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Birth weight intra-urban differentials in the city of São Paulo

ABSTRACT

OBJECTIVE: To identify intra-urban differentials and risk factors in low birth weight prevalence.

METHODS: Information was gathered in the live birth declarations made by mothers residing in the city of São Paulo (Southern Brazil), and obtained through the Live Birth Information System and the Seade Foundation, for the period between 2002 and 2003, totaling 388,980 live births. The addresses were georeferenced in census tracts and classified into six vulnerability groups according to the São Paulo State Social Vulnerability Index. To identify potential risk factor logistic regression analysis was performed.

RESULTS: A positive growth trend was observed in the prevalence of low birth weight with an increase in the vulnerability rate (from 6.8% to 8.1%). There were significant differences among groups in terms of mothers' demographics, prenatal care and the proportion of non-preterm low weight births. In the low birth weight non-preterm group, a proxy measure to estimate intra-uterine growth delay, residing in vulnerable areas (1.29;1.17-1.43) and unfavorable mothers' demographics, such as teenage mothers (1.13;1.04-1.22), low schooling (1.26;1.17-1.35) and high number of children (1.10;1.01-1.20) were considered risk factors, as were older mothers (1.38;1.30-1.47), and single mothers (1.15;1.11-1.20). The lack of prenatal care produced the highest risk of low weight at birth in preterm (3.39;2.86-4.02) and non-preterm births (2.12;1.87-2.41). There was a decrease in the risk for low birth weight with an increase in prenatal care appointments in preterm and non-preterm births.

CONCLUSIONS: There are low birth weight prevalence differences across vulnerability groups. Prenatal care proved to be unequal across vulnerability groups and its high risk in terms of low birth weight shows the importance of increasing the access to and the quality of healthcare services.

DESCRIPTORS: Infant, Low Birth Weight. Prenatal Care. Risk Factors. Socioeconomic Factors. Health Vulnerability. Urban Zones. Epidemiology. Preterm Birth.

INTRODUCTION

Georeferencing techniques have leveraged the study of intra-urban health differentials. Georeferencing, together with increased access to electronic databases, has given rise to new definitions of space, which is no longer treated as a mere dimension of the environment, unrelated to the individual.[15] In this sense, some authors adopt the definition of Santos (1996)[17] who considers space as a true field of forces, whose acceleration is unequal and, for this reason, the evolution of space does not take place equally across places. Space is, therefore, considered as an integral part of the health-illness process and enables a rapid visualization of complex social relations.

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São Paulo is an example of a metropolis that combined unruly urban growth and lack of infrastructure, which resulted in heterogeneous spaces revealing many different kinds of social exclusion. The São Paulo Vulnerability Rate (IPVS - *Índice Paulista de Vulnerabilidade Social*), created by the State System Data Analysis Foundation (Seade - *Fundação Sistema Estadual de Análise de Dados*), based on 2000 census tract data (IBGE, 2002[a]), spatially measures living conditions and vulnerability differentials for the population residing within the city of São Paulo. Despite the large amount of information on intra-urban mortality differentials, there are no studies on birth-weight differentials in metropolitan areas. The goal of this study was to identify intra-urban differentials in low birth-weight prevalence and its potential risk factors.

METHODS

Information was gathered from the live birth declarations (LBD) of resident mothers in the city of São Paulo, obtained through the Live Birth Information System (Sinasc - *Sistema de Informação de Nascidos Vivos)* at the Seade Foundation, in the period of 2002 and 2003, during which there were 368,980 live births.

Birth weight was categorized in: low birth-weight (LBW) [less than 2.500g]; and non-low birth-weight-2.500g and over (NLBW).

The variables of exposure were: maternal schooling in years (<8. 8 to 11, ≥12); marital status (with or without a partner); mother's age (≤18 years, 19-34, ≥35); mother's parity rate (zero, 1 to 3, ≥4 previous births); duration of pregnancy (37 weeks [preterm], and ≥37 [non-preterm]); and sex of newborn.

Mothers home addresses registered on birth certificates were geo-referenced according to the 13,229 census tracts in the city of São Paulo, and 94.3% of which were identified.[8] Losses were not homogenous and were more frequent in peripheral census tracts, in recently urbanized areas where it was difficult to find the addresses.

The census tracts were classified according to IPVS. This compound indicator was obtained by group analysis, which resulted in census tract groups with similar features in terms of the dimensions initially identified through factorial analysis. The variables used were: mean number of individuals in the household; proportion of households whose head: could read and write, had completed elementary school, mean number of years of schooling, and mean nominal income of the person in charge of the household; proportion of households headed by women, proportion of household with family income up to three minimum wages, proportion of households headed by individuals aged between ten and 29 years; proportion of households with children from zero to four years of age in relation to the total number of residents.[8]

The São Paulo city census tracts were grouped along six vulnerability groups, from none to very high vulnerability.[8] The high and very high vulnerability groups were collapsed (groups 5 and 6) in order to obtain more precise measures and were called as high vulnerability group (group 5). The group IPVS variable had a loss of 31,993 (8,7%) birth certificates (BC).

Birth-weight was not informed in 13 birth certificates and stated as unknown in 1,407 (0.4%). These events were excluded. In addition, birth certificates with no information on: maternal schooling (19,135); marital status (10,006) and age (55), number of prenatal appointments (18,280) and parity that corresponds to the number of previous births (45,175), were also not considered. The sex variable was not completed in 16 certificates and the duration of pregnancy was reported as unknown in 616. There was no information on type ofloss in 2.278 LBDs. In some certificates, more than two variables were not completed, the total number of birth certificates excluded due to lack of information corresponds to 64,112 events, accounting for 17.4% of the total number of live births in the study period.

Birth certificates (224) informing mother's place of residence being the Marsilac district were excluded (because it presents rural features, IBGE[a] 2002). Also excluded from the study were multiple pregnancy births (7,838), with presence of congenital malformation (2 165) and non-hospital deliveries (1.385). After these exclusions, the final number of live births considered valid for the multivariate analysis was 261,263.

Chi-square test was used for trend assessment was of dose-response, performed with *Open Epi Calculator*.[6] To estimate the effect of potential risk factors associated to LBW, multiple stepwise forward logistic regression was performed, based on the set of variables that presented $p<0.20$, adding one at each time and processed in SPSS, version 13.0,[4] with significance rate of 5%.

RESULTS

High vulnerability census tracts were mainly located in the outskirts of the city of São Paulo, however there were spots of high vulnerability in the city's central area. Only 13.9% of the population resided in areas of no vulnerability (group 1) and 12.9% resided in high vulnerability rate areas (group 5).

[a] Instituto Brasileiro de Geografia e Estatística. Censo demográfico 2000: documentação de micro dados da amostra. Rio de Janeiro; 2002.

The prevalence of LBW was 8.1% on singleton births in the city of São Paulo (Table 1). There was a statistically significant increasing trend of LBW prevalence according to vulnerability: LBW was 26% higher in group 5 than in group 1.

Births to mothers having between eight and 11 years of schooling prevailed. There was a statistically significant decrease in maternal schooling rate as vulnerability increased. A similar behavior was observed in births from single and high parity mothers (Table 1).

Maternal mean age decreased with the increase in vulnerability, and there was a statistically significant increase in the proportion of births from teenage mothers with the increase in vulnerability. Births to teenage mothers were almost four times more frequent in group 5 than in group 1. The opposite trend was observed for births to mothers over 35 years of age (Table 1).

There was a statistically significant decrease in prenatal care adequacy with the increase in vulnerability. Whereas in group 1, 84.7% of the mothers had been to seven or more appointments, in group 4, only half of the mothers had adequate prenatal care. Inadequacy of prenatal care was about 3.2 times more frequent in group 5 than in group 1 (Table 1). It was also found that teenage mothers had 49% more chance of having inadequate prenatal care (RP=1.49; 95% CI: 1.47;1.51) than mothers older than 18 years of age. Single mothers presented a higher proportion of inadequate number of prenatal appointments (39%) (RP=1.39; 95% CI: 1.38;1.40) than mothers with a partner.

There was no statistically significant difference in terms of gender of infants in the five vulnerability groups. The same was found for frequency of preterm births (Table 1).

The prevalence of LBW in preterm births was 57.2% against 4.0% for non-preterm births in the city of São Paulo. The prevalence of LBW among non-preterm births was 3% in group 1; 3.8% in group 2; 3.9% in group 3; 4.3% in group 4 and 4.5% in group 5. There was a statistically significant increasing trend of non-preterm LBW with an increase in vulnerability (χ^2= 82.94; p<0.01).

There was a decreasing trend in LBW prevalence according to the number of prenatal appointments attended by the mother (χ^2= 1466.25; p<0.01). For no appointments, prevalence was 18.5%, whereas for one to three, four to six and seven appointments ore more prevalence rates were, respectively, 16.7%, 9.2% and 5.7%.

The following variables can be considered as risk factors for LBW: living in vulnerability areas, single mothers, low maternal schooling rate, nulliparous, teenage or mature mothers, inadequate prenatal care, and female newborns (Table 2).

Preterm and non-preterm LBWs were analyzed separately, since they may present different etiologies (Tables 3 and 4). Risk factors associated to preterm LBW were births to mothers without a partner, mothers older than 35, nulliparous women, and women who attended less than seven prenatal appointments, and female newborns. In this group, the effect of the place of residence was not observed; the same applies to young age and low maternal schooling, and to high parity (Table 3). In non-preterm low weight births, all the variables were associated to the outcome (Table 4).

DISCUSSION

Studies that take into account the geographical dimension are particularly important in big metropolis, where heterogeneous living conditions and spatial concentration of poverty can be found. By investigating smaller units, these studies enable one to see the internal differences and highlight the nuances of socioeconomic features. By adopting census tracts as a unit of analysis, it was possible to obtain gain in homogeneity and differatition[20] of living conditions, which are not always possible in studies which employ large areas, such as administrative districts or municipalities. These smaller units of study grouped according to IPVS enabled homogeneity, at the same time, they prevented fluctuations in the distribution of events, thus resulting in more precise measures.[20]

The no vulnerability area (group 1) is small and is located in the central area of the city, whereas vulnerability tends to increase as one moves out towards the outskirts. Nevertheless, even in the no vulnerability area, there were spots of high vulnerability. A large part of the population (86%) lived in areas of some vulnerability in the city of São Paulo. There is almost equivalence in the proportion of the population residing in the two extremes of the vulnerability scale: 13.9% of the population resided in group 1 and 12.9% resided in group 5 in 2000. The distribution of census tracts according to vulnerability rates is similar to the results of the Social Exclusion Map.[10]

LBW prevalence was 9.4% in 2002/2003 in the city of São Paulo, according to official data,[8] thus confirming the century-old LBW prevalence, as reported by Monteiro et al.[14] Prevalence of LBW is higher than in developed countries, where the rates range from 3 to 7%, in the same period, according to UNICEF (2006).[a]

Live Birth Information System (SINASC) shows that coverage of events and birth weight completeness is high: there was only 0.4% of non informed birth weight in the city of São Paulo and, therefore, the quality of the information is considered good.[1,2,16] Uncompleted birth certificates were excluded from the study. A national study on Sinasc data revealed an association between

[a] UNICEF. The State of the World's Children [internet]. 2006 [cited 2006 May 30]. Available from: http://www.childinfo.org/cmr/revis/db1.htm

Table 1. Live births distribution according to by vulnerability groups, characteristics of mother and newborn. São Paulo, Southeastern Brazil, 2002-3.

Variable	Vulnerability Groups (IPVS)										Total		p[a]
	Group 1		Group 2		Group 3		Group 4		Group 5				
	n	%	n	%	n	%	n	%	n	%	n	%	
Maternal schooling/years of study (N=308.997)													
Elementary school (incomplete)	4,040	13.9	18,065	24.6	27,648	32.6	34,461	42.2	19,356	48.5	103,570	33.5	0,000
8 to 11 years	7,373	25.4	35,436	48.2	43,416	51.1	38,915	47.7	17,656	44.2	142,796	46.2	0,000
12 years or more	17,628	60.7	20,008	27.2	13,872	16.3	8,223	10.1	2,900	7.3	62,631	20.3	
Marital status (N=316,677)													
No partner	8,009	27.2	30,169	40.1	36,384	41.8	36,543	43.6	18,802	45.8	129,907	41.0	0,000
With partner	21,436	72.8	45,086	59.9	50,760	58.2	47,263	56.4	22,225	54.2	186,770	59.0	
Maternal age (N=324,742)													
Less than 18	749	2.5	4,057	5.3	6,046	6.8	7,130	8.3	4,063	9.7	22,045	6.8	0,000
18 to 34	22,950	75.9	61,985	80.6	73,250	81.9	70,530	81.9	34,253	81.2	262,968	81.0	
35 and over	6,518	21.6	10,881	14.1	10,080	11.3	8,400	9.8	3,850	9.1	39,729	12.2	0,000
Mean	30		27		26		26		25		26		
Parity/previous births (N=286,135)													
Zero	11,819	46.7	27,783	41.8	30,130	38.2	27,041	35.1	12,971	33.8	109,744	38.4	0,000
1 to 3	12,884	50.9	35,751	53.7	43,906	55.6	43,780	56.8	21,605	56.4	157,926	55.2	
4 and over	617	2.4	2,975	4.5	4,903	6.2	6,223	8.1	3,747	9.8	18,465	6.5	0,000
Prenatal appointments (N=309,690)													
None	224	0.8	1,006	1.4	1,509	1.8	1,808	2.2	1,038	2.6	5,585	1.8	0,000
1 to 3 appointments	755	2.6	3,044	4.2	5,131	6.0	6,087	7.4	3,547	8.8	18,564	6.0	0,000
4 to 6 appointments	3,448	11.9	18,541	25.4	26,420	31.1	29,531	35.8	15,444	38.2	93,384	30.2	0,000
7 appointments or more	24,507	84.7	50,380	69.0	51,827	61.1	44,982	54.6	20,461	50.5	192,157	62.0	
Duration of pregnancy (N=320,336)													
Preterm (less than 37 weeks)	2,140	7.1	5,438	7.2	6,527	7.4	6,022	7.1	2,938	7.1	23,065	7.2	0,507
Non-preterm (37 weeksand over)	27,791	92.9	70,527	92.8	81,697	92.6	78,728	92.9	38,528	92.9	297,271	92.8	
Sex (N=324,741)													
Male	15,598	51.6	39,389	51.2	45,774	51.2	43,839	50.9	21,601	51.2	166,201	51.2	
Female	14,619	48.4	37,534	48.8	43,602	48.8	42,220	49.1	20,565	48.8	158,540	48.8	0,179
Birth Weight (N=324,744)													
Less than <2500 grams	2,048	6.8	6,074	7.9	7,294	8.2	7,264	8.4	3,636	8.6	26,316	8.1	0,000
2500 grams or more	28,169	93.2	70,850	92.1	82,083	91.8	78,796	91.6	38,530	91.4	298,428	91.9	

Source: Crude data: SINASC/ Fundação Seade. IPVS - The São Paulo Vulnerability Index

[a] Chi-square significance level for linear trend of variables according to IPVS groups.

Table 2. Crude and adjusted odds ratio, 95% confidence interval for low birth weight. São Paulo, Southeastern Brazil, 2002-3. (N=261,263)

Vulnerability groups/Variable	OR crude	95% CI	OR Adjusted	95% CI	p
Vulnerability groups (IPVS)					0,031
Group 1	1		1		
Group 2	1.18	1.11;1.25	1.10	1.04;1.17	
Group 3	1.22	1.15;1.29	1.09	1.03;1.16	
Group 4	1.25	1.18;1.33	1.08	1.02;1.15	
Group 5	1.28	1.20;1.37	1.07	0.99;1.14	
Maternal schooling (years of study)					0.000
Less than 8 years	1.23	1.18;1.28	0.91	0.86;0.95	
8 to 11 years	1.13	1.09;1.18	0.93	0.88;0.97	
12 years or more	1		1		
Marital status					0.000
No partner	1.28	1.24;1.32	1.13	1.09;1.16	
With partner	1		1		
Maternal age (years)					0.000
Less than 18	1.59	1.51;1.68	1.15	1.09;1.22	
18 to 34	1		1		
35 and over	1.26	1.21;1.32	1.48	1.42;1.55	
Parity (previous births)					0.000
Zero	1.29	1.25;1.33	1.44	1.39;1.48	
1 to 3	1		1		
4 and over	1.39	1.32;1.47	1.03	0.97;1.10	
Prenatal appointments					0.000
None	3.77	3.49;4.08	4.21	3.89;4.56	
01 to 03	3.34	3.19;13.50	3.62	3.44;3.80	
04 to 06	1.69	1.64;1.75	1.79	1.73;1.85	
7 or more	1		1		
Sex					0.000
Male	1		1		
Female	1.24	1.21;1.28	1.25	1.21;1.29	

Source: Crude data: SINASC/ Fundação Seade.
IPVS - São Paulo Vulnerability Index

absence of registered information and the poverty and inequality indicators,[16] showing that exclusions of birth certificates (17.4%) may have occurred in the more vulnerable groups. Exclusions were also due to the impossibility of georeferencing addresses, which was more frequent in peripheral areas of town. Multiple births and births with congenital abnormalities were not considered. These exclusions contributed to the lower LBW prevalence found in this study (8.1%).

In the same fashion as other studies addressing intra-urban differentials in mortality, there was a statistically significant increase in LBW prevalence with the increase of vulnerability, revealing that unequal living conditions are also mirrored in LBW prevalence. Similar findings have already been seen in developed countries, such as in a study carried out in British Columbia (Canada), where intra-urban differentials in LBW were identified according to household income quintiles,[12] in the city of Campinas (State of São Paulo).[3] This result differs from the findings obtained in Belo Horizonte (State of Minas Gerais) where a random distribution of LBW and premature births was found according the reference areas covered by the Primary Care Health Units (UBS - *Unidades Básicas de Saúde*).[7]

The results show there were differences in maternal characteristics according to vulnerability group. Group 1 mothers accounted for 9.3% of live births in the city of São Paulo, and approximately 60% of these mothers had university education (12 or more years of schooling), whereas in group 5 this proportion was 7.1%. Two effects may have contributed to these findings. The first is that the IPVS is based on the schooling rate of the head of the family and another study found an association between this rate and maternal schooling

Table 3. Crude and adjusted odds ratio, 95% confidence interval for low birth weight in the preterm live birth group. São Paulo, Southeastern Brazil, 2002-3. (N=17,889)

Vulnerability groups/Variable	OR Crude	95% CI	OR Adjusted	95% CI	p
Vulnerability groups (IPVS)					0.133
Group 1	1		1		
Group 2	1.21	1.08;1.36	1.09	0.96;1.23	
Group 3	1.22	1.10;1.37	1.05	0.93;1.19	
Group 4	1.25	1.11;1.39	1.03	0.91;1.17	
Group 5	1.20	1.06;1.36	0.95	0.83;1.09	
Maternal schooling (years of study)					0.197
Less than 8	1.19	1.10;1.30	0.95	0.86;1.05	
8 to 11 years	1.21	1.11;1.30	1.01	0.93;1.11	
12 years and over	1		1		
Marital status					0.007
No partner (single)	1.24	1.16;1.31	1.09	1.02;1.16	
With partner	1		1		
Maternal age					0.000
Younger than 18	1.25	1.12;1.39	0.90	0.80;1.01	
18 to 34	1		1		
35 and older	1.09	1.00;1.18	1.30	1.19;1.42	
Parity (previous births)					0.000
Zero	1.34	1.25;1.42	1.47	1.37;1.58	
1 to 3	1		1		
4 and over	1.18	1.06;1.33	0.97	0.86;1.10	
Prenatal appointments					0.000
None	2.96	2.96;3.49	3.39	2.86;4.02	
1 to 3 appointments	2.48	2.26;2.73	2.73	2.47;3.03	
4 to 6 appointments	1.59	1.48;1.69	1.67	1.56;1.80	
7 appointments or more	1		1		
Sex					0.000
Male	1		1		
Female	1.17	1.10;1.24	1.18	1.11;1.26	

Source: Raw data: SINASC/ Fundação Seade.
IPVS - São Paulo Vulnerability Index

rate,[a] which may have contributed to the concentration of mothers with higher levels of schooling in group 1 and a larger proportion of mothers with low schooling rate in group 5. The second effect is the fact that Sinasc overestimates the low schooling rate of the mother.[1,16] However, despite these distortions, there is a statistically significant decreasing trend of maternal schooling rate with the increase in vulnerability.

A high proportion of single mothers was found in the city of São Paulo. However, Sinasc may be overestimating births to single mothers. The birth certificates are completed by the health services after delivery and are submitted to the Registrar's Office to register births. It is possible that mothers in informal relationships are incorrectly identified by Sinasc as not having a partner.[1] Even if the real number for mothers without a partner is smaller than the results obtained, there was a statistically significant increasing trend in the frequency of this variable with the increase in vulnerability. A similar result was found in British Columbia, in Canada, where it was found that there is larger number of unmarried women in poorer areas.[12]

There was a decreasing trend in mother's mean age with an increase in vulnerability. There was an increasing trend in births to teenage mothers and vulnerability, whereas the trend of births to older mothers (≥35 years) was the opposite. The results indicate that there is a differentiated birth pattern according to mother's age and vulnerability areas. A similar trend has been observed in a study of fertility rates and Human Development

[a] César CLG, Goldbaum M. Uso de serviços de saúde. In: Saúde e condição de vida em São Paulo, inquérito multicêntrico de saúde no Estado de São Paulo. São Paulo: Faculdade de Saúde Pública da USP; 2005. p.185-98.

Table 4. Crude and adjusted odds ratio, 95% confidence interval for low birth weight in the non preterm live birth group. São Paulo, Southeastern Brazil, 2002-3. N= 243,374

Vulnerability groups/Variable	OR Crude	95% CI	OR Adjusted	95% CI	p
Vulnerability groups (IPVS)					0,000
Group 1	1		1		
Group 2	1.28	1.17;1.40	1.18	1.08;1.30	
Group 3	1.31	1.20;1.43	1.18	1.08;1.29	
Group 4	1.43	1.31;1.56	1.25	1.14;1.37	
Group 5	1.52	1.38;1.67	1.29	1.17;1.43	
Maternal schooling (years of study)					0.000
Less than 8 years	1.44	1.36;1.53	1.26	1.18;1.35	
8 to 11 years	1.25	1.18;1.33	1.13	1.06;1.21	
12 years or more	1		1		
Marital status					0.000
No partner	1.27	1.22;1.32	1.15	1.11;1.20	
With partner	1		1		
Maternal age (years)					0.000
Less than 18	1.49	1.38;1.61	1.13	1.04;1.22	
18 to 34	1		1		
35 and over	1.21	1.14;1.28	1.38	1.30;1.47	
Parity (previous births)					0.000
Zero	1.29	1.24;1.35	1.40	1.34;1.47	
1 to 3	1		1		
4 and over	1.39	1.29;1.51	1.10	1.01;1.20	
Prenatal appointments					0.000
None	2.19	1.93;2.48	2.12	1.87;2.41	
1 to 3 appointments	1.80	1.67;1.94	1.73	1.59;1.87	
4 to 6 appointments	1.29	1.23;1.34	1.23	1.18;1.29	
7 appointments or more	1		1		
Sex					0.000
Male	1		1		
Female	1.55	1.49;1.62	1.56	1.49;1.62	

Source: Crude data: SINASC/ Fundação Seade.
IPVS - São Paulo Vulnerability Index

Index areas in the city of São Paulo using,[13] and income quintiles in British Columbia, Canada.[12]

There is criticism concerning the quality of the information on parity data from Sinasc.[1] However, Romero & Cunha[16] have shown that parturition levels obtained from Sinasc data were comparable to the results obtained in the 2000 Population Census, thus indicating that these data can be used. Births from high parity mothers (four or more previous births) are 3.2 times higher in high vulnerability areas, than in a no vulnerability area. This expresses the fertility rate differentials across the city of São Paulo.[13]

Approximately 85% of mothers belonging to group 1 had had adequate prenatal care (seven or more appointments), whereas 49.5% of the mothers in group 5 had a number of prenatal appointments considered inadequate. Sometimes, seven or more prenatal appointments are not possible in preterm births[23] Frequency of preterm births alone cannot explain the lower number of prenatal appointments in vulnerability groups, because an increase trend of preterm births with an increase in vulnerability was not found.

Births to mothers who had no prenatal care were 3.6 higher in group 5 when compared to mothers in group 1, thus indicating difficulties in having access to healthcare. This result is similar to studies on the geographical distribution of prenatal care, where there is an association between poor areas[12] or socially deprived ares[5] or peripheral areas and low level of prenatal care appointments.[7] It would be expected that the action of healthcare services could minimize the negative effect of unfavorable living conditions on the prevalence of LBW. These actions would take place by means of educational

campaigns to reduce smoking during pregnancy, to promote early diagnosis and treatment of adverse events, – such as urogenital infections and high blood pressure among others – that contribute to low birth weight infants. There were statistically significant associations between the inadequate number of prenatal appointments and teenage or single mothers. This result was also found in other studies,[9,19] indicating that the characteristics of the mothers also influence in prenatal care.

In regard to gestational age information registered in Sinasc, a study carried out in the city of São Luís (State of Maranhão in Northeastern Brazil) in 1998, Silva et al[18] found that this variable underestimated the proportion of preterm births. However, a study carried out in the south of the city of São Paulo (2000/2001) revealed that there was a high concordance rate between the information obtained from Sinasc and information on the medical records.[1] In addition, this variable showed high specificity (over 90%) in identifying preterm births, these results indicate the variable's viability. As expected there was a high LBW prevalence among the preterm births in the study (57.2%). This rate was higher than rates obtained in the U.S. (36.7%) in 1998.[21] These findings suggest that there are high rates of very premature births (with lower weight gain), which explains the high LBW proportion among preterm births in the city of São Paulo when compared to the U.S.

Prevalence of LBW among non-preterm births was small (4%) in the city of São Paulo, but there is a statistically significant increasing trend of LBW with an increase in vulnerability. Low birth weight in non-preterm births indicates presence of intrauterine growth retardation (IUGR). These findings suggest that vulnerability is being expressed through low weight gain during pregnancy.

Almost all the risk factors studied were associated to LBW prevalence in São Paulo, except for high parity of mother. The results show that residing in vulnerable areas may be considered a risk for LBW, similarly to what was found in intra urban health differential studies carried out in Florida and Washington[5] and Tehran.[22] These results show that in addition to unfavorable socioeconomic conditions (low maternal schooling rate, low income, teenage mothers and older mothers),[5] social inequalities are also mirrored by differences in the social occupation of space.

Preterm and non-preterm low weight births were analyzed separately. The results show that the effect of residing in areas of vulnerability on low birth weight is expressed through the presence of retarded intra uterine growth, because it was only present in non-preterm low birth weight infants, and absent in preterm births. The unfavorable socioeconomic features of mothers were more frequent among the risk factors for non-preterm low weight births, and less present in preterm births. This result suggests that social factors contribute mainly to low weight gain during pregnancy. Female gender was found to be a risk factor for both types of LBW, similarly to what was found in the city of Campinas.[3] Some studies also have shown a higher IUGR rate for female babies.[24]

Among unfavorable maternal characteristics it was found that teenage pregnancy and high parity were present only in IUGR births. In regard to teenage pregnancy, similar results were found in the city of São Luís[2] (Northeastern region) and diverging results in the cities of Ribeirão Preto[2] and Campinas[3] (both in the State of São Paulo). High parity was not a risk factor for IUGR in the studies carried out in São Luis[2] and in Ribeirão Preto,[2] probably because this effect expresses one of the dimensions of poverty in metropolitan areas.

In preterm low weight infants, risk factors mirroring, in a more direct way, the living conditions of the mother, – such as vulnerability area, maternal schooling, teenage mothers and high parity – thus indicating that these variables were not risk factors for preterm births. However, the following variables were present: advanced maternal age, inadequate prenatal care and female babies. Although a Brazilian study has found an association between teenage mothers and preterm births,[9] another study has associated it only to advanced maternal age.[3]

Births to single mothers were associated to both LBW groups, this finding is corroborated by other studies which shows the importance of this situation in negative reproductive outcomes, such as neonatal and foetal mortality, preterm pregnancies and low birth weight.[9,12,24]

Inadequate or lack of prenatal care presents a high risk for both LBW groups, as found in prior studies.[3,12] This effect is not seen in randomized controlled studies as Kramer et al[11]pointed out. The authors suggest that the lack of or inadequate prenatal care can be due, to a certain extent, to unwanted pregnancies, in countries where there are no difficulties of access to prenatal healthcare. The association between the inadequate number of prenatal appointments and teenage mothers and single mothers suggest that unwanted pregnancies may have contributed to inadequate prenatal care in the City of São Paulo. However, this effect cannot be assessed in studies based on secondary data. On the other hand, the unequal distribution of prenatal care across vulnerability areas suggests the existence of difficulties in accessing the healthcare services.

This study concluded that the effect of vulnerability on LBW prevalence occurs through IUGR. The healthcare services, in providing prenatal care, instead of acting in a positive way to reduce social inequalities, were found to be one of the elements of vulnerability. It is possible that improving the quality of and access to prenatal healthcare may play an important role in reversing the LBW stability trend in the city of São Paulo.

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