Neighborhood Inequalities in Adverse Pregnancy Outcomes in an Urban Setting in Spain: A Multilevel Approach

Irene Garcia-Subirats, Glòria Pérez, Maica Rodríguez-Sanz,
Dolores Ruiz Muñoz, and Joaquín Salvador

ABSTRACT *The aim of the present study was to describe socioeconomic inequalities in low birth weight (LBW), premature birth (PM) and small size for gestational age at birth (SGA) between 2000 and 2005 in Barcelona, Spain, jointly evaluating the effect of mother's country of origin, and neighborhood of residence socioeconomic level measured using unemployment and educational level. We performed a cross-sectional study of births to mothers aged 12–49 years who were residents in the city of Barcelona in 2000–2005, analyzing adverse pregnancy outcomes ($n=61,676$). Weighted multilevel logistic regression models were fitted with individual data on level 1 and neighborhood data on level 2, to obtain adjusted odds ratios (aOR) with 95% confidence intervals and residual variance. Individually, pregnancy outcomes are more favorable in births to older mothers and to mothers from Maghrib and Central and South America than from developed countries (including Spain) or from other developing countries. After adjusting for individual variables, poor pregnancy outcomes were associated with poor neighborhoods (more unemployment was associated to LBW: aOR = 1.56; PM aOR = 1.51; SGA aOR = 1.66). The same trend was observed for associations with illiteracy rate. The present study shows that there are socioeconomic inequalities in adverse pregnancy outcomes in the city of Barcelona. One of the main challenges in perinatal health continues to be the reduction of adverse pregnancy outcomes in the city.*

KEYWORDS *Immigration, Inequities, Low birth weight, Premature birth, Small for gestational age*

INTRODUCTION

There is considerable literature on the associations of adverse pregnancy outcomes with numerous maternal and fetal factors. Among them, maternal age has been considered to represent the mother's level of preparation for childbearing from biological, social, and psychological perspectives.^{1,2} Recently, it has been established

Garcia-Subirats, Pérez, Rodríguez-Sanz, Muñoz, and Salvador are with the Agencia de Salut Pública de Barcelona, Barcelona, Spain; Garcia-Subirats, Pérez, Rodríguez-Sanz, Muñoz, and Salvador are with the Centro de Investigación Biomédica en Red de Epidemiología y Salud Pública (CIBERESP), Parc de Recerca Biomèdica de Barcelona, Barcelona, Spain; Pérez and Rodríguez-Sanz are with the Facultat de Ciències de la Salut i de la Vida, Universitat Pompeu Fabra, Barcelona, Spain; Pérez, Rodríguez-Sanz, Muñoz, and Salvador are with the Institute of Biomedical Research (IIB Sant Pau), Hospital de la Santa Creu i Sant Pau, Barcelona, Spain.

Correspondence: Glòria Pérez, Agencia de Salut Pública de Barcelona, Plaça Lesseps 1, 08023-Barcelona, Spain. (E-mail: gperez@aspb.cat)

that mothers with lower educational level,³ those belonging to a less-privileged social class,⁴ and those with lower incomes⁵ are at higher risk of having babies with low birth weight, or who are premature or small for their gestational age. At the contextual level, recent studies have found that more disadvantaged neighborhoods, measured in terms of poverty,⁶ unemployment,⁷ income,⁸ compound deprivation index,⁹ or violent crime rate,¹⁰ have higher prevalence of adverse pregnancy outcomes; also, mothers residing in such neighborhoods have higher individual risk of presenting an adverse pregnancy outcome.^{11,12} Neighborhood socioeconomic level is the result of macro-level structural factors including economic aspects, migration, discrimination, political decisions, and public policies¹³ thus constituting a key area of health inequalities research.¹⁴

In Spain, immigration (from developing countries) is a fairly recent phenomenon. Barcelona (the second largest city in the country), like many other large cities in Europe, has experienced a sudden and considerable multicultural and multinational immigration in recent years. Immigrants have become an important part of the city's population; in 2001, 4.9% of Barcelona's 1.6 million inhabitants were foreign-born, while in 2007 the corresponding figure was 16.2%. These immigrants are mostly from Ecuador, Bolivia, Peru, Colombia, Argentina, Morocco, Pakistan, and China. Immigrants tend to be younger people, with varying levels of educational attainment, engaged in manual jobs.¹⁵ Research on recent immigration highlights the fact that immigrants often have better health than established residents of the host-country (healthy migrant effect) but that their health deteriorates with time in the host country.¹⁶

Although there are other studies on adverse pregnancy outcomes among immigrants in Spain, they have used hospital-based registries.^{17,18} Despite the considerable body of research into socioeconomic inequalities in adverse pregnancy outcomes in geographical areas of developed countries, we only know of one other study, conducted in Canada, which has examined adverse pregnancy outcomes and recent immigration using multi-level analysis.¹⁹ Thus, the aim of the present study was to describe socioeconomic inequalities in adverse pregnancy outcomes among mothers who gave birth between 2000 and 2005 in Barcelona (Spain) jointly evaluating the effect of the mother's country of origin, and socioeconomic level of neighborhood of residence, measured through unemployment and educational level.

METHODS

Design and Population of Study

A cross-sectional study was carried out using individual and neighborhood data on adverse pregnancy outcomes. Birth data were obtained from the Birth Register of the Institute of Statistics of Catalonia and is compiled from the Birth Statistical Bulletin; registration of births has been mandatory in Spain since 1975 and constitutes a necessary step to gain access to public health resources or schooling.²⁰ Data about neighborhood socioeconomic level were provided by the Statistics Department of the Barcelona City Council.

The population comprises the 81,558 births to women aged 12 to 49 years and resident in Barcelona during the period 2000–2005. The units of analysis were mothers at individual level and the 38 neighborhoods of the city at the contextual level. For each birth, neighborhood was geo-coded from the mother's address, which was successful for 98.5% of the birth records—that is, of the 81,558 births recorded (1.5% could not be mapped) with a similar distribution in the dependent variables.

Implausible values for weight (less than 500 g or more than 6,000 g) and for gestational age (less than 22 weeks) led to the exclusion of 18,638 observations. Thus, the final total number of births analysed was 61,676, and the total number of singleton births analysed was 59,320.

Variables and Indicators

The dependent variables were low birth weight (LBW), defined as a birth weight between 500 and 2,499 g in singletons; premature birth (PM), defined as a gestational age between 22 and 36 weeks in singletons; and small for gestational age (SGA), defined as cases situated below the third percentile, based on sex-specific national standards for births obtained from reference curves of fetal growth.²¹ Analyses involving LBW and PM only took into account the singleton deliveries because multiple births are strongly associated with these two indicators.²²

Independent variables at individual level were: maternal age, grouped into four ranges (i.e. 12–19, 20–24, 25–34, and 35–49 years) and maternal country of origin, grouped into eight regions: Spain, developed countries (USA, Canada, Japan, and Europe, but excluding Eastern European countries), Central and South America, Maghrib countries (North Africa), Eastern European countries, and Asiatic countries except Japan. Other explanatory variables used were sex of the newborn and parity (either primiparous or not primiparous).

Independent variables at neighborhood level were:

- (1) the percentage of unemployment (2001), defined as the percentage of unemployed people, including those ≥ 16 years of age seeking work for the first time, out of the total active population; the active population is defined as all persons aged over 16 but under 64 who are actively employed or seeking employment and hence furnish the supply of labor for production
- (2) the percentage of people with low educational level (2001), defined as the percentage of people who cannot read or write or have less than 5 years of schooling, out of the total number of people aged over 16 years
- (3) the percentage of immigrants (whether from developing or developed countries) (2004)
- (4) the change in the percentage of immigrants between 2000 and 2005 in each neighborhood.

Statistical Analysis and Modelling Strategy

First, an ecological study was conducted to determine the distribution of adverse pregnancy outcomes and contextual socioeconomic variables by neighborhood. This has been published elsewhere,²³ but briefly, it included a descriptive univariate analysis of the pregnancy outcome indicators and contextual indicators. Bar charts and quartile maps were elaborated to detect possible geographical patterns. Spearman correlation coefficients were calculated, and linear regressions performed, between dependent variables (prevalences per 100 newborns of the different adverse pregnancy outcomes) and contextual variables, and among contextual variables themselves, to describe their relationships and to establish degrees of association. Prevalences for LBW, PM, and SGA were presented stratified by mother's age and by mother's country of origin.

Finally, multilevel logistic regression models were fitted to obtain adjusted odds ratios (aOR) with 95% confidence intervals and the residual variance. The

multilevel analysis involved the following models for each of the three dependent variables: model 0, or empty model, with a random parameter (constant); model 1, or individual-level model, which was fitted including individual variables; and models 2 onwards, constructed by adding contextual variables to the individual model using a different contextual variable in each one. Models including more than one contextual variable were explored, but excluded because they did not achieve any further reduction in variability with respect to the individual model. The reduction of variability was measured in relation to the empty model.

Given the possible existence of non-linear relationships between neighborhood socioeconomic position variables and adverse pregnancy outcomes, quintiles for neighborhood socioeconomic level were used. All statistical analyses were performed with Stata software, version 9.0,²⁴ HLM version 6.02,²⁵ and R version 2.8.0.²⁶

RESULTS

Mothers born in Spain accounted for 83% of births and of the remainder, 14% were to mothers born in developing countries (Table 1). The prevalence of LBW, PM, and SGA differed depending on mother's country of origin. The prevalence of LBW was highest in births to Asian-born women (6.0) and lowest in births to Maghrib-born women (4.0). The prevalence of PM varies from 3.7 per 100 newborns among Maghrib-born women to 8.3 for East European-born women. The prevalence of SGA ranged from 1.7 in births to mothers born in developed countries to 3.8 in births to mothers born in Asia. In the case of mothers born in Spain, all indicators are situated around the middle of their corresponding range (Table 1). The prevalence of adverse pregnancy outcomes also varies with maternal age; infants born to the youngest mothers have the highest prevalence of LBW (8.8), PM (9.4), and SGA (3.4). Moreover, there was a clear gradient in the prevalence of adverse pregnancy outcomes across neighborhood socioeconomic level quintiles; compared to births to mothers in the lowest quintile of unemployment, births to mothers in the highest quintile of unemployment were more likely to present LBW, PM, or SGA. The same gradient was observed when using the other indicators of neighborhood socioeconomic position (Table 1). The ecological study, based on this data and published elsewhere,²³ showed that neighborhoods with less unemployment had lower prevalences of LBW, PM, and SGA than neighborhoods with more unemployment.

Multilevel modelling revealed significant variability between neighborhoods before adjusting for independent variables (model 0 in Tables 2, 3, and 4). After including individual variables (maternal age, country of origin, parity, sex of newborn), there was still variability in the prevalence of adverse pregnancy outcomes between neighborhoods (model 1 in Tables 2, 3, and 4).

The lowest prevalence of LBW corresponded to births to mothers who were aged 25–34, from Maghrib or from Central and South America, which were non-primiparous, and where the newborn was male (Table 2). Model 2 included the percentage of unemployment, while model 3 included the illiteracy rate (Table 2) both separately. Births to mothers residing in neighborhoods with lower levels of unemployment (aOR = 1.27; 95% CI, 1.14–1.41) or lower levels of illiteracy (aOR = 1.22; 95% CI, 1.09–1.37) had lower prevalence of LBW. The variability of LBW between neighborhoods was reduced by 83.55% and 80.41% in models 2 and 3 with respect to the empty model. Thus, in these two models the variability between neighborhoods was no longer statistically significant. Other models which included

TABLE 1 Prevalence of adverse pregnancy outcomes in singleton births according to mother's socioeconomic position and neighborhood socioeconomic level in Barcelona, Spain, 2000–2005

	Births		Birth outcomes					
			LBW (Singleton)		PM (Singleton)		SGA P3 (All births)	
	Number	Percent	Number	P	Number	P	Number	P
Total			3,931	5.6	3,395	5.6	1,741	2.8
Maternal age								
12–19 years	841	1.4	74	8.8	79	9.4	29	3.4
20–24 years	3,750	6.3	243	6.5	257	6.9	126	3.3
25–34 years	37,160	62.6	1,890	5.1	1,871	5.0	1,044	2.7
35–49 years	17,569	29.6	1,072	6.1	1,073	6.1	542	2.9
Country of origin								
Spain	49,103	82.9	2,761	5.6	2,657	5.4	1,488	2.9
Developed countries	1,736	3.0	75	4.3	94	5.4	31	1.7
Eastern Europe	578	1.0	31	5.4	48	8.3	15	2.5
Maghrib (North Africa)	857	1.4	34	4.0	32	3.7	20	2.3
Africa	194	0.3	9	4.6	11	5.7	8	3.4
Central and South America	5,161	8.7	265	5.1	329	6.4	117	2.2
Asia	1,159	2.0	71	6.1	62	5.4	45	3.8
(Missing)	532	0.9	33	6.2	47	8.8	17	3.5
Parity								
Primiparous	30,330	51.1	1,837	6.1	1,673	5.5	927	3.0
Not primiparous	28,990	48.9	1,442	5.0	1,607	5.5	814	2.6
Sex of the newborn								
Male	30,397	51.2	1,516	5.0	1,791	5.9	926	2.9
Female	28,293	48.8	1,763	6.1	1,489	5.2	815	2.7
Percentage of unemployment in quintiles (2001)								
Q1 (less)			708	4.5	764	4.9	358	2.2
Q2			699	5.7	679	5.6	358	2.8
Q3			821	5.4	782	5.2	450	2.9
Q4			679	6.2	673	6.2	378	3.3
Q5 (more)			372	6.9	382	7.1	197	3.5
Percentage of illiterate or insufficient instruction in quintiles (2004)								
Q1 (less)			708	4.6	747	4.8	362	2.2
Q2			785	5.6	775	5.5	398	2.7
Q3			611	5.4	612	5.4	327	2.8
Q4			751	6.1	733	6.0	407	3.1
Q5 (more)			424	7.1	413	7.0	247	4.0
Percentage of people from developing countries in quintiles (2004)								
Q1 (less)			615	4.7	661	5.1	332	2.4
Q2			786	5.5	773	5.4	413	2.8
Q3			837	6.1	811	5.9	447	3.1
Q4			677	5.4	668	5.3	362	2.7
Q5 (more)			364	6.7	367	6.7	187	3.3

TABLE 1 Continued

	Births		Birth outcomes					
			LBW (Singleton)		PM (Singleton)		SGA P3 (All births)	
	Number	Percent	Number	P	Number	P	Number	P
Change in the percentage of foreigners in quintiles (2000-2005)								
Q1 (less)			561	4.8	634	5.4	294	2.4
Q2			927	5.6	893	5.4	450	2.6
Q3			565	5.3	563	5.2	306	2.8
Q4			695	5.8	686	5.7	376	3.0
Q5 (more)			531	6.6	504	6.2	315	3.7

SGA P3 small for gestational age below percentile 3, P prevalence per 100 new births, BW low birth weight, PM premature birth

other contextual variables such as the percentage of foreigners in the neighborhoods or the change in the percentage of foreigners did not reduce variability.

The lowest prevalence of PM was for births to mothers aged 25–34, from Maghrib, Asia, and Central and South America, and where the newborn was female (Table 3). Model 2 included the percentage of unemployment, while model 3 included the illiteracy rate (Table 3). Births to mothers residing in neighborhoods with lower levels of unemployment (aOR = 1.13; 95% CI, 1.03–1.24) or lower levels of illiteracy (aOR = 1.14; 95% CI, 1.06–1.24) had lower prevalence of PM. The variability of PM between neighborhoods was reduced by 71.62% and 60.74% in models 2 and 3 with respect to the empty model, although the variability between neighborhoods remained statistically significant.

In relation to SGA, maternal age did not present a significant relationship with SGA (Table 4), while the lowest prevalence of SGA corresponded to births to mothers born in Spain or in Central and South America and who were not primiparous. As previously, model 2 included the percentage of unemployment and model 3 the illiteracy rate (Table 4). Births to mothers residing in neighborhoods with lower levels of unemployment (aOR = 1.30; 95% CI, 1.15–1.47) or lower levels of illiteracy (aOR = 1.23; 95% CI, 1.07–1.40) had lower prevalence of SGA. The variability of SGA between neighborhoods was reduced by 83.86% and 99.94% in models 2 and 3 with respect to the empty model. The variability between neighborhoods was no longer statistically significant.

DISCUSSION

The present study shows that there are socio-economic inequalities in adverse pregnancy outcomes in the city of Barcelona, Spain. Firstly, individual factors (mother’s country of origin, maternal age and parity) are strongly associated with adverse pregnancy outcomes even when contextual socioeconomic factors are taken into account. The study found that births to mothers from some developing regions, specifically those from Maghrib or North Africa and from Central and South America, are less likely to suffer an adverse pregnancy outcome than mothers from developed countries or from other developing regions. These results are similar in

TABLE 2 Multilevel associations between low birth weight in singleton births, mother's socioeconomic position and neighborhood socioeconomic level in Barcelona, Spain, 2000–2005

	Model 0					Model 1	Model 2	Model 3	Model 4	Model 5
						aOR (IC 95%)	aOR (IC 95%)	aOR (IC 95%)	aOR (IC 95%)	aOR (IC 95%)
Maternal age										
12–19 years						1.50 (1.23–1.81)	1.47 (1.21–1.77)	1.47 (1.22–1.78)	1.48 (1.23–1.78)	1.49 (1.23–0.81)
20–24 years						1.28 (1.14–1.43)	1.26 (1.12–1.43)	1.26 (1.12–1.41)	1.27 (1.14–1.42)	1.27 (1.13–1.43)
25–34 years						1	1	1	1	1
35–49 years						1.23 (1.15–1.30)	1.23 (1.16–1.31)	1.24 (1.16–1.32)	1.23 (1.15–1.30)	1.23 (1.16–1.31)
Country of origin										
Spain						1	1	1	1	1
Developed countries						0.80 (0.64–1.00)	0.81 (0.65–1.01)	0.82 (0.65–1.02)	0.79 (0.63–1.00)	0.81 (0.65–1.01)
Eastern Europe						0.89 (0.63–1.27)	0.89 (0.63–1.27)	0.90 (0.63–1.28)	0.88 (0.62–1.26)	0.90 (0.64–1.27)
Maghrib Countries						0.57 (0.43–0.76)	0.56 (0.42–0.74)	0.57 (0.43–0.75)	0.55 (0.41–0.73)	0.57 (0.43–0.76)
Africa						0.78 (0.39–1.56)	0.77 (0.38–1.55)	0.77 (0.38–1.54)	0.77 (0.38–1.55)	0.77 (0.39–1.55)
Central and South America						0.87 (0.77–0.99)	0.87 (0.77–0.98)	0.88 (0.78–0.99)	0.86 (0.77–0.98)	0.88 (0.78–0.99)
Asia						1.18 (0.94–1.48)	1.17 (0.94–1.46)	1.22 (0.97–1.54)	1.15 (0.92–1.43)	1.20 (0.95–1.51)
Sex of the newborn										
Male						1	1	1	1	1
Female						1.28 (1.21–1.35)	1.27 (1.20–1.35)	1.28 (1.20–1.36)	1.28 (1.21–1.35)	1.28 (1.21–1.35)
Primiparous										
No						1	1	1	1	1
Yes						1.26 (1.17–1.35)	1.25 (1.17–1.34)	1.26 (1.18–1.34)	1.25 (1.17–1.35)	1.26 (1.17–1.35)
Unemployment rate (2001)										
Q1 (less)						1	1			
Q2						1.27 (1.14–1.41)				
Q3						1.19 (1.09–1.32)				
Q4						1.40 (1.21–1.62)				
Q5 (more)						1.56 (1.37–1.78)				

TABLE 2 Continued

	Model 0	Model 1	Model 2	Model 3	Model 4	Model 5
		aOR (IC 95%)	aOR (IC 95%)	aOR (IC 95%)	aOR (IC 95%)	aOR (IC 95%)
Illiteracy rate (2004)						
Q1 (less)				1		
Q2				1.22 (1.09–1.37)		
Q3				1.19 (1.06–1.33)		
Q4				1.36 (1.19–1.54)		
Q5 (more)				1.56 (1.39–1.74)		
% Foreigners (2004)						
Q1 (less)					1	
Q2					1.11 (0.94–1.32)	
Q3					1.26 (1.04–1.53)	
Q4					1.14 (0.96–1.36)	
Q5 (more)					1.46 (1.23–1.74)	
Change in % foreigners (2000–2005)						
Q1 (less)						1
Q2						1.05 (0.84–1.31)
Q3						0.97 (0.78–1.22)
Q4						1.10 (0.87–1.38)
Q5 (more)						1.24 (0.97–1.59)
tj (p value)						0.01699 (<0.001)
Reduction tj in relation to model 0	0.02200 (<0.001)	0.02038 (<0.001) 7.36%	0.00362 (0.195) 83.55%	0.00431 (0.116) 80.41%	0.01071 (0.001) 51.32%	22.77%

tj = variance, aOR = adjusted OR

TABLE 3 Multilevel associations between premature birth in singleton births, mother's socioeconomic position and neighborhood socioeconomic level in Barcelona, Spain, 2000–2005

	Model 0					Model 1	Model 2	Model 3	Model 4	Model 5
	aOR (IC 95%)					aOR (IC 95%)	aOR (IC 95%)	aOR (IC 95%)	aOR (IC 95%)	aOR (IC 95%)
Maternal age										
12–19 years						1.79 (1.42–2.26)	1.75 (1.39–2.22)	1.77 (1.40–2.24)	1.78 (1.41–2.24)	1.78 (1.41–2.26)
20–24 years						1.27 (1.13–1.42)	1.25 (1.11–1.40)	1.25 (1.11–1.41)	1.26 (1.12–1.42)	1.26 (1.12–1.42)
25–34 years						1	1	1	1	1
35–49 years						1.25 (1.60–1.35)	1.26 (1.16–1.36)	1.26 (1.17–1.36)	1.25 (1.16–1.35)	1.25 (1.16–1.35)
Country of origin										
Spain						1	1	1	1	1
Developed countries						1.00 (0.77–1.30)	1.01 (0.78–1.30)	1.02 (0.79–1.32)	1.00 (0.77–1.29)	1.01 (0.78–1.31)
Eastern Europe						1.44 (1.08–1.92)	1.43 (1.07–1.91)	1.44 (1.08–1.93)	1.43 (1.08–1.90)	14.44 (1.08–1.92)
Maghrib countries						0.65 (0.51–0.83)	0.64 (0.50–0.81)	0.65 (0.51–0.83)	0.63 (0.50–0.81)	0.65 (0.51–0.83)
Africa						1.08 (0.54–2.15)	1.06 (0.53–2.13)	1.06 (0.53–2.12)	1.06 (0.53–2.13)	1.07 (0.53–2.14)
Central and South America						1.13 (1.01–1.27)	1.12 (1.00–1.26)	1.13 (1.01–1.27)	1.13 (1.00–1.26)	1.14 (1.01–1.28)
Asia						0.87 (0.67–1.12)	0.86 (0.67–1.10)	0.90 (0.69–1.15)	0.85 (0.67–1.09)	0.88 (0.68–1.13)
Sex of the newborn										
Male						1	1	1	1	1
Female						0.86 (0.80–0.93)	0.86 (0.80–0.93)	0.86 (0.80–0.93)	0.86 (0.80–0.93)	0.86 (0.80–0.93)
Primiparous										
No						1	1	1	1	1
Yes						1.01 (0.94–1.08)	1.01 (0.94–1.08)	1.01 (0.94–1.08)	1.01 (0.94–1.08)	1.01 (0.94–1.08)
Unemployment rate (2001)										
Q1 (less)						1	1	1	1	1
Q2							1.13 (1.03–1.24)			
Q3							1.09 (1.01–1.18)			
Q4							1.26 (1.08–1.48)			
Q5 (more)							1.51 (1.27–1.79)			

TABLE 3 Continued

	Model 0	Model 1	Model 2	Model 3	Model 4	Model 5
		aOR (IC 95%)	aOR (IC 95%)	aOR (IC 95%)	aOR (IC 95%)	aOR (IC 95%)
Illiteracy rate (2004)						
Q1 (less)			1	1		
Q2			1.14 (1.06–1.24)	1.14 (1.06–1.24)		
Q3			1.13 (1.03–1.24)	1.13 (1.03–1.24)		
Q4			1.27 (1.07–1.52)	1.27 (1.07–1.52)		
Q5 (more)			1.47 (1.31–1.66)	1.47 (1.31–1.66)		
% Foreigners (2004)						
Q1 (less)					1	
Q2					1.07 (0.92–1.25)	
Q3					1.15 (0.97–1.37)	
Q4					1.04 (0.87–1.23)	
Q5 (more)					1.31 (1.07–1.61)	
Change in % foreigners (2000–2005)						
Q1 (less)						1
Q2						0.96 (0.77–1.20)
Q3						0.95 (0.77–1.18)
Q4						1.05 (0.84–1.32)
Q5 (more)						1.15 (0.87–1.54)
tj(p value)						0.02058 (<0.001)
Reduction tj in relation to model 0	0.02213 (<0.001)	0.02151 (<0.001) 2.49%	0.00626 (0.025) 71.62%	0.00866 (0.008) 60.74%	0.01716 (<0.001) 22.21%	6.71%

tj = variance, aOR = adjusted OR

TABLE 4 Multilevel associations between small for gestational age in singleton births, mother's socioeconomic position and neighborhood socioeconomic level in Barcelona, Spain, 2000-2005

Value	Model 0	Model 1	Model 2	Model 3	Model 4	Model 5
		aOR (IC 95%)	aOR (IC 95%)	aOR (IC 95%)	aOR (IC 95%)	aOR (IC 95%)
Maternal age						
12-19 years		1.21 (0.83, 1.78)	1.18 (0.81-1.71)	1.17 (0.80-1.72)	1.19 (0.82-1.73)	1.20 (0.82-1.77)
20-24 years		1.20 (0.99, 1.47)	1.18 (0.96-1.44)	1.16 (0.95-1.42)	1.19 (0.98-1.45)	1.18 (0.97-1.45)
25-34 years		1	1	1	1	1
35-49 years		1.11 (0.99, 1.24)	1.11 (1.00-1.24)	1.12 (1.00-1.26)	1.11 (0.99-1.24)	1.12 (1.00-1.25)
Country of origin						
Spain		1	1	1	1	1
Developed countries		0.61 (0.39, 0.97)	0.62 (0.39-0.98)	0.63 (0.40-0.99)	0.61 (0.38-0.97)	0.63 (0.40-1.00)
Eastern Europe		0.80 (0.50, 1.29)	0.79 (0.49-1.28)	0.80 (0.49-1.29)	0.79 (0.49-1.28)	0.81 (0.50-1.30)
Maghrib Countries		0.71 (0.49, 1.04)	0.68 (0.47-0.99)	0.69 (0.47-1.01)	0.69 (0.47-1.00)	0.73 (0.50-1.01)
Africa		1.25 (0.62, 2.53)	1.24 (0.61-2.51)	1.21 (0.60-2.45)	1.23 (0.60-2.52)	1.24 (0.61-2.51)
Central and South America		0.72 (0.62, 0.83)	0.71 (0.61-0.82)	0.71 (0.62-0.82)	0.71 (0.61-0.82)	0.72 (0.63-0.84)
Asia		1.23 (0.93, 1.62)	1.19 (0.90-1.56)	1.26 (0.97-1.63)	1.19 (0.91-1.57)	1.29 (0.97-1.72)
Primiparous						
No		1	1	1	1	1
Yes		1.17 (1.04, 1.32)	1.16 (1.03-1.31)	1.17 (1.04-1.32)	1.17 (1.03-1.32)	1.17 (1.04-1.32)
Unemployment rate (2001)						
Q1 (less)			1			
Q2			1.30 (1.15-1.47)			
Q3			1.31 (1.62-1.47)			
Q4			1.51 (1.25-1.82)			
Q5 (more)			1.66 (1.29-1.12)			

TABLE 4 Continued

Value	Model 0	Model 1	Model 2	Model 3	Model 4	Model 5
		aOR (IC 95%)	aOR (IC 95%)	aOR (IC 95%)	aOR (IC 95%)	aOR (IC 95%)
Illiteracy rate (2004)						
Q1 (less)			1	1		
Q2			1.23 (1.07–1.40)	1.23 (1.07–1.40)		
Q3			1.23 (1.09–1.40)	1.23 (1.09–1.40)		
Q4			1.40 (1.21–1.64)	1.40 (1.21–1.64)		
Q5 (more)			1.83 (1.58–2.13)	1.83 (1.58–2.13)		
% Foreigners (2004)						
Q1 (less)					1	
Q2					1.10 (0.86–1.40)	
Q3					1.25 (0.98–1.62)	
Q4					1.12 (0.89–1.41)	
Q5 (more)					1.37 (0.99–1.91)	
Change in % foreigners (2000–2005)						
Q1 (less)						1
Q2						1.06 (0.86–1.32)
Q3						1.11 (0.89–1.38)
Q4						1.23 (0.96–1.57)
Q5						1.56 (1.20–2.03)
tj (p value)						0.01262 (0.023)
Reduction tj in relation to model 0	0.03426 (<0.001)	0.03031 (<0.001)	0.00537 (0.109)	0.00002 (>0.500)	0.02541 (<0.001)	62.07%
		8.90%	83.86%	99.94%	23.62%	

tj = variance, aOR = adjusted OR

some respects to others reported in the literature.^{1,27,28} One of the main arguments to explain better pregnancy outcomes among women who migrate from a developing country to a developed one involves the healthy migrant effect, according to which people who have had to go through the migratory process tend to be younger, stronger, and have a healthier lifestyle.^{29,30} We are not able to confirm the healthy migrant effect in our population because not all births to migrant women presented similar trends in prevalence of adverse pregnancy outcomes.

On the other hand, after a period of years living in the host country, the health status of migrant people tends to converge towards the status of their corresponding social class.³¹ Some international studies involving countries where migration is not a new phenomenon have compared migrants born outside the host country with members of the same ethnicity born inside the host country and found that the (foreign-born) migrants have better birth outcomes,^{32,33} which in turn depend on the migrant subgroup.³⁴

Secondly, adverse pregnancy outcomes are not equally distributed geographically across the city of Barcelona; the prevalence of adverse pregnancy outcomes was lower among births to women residing in the neighborhood with the highest socioeconomic level. Some of these socioeconomic aspects are probably related to cultural and traditional characteristics but also with political factors which determine different types of policies and interventions in reproductive health. In Spain, the National Health Service provides universal coverage for pregnancy care; however, women of manual social class were less likely to attend obstetrics controls and to follow recommendations about folic acid intake or smoking in pregnancy.³⁵

Thus, the effect of neighborhood socioeconomic poverty on adverse pregnancy outcomes already described in the literature appears relevant; living in neighborhoods with lower income⁸ and higher unemployment rate⁷ is associated with an increased probability of experiencing an adverse pregnancy outcome. Our findings contribute to the evidence that neighborhood socioeconomic level can either have a positive or negative effect on the health and well-being of residents.^{36,37,38}

Some authors have reported a negative effect of racial segregation on adverse pregnancy outcomes,^{39,40,41} while others have found that the fact of living in a community with a high rate of immigration acts as a protective factor.⁴² In Barcelona, there is no evidence that living in a community surrounded by your peers is protective.

In fact, the percentage of migrant population in a neighbourhood is not only linked to the phenomenon of segregation, since immigrants tend to seek residence in the cheaper areas of cities. In Barcelona (as probably happens in many large cities) neighborhoods with higher percentages of migrants from developing countries are also the cheaper ones, whereas neighborhoods with less poverty are chosen by migrants from developed countries. So any possible protective effect of segregation may be offset by living in a poorer neighborhood.

Multilevel research tries to avoid the four types of fallacies (ecological, atomistic, psychologistic, and sociologistic).⁴³ In our study, the attribution of ecological effects is probably at some risk of the sociologistic fallacy because we do have individual-level information about socio-economic position.

In relation to limitations, first of all, grouping women in eight major regions of origin ignores the heterogeneity of subgroups with cultural, ethnic, religious, or other differences that can affect the risk of adverse pregnancy outcomes,¹⁶ but the low number of adverse pregnancy outcomes precluded stratifying for units smaller than regions. However, in our study, mother's country of origin is a useful measure of recent migration, as there are relatively few second-generation or longer-term

immigrants. Thus, we could not determine if women, through processes of integration, have suffered a deterioration in pregnancy outcomes and other health indicators due to the tendency for such patterns to become similar to those of Spain-born women.

Another limitation is connected with the high percentage of missing values among immigrant women for certain variables such as birth weight (11% missing, 3% in women born in Spain) and weeks of pregnancy (21% missing, 7% in women born in Spain). We think this could result from their failing to answer questions due to language issues, beliefs, and/or cultural reasons. In spite of this lack of information, we believe pregnancy outcomes would have been similar to the results obtained, and therefore our findings and conclusions would be even stronger, showing the better outcomes among immigrant women.

In our study, we do not have information about the time of arrival to this country or levels of language comprehension and integration of immigrant people. This lack of information has two consequences. Firstly, that it probably results from failing to answer questions related to health due to language issues, beliefs, and/or cultural reasons that could reflect the level of missing data in mother's country of origin. Secondly, that we could not explore the influence of acculturation, which is important in relation to the "healthy migrant" effect.

Unfortunately, we do not have information about mother's factors such as income, occupation, level of education, obstetric history, health behaviors, anthropometrics, and an immigrant's length of stay in the country. These unmeasured factors could be potential confounders or mediators of estimates, thus caution must be exercised in interpreting the results. As immigration in the city mostly has an economic origin, the majority of immigrant people (79%), independent of their true level of education, have been assigned an occupational social class of unskilled manual work.⁴⁴

Finally, because live births were not linked to infant deaths, no information was available about fatal birth outcomes at the moment of conducting this research.

As conclusions, we can affirm that pregnancy outcomes are more favorable for births to older mothers and those from certain developing countries than from developed countries (including Spain) or from other developing countries. Also, mothers residing in disadvantaged neighborhoods experienced more adverse pregnancy outcomes than women residing in privileged areas, and the effect of neighborhood socioeconomic level on adverse pregnancy outcomes seems to be independent of the individual characteristics.

In our city, we have extensive experience in implementation of programs to reduce social inequalities in maternal and child health.⁴⁵ One consequence of recent immigration (since 2000) is that the health information system has had to be adapted to obtain maternal and child health indicators which reflect our new reality, an adaptation which is not yet complete. More research is needed trying to identify small areas with worse perinatal health indicators in order to facilitate possible interventions. On the other hand, socioeconomic indicators at individual-level will be very useful to generate new evidence. Particular attention should be paid to gathering information about time since arrival, and about second generations.

Furthermore, international research is required to consider the effects of migrant subgroup, defined as a combination of maternal culture, tradition, migrant status, region of origin, and the current place of residence³⁴ in birth outcomes and in health status.

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