DOI: 10.1590/1980-5497201700040010

ORIGINAL ARTICLE / *ARTIGO ORIGINAL*

Maternal socioeconomic factors and adverse perinatal outcomes in two birth cohorts, 1997/98 and 2010, in São Luís, Brazil

Fatores socioeconômicos maternos e eventos perinatais adversos em duas coortes de nascimento, 1997/98 e 2010, em São Luís, Brasil

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ABSTRACT: Several studies have identified social inequalities in low birth weight (LBW), preterm birth (PTB), and intrauterine growth restriction (IUGR), which, in recent years, have diminished or disappeared in certain locations. ***Objectives:*** Estimate the LBW, PTB, and IUGR rates in São Luís, Maranhão, Brazil, in 2010, and check for associations between socioeconomic factors and these indicators. ***Methods:*** This study is based on a birth cohort performed in São Luís. It included 5,051 singleton hospital births in 2010. The chi-square test was used for proportion comparisons, while simple and multiple Poisson regression models with robust error variance were used to estimate relative risks. ***Results:*** LBW, PTB and IUGR rates were 7.5, 12.2, and 10.3% respectively. LBW was higher in low-income families, while PTB and IUGR were not associated with socioeconomic factors. ***Conclusion:*** The absence or weak association of these indicators with social inequality point to improvements in health care and/or in social conditions in São Luís.

Keywords: Socioeconomic factors. Infant, low birth weight. Premature birth. Fetal growth retardation.

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Conflict of interests: nothing to declare – **Financial support**: This research was supported by CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico – Portuguese acronym for the Brazilian National Research Council), grants 471923/2011-7 and 561058/2010-5, FAPESP (Fundação de Amparo à Pesquisa do Estado de São Paulo – Portuguese acronym for the São Paulo Research Foundation), grant 2008-53593-0 and FAPEMA (Fundação de Amparo à Pesquisa e ao Desenvolvimento Científico e Tecnológico do Maranhão – Portuguese acronym for the Maranhão State Research Foundantion), grants 0035/2008, 00356/11 and 01362-11.

RESUMO: Vários estudos mostram desigualdades sociais no baixo peso ao nascer (BPN), nascimento pré-termo (NPT) e restrição do crescimento intrauterino (RCIU), que nos últimos anos diminuíram ou desapareceram em determinados locais. ***Objetivos:*** Estimar as taxas de BPN, NPT e RCIU em São Luís, Maranhão, Brasil, em 2010, e verificar as associações entre fatores socioeconômicos e esses indicadores. ***Métodos:*** Este estudo baseia-se em uma coorte de nascimentos realizada em São Luís. Incluiu 5.051 nascimentos únicos hospitalares em 2010. O teste do qui-quadrado foi utilizado para comparação de proporções, enquanto modelos de regressão de Poisson simples e múltipla com variância robusta foram usados para estimar riscos relativos. ***Resultados:*** As taxas de BPN, NPT e RCIU foram de 7,5, 12,2 e 10,3%, respectivamente. O BPN foi maior em famílias de baixa renda, enquanto NPT e RCIU não estiveram associados com fatores socioeconômicos. ***Conclusão:*** A ausência ou associação fraca desses indicadores com desigualdades sociais aponta para melhorias na atenção à saúde e/ou em condições sociais em São Luís.

Palavras-chave: Fatores Socioeconômicos. Recém-nascido de baixo peso. Nascimento prematuro. Retardo do crescimento fetal.

INTRODUCTION

It is well documented in the literature that low birth weight (LBW), preterm birth (PTB) and intrauterine growth restriction (IUGR) are implicated in major infant and perinatal morbidities and mortality and are risk factors for diseases in adult life[1-3].

The World Health Organization (WHO) showed that newborns weighing between 1,500–2,000 grams have a 20 times higher mortality rate than newborns without LBW[2]. About 65% of deaths from children in the United States were due to LBW and PTB[3], with PTB being responsible for three million deaths worldwide[1]. Moreover, these indicators are related to morbidities in adult life: LBW is related to hypertension, diabetes, and metabolic syndrome[4,5]; PTB to lung, neurological and ophthalmological diseases[6-8]; and IUGR to diabetes, hypertension and coronary artery disease[9,10].

Birth weight is determined by two processes: duration of pregnancy and intrauterine growth, therefore LBW is due to either PTB, IUGR or an association of both. In developed countries, PTB is responsible for the largest number of neonates with LBW. On the other hand, in developing countries, IUGR is the most important factor[11-13]. In the year 2000 in China, 38.8% of LBW were due to PTB and 61.2% to IUGR, whereas in 2011 PTB had contributed to 69.6% of LBW and IUGR contributed to 30.4%. This change was attributed to improvements in the Chinese health system that have been occurring over the years[13]. In the city of Pelotas, Rio Grande do Sul, Brazil, similar changes were observed between 1993 and 2004, when PTB with LBW rates rose from 42.5 to 67.3%[14].

Several studies have shown how socioeconomic inequality influences these indicators. In China, the LBW rate ranged from 2.5 to 9.4%, depending on the region studied,

being higher in underdeveloped regions and lower in economically developed ones[13]. This same study showed that lower educational levels are associated with a greater risk of LBW.

In Quebec, Canada, between the years 2000 and 2008, mothers with low education and income had a higher risk of IUGR[15]. In Newcastle, England, between 1961 and 2000, PTB and LBW were higher in neonates of mothers from lower economic classes. In this same study, PTB rate increased in the lower classes but declined in the upper classes within the same period, but the factors involved in these changes have not yet been identified[16]. Despite studying different perinatal outcomes, both studies show the negative impact of low socioeconomic status in perinatal health.

In Pelotas, the risk of LBW was 2.8 times higher in families with lower income in 1982. In 2004, despite the drop in LBW with increasing income, there was an increase in the percentage of LBW among those in the higher wage stratum. The authors attributed this change to greater medical intervention in the high-income group[14].

In the city of Ribeirão Preto, São Paulo, Brazil, in the years 1978/79 and 1994, LBW and IUGR rates were lower in families of higher income, education, and non-manual occupations. PTB rates had the same socioeconomic pattern in 1978/79, but this difference disappeared in 1994[17].

In São Luís, Maranhão, Brazil, in 1997/98 there were no differences in LBW and PTB rates regarding schooling, income, and occupation of the head of the family. On the other hand, IUGR was more prevalent in mothers with low income and schooling[17].

In Brazil, in the year 2005, a higher proportion of term neonates with LBW were found in mothers with low education[18]. In other study, with data from 2006/2007, LBW was again more prevalent in mothers with low education, however it was more prevalent in the South and Southeast Brazilian regions, considered the richest area in Brazil, and least prevalent in the North and Northeast regions, considered the poorest in Brazil[19]. Other Brazilian study performed in 2009 found similar results, with LBW and PTB being more prevalent in the richest regions and less prevalent in the poorest regions of the country[20].

The objectives of this study were to estimate LBW, PTB and IUGR rates in São Luís, in 2010; to verify if social inequalities were related to these indicators; and to verify if those socioeconomic inequalities remained, increased, or decreased between 1997/98 and 2010 in this town.

METHODS

This study used data from a birth cohort study called Brazilian Ribeirão Preto and São Luís Birth Cohort Studies (BRISA), carried out from January 1st to December 31st 2010. In this paper we used data only from the city of São Luís.

The city of São Luís is the capital of the state of Maranhão, located in the northeast of Brazil, the country's poorest region. The city had an estimated population of 1,082,935 inhabitants in 2016[21] and a human development index (HDI) of 0.768, occupying the 249th place in the national ranking in 2010[22].

SAMPLING

A population-based sample from hospital live births with gestational age (GA) > 20 weeks or birth weight > 500 grams was studied. The study was limited to women residing in the municipality of São Luís for at least six months. Hospital births accounted for 98% of births in 2010[23,24].

For the selection of maternity hospitals, data recorded in the Brazilian National System of Information on Live Births (SINASC) in the year of 2008 were retrieved, and 18,255 live births of residents in the municipality were recorded. The live births were distributed across 16 health units, including public and private ones. After the exclusion of hospitals in which less than 100 births were performed in the year of 2008 (3.3% of all hospital births in the city of São Luís), 10 maternity wards were selected. Hence, the sample frame included 94.7% of all births that occurred in 2010[23,24].

A systematic sampling technique was used, and the sample was stratified by maternity hospital with shares proportional to the number of births in each maternity ward. A sampling interval of three was defined, corresponding to approximately 6,000 deliveries, or 1/3 of all births that occurred in 2010, according to data from SINASC. A list of all births occurring in each hospital, according to the order of birth, was made. On the first day, for each hospital or maternity, a casual number between 1 and 3 was randomly chosen. Then, the sampling interval value was added to the casual number, and all births were randomly drawn for this study, successively[23,24].

With the study sample, it was possible to estimate rates of LBW, PTB or IUGR of around 50% (maximum product of p and q, being p the estimated rate and $q = 1 - p$) with an accuracy of 2 and 99% confidence level. It was also possible to compare two proportions, considering a 5% probability of type I error, and an 80% study power, working with the product maximum of $p \times q$ (event proportion of 50%) and fixing in 4% the minimum difference to be detected as significant. For rates of less than 50%, it was possible to detect smaller differences (it was possible to detect a relative difference of 3% for rates of 10% and of 2% for rates of 5%)[25].

At the end of 2010, there was a total of 21,401 births in São Luís, one-third of which were picked by drawing lots (7,133). Of them, 5,475 were residents in the municipality for at least six months. With a loss of 4.6% from mothers that refused to be interviewed, and from early discharges, a total of 5,236 interviews was undertaken. After excluding multiple births, stillbirths and births with no weight record, the final sample of this study was 5,051 births.

INSTRUMENTS AND VARIABLES

For the collection of maternal, paternal and fetal data, a standardized questionnaire with questions related to identification, sociodemographic conditions, health, pregnancy, labor and birth was used.

For this study, the following variables were analyzed: newborn weight, date of last menstrual period, maternal education, head of the family occupation, family income and economic class[23].

Prior to data collection, the research team was trained and a pilot study with all stages of the research was held for 24 hours for correction of possible errors.

Before the interview, mothers were informed about the objectives of the study and an informed consent was obtained.

Infants weighing < 2,500 grams were considered LBW. Birth weight was measured using infant digital scales adjusted to 10 grams[26]. The newborns were weighed immediately after birth without clothes[23].

Gestational age was calculated from the date of the last menstrual period reported by the mother. The 15th day of the month was imputed in all cases for which only the day (not the month) of the last menstrual period was unknown. In cases of incompatible weight for gestational age, or gestational age located above the 99th percentile of the English curve[27], the date of the last menstrual period was recoded as missing. The same procedure was used for cases of implausible gestational age (less than 20 or more than 50 weeks). Finally, a process of imputation was performed for gestational age. All cases of originally missing data on gestational age or data recorded as missing were imputed in a linear regression model. Predictors of gestational age were birth weight, parity, family income, and sex of the newborn. A total of 446 cases were imputed, 29 as preterm and 458 as term based on the complete cases.

Newborns with a gestational age of less than 37 weeks were classified as preterm[26].

The classification of weight for gestational age was based on Williams curve[28]. IUGR was considered when birth weight was below the 10th percentile.

For the definition of socioeconomic indicators, maternal education was classified into four groups: 0–4, 5–8, 9–11 and greater than or equal to 12 years of education. The person with the highest income in the family was regarded as the head of the family, and his/her occupation was classified as non-manual, manual skilled/semi-skilled and manual unskilled/unemployed.

For the definition of economic class the Brazilian criterion of economic classification was used, ranking families in class A (high purchasing power), B, C, D or E (low purchasing power)[29]. For the family income variable, the monthly family income group ranges were defined as up to and including 1 minimum wage, greater than 1 and less than or equal to 3 minimum wages, and more than 3 minimum wages. Since a high percentage of mothers did not report their family income, a missing category was added to this variable, instead of excluding cases with missing values from the analysis. The minimum wage as of August 17th, 2015 was R$ 510.00, corresponding to US$ 146.97 monthly or US$ 1,910.61 annually.

STATISTICAL ANALYSIS

The data were entered in duplicates in Microsoft Office Access 2007 computer program, and were compared for error correction. Subsequently, they were transferred to Stata 12 (Stata Corporation, College Station, Texas, USA) and analyzed.

Absolute frequencies and percentages were calculated for descriptive analysis. For the comparison of proportions, we used the chi-square test with a significance level of 5% ($p < 0.05$). To check the associations between socioeconomic indicators with perinatal outcomes, we initially used the simple Poisson regression with robust adjustment of variance to calculate the relative risk (RR) with a 95% confidence interval (CI)[30]. We then used separate models for LBW, PTB and IUCR, and, in each of those models, the socioeconomic variables were analyzed together, using multiple Poisson regression with robust adjustment of variance for control of confounding variables[30].

ETHICAL ASPECTS

This study meets the criteria established by Resolution no. 196/96 of the National Health Council and its complementary regulations. Mothers who agreed to participate in the study signed an informed consent form. The participants had the option to leave the study at any time without any consequences to them or their families. The project and the informed consent form were approved by the Ethics Committee of the University Hospital of the Federal University of Maranhão.

RESULTS

LBW, PTB and IUGR rates were 7.5, 12.2 and 10.3%, respectively, in 2010. In the unadjusted analysis, LBW rates were not associated with maternal socioeconomic indicators. However, there was a 34% higher risk of PTB among infants of mothers with 5–8 years of education (Table 1).

There was also a 41% higher risk of IUGR among infants of mothers with 9–11 years of education, a 38% higher risk in newborns whose head of the family had a manual skilled/semiskilled occupation, a 27% higher risk among infants of mothers with a family income of > 1 and ≤ 3 minimum wages, and a 37% higher risk among those whose families earned ≤ 1 monthly minimum wage (Table 1).

After adjustment for confounding variables, a 50% higher risk of LBW among infants of mothers ≤ 1 minimum wage ($p = 0.040$; 95%CI 1.02 – 2.20) was demonstrated. There were no associations between the socioeconomic variables and PTB or IUGR after adjustment for the confounding variables (Table 2).

Table 1. Non-adjusted analysis of low birth weight, preterm birth and intrauterine growth restriction according to socioeconomic variables in São Luís, 2010.

	n	Low birth weight		Preterm birth		Intrauterine growth restriction	
		%	RR (CI95%)	%	RR (CI95%)	%	RR (CI95%)
Maternal schooling (years)		p = 0.933		p = 0.105		p = 0.065	
≥ 12	758	7.3	1.00	10.2	1.00	7.8	1.00
9 to 11	2,925	7.7	1.06 (0.80 – 1.41)	11.9	1.17 (0.93 – 1.48)	11	1.41 (1.08 – 1.84)
5 to 8	1,127	7.3	1.00 (0.72 – 1.39)	13.7	1.34 (1.04 – 1.74)	10.4	1.33 (0.99 – 1.80)
0 to 4	228	7	0.97 (0.56 – 1.65)	14	1.38 (0.94 – 2.03)	8.8	1.13 (0.69 – 1.83)
Ocupation		p = 0.188		p = 0.310		p = 0.047	
Non manual	1,036	6.9	1.00	11	1.00	9.1	1.00
Manual skilled/ semiskilled	2,055	8.3	1.20 (0.92 – 1.56)	12.7	1.16 (0.94 – 1.42)	11.6	1.28 (1.02 – 1.60)
Manual unskilled	1,794	6.9	0.99 (0.75 – 1.31)	11.6	1.05 (0.85 – 1.31)	9.7	1.07 (0.85 – 1.36)
Economic class		p = 0.716		p = 0.093		p = 0.073	
A	143	6.3	1.00	10.5	1.00	8.4	1.00
B	769	6.9	1.09 (0.55 – 2.17)	10.3	0.98 (0.58 – 1.65)	8.1	0.96 (0.53 – 1.74)
C	2,555	7.6	1.21 (0.63 – 2.31)	12.2	1.16 (0.71 – 1.90)	10.2	1.22 (0.70 – 2.11)
D	1,094	7.2	1.15 (0.59 – 2.24)	12	1.14 (0.69 – 1.89)	11	1.31 (0.74 – 2.30)
E	190	8.9	1.42 (0.65 – 3.10)	14.2	1.35 (0.75 – 2.45)	11.6	1.38 (0.71 – 2.69)
Missing	300	9.3	1.48 (0.72 – 3.06)	16.7	1.59 (0.92 – 2.73)	14	1.67 (0.91 – 3.07)
Family Income (in minimum wages)		p = 0.246		p = 0.071		p = 0.008	
> 3	1,375	6.3	1.00	11	1.00	8.9	1.00
> 1 to 3	2,031	7.9	1.24 (0.97 – 1.60)	11.6	1.05 (0.86 – 1.27)	11.3	1.27 (1.03 – 1.56)
Up to 1	734	8.3	1.31 (0.96 – 1.80)	13.1	1.18 (0.93 – 1.50)	12.3	1.37 (1.06 – 1.77)
Missing	911	8	1.27 (0.94 – 1.71)	14.4	1.30 (1.05 – 1.62)	8.3	0.93 (0.71 – 1.23)

N: sample number; RR: relative risk; CI: confidence interval.

Table 2. Adjusted analysis of low birth weight, preterm birth and intrauterine growth restriction according to socioeconomic variables in São Luís, 2010.

	n	Low birth weight		Preterm birth		Intrauterine growth restriction	
		%	RR (CI95%)	%	RR (CI95%)	%	RR (CI95%)
Maternal schooling (years)							
≥ 12	758	7.3	1.00	10.2	1.00	7.8	1.00
9 to 11	2,925	7.7	0.88 (0.61 – 1.26)	11.9	1.06 (0.80 – 1.42)	11	1.22 (0.88 – 1.69)
5 to 8	1,127	7.3	0.77 (0.51 – 1.17)	13.7	1.16 (0.83 – 1.60)	10.4	1.09 (0.75 – 1.59)
0 to 4	228	7	0.62 (0.32 – 1.19)	14	1.11 (0.70 – 1.77)	8.8	0.88 (0.51 – 1.52)
Ocupation							
Non manual	1,036	6.9	1.00	11	1.00	9.1	1.00
Manual skilled/ semiskilled	2,055	8.3	1.13 (0.84 – 1.53)	12.7	1.07 (0.85 – 1.34)	11.6	1.12 (0.87 – 1.43)
Manual unskilled	1,794	6.9	0.91 (0.66 – 1.24)	11.6	0.95 (0.75 – 1.21)	9.7	0.91 (0.70 – 1.19)
Economic class							
A	143	6.3	1.00	10.5	1.00	8.4	1.00
B	769	6.9	1.02 (0.51 – 2.03)	10.3	0.95 (0.55 – 1.67)	8.1	0.82 (0.45 – 1.50)
C	2,555	7.6	1.07 (0.52 – 2.17)	12.2	1.09 (0.61 – 1.95)	10.2	0.95 (0.51 – 1.75)
D	1,094	7.2	1.00 (0.48 – 2.11)	12	1.04 (0.57 – 1.91)	11	1.01 (0.53 – 1.92)
E	190	8.9	1.28 (0.54 – 3.01)	14.2	1.12 (0.55 – 2.26)	11.6	1.15 (0.54 – 2.42)
Missing	300	9.3	1.41 (0.63 – 3.16)	16.7	1.31 (0.71 – 2.60)	14	1.50 (0.76 – 2.99)
Family Income (in minimum wages)							
> 3	1,375	6.3	1.00	11	1.00	8.9	1.00
> 1 to 3	2,031	7.9	1.30 (0.94 – 1.80)	11.6	0.98 (0.77 – 1.24)	11.3	1.11 (0.87 – 1.42)
Up to 1	734	8.3	1.50 (1.02 – 2.20)	13.1	1.10 (0.82 – 1.47)	12.3	1.24 (0.91 – 1.69)
Missing	911	8	1.33 (0.93 – 1.91)	14.4	1.17 (0.90 – 1.52)	8.3	0.79 (0.58 – 1.08)

N: sample number; RR: relative risk; CI: confidence interval.

DISCUSSION

PTB and IUGR rates were not associated to socioeconomic variables. LBW rate was higher in infants from low-income families, but that association was close to the significance level.

Compared to a similar cohort performed in 1997/98 in São Luís, there was a drop in IUGR rate from 13.3 to 10.3% ($p < 0.001$), but LBW (7.5%) and PTB (12.2%) rates remained stable[17].

Those rates were comparable to the ones in developed countries like the United States, which had a LBW rate of 8% and PTB of 11.4% in 2013[31]. However, they are still high compared to other countries like Spain, with a PTB rate of 7% in 2010[32], Iceland, with a 3% LBW, 4.6% PTB and 1.5% IUGR rate from 2006 to 2009[33], Finland, with a 3.1% IUGR rate from 1967 to 2010[34], or Sweden, with a 4.8% PTB and 2% IUGR rate from 1999 to 2010[35].

Compared to a cohort in São Luís in 1997/98, LBW and PTB rates stayed the same in the socioeconomic groups analyzed. IUGR decreased among less educated mothers (from 14.2 to 10.4%, $p = 0.007$ in mothers with 5–8 years of education, from 15.3 to 8.8%, $p = 0.018$ in mothers with 0–4 years of education) and in mothers whose head of the family had manual unskilled jobs or were unemployed (14.8 to 9.7%, $p < 0.001$)[17]. The decrease in IUGR rate over the past 10 years, accompanied by a reduction in the number of growth restricted neonates in less advantaged social groups, suggested an improvement in health care and/or health conditions, especially in the lower classes, the most prevalent in this study. The improvement in health care and/or health conditions may be in part explained by the implementation of the Bolsa Família Program (conditional cash transfer program) in 2003 and the Family Health Program (geographically organized public family health multidisciplinary teams providing primary care for defined populations) in 1994[36,37]. Both programs are geared towards the improvement of quality of life of underserved populations. Aquino et al. showed that infant mortality rates decreased as the Family Health Program coverage increased[38]; and Rasella et al. showed that, among children under 5 years old, mortality rates decreased as the Bolsa Família Program coverage increased[37]. It is possible that weak or non-existing socioeconomic inequalities in perinatal indicators, depicted here, could be due, at least partially, to the effects of those programs.

Lamy et al. showed that in São Luís, in 1997/98, there were no associations of LBW with socioeconomic variables. PTB was lower in middle-income families (> 1 and ≤ 3 minimum wages), and IUGR was associated with low education (0–4 years) and low income (≤ 1 minimum wage)[17]. In 2010 minimal socioeconomic inequality in adverse perinatal outcomes were detected because, only in the case of low birth weight, families with ≤ 1 minimum wage had a 50% higher risk of LBW. However, since the p-value was very close to the significance level, that association may be due to random error.

LBW is caused mainly by IUGR in developing countries, and by PTB in developed countries. In China, for example, there was a reversal over ten years; LBW was mainly caused by IUGR in 2000, but became mainly caused by PTB in 2011[11-13]. In Pelotas, similar results from 1993 to 2004 were observed[14]. However, in São Luís, the percentage of PTB among LBW did not change significantly: from 51.1% in 1997/98 to 54.3% in 2010 ($p = 0.646$)[17,39].

The results of our study oppose several studies in Brazil, Europe, Asia and North America, which found a higher risk of adverse perinatal outcomes among families of low socioeconomic class, education, and whose parents had manual jobs[13,15-19,32,34,40-43].

The main strength of this study is the use of a random population-based sample (a 1/3 of the births of São Luís' residents), which allows for generalization of the results for the general population of live births.

One of the limitations of our study is the percentage of missing values for gestational age, which was attenuated by the imputation of those values. The missing values for income (911) and economic class (300) were also important to mention.

CONCLUSION

In São Luís, from 1997/98 to 2010, there was a drop in IUGR rate and a stability of LBW and PTB rates. Moreover, there was no socioeconomic inequality in PTB and IUGR rates. Regarding LBW, there was little inequality in terms of income, since only those ones born in families with ≤ 1 minimum wage showed a higher LBW rate, and that association was close to the level of significance. Overall, it points to an improvement in health care and/or in health and living conditions, as there was little social inequality according to the three studied perinatal outcomes.

ACKNOWLEDGEMENTS

We thank the interviewers and the mothers who kindly agreed to participate in the study.

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Received on: 02/10/2017
Final version presented on: 06/28/2017
Accepted on: 07/11/2017