;1.1)	25	36.8	0.6 (0.3;1.1)
Previous preterm								
No	295	88.9	46	61.3	1	35	64.8	1
Yes	37	11.1	29	38.7	5.0 (2.8;9.0)	19	35.2	4.3 (2.3;8.3)
Hypertension								
No	315	80.6	68	71.6	1	46	68.7	1
Yes	76	19.4	27	28.4	1.6 (1.0;2.8)	21	31.3	1.9 (1.1;3.4)
Anaemia								
No	253	64.9	58	61.7	1	43	65.2	1
Yes	137	35.1	36	38.3	1.2 (0.7;1.8)	23	34.8	1.0 (0.6;1.7)
Gestational diabetes								
No	372	95.6	89	93.7	1	61	91.0	1
Yes	17	4.4	6	6.3	1.5 (0.6;3.9)	6	9.0	2.2 (0.8;5.7)
Infections								
No	281	72.6	64	68.1	1	46	69.7	1
Yes	106	27.4	30	31.9	1.2 (0.8;2.0)	20	30.3	1.2 (0.7;2.0)

LBW: Low birthweight; PTLBW: Low birthweight and preterm; Control: Normal weight term.
[a] OR = odds ratio of LBW/normal weight term.

Table 3. Results of the analysis of inadequate housing conditions with preterm low birth weight and low birth weight, adjusted for covariates. Rio de Janeiro, Southeastern Brazil, 2005.

Variable	LBW		Preterm LBW	
	Adjusted OR	95% CI	Adjusted OR	95% CI
Level 1				
Housing conditions				
Adequate	1		1	
Inadequate level 1	2.3	1.1;4.6*	2.2	1.1; 4.3*
Inadequate level 2	7.6	2.1;27.6**	7.6	2.4; 23.9**
Mother's income (minimum wages)				
≥½	1	1	-	-
<½	2.3	1.1;4.9*	-	-
Level 2				
Body mass index, n (%)				
Normal weight/overweight	1	1	-	-
Low weight	2.6	1.1;6.8*	-	-
Prenatal care visits				
≥5	1	1	1	1
0–4	3.2	1.5;7.0**	3.5	1.7; 7.1**
Level 3				
Previous preterm birth				
No	1	1	1	1
Yes	4.3	1.9;9.5**	3.6	1.8;7.6**

LBW: Low birth weight
* p<0.05, ** p<0.01

were included in the first model, and remained statistically associated with PTLBW. At level 2, of those variables with statistical association with PTLBW in the bivariate analysis – anxiety, marital status, BMI and prenatal care –, only prenatal care maintained a positive association with PTLBW after adjusting for the variables at this level and at the level 1. At level 3, previously significant variables remained associated with PTLBW. In addition, a positive association between previous preterm birth and PTLBW remained.

After adjustment for independent variables, the following variables were found more strongly associated with PTLBW (95% confidence interval): inadequate housing conditions level 1 (OR=2.2; 95% CI 1.1;4.3) and highly inadequate housing conditions level

Table 4. Improvement of goodness-of-fit of logistic regression model for low birth weight by adding variables groups stepwise (n=489). Rio de Janeiro, Southeastern Brazil, 2005.

Variable groups of factors in the model	Log likelihood	Difference of deviance	df	p[a]
1	-225,17308		2	
2	-218,2787	6,89438	6	0.008
3	-134,3458	83,9329	9	< 0.001
4	-130,26701	4,07879	10	0.004
5	-132,51039	2,24338	6	0.344

[a] Likelihood ratio test
1. Inadequate housing condition.
2. Inadequate housing condition + marital status + mother's income.
3. Inadequate housing condition + marital status + mother's income + inadequate prenatal care + higher levels of anxiety + lower body mass index.
4. Inadequate housing condition + mother's income + inadequate prenatal care + lower body mass index + smoking during pregnancy + gestational diabetes + gestational hypertension + infections + previous preterm birth.
5. Inadequate housing condition + mother's income + inadequate prenatal care + lower body mass index + previous preterm birth.

Table 5. Improvement of goodness-of-fit of logistic regression model for preterm low birth weight by adding variables groups stepwise (n=489). Rio de Janeiro, Southeastern Brazil, 2005.

Variable groups of factors in the model	Log likelihood	Difference of deviance	df	p-value[a]
1	-183,57777		2	
2	-181,53670	2,04107	2	<0.001
3	-130,83167	50,70053	4	<0.001
4	-80,513977	50,317693	6	0.037
5	-133,70265	53,188673	4	0.787

[a] Likelihood ratio test
1. Inadequate housing condition.
2. Inadequate housing condition + marital status + mother's income + work during pregnancy.
3. Inadequate housing condition + marital status + mother's income + work during pregnancy + inadequate prenatal care + higher levels of anxiety + lower body mass index.
4. Inadequate housing condition + marital status + mother's income + work during pregnancy + inadequate prenatal care + higher levels of anxiety + lower body mass index + smoking during pregnancy + parity + gestational diabetes + gestational hypertension + infections + previous preterm birth.
5. Inadequate housing condition + inadequate prenatal care + previous preterm birth.

2 (OR=7.6; 95% CI 2.4;23.9), inadequate prenatal care (OR=3.5; 95% CI 1.7;7.1) and previous preterm birth (OR=3.6; 95% CI 1.8;7.6) (Table 3).

The variables added at each level significantly improved the explanation of the occurrence of LBW and PTLBW (Tables 4 and 5). In both analysis, the model 5 that included the variables presented in Tables 4 and 5 was considered the most parsimonious one as it included those that significantly explained the target outcome, LBW (p=0.344) and PTLBW (p=0.787).

DISCUSSION

Women living in inadequate housing conditions were likely to have LBW and PTLBW infants compared to those living in adequate housing conditions in Rio de Janeiro. This finding is consistent with other Brazilian studies that reported a negative effect of social indicators on fetal development when groups with marked social differences were compared.[2,10] Other studies on child health epidemiology found a relationship between poverty, living in a slum area and density of people per room and infant mortality.[17,18]

Other associated factors with preterm LBW reported in the present study were mother's income, maternal lower BMI, inadequate prenatal care and previous preterm birth. Similar findings were reported in a survey of approximately 10,000 mothers in Rio de Janeiro.[1,11] A study in a rural area of southern Brazil did not find an association between prenatal visits and LBW.[8] The potential risk factors for LBW were hospital admission during pregnancy and maternal age lower than 20.[8] Methodological differences, such as the inclusion criteria for mothers' age and population characteristics may explain these inconsistent results. The association between maternal anthropometric characteristics and LBW found in the present study was also reported in a study in Northeast Brazil.[19] In contrast with our results, maternal smoking was associated with LBW.[19]

One important finding of our study regarding maternal and child health from a public health perspective was that social disadvantage affected pregnancy even when women received prenatal care in public services. This is a very relevant data for prenatal care planning of public services in developing countries worldwide.

As in the present study dwelling conditions could easily be assessed by health workers. The identification of families living in inadequate housing conditions could be used as a strategic tool to redefine and redirect interventions in a multifactor approach to reduce inequalities regarding preterm LBW among poor people. Taking into account housing conditions in health care actions supports the concept that adequate living conditions is a major component during pregnancy for healthy fetus development and newborns.

In many countries lower socioeconomic people have poorer health outcomes and higher death rates than those who are better off. Poor health is not seen only among the poorest in society. There is a social gradient in health: the lower a person's social position, the worse their health.[14] Since the 1990s the robustness of this gradient has been shown when different countries were compared.[7,12] In European countries there are variations in health outcomes, such as mortality and life expectancy, according to social condition. Socioeconomic gradients in mortality varied between countries and in different age groups, but there were gradients within countries.[5,13] Since most studies have been carried out in European countries and US, little is known about the effect of socioeconomic gradients in developing countries. The present study found a gradient of inadequate housing conditions with preterm LBW and LBW in low-income women. Similar odds ratios for

LBW and PTLBW were found among those women living in inadequate internal or external housing conditions (2.3 and 2.2, respectively). As housing conditions became less favorable, the odds ratios increased. The odds ratio for those women living in both internal and external inadequate housing conditions in both case groups increased to 7.6.

Case-control studies are easy-to-perform and feasible. Another advantage is that they are often carried out in more natural settings so that the study population is more representative of the target population. However, the findings from case-control studies are also more prone to bias and confounders, especially classification bias.[22] The use of validated methodology for gestational age assessment as well as calibrated scales and weighting newborns immediately after delivery provided adequate classification of cases and controls. Other strengths of this study include appropriate statistical approach through hierarchical logistic regression and use of appropriate instruments to measure covariates avoiding potential bias induced by measurement errors. Analytical observational studies are also susceptible to confounding.[22] Inclusion and exclusion criteria and multivariable analysis were the strategies applied to control for potential confounders, resulting in findings that can be considered valid.

The cross-sectional design used to test the association of poor housing conditions with LBW and PTLBW is the main weakness of the present study. Since no temporal relationship between exposure and outcomes can be inferred in cross-sectional studies, it is not possible to make any causal inferences based on the present findings. Even though mother's income may result in residual bias to some extent, family income was not used because this information was found to be inaccurate during the pilot study. In addition, the present results are limited to low-income women aged 30 years and more.

In conclusion, inadequate housing conditions not only reflect social inequality but also can be considered an important social determinant of adverse pregnancy outcomes. This study supports the approach on social determinants of health and the need for intersectorial interventions for improved housing conditions and better health outcomes of mothers and their children. Further studies on LBW newborns with fetal growth restriction would provide interesting information on risk factors for undesirable pregnancy outcomes.

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