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Contrasting socioeconomic gradients in small for gestational age and preterm birth in Argentina, 2003–2007

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Abstract

Objectives To examine the socioeconomic gradients in birth outcomes among singleton infants in Argentina, 2003–2007.

Methods We analyzed data of 3,230,031 singleton infants born in 2003–2007, obtained from vital statistics. Associations between birth outcomes [small for gestational age (SGA), low birth weight (LBW), and preterm birth (PTB)] and socioeconomic indicators (maternal education and area-based material deprivation quintiles) were assessed with logistic regression.

Results The risk of SGA increased with higher socioeconomic disadvantage, but that of PTB decreased. Compared to mothers who attained a tertiary or university degree, mothers who did not complete primary school were more likely to have a SGA infant [adjusted OR (95 % CI): 1.65 (1.62, 1.68)], but less likely to deliver preterm [0.92 (0.90, 0.94)]. As a result of the conflicting trends in SGA and PTB, LBW exhibited inconsistent socioeconomic gradients.

Conclusions The excess risk of adverse birth outcomes associated with socioeconomic disadvantage was consistently reflected by SGA, but not by LBW and PTB. These findings challenge the usefulness of LBW as an indicator population health. Further research is needed to explain the reverse socioeconomic gradients in PTB.

Keywords Low birth weight · Preterm birth · Small for gestational age · Argentina · Socioeconomic gradients · Material deprivation

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Introduction

Low birth weight (LBW), defined as a birth weight below 2,500 grams, has been traditionally used as an overall public health indicator of maternal and infant health (United Nations Children's Fund and World Health Organization 2004). Despite the fact that the relevance and utility of LBW as an outcome for epidemiologic studies have been questioned (Solis et al. 2000; Wilcox 2001), it is still widely used. Its popularity relies on the fact that birth weight is measured with high precision and completeness, and is routinely recorded in birth certificates in most countries, which facilitates its inclusion in surveillance systems. In addition, its widespread use in epidemiologic studies has stemmed from its strong association with perinatal mortality and other health outcomes later in life (Wilcox 2001).

Concerns about its suitability as an indicator of maternal and infant risk of adverse outcomes are several. It is increasingly believed that the association between LBW and perinatal mortality is not causal (Basso et al. 2006; Wilcox 2001), but that both are common consequences of pathological processes operating during pregnancy. While a few decades ago short gestation and fetal growth restriction were considered as synonyms under the term "prematurity", more recently experts have adopted the view that those two are distinct processes that should be measured separately prevailed. Thus, the term "prematurity" has fallen into disuse, and preterm birth (PTB) is now used to directly indicate the short gestation. Likewise, fetal growth restriction has become understood as a process by which the fetus fails to attain its true growth potential. Small for gestational age (SGA), defined as a birth weight below certain population percentiles or deviations from the mean (e.g., 10th percentile, <2 Standard Deviations), has thus been proposed as a proxy for fetal growth restriction. As LBW may reflect short gestation, slow fetal growth or a combination of both, its interpretation may be problematic. At the population level, changes in LBW rates may be affected by changes in the mean birth weight or its standard deviation, but these changes may not necessarily be associated with perinatal risk. Thus, LBW may not be amenable to interventions aimed at reducing perinatal risk at the population level (Frank and Haw 2011; Wilcox 2001). Because of the concerns above, it has been suggested that LBW has become obsolete as a sole indicator for monitoring inequalities in perinatal health (Frank and Haw 2011). In countries like Canada, LBW has been replaced by the paired outcomes PTB and SGA in recent surveillance reports (Canadian Institute for Health Information 2009; Public Health Agency of Canada 2008), under the understanding that LBW does not provide additional information beyond that provided by PTB and SGA.

While the assessment of socioeconomic inequalities in birth outcomes in Latin American countries has historically focused on LBW and infant mortality, less common is the simultaneous evaluation of LBW and its two components PTB and SGA. With the goal of filling this gap, we examined socioeconomic inequalities in these three outcomes using nationwide data of live births in Argentina in the 5-year period 2003–2007.

Methods

Data

Live birth data, based on the statistical report of live birth (SRLB) (http://www.deis.gov.ar/descrformularios.htm), were obtained from vital statistics of the Ministry of Health (2001). The study population included all singleton live births occurring in the calendar years 2003–2007. We excluded records with missing or invalid information on gestational age, birth weight, infant sex, maternal place of residence and births occurring outside the gestational age range 22–43. Finally, records with misclassification of gestational age as indicated by a method developed to correct errors in gestational age based on menstrual dates (Urquia et al. 2012) were also excluded.

Completion of the SRLB requires the notification of the department of residency of the mother in the whole country, with the exception of the city of Buenos Aires, where departments do not exist and were approximated by administrative units called electoral circumscriptions. Information on household material deprivation was obtained from the 2001 National Census of Population, Households, and Dwellings, and aggregated at the level of departments and electoral circumscriptions. Use of the data was approved by the Ethics Review Board of the Hospital Interzonal General de Agudos Evita-Lanús, of the province of Buenos Aires.

Definitions

SGA infants were identified on the basis of recently developed references of birth weight for gestational age for the Argentine population. SGA was defined as a birth weight below the 10th percentile for its sex and gestational age (Urquia et al. 2011). Misclassification of gestational age based on the last menstrual period was corrected using a normal mixture model, shown to correct preterm birth rates by 90 % based on United States birth certificate data (Urquia et al. 2012).

LBW was defined as a birth weight below 2,500 grams. Preterm birth (PTB) was defined as a birth occurred before completing 37 weeks of gestation.

These birth outcomes were examined in relation to other variables available in the SRLB: maternal age, parity, marital status, maternal education, health insurance status, place of delivery and place of residence of the mother. The categories of these variables are shown in Table 1. In order to assess if missing information was associated with the outcomes, we created missing data indicators for each variable.

Main socioeconomic characteristics included *maternal education*, measured by the highest educational level attained by the mother (Tertiary or University degree, High School diploma, Primary School diploma, Less than Primary School) as reported in the SRLB, and *material deprivation* of the area of residence of the mother at the time of delivery, categorized into quintiles. Material deprivation was measured according to the level of the Argentinean Household Material Deprivation Index of the

Table 1 Singleton live births according to maternal and delivery characteristics, Argentina, 2003–2007

	Live births	
	$N = 3{,}230{,}031$	%
Maternal educational attainment		
Tertiary or university degree	358,244	11.1
High school diploma	927,972	28.7
Primary school diploma	1,612,964	50.0
Incomplete primary school	268,059	8.3
Unknown	62,792	1.9
Area-based material deprivation		
Quintile 1 (lowest deprivation)	755,303	23.4
Quintile 2	558,429	17.3
Quintile 3	637,075	19.7
Quintile 4	704,183	21.8
Quintile 5 (highest deprivation)	575,041	17.8
Maternal age (in years)		
<18	205,204	6.3
18–19	276,831	8.6
20–24	828,725	25.7
25–29	830,234	25.7
30–34	642,015	19.8
35–39	332,760	10.3
≥40	34,470	1.1
Unknown	79,792	2.5
Parity		
No previous live birth	1,192,450	36.9
1–2	863,416	26.7
3–5	909,036	28.2
More than 5	230,090	7.1
Unknown	35,039	1.1
Cohabitation status		
Does not live with partner	452,235	14.0
Lives with partner	2,685,867	83.1
Unknown	91,929	2.9
Health insurance		
No	1,295,262	40.1
Yes	1,170,885	36.2
Unknown	763,884	23.7
Place of delivery		
Public institution	1,655,003	51.2
Private institution	1,065,974	33.0
At home	17,265	0.5
Other (street, etc.)	2,277	0.1
Unknown	489,512	15.2
Region of residence of the mother		
Central	1,990,749	61.6
Cuyo	289,614	9.0
Northeast	339,607	10.5
Norwest	408,404	12.6
South	201,657	6.3

538 departments of residence of the mother at the time of the 2001 National Census (NationaI Institute of Statistics and Censuses 2004). The index identifies households according to two dimensions: (a) patrimonial, based on characteristics of the dwellings reflecting an accumulation of resources relatively stable over time, and (b) of current resources, when households face challenges in acquiring the basic goods and services needed for the subsistence of their members. When these two types of deprivation coexist, deprivation is defined as *convergent*. We calculated the percentage of households with convergent deprivation within each administrative unit (electoral circumscriptions in the city of Buenos Aires and departments in the rest of the country). These areas were then sorted by the proportion of convergent deprivation and grouped into five groups of approximately equal size of live births (quintiles).

Statistical analysis

To assess associations between characteristics of the mother and the delivery and the occurrence of birth outcomes, we used logistic regression to obtain Odds ratios (OR) with 95 % confidence intervals (CI). We used unadjusted models and models adjusted for maternal age and parity. To account for the heterogeneity in the outcomes across strata of the predictors and areas of residence of the mothers, we corrected for overdispersion by multiplying the covariance matrix by the dispersion parameter estimated by the Pearson statistic divided by its degrees of freedom. Associations between the socioeconomic indicators and birth outcomes at the country level were plotted graphically and expressed as predicted probabilities (percentages) to provide a better picture of the socioeconomic gradients. Data were manipulated and analyzed with the statistical package SAS 9.3© (SAS Institute, Cary, NC, USA).

Results

There were 3,480,947 singleton live births in the study period. Of these, 159,558 (4.6 %) were excluded because of missing or invalid information on infant sex, birth weight, gestational age and place of residence of the mother and being outside the gestational age range

22–43 weeks. Compared with mothers retained for analyses, mothers whose records were excluded were more likely to have less than high school (13.0 vs. 8.3 %) and more likely to have incomplete information in other characteristics, suggesting poorer data quality overall. In addition, 91,358 (2.6 %) were excluded due to errors in the classification of gestational age. In total, 250,916 records (7.2 %) were excluded, leaving 3,230,031 for the analyses.

Live births were more common in mothers aged 20–29 years (Table 1), primiparous women, those living with a partner, women who at least completed primary school, who delivered in hospitals and resided in the central region of the country. Although lack of health insurance was reported in 40 % of births, this proportion may be even higher due to the important proportion of missing information in this variable (24 %). The distribution of births according to the material deprivation of the area of residence of the mother merely reflects the grouping of births into quintiles of approximately equal size for comparison purposes.

Table 2 shows the associations between characteristics of the mother and the delivery and SGA, LBW and PTB, before and after adjustment for maternal age and parity. The risk of SGA and LBW increased as maternal educational attainment decreased, but that pattern was reversed for PTB. The association with maternal education (Incomplete Primary School vs. Tertiary or University degree) was stronger for SGA [adjusted OR (95 % CI) 1.65 (1.62, 168)], but somewhat attenuated for LBW [1.22 (1.19, 125)], offset by a reverse association for PTB [0.92 (0.90, 0.94)]. Area-based material deprivation (quintile 5 vs. quintile 1) was also positively associated with SGA [1.25 (1.23, 1.27)], but negatively associated with PTB [0.89 (0.88, 0.91)]. As a result of these opposite trends canceling out, there was no association with LBW.

Figure 1 shows the socioeconomic gradients according to maternal educational attainment, expressed in percentages. SGA increased linearly as maternal education levels decreased. The gradient was quite attenuated for LBW. In contrast, PTB showed a gradient in the opposite direction. Similar patterns were observed according to the area-based material deprivation (Fig. 2). However, LBW showed little, if any, variation across deprivation quintiles.

Discussion

Our findings confirm the existence of socioeconomic inequalities in birth outcomes in Argentina. The main finding was that SGA was positively associated with socioeconomic disadvantage. This association did not vary with respect to the socioeconomic indicator (maternal education or area-based material deprivation) and the association did not disappear after adjustment for potential confounders.

Less clear were the associations between the socioeconomic indicators and LBW and PTB. Socioeconomic disadvantage was not associated with lower rates of preterm birth, which is counter-intuitive, since it suggests a paradoxical protective effect of poverty and lack of formal education on preterm birth. As already noted, LBW may reflect impaired fetal growth, short gestation or a combination of the two. Therefore, it is not surprising to find that socioeconomic gradients in LBW sit somewhere in between those observed for SGA and PTB. Moreover, when SGA and PTB gradients run in opposite directions, these influences tend to cancel out, leading to an apparent absence of socioeconomic inequalities in LBW.

The measure of SGA proved to be more robust and sensitive to socioeconomic conditions than those of LBW and PTB. This measure of SGA, which includes the 10 % of the smallest newborns regardless of their gestational age, may reflect the influence of insufficient maternal and fetal nutrition, environmental exposures (e.g., tobacco, pollution, stress), low maternal height, maternal illnesses or complications during pregnancy affecting fetal growth—all characteristics that are known to be associated with socioeconomic disadvantage.

Even though the observed reverse socioeconomic gradients in PTB were not expected, they are not completely surprising. To our knowledge, two factors may have contributed to shaping such reverse patterns: poor data quality and trends in obstetric practices. First, if missing and incorrect information on gestational age is generally more common among the socioeconomically disadvantaged (as it is the case of spontaneous preterm birth), the exclusion of such records may have resulted in artifactual reductions in PTB rates among those at the bottom of the social scale. However, we repeated analyses without removing records affected by potential errors in the classification of gestational age and the reverse gradients did not change. Also, missing information on maternal education was associated with higher PTB rates in the Northwest region but with lower rates in the Northeast region, these being the two regions with the steepest reverse gradients in PTB (data not shown). However, less than 2 % of birth records had missing information on maternal education, suggesting that the bias, if any, is small. In addition, area-based material deprivation also showed patterns similar to those of maternal education and there were no missing data on the material deprivation index. Without denying that data quality may have contributed to the attenuation of socioeconomic gradients in our study, it is unlikely that missing information may explain out the observed patterns.

Second, an alternative potential explanation builds upon the changing trends in obstetric practices. There is an

Table 2 Associations between socioeconomic indicators and other characteristics of the mother and birth outcomes, Argentina, 2003–2007

	Small for gestational age (SGA) (<10th percentile)		Low birth weight (LBW) (<2,500 g)		Preterm birth (PTB) (<37 weeks)	
	Unadjusted OR (95 % CI)	Adjusted[a] OR (95 % CI)	Unadjusted OR (95 % CI)	Adjusted[a] OR (95 % CI)	Unadjusted OR (95 % CI)	Adjusted[a] OR (95 % CI)
Maternal educational attainment						
Tertiary or university degree	1.00	1.00	1.00	1.00	1.00	1.00
High school diploma	1.14 (1.10, 1.18)	1.12 (1.11, 1.14)	1.09 (1.06, 1.12)	1.11 (1.09, 1.13)	1.05 (1.01, 1.09)	1.07 (1.05, 1.09)
Primary school diploma	1.38 (1.34, 1.43)	1.41 (1.39, 1.44)	1.24 (1.21, 1.27)	1.23 (1.21, 1.25)	1.11 (1.07, 1.15)	1.06 (1.04, 1.07)
Incomplete primary school	1.56 (1.49, 1.62)	1.65 (1.62, 1.68)	1.26 (1.22, 1.30)	1.22 (1.19, 1.25)	1.02 (0.97, 1.07)	0.92 (0.90, 0.94)
Unknown	1.71 (1.60, 1.83)	1.66 (1.61, 1.71)	1.35 (1.27, 1.42)	1.26 (1.22, 1.31)	1.16 (1.07, 1.26)	1.10 (1.06, 1.15)
Area-based material deprivation						
Quintile 1 (lowest deprivation)	1.00	1.00	1.00	1.00	1.00	1.00
Quintile 2	1.09 (1.03, 1.16)	1.09 (1.07, 1.11)	1.02 (0.98, 1.06)	1.01 (1.00, 1.03)	0.97 (0.91, 1.02)	0.96 (0.94, 0.98)
Quintile 3	1.13 (1.07, 1.19)	1.12 (1.11, 1.14)	0.98 (0.95, 1.02)	0.97 (0.96, 0.99)	0.89 (0.84, 0.94)	0.88 (0.86, 0.90)
Quintile 4	1.24 (1.17, 1.31)	1.23 (1.21, 1.25)	1.01 (0.98, 1.05)	1.00 (0.98, 1.01)	0.93 (0.88, 0.98)	0.92 (0.90, 0.93)
Quintile 5 (highest deprivation)	1.26 (1.19, 1.34)	1.25 (1.23, 1.27)	1.01 (0.97, 1.04)	0.99 (0.97, 1.00)	0.92 (0.87, 0.97)	0.89 (0.88, 0.91)
Maternal age (in years)						
<18	1.59 (1.54, 1.64)		1.75 (1.71, 1.79)		1.59 (1.54, 1.64)	
18–19	1.42 (1.38, 1.46)		1.39 (1.36, 1.42)		1.26 (1.23, 1.30)	
20–24	1.18 (1.16, 1.21)		1.12 (1.10, 1.14)		1.05 (1.03, 1.08)	
25–29	1.00		1.00		1.00	
30–34	0.95 (0.92, 0.97)		1.05 (1.03, 1.07)		1.10 (1.07, 1.12)	
35–39	1.00 (0.97, 1.03)		1.28 (1.25, 1.31)		1.33 (1.29, 1.36)	
≥40	1.13 (1.05, 1.22)		1.53 (1.45, 1.61)		1.52 (1.42, 1.63)	
Unknown	1.31 (1.25, 1.38)		1.60 (1.54, 1.66)		1.45 (1.38, 1.52)	
Parity						
No previous live birth	1.44 (1.41, 1.48)		1.39 (1.36, 1.42)		1.21 (1.18, 1.24)	
1–2	1.00		1.00		1.00	
3–5	1.00 (0.97, 1.02)		1.12 (1.09, 1.14)		1.17 (1.14, 1.20)	
More than 5	1.08 (1.04, 1.13)		1.33 (1.29, 1.37)		1.33 (1.27, 1.38)	
Unknown	1.46 (1.34, 1.60)		1.58 (1.48, 1.68)		1.21 (1.10, 1.33)	
Cohabitation status						
Does not live with partner	1.38 (1.34, 1.43)	1.24 (1.22, 1.25)	1.38 (1.36, 1.41)	1.27 (1.25, 1.28)	1.25 (1.21, 1.29)	1.19 (1.17, 1.21)
Lives with partner	1.00	1.00	1.00	1.00	1.00	1.00
Unknown	1.26 (1.18, 1.34)	1.17 (1.14, 1.20)	1.16 (1.10, 1.21)	1.07 (1.04, 1.10)	1.01 (0.94, 1.09)	0.97 (0.94, 1.00)
Health insurance						
No	1.26 (1.23, 1.29)	1.24 (1.23, 1.26)	1.15 (1.13, 1.18)	1.13 (1.12, 1.15)	0.99 (0.96, 1.02)	0.96 (0.94, 0.97)
Yes	1.00	1.00	1.00	1.00	1.00	1.00
Unknown	1.53 (1.49, 1.58)	1.53 (1.51, 1.54)	1.23 (1.21, 1.26)	1.22 (1.20, 1.23)	1.10 (1.06, 1.13)	1.08 (1.06, 1.09)
Place of delivery						
Public institution	1.00	1.00	1.00	1.00	1.00	1.00
Private institution	0.77 (0.76, 0.79)	0.78 (0.77, 0.79)	0.82 (0.80, 0.83)	0.82 (0.81, 0.83)	0.95 (0.92, 0.98)	0.98 (0.97, 0.99)
At home	1.89 (1.70, 2.10)	1.94 (1.85, 2.03)	1.25 (1.13, 1.37)	1.23 (1.16, 1.31)	1.11 (0.95, 1.30)	1.08 (1.01, 1.16)
Other (street, etc.)	1.46 (1.07, 2.01)	1.47 (1.29, 1.69)	1.82 (1.45, 2.29)	1.81 (1.57, 2.09)	1.76 (1.23, 2.54)	1.75 (1.50, 2.05)
Unknown	1.22 (1.19, 1.25)	1.23 (1.22, 1.25)	1.06 (1.04, 1.09)	1.07 (1.06, 1.09)	1.10 (1.07, 1.14)	1.13 (1.11, 1.14)
Region of residence of the mother						
Central	1.40 (1.29, 1.53)	1.42 (1.39, 1.45)	1.17 (1.11, 1.22)	1.17 (1.15, 1.20)	1.06 (0.98, 1.14)	1.07 (1.04, 1.09)
Cuyo	1.31 (1.19, 1.46)	1.33 (1.30, 1.37)	1.14 (1.08, 1.21)	1.15 (1.12, 1.18)	0.89 (0.81, 0.98)	0.89 (0.87, 0.92)
Northeast	1.42 (1.29, 1.57)	1.40 (1.37, 1.44)	1.14 (1.08, 1.21)	1.11 (1.08, 1.14)	0.93 (0.84, 1.02)	0.90 (0.87, 0.92)

Table 2 continued

	Small for gestational age (SGA) (<10th percentile)		Low birth weight (LBW) (<2,500 g)		Preterm birth (PTB) (<37 weeks)	
	UnadjustedOR (95 % CI)	Adjusted[a]OR (95 % CI)	UnadjustedOR (95 % CI)	Adjusted[a]OR (95 % CI)	UnadjustedOR (95 % CI)	Adjusted[a]OR (95 % CI)
Norwest	1.36 (1.23, 1.49)	1.36 (1.33, 1.40)	1.08 (1.02, 1.14)	1.07 (1.04, 1.09)	0.99 (0.90, 1.08)	0.97 (0.95, 1.00)
South	1.00	1.00	1.00	1.00	1.00	1.00

OR Odds ratio, *CI* confidence intervals, *SGA* small for gestational age, *LBW* low birthweight, *PTB* Preterm Birth

[a] Adjusted for maternal age and parity

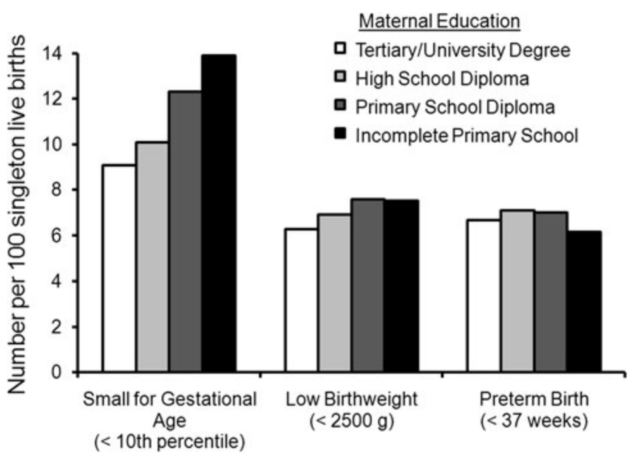

Fig. 1 Singleton birth outcomes[a] according to maternal education, Argentina, 2003–2007. [a]Predicted probabilities. Adjusted for maternal age and parity

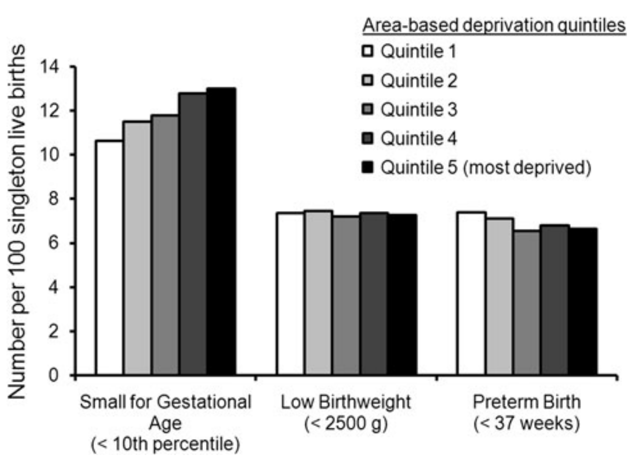

Fig. 2 Singleton birth outcomes[a] according to area-based material deprivation, Argentina, 2003–2007. [a]Predicted probabilities. Adjusted for maternal age and parity

increasing body of literature suggesting that the meaning of PTB has been changing lately (Joseph et al. 2002; Joseph et al. 2003; Klebanoff and Keim 2011) in parallel with the secular increases in PTB rates in North America and other countries. Such increases have been associated with a widespread increase in obstetric interventions, namely caesarean sections and induction of labor (Joseph et al. 2002, 2003). It is noteworthy that despite a shortening in the length of gestation, perinatal mortality rates have diminished. This indicates that such obstetric interventions have been increasingly indicated to prevent more serious outcomes in complicated pregnancies, trading-off preterm delivery against infant survival. Other modern interventions, such as assisted reproductive technologies, are not only associated with increases in preterm delivery but also with increases in stillbirth, even among singleton births (Schieve et al. 2004; Wisborg et al. 2010), and are typically more common among high-income women.

There are indications that changes in obstetric practice may have also impacted on socioeconomic gradients in PTB, particularly in Latin American countries, where the overall rates of caesarean section are significantly higher than in North America and Europe (Belizan et al. 1999). For example, in Chile in the 1990s, 40 % of births were delivered by caesarean sections and the rate of elective caesarean sections were in the range 30–68 % if performed by obstetricians working in private institutions, which target higher income women (Murray 2000). Consistent with our findings, an analysis of 2004 birth data of Santiago de Chile observed that the socioeconomic gradient in PTB was barely noticeable (Kaufman et al. 2008). If elective caesarean sections are associated with PTB and are more common among women of higher socioeconomic strata then it is reasonable to expect that historical socioeconomic gradients in PTB are attenuated or reversed. Positive correlations between better socioeconomic conditions and higher rates of caesarean sections have been reported in two ecological studies (Belizan et al. 1999; Casale 2009), one of which used Argentine provinces as units of analysis (Casale 2009). It is possible that these patterns of care help to explain the reverse gradients in PTB in Argentina, where the rates of caesarean sections are also high. Data from the 2001 Argentinean Survey on Living Conditions indicates that the rates of caesareans were 28 % among women in the poorest income quintile and 48 % among those in the richest quintile. Among women in the richest quintile, 98 % of caesareans were performed in private institutions (Casale 2009; Observatory of Maternity Foundation 2001). More recently, the 2005 WHO global survey on maternal and perinatal health in Latin America reported that the caesarean section rates in Argentina were 29 and 56 % in public and private institutions, respectively (Villar et al. 2006). However, and unlike industrialized countries, high rates of caesarean section in Latin American countries are not generally associated with improved perinatal outcomes, but with unnecessary interventions that may do more harm than good (Villar et al. 2007). Despite this suggestive indirect evidence, our data do not include enough information to test whether the reverse socioeconomic pattern in PTB and its impact on LBW are explained by the socioeconomic patterning of elective inductions and caesarean sections and other modern reproductive interventions.

This study has some strengths and several limitations. Strengths include the large size of the study population, with national coverage in a recent period, and so that it is representative of the country. We minimized the impact of errors in the classification of gestational age, based on the last menstrual period, using a correction method validated with US birth certificates (Urquia et al. 2012). Our findings are not an artifact of the application of this method, since socioeconomic gradients did not change substantially when based on the uncorrected data. Among our study's limitations, we highlight the reliance on the SRLB as the data source, the collection of data which is guided primarily by administrative rather than research purposes. Therefore, we lacked key information (i.e., type, onset and mode of delivery, fetal and maternal diagnoses, and maternal health behaviors such as smoking) that may have shed light on the observed associations. Missing data may have affected our results, as already discussed, but it is unlikely that they account for the observed patterns because of their low frequency. Another limitation is the use of information of the area of residence of the mother to assess material deprivation, since data aggregated at the area-level may not necessarily reflect individual deprivation. Unfortunately, the smallest geographic unit that could be used was the department, which is still relatively large and can be highly heterogeneous in terms of living conditions. This potential for ecological misclassification of the maternal social class may have diluted associations between the index of material deprivation and birth outcomes (Demissie et al. 2000). The use of smaller areas, more homogeneous with respect to the socioeconomic profile of their inhabitants, might have yielded stronger associations. Nonetheless, the use of maternal education, which was measured at the individual level, showed gradients in SGA in the same direction and similar strength, which validates to some extent the usefulness of area-level material deprivation as a socioeconomic indicator in these national analyses.

Conclusion

In Argentina, SGA status is significantly more frequent among infants born to mothers with low educational levels and living in areas of high material deprivation. The traditional perinatal health indicator, LBW, does not seem to be a sensible indicator to capture the excess perinatal risk associated with socioeconomic disadvantage in some middle-income countries such as Argentina. Exclusive reliance on LBW to assess and monitor socioeconomic inequalities between population groups should be avoided. Use of LBW should be complemented with the paired outcomes SGA and PTB to ensure an appropriate interpretation. Further research is needed to understand the underlying mechanisms behind the apparently reverse socioeconomic gradients in preterm birth, observed in this study.

References

Basso O, Wilcox AJ, Weinberg CR (2006) Birth weight and mortality: causality or confounding? Am J Epidemiol 164(4):303–311

Belizan JM, Althabe F, Barros FC, Alexander S (1999) Rates and implications of caesarean sections in Latin America: ecological study. BMJ 319(7222):1397–1400

Canadian Institute for Health Information (2009) Too early, too small: a profile of small babies across Canada. CIHI, Ottawa

Casale RA (2009) Socioeconomic levels and cesarean rates. Inequity in health care access? An ecologic study. Revista de Obstetricia y Ginecologia de Buenos Aires 88(982):200–211

Demissie K, Hanley JA, Menzies D, Joseph L, Ernst P (2000) Agreement in measuring socio-economic status: area-based versus individual measures. Chronic Dis Can 21(1):1–7

Frank JW, Haw S (2011) Best practice guidelines for monitoring socioeconomic inequalities in health status: lessons from Scotland. Milbank Q 89(4):658–693

Joseph KS, Demissie K, Kramer MS (2002) Obstetric intervention, stillbirth, and preterm birth. Semin Perinatol 26(4):250–259

Joseph KS, Young DC, Dodds L, O'Connell CM, Allen VM, Chandra S, Allen AC (2003) Changes in maternal characteristics and obstetric practice and recent increases in primary cesarean delivery. Obstet Gynecol 102(4):791–800

Kaufman JS, Alonso FT, Pino P (2008) Multi-level modeling of social factors and preterm delivery in Santiago de Chile. BMC Pregnancy Childbirth 8:46

Klebanoff MA, Keim SA (2011) Epidemiology: the changing face of preterm birth. Clin Perinatol 38(3):339–350

Ministry of Health (2001) Forms and Instructions of the Vital Statistics System. Ministerio de Salud de la Nación, Dirección de Estadística e Información de Salud, Programa Nacional de Estadísticas de Salud, Buenos Aires

Murray SF (2000) Relation between private health insurance and high rates of caesarean section in Chile: qualitative and quantitative study. BMJ 321(7275):1501–1505

National Institute of Statistics and Censuses (2004) The study of poverty in the 2001 National Census of Population, Households

and Dwellings. Methodology of the development of the Household Material Deprivation Index. INDEC, Buenos Aires
Observatory of Maternity Foundation (2001) Deliveries by mode and type of institution according to per capita household income quintiles and poverty status. Fundación Observatorio de la Maternidad
Public Health Agency of Canada (2008) Canadian Perinatal Health Report, 2008th edn. Public Health Agency of Canada, Ottawa
Schieve LA, Ferre C, Peterson HB, Macaluso M, Reynolds MA, Wright VC (2004) Perinatal outcome among singleton infants conceived through assisted reproductive technology in the United States. Obstet Gynecol 103(6):1144–1153
Solis P, Pullum SG, Frisbie P (2000) Demographic models of birth outcomes and infant mortality: an alternative measurement approach. Demography 37(4):489–498
United Nations Children's Fund and World Health Organization (2004) Low birthweight: country, regional and global estimates. UNICEF, New York
Urquia ML, Alazraqui M, Spinelli HG, Frank JW (2011) Reference birthweights for the Argentine population by multiplicity of birth, sex, and gestational age. Rev Panam Salud Publica 29(2): 108–119
Urquia ML, Moineddin R, Frank JW (2012) A mixture model to correct misclassification of gestational age. Ann Epidemiol 22(3):151–159
Villar J, Valladares E, Wojdyla D, Zavaleta N, Carroli G, Velazco A, Shah A, Campodonico L, Bataglia V, Faundes A, Langer A, Narvaez A, Donner A, Romero M, Reynoso S, de Padua KS, Giordano D, Kublickas M, Acosta A (2006) Caesarean delivery rates and pregnancy outcomes: the 2005 WHO global survey on maternal and perinatal health in Latin America. Lancet 367(9525):1819–1829
Villar J, Carroli G, Zavaleta N, Donner A, Wojdyla D, Faundes A, Velazco A, Bataglia V, Langer A, Narvaez A, Valladares E, Shah A, Campodonico L, Romero M, Reynoso S, de Padua KS, Giordano D, Kublickas M, Acosta A (2007) Maternal and neonatal individual risks and benefits associated with caesarean delivery: multicentre prospective study. BMJ 335(7628):1025
Wilcox AJ (2001) On the importance—and the unimportance—of birthweight. Int J Epidemiol 30(6):1233–1241
Wisborg K, Ingerslev HJ, Henriksen TB (2010) IVF and stillbirth: a prospective follow-up study. Hum Reprod 25(5):1312–1316