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ORIGINAL PAPER

Newborn Birth Weights and Related Factors of Native and Immigrant Residents of Spain

Sandra L. Restrepo-Mesa · Alejandro Estrada-Restrepo · Laura I. González-Zapata · Andrés A. Agudelo-Suárez

Abstract Birth weight is a high impact factor in populations with high rates of immigration. This study establishes differences in birth weight (BW) and related factors among full-term newborn (NB) infants born to native and immigrant women living in Spain during 2007–2008. All NBs from Spanish mothers and mothers from the five nationalities with the highest birth rates in Spain (Morocco, Romania, Ecuador, Bolivia, and Colombia) according to the Statistical Bulletin of Births in Spain were included. BW was classified as low BW (LBW; <2,500 g), underweight (UW; 2,500–2,999 g), adequate weight (3,000–3,999 g), and macrosomia (≥4,000 g). The characteristics associated with a higher likelihood of LBW were Spanish mother, lower training level (OR = 1.3), more children (OR = 1.8), age ≤19 years (OR = 1.2) or ≥40 years (OR = 1.3), and female NB. The probability of macrosomia was higher in Bolivian mothers (OR = 3.0) with more children (OR = 1.7) and male NBs (OR = 2.0). The NBs of Spanish mothers have a higher likelihood of LBW and the lowest odds for macrosomía compared with immigrants from the other countries.

Keywords Spain · Migration · Pregnancy · Birth weight

Introduction

Since the 1990s, Spain has changed the demographic profile because of its incoming immigrants, mostly for economic and working reasons [1]. This process has been characterized by the magnitude of the population received mostly from low-income countries but differences in nationality, religion, and culture.

Immigration has led to a demographic shift characterized by a rising birth rate. A total of 545,457 live births to foreign mothers were recorded during 2001–2008, representing 15 % of all births in Spain. These births were primarily from mothers from Central America, Africa, and South America [2]. Immigrant women maintain the reproductive patterns of their countries of origin, both with regard to number of children and the age at which they begin to have ones. Overall, this statistic represents an increase in the birth rates of Spain, which allows for population replacement and the greater presence of a young working-age population [3].

Many studies focusing on the health of immigrants have analyzed the "healthy migrant effect" [4, 5]. This effect suggests that newly established people in a host country have better health indicators than native citizens. One explanation for this phenomenon is given by the selective migration of

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people with better health who have more resources to cope with the immigration process; however, differences might also be attributable to country of origin, such as social and health inequalities, which influence birth weight (BW).

Various studies performed in the United States and Europe have shown this effect. For example, previous research compared immigrant and native mothers with regard to preterm delivery (i.e., prior to 37 weeks of gestation) and low BW (LBW; i.e., less than 2,500 g) in infants 37 weeks or older [6–8].The results of these studies can be explained by better practices related to healthy habits of these women during pregnancy or the fact that women from developing countries are more likely to have their first child at a younger age, which corresponds to the reproductive patterns of their countries of origin [8].

Within Spain, statistics show that LBW infants increased 31 % during 1996–2005, with a prevalence of 7.2 % in 2005. This increase was related to the change in reproductive patterns in Spain characterized by a high prevalence of births to more adult women [9]. However, most studies describe these rates across large geographic areas [10, 11]. Additional studies are required to estimate relationships by country of origin via stratified analyses to observe related socioeconomic factors. Thus, this study aimed to establish the differences in BW and its related factors among full-term newborn (NB) infants born to native and immigrant women from Morocco, Romania, Ecuador, and Colombia living in Spain during 2007–2008.

Methods

Participants

A retrospective study was performed based on information obtained from the Birth Registry that contains data regarding all live births in Spain from the Childbirth Statistical Bulletin [2]. The files of 1,012,306 NBs were obtained from the National Institute of Statistics of Spain (INE) website from January 2007 to December 2008. This study examined all live, singleton, full-term NB births (>37 weeks of gestation) with weights greater than or equal to 800 g born to mothers from Spain (N = 599,660) or those from the five countries with highest proportion of births according to the official statistics: Morocco (n = 27,072), Romania (n = 15,305), Bolivia (n = 8,571) and Colombia (n = 8,544). Thus, 72,567 NBs born to migrant mothers were included. All variables of interest were found in the aforementioned bulletin.

Measures

The outcome was BW, classified into the following categories: LBW (<2,500 g), underweight (UW; 2,500–2,999 g), adequate (3,000–3,999 g), and macrosomía (≥4,000 g). The maternal predictors were country of origin (Spain, Morocco, Romania, Ecuador, Bolivia, or Colombia), education level (illiterate, primary, secondary, intermediate, or higher degree/professionals), occupation (white collar, blue collar, student, pensioner/retiree, or other), marital status (with partner or no partner), age in years (≤19, 20–29, 30–39, 40, or older), the total number of live births (1, 2, 3, or ≥4 children), and birth interval (<24 months or ≥24 months). NB sex was also investigated (boy or girl).

The current study was conducted using secondary sources of information, which does not constitute a risk to the target population. This research followed international guidelines (Declaration of Helsinki) and the legal regulations regarding data confidentiality. The researchers declare that have no conflicts of interest with regard to the participants tested or the entity that provided data and researchers. To preserve participant confidentiality, the database did not contain identifying information of the mothers or their NBs.

Data Analysis

Descriptive analyses of the study variables were performed. The prevalence of BW was estimated across the categories defined above based on maternal nationality. The Chi squared test was used to compare the variables of interest by nationality. For the multivariate analysis, three BW categories were taken into account: LBW (<2,500 g), adequate BW (2,500–3,999 g), and macrosomia (≥4,000 g). For the multinomial regression analysis, associations between LBW, macrosomia with other variables of interest were established using adequate BW as a reference category. For this analysis, odds ratios (ORs) and corresponding 95 % confidence intervals were calculated. In addition, a regression tree was generated with BW as the primary node in the three aforementioned categories. The software used was SPSS version 18.0.

Results

Upon analyzing the characteristics of mothers whose children were born in Spain from January 2007 to December 2008 by education level, we found that 42.4 % of Moroccans were illiterate or had primary education, which was a much higher statistic than those found in other countries. In contrast, 55.3 % of Spanish women (followed by 24.3 % of Colombians) had education levels that corresponded to mid-upper socioeconomic status or professional degrees (Table 1).

Table 1 Demographic characteristics, the number of live births, and birth intervals by maternal birth country

Characteristics	Maternal birth country													
	Spain		Romania		Morocco		Bolivia		Colombia		Ecuador		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Maternal education														
Illiterate	1,106	0.2	383	2.5	5,455	20.1	26	0.3	8	0.1	21	0.2	6,999	1.0
Primary	3,743	0.6	764	5.0	6,039	22.3	394	4.6	83	1.0	290	2.2	11,313	1.7
Secondary	262,967	43.9	11,672	76.3	13,896	51.3	7,160	83.5	6,377	74.6	11,342	86.7	313,414	46.6
Mid-higher degree	217,966	36.3	1,927	12.6	1,169	4.3	675	7.9	1,271	14.9	1,082	8.3	224,090	33.3
Professionals	113,878	19.0	559	3.7	513	1.9	316	3.7	805	9.4	340	2.6	116,411	17.3
Total	599,660	100.0	15,305	100.0	27,072	100.0	8,571	100.0	8,544	100.0	13,075	100.0	672,227	100.0
Maternal occupation														
White collar	299,492	49.9	1,654	10.8	1,883	7.0	579	6.8	1,689	19.8	1,369	10.5	306,666	45.6
Bluecollar	161,605	26.9	6,020	39.3	6,770	25.0	1,935	22.6	3,077	36.0	5,340	40.8	184,747	27.5
Student	5,989	1.0	185	1.2	330	1.2	238	2.8	368	4.3	571	4.4	7,681	1.1
Pensioner/retired	1,723	0.3	48	0.3	82	0.3	4	0.0	16	0.2	23	0.2	1,896	0.3
Other	130,851	21.8	7,398	48.3	18,007	66.5	5,815	67.8	3,394	39.7	5,772	44.1	171,237	25.5
Total	599,660	100.0	15,305	100.0	27,072	100.0	8,571	100.0	8,544	100.0	13,075	100.0	672,227	100.0
Maternal marital status														
Single/separated/ divorced/widow	167,624	28.0	6,898	45.1	3,146	11.6	6,223	72.6	4,639	54.3	7,943	60.7	196,473	29.2
Married	432,036	72.0	8,407	54.9	23,926	88.4	2,348	27.4	3,905	45.7	5,132	39.3	475,754	70.8
Total	599,660	100.0	15,305	100.0	27,072	100.0	8,571	100.0	8,544	100.0	13,075	100.0	672,227	100.0
Age														
≤19 years	12,312	2.1	1,313	8.6	1,399	5.2	523	6.1	669	7.8	1,197	9.2	17,413	2.6
20–29	165,028	27.5	10,032	65.5	15,010	55.4	5,518	64.4	3,602	42.2	6,424	49.1	205,614	30.6
30–39	398,035	66.4	3,816	24.9	9,466	35.0	2,367	27.6	3,903	45.7	5,010	38.3	422,597	62.9
40 or older	24,285	4.0	144	0.9	1,197	4.4	163	1.9	370	4.3	444	3.4	26,603	4.0
Total	599,660	100.0	15,305	100.0	27,072	100.0	8,571	100.0	8,544	100.0	13,075	100.0	672,227	100.0
Total number of live births														
1	330,075	55.0	10,028	65.5	13,022	48.1	4,351	50.8	4,308	50.4	5,614	42.9	367,398	54.7
2	218,567	36.4	4,148	27.1	8,102	29.9	2,643	30.8	3,031	35.5	4,671	35.7	241,162	35.9
3	40,768	6.8	802	5.2	3,452	12.8	1,025	12.0	917	10.7	1,886	14.4	48,850	7.3
4 or more	10,250	1.7	327	2.1	2,496	9.2	552	6.4	288	3.4	904	6.9	14,817	2.2
Total	599,660	100.0	15,305	100.0	27,072	100.0	8,571	100.0	8,544	100.0	13,075	100.0	672,227	100.0
Birth interval														
24 months or more	366,130	66.9	6,671	50.9	17,948	67.9	3,921	56.8	4,753	64.4	7,480	67.5	406,903	66.5
<24 months	180,866	33.1	6,425	49.1	8,486	32.1	2,981	43.2	2,622	35.6	3,595	32.5	204,975	33.5
Total	546,996	100.0	13,096	100.0	26,434	100.0	6,902	100.0	7,375	100.0	11,075	100.0	611,878	100.0
Sex														
Male	308,315	51.4	7,861	51.4	14,018	51.8	4,324	50.4	4,298	50.3	6,742	51.6	345,558	51.4
Female	291,345	48.6	7,444	48.6	13,054	48.2	4,247	49.6	4,246	49.7	6,333	48.4	326,669	48.6
Total	599,660	100.0	15,305	100.0	27,072	100.0	8,571	100.0	8,544	100.0	13,075	100.0	672,227	100.0

Spanish women predominately held white-collar occupations (50 %), where as blue-collar activities predominated among women of other nationalities. White-collar activities quadrupled among all women except those from Colombia and Spain, where this trend doubled. A total of 88.4 % of Moroccan women had a partner, in contrast to the 72.6 % of all other women who did not have one. Other nationality-related characteristics of birth of the mother are described in Table 1.

The average BW was above 3,000 g, with a standard deviation of approximately 452 g for all countries studied. Higher frequencies of LBW and UW (3.6 % and 21.7 %,

Table 2 Classification of BW by maternal birth country

Maternal birth country	Low weight		Underweight		Adequate		Macrosomia	
	n	%	n	%	n	%	n	%
Spain	21,508	3.6	130,059	21.7	415,656	69.3	32,437	5.4
Romania	425	2.8	2,894	18.9	10,747	70.2	1,239	8.1
Morocco	649	2.4	3,913	14.5	19,344	71.5	3,166	11.7
Bolivia	139	1.6	882	10.3	6,308	73.6	1,242	14.5
Colombia	198	2.3	1,375	16.1	6,240	73.0	731	8.6
Ecuador	328	2.5	2,058	15.7	9,553	73.1	1,136	8.7

Chi squared: $X^2_{15} = 5{,}054.35$, $p < 0.001$

respectively) were born to Spanish and Romanian (2.8 % and 18.9 %, respectively) mothers. Bolivian women had the highest proportion of NBs of adequate weight (73.6 %) and macrosomia (14.5 %; Table 2).

Increased frequencies of LBW and UW were found among women with secondary education (3.6 % and 21.4 %, respectively); women with professional degrees had the highest proportion of adequate weight infants (71.3 %); and macrosomia was highest among children of illiterate women (12.0 %) but decreased to the extent that education level improved (Table 3).

Blue-collar mothers had higher frequencies of LBW (3.6 %) and macrosomia (6.0 %) NBs; the highest percentage of adequate BW was found among student mothers (70.5 %) and those with white-collar activities (70.3 %); the highest frequency of UWNBs occurred among pensioners/retirees (24.5 %). LBW (3.8 %) and UW (22.5 %) NBs were more common among women without a partner, whereas adequate weight (70.2 %) and macrosomia (6.1 %) NBs were more common among women with a partner (Table 3).

Women aged 40 years or older showed the highest proportion of LBW NBs (4.7 %). The highest proportion of UW NBs (24.3 %) and the lowest rate of macrosomia (4.4 %) were associated with women aged 19 years or less. The highest frequency of macrosomia occurred among NBs from women aged 40 years or older (6.3 %).With regard to number of children, the highest proportion of UW NBs (22.2 %) occurred among women who had one child, whereas the highest percentage of macrosomia (10.1 %) occurred among mothers with four or more children. A higher prevalence of LBW was observed among girls (4.2 %),where as macrosomía primarily affected boys (7.8 %; Table 3).

A multinomial regression model revealed that Spanish mothers were more likely to have LBW infants compared with mothers of other nationalities. The opposite effect occurred with regard to macrosomia: Spanish mothers were less likely to have children heavier than 4,000 g. According to Model 1, Bolivian mothers had a 50 % lower probability of having NBs with LBW (OR = 0.5; 95 % CI = 0.4–0.6) and were three times as likely to have NBs with macrosomia (OR = 2.9; 95 % CI = 2.7–3.1). After adjusting for education level, occupation, marital status, and age (Model 2), we found that Bolivian mothers had a 60 % lower chance of having an NB with LBW (OR = 0.4; 95 % CI = 0.4–0.5) and were three times as likely to have NBs with macrosomia (OR = 3.0; 95 % CI = 2.8–3.2) compared with Spanish mothers. After also adjusting for infant sex, the number of total live births and birth interval be haved similar to Model 2 (Table 4).

According to the regression tree (Fig. 1a, b), the prevalence of LBW NBs was 3.5 %. This figure increased to 5.3 % when the mothers were Spanish and had more than two children. The prevalence was lower (1.6 %) when the mothers were Bolivian, had one child, or were less than or equal to 29 years old. The overall prevalence of macrosomía increased from 5.9 % to 15.6 % when mothers were Moroccan with more than two children; likewise, this rate was 14.4 % when the mothers were Bolivian, had sons, and were between 20 and 29 years old; lastly, it reached 12.9 % when the mothers were Moroccan with two children or less. Conversely, the prevalence of macrosomia decreased to 4.7 % among Spanish mothers with only one child.

Discussion

The current study showed that immigrants from Romania, Morocco, Bolivia, Colombia, and Ecuador had different rates of infants with LBW and macrosomia compared with Spanish mothers; furthermore, the latter had NBs with greater LBW and less macrosomia even after adjusting for maternal characteristics and infant sex.

Several studies have documented that immigrant women have less education, lower socioeconomic status, and work at blue-collar jobs (particularly in agriculture and domestic service). They also receive less medical attention and have specific social disadvantages compared with native women. These situations can increase the risk for adverse birth outcomes [6, 12, 13]. In this study, a similar pattern was

Table 3 Demographic characteristics, number of live births, and birth intervals according to BW classification

Characteristic	Total	Low weight		Underweight		Adequate		Macrosomia		p*
		n	%	n	%	n	%	n	%	
Total	672,227	23,247	3.5	141,181	21.0	467,848	69.6	39,951	5.9	
Education level										
Illiterate	6,999	212	3.0	1,112	15.9	4,835	69.1	840	12.0	<0.001
Primary	11,313	364	3.2	2,013	17.8	7,814	69.1	1,122	9.9	
Secondary	313,414	11,372	3.6	66,953	21.4	215,286	68.7	19,803	6.3	
Mid-higher degree	224,090	7,644	3.4	47,389	21.1	156,873	70.0	12,184	5.4	
Professionals	116,411	3,655	3.1	23,714	20.4	83,040	71.3	6,002	5.2	
Total	672,227	23,247	3.5	141,181	21.0	467,848	69.6	39,951	5.9	
Occupation										
White collar	306,666	10,316	3.4	64,492	21.0	215,500	70.3	16,358	5.3	<0.001
Bluecollar	184,747	6,708	3.6	39,325	21.3	127,544	69.0	11,170	6.0	
Student	7,681	212	2.8	1,615	21.0	5,418	70.5	436	5.7	
Pensioner/retiree	1,896	88	4.6	465	24.5	1,235	65.1	108	5.7	
Other	171,237	5,923	3.5	35,284	20.6	118,151	69.0	11,879	6.9	
Total	672,227	23,247	3.5	141,181	21.0	467,848	69.6	39,951	5.9	
Marital status										
Single/separated/ divorced/widow	196,473	7,456	3.8	44,294	22.5	133,727	68.1	10,996	5.6	<0.001
Married	475,754	15,791	3.3	96,887	20.4	334,121	70.2	28,955	6.1	
Total	672,227	23,247	3.5	141,181	21.0	467,848	69.6	39,951	5.9	
Age										
≤19 years	17,413	646	3.7	4,227	24.3	11,769	67.6	771	4.4	<0.001
20–29	205,614	6,671	3.2	42,962	20.9	143,531	69.8	12,450	6.1	
30–39	422,597	14,691	3.5	88,200	20.9	294,639	69.7	25,067	5.9	
40-older	26,603	1,239	4.7	5,792	21.8	17,909	67.3	1,663	6.3	
Total	672,227	23,247	3.5	141,181	21.0	467,848	69.6	39,951	5.9	
Total number of live births										
1	367,398	11,735	3.2	81,698	22.2	255,310	69.5	18,655	5.1	<0.001
2	241,162	8,509	3.5	46,562	19.3	169,875	70.4	16,216	6.7	
3	48,850	2,292	4.7	10,103	20.7	32,874	67.3	3,581	7.3	
4 or more	14,817	711	4.8	2,818	19.0	9,789	66.1	1,499	10.1	
Total	672,227	23,247	3.5	141,181	21.0	467,848	69.6	39,951	5.9	
Birth interval										
24 months or more	406,903	13,746	3.4	82,391	20.2	285,026	70.0	25,740	6.3	<0.001
<24 months	204,975	6,892	3.4	44,491	21.7	142,318	69.4	11,274	5.5	
Total	611,878	20,638	3.4	126,882	20.7	427,344	69.8	37,014	6.0	
Sex										
Male	345,558	9,651	2.8	60,303	17.5	248,704	72.0	26,900	7.8	<0.001
Female	326,669	13,596	4.2	80,878	24.8	219,144	67.1	13,051	4.0	
Total	672,227	23,247	3.5	141,181	21.0	467,848	69.6	39,951	5.9	

* Chi squared test

evident with regard to characteristics such as education and employment (in which immigrants showed lower rates of higher education and professional jobs, where as a higher percentage of Spanish women had white-collar jobs).

LBW infants are at high risk for morbidity and mortality, where as an intermediate weight range of 2,500–3,999 g is adequate. For several years, however, different authors have shown that NBs between 2,500 and 2,999 g (i.e., UW NBs) share certain characteristics and metabolic disadvantages with those who weigh less than 2,500 g [14]. Furthermore, they are more susceptible to chronic diseases in adulthood. This finding has led researchers to recognize the importance of defining this group of NBs [15].

Table 4 Multinomial model for low weight and macrosomia

Characteristic	Model 1				Model 2				Model 3			
	Low peso		Macrosomia		Low weight		Macrosomia		Low weight		Macrosomia	
	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
Country												
Spain	1.0		1.0		1.0		1.0		1.0		1.0	
Romania	0.8	0.7; 0.9	1.5	1.4; 1.6	0.8	0.7; 0.8	1.6	1.5; 1.7	0.7	0.6; 0.8	1.6	1.5; 1.7
Morocco	0.7	0.7; 0.8	2.3	2.2; 2.4	0.6	0.6; 0.7	2.0	1.9; 2.1	0.6	0.6; 0.7	2.0	2.0; 2.2
Bolivia	0.5	0.4; 0.6	2.9	2.7; 3.1	0.4	0.4; 0.5	3.0	2.8; 3.2	0.4	0.3; 0.5	2.8	2.8; 3.2
Colombia	0.7	0.6; 0.8	1.6	1.5; 1.7	0.6	0.5; 0.7	1.6	1.5; 1.8	0.6	0.5; 0.7	1.5	1.5; 1.8
Ecuador	0.7	0.6; 0.8	1.6	1.5; 1.8	0.7	0.6; 0.7	1.7	1.6; 1.8	0.6	0.5; 0.7	1.5	1.5; 1.7
Education level												
Illiterate					1.4	1.2; 1.7	1.4	1.3; 1.5	1.3	1.1; 1.5	1.2	1.1; 1.4
Incomplete primary					1.4	1.2; 1.6	1.3	1.2; 1.4	1.2	1.1; 1.4	1.2	1.1; 1.3
Sec. Incomplete/complete					1.2	1.2; 1.3	1.2	1.1; 1.2	1.2	1.2; 1.3	1.1	1.1; 1.2
Mid-high degree					1.1	1.1; 1.1	1.1	1.0; 1.1	1.1	1.1; 1.2	1.0	1.0; 1.1
Professionals					1.0		1.0		1.0		1.0	
Occupation												
Other					1.0	1.0; 1.1	1.1	1.1; 1.1	1.0	0.9; 1.0	1.0	1.0; 1.1
Pensioner/retiree					1.3	1.0; 1.6	1.0	0.8; 1.2	1.3	1.1; 1.7	1.0	0.8; 1.2
Student					0.8	0.7; 0.9	1.1	1.0; 1.2	0.9	0.7; 1.0	1.1	1.0; 1.3
Bluecollar					1.0	1.0; 1.1	1.0	1.0; 1.1	1.1	1.0; 1.1	1.0	1.0; 1.1
White collar					1.0		1.0		1.0		1.0	
Marital status												
With partner					1.0		1.0		1.0		1.0	
Without partner					1.2	1.1; 1.2	0.9	0.9;0.9	1.0	1.0; 1.1	0.9	0.9;1.0
Age												
20–29					1.0		1.0		1.0		1.0	
≤19 years					1.1	1.0; 1.2	0.7	0.6; 0.7	1.2	1.1; 1.3	0.7	0.7;0.8
30–39					1.1	1.1; 1.2	1.2	1.1; 1.2	1.0	1.0; 1.1	1.1	1.0; 1.1
40 or older					1.5	1.4; 1.6	1.2	1.1; 1.3	1.3	1.2; 1.4	1.1	1.0; 1.1
Sex												
Female									1.0		1.0	
Male									0.7	0.7; 0.7	2.0	2.0; 2.1
Number of children												
4 or more									1.8	1.6; 1.9	1.7	1.6; 1.8
3									1.6	1.6; 1.7	1.4	1.3; 1.4
2									1.1	1.1; 1.2	1.3	1.3; 1.4
1									1.0		1.0	
Birth interval												
<24 months									1.0		1.0	
24 months or more									0.9	0.9; 1.0	1.0	1.0; 1.0

The reference category for adequate BW was 2,500–3,999; 95 % CI: 95 % OR confidence intervals; Model 1: raw model; Model 2: Adjusted for maternal sociodemographic variables; Model 3: Adjusted for maternal sociodemographic variables, infant sex, total number of live births, and birth interval

In a cohort study of 37,615 births, Olivé et al. [16] found that infants with BW between 2,500 and 2,999 g were twice as likely to die than those with BWs greater than 3,000 g due to a significant increase in morbidity. The crude mortality rate of infants weighing between 3,000 and 4,000 g was 2.7 %, whereas it was 5.8 % for NBs weighing between 2,500 and 2,999 g. An UW status also negatively predicts growth and development during the early

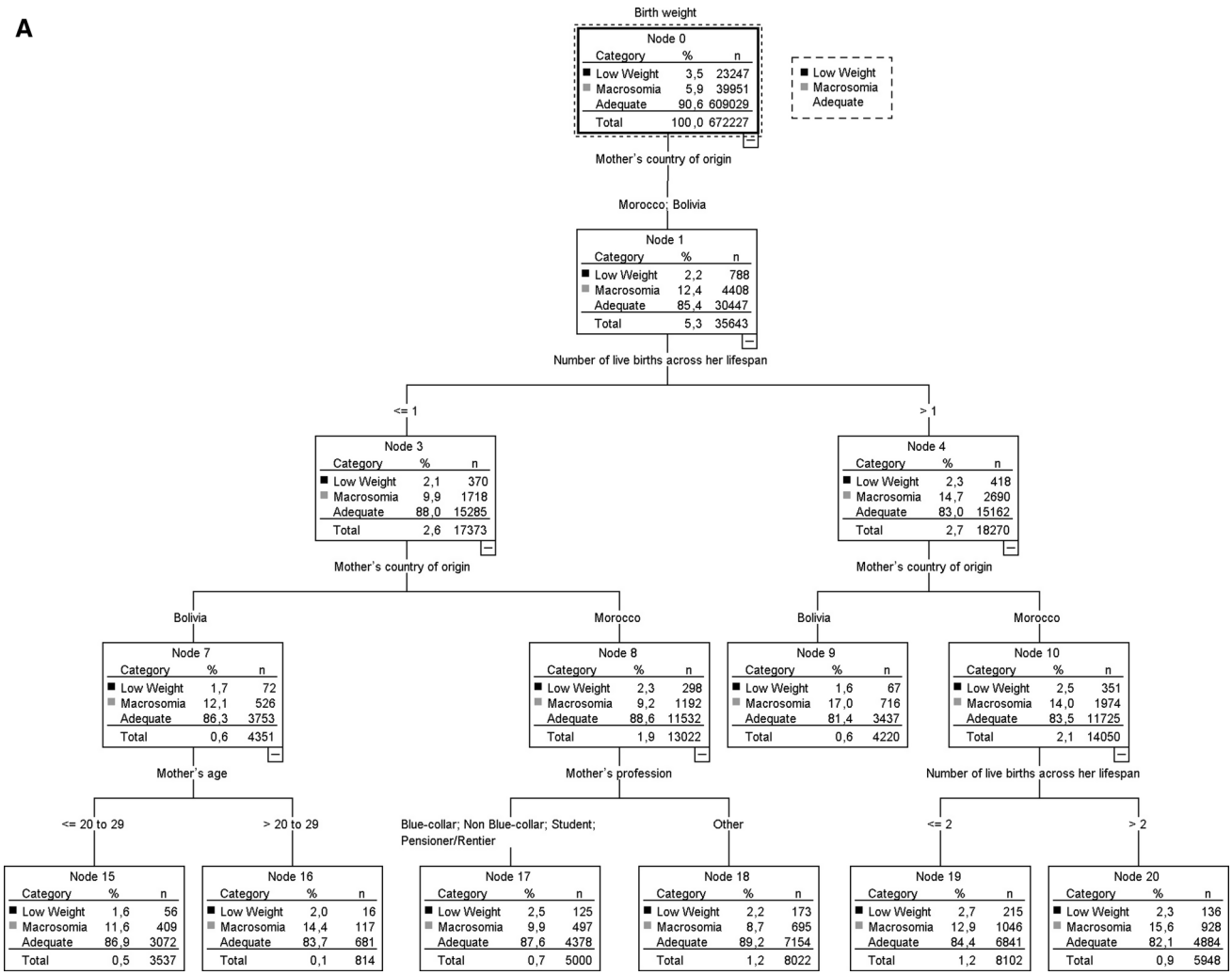

Fig. 1 Classification of birth weight and maternal characteristics

stages of life. Importantly, studies of weight differentiation show that the proportion of UWNBs is four times higher than that of LBWNBs [16]. A similar situation was found in the present study in which the rate of UW NBs was six times greater than that of LBW NBs.

Regarding macrosomia, there is scientific evidence that high birth weight is related with obesity in school-age and later [17, 18], and this situation could increase the risk of morbidity related to metabolic diseases.

The current study found an association between maternal variables and BW classification. Díaz et al. [19] and Auger et al. [20] found higher proportions of LBW infants born to mothers with low education levels in Cuba and Montreal, respectively. Women younger than 19 years old or those older than 40 years old showed an increased risk of have an NB with LBW [9, 21, 22].

Parity is another factor to consider. Although previous authors have stated that past birth experience positively affects BW [23], our study and others [20, 22] showed a higher proportion of LBW NBs among women with more children.

On the other hand, a higher proportion of LBW NBs was observed among Spanish women compared with immigrant women. This finding is important in light of the scientific evidence suggesting that LBW substantially contributes to neonate and infant morbidity and mortality as well as the development of chronic diseases in adulthood. The adaptations caused by nutritional deficiencies in utero among these NBs permanently change the structures of organs, physiology, and cellular metabolism (i.e., metabolic programming). This change manifests early postnatal complications such as developmental disorders, malnutrition, growth failure, abnormal cognitive development, neurological deterioration, and poor school performance [9, 24].

Several studies have found a lower incidence of LBW infants born to immigrant mothers compared with native

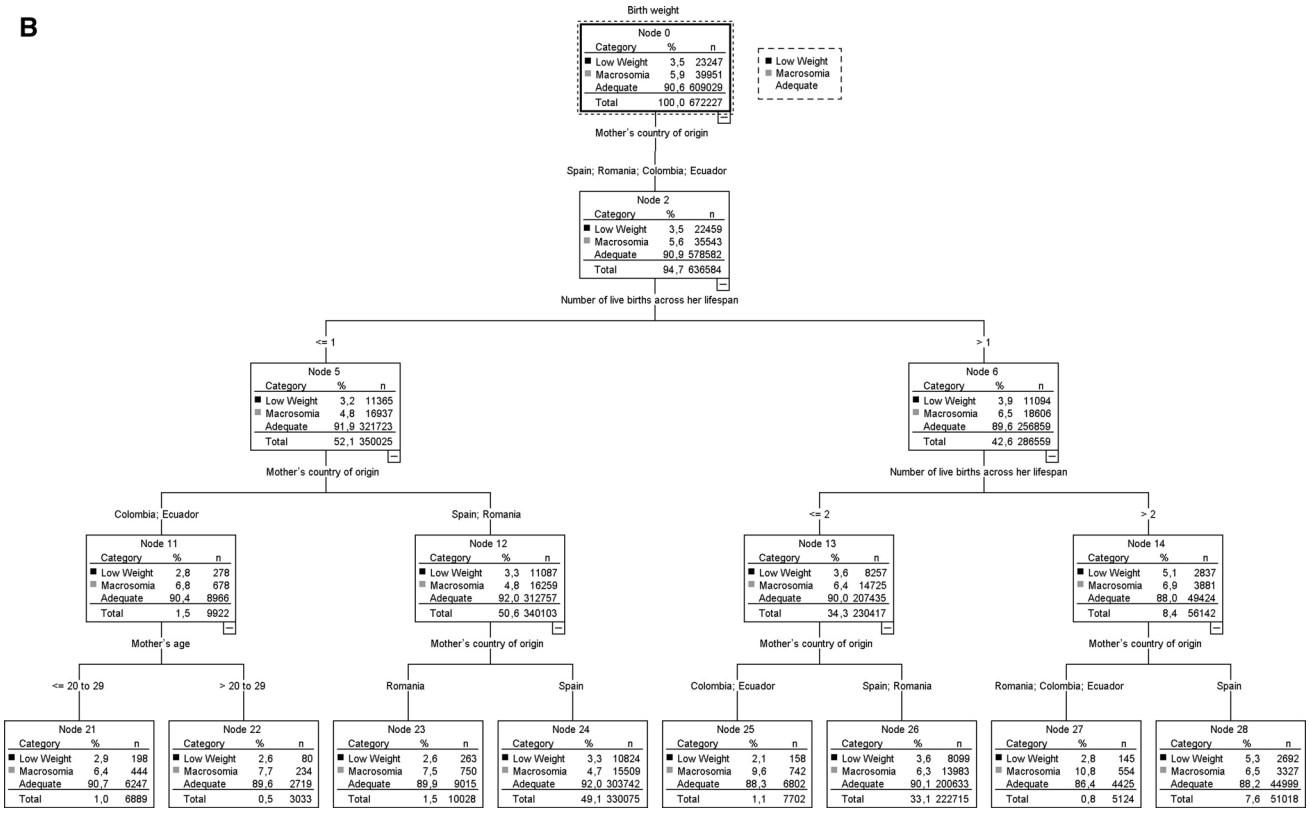

Fig. 1 continued

mothers, which has been described as the "epidemiological paradox" [13, 25] or the "healthy immigrant paradox" [8, 12, 26]. Our study revealed that immigrants had lower prevalence of LBW infants compared with native women, even after adjusting for certain variables. A similar result was found in studies performed with regard to Americans and Latin immigrants [25, 26], Americans and Eastern European immigrants [27], Belgians and North African immigrants [28], French and Belgians and North African immigrants [29], and Spanish and other immigrants [1, 8, 30–32].

Despite what is known regarding the healthy immigrant paradox, no clear mechanisms exist for the superior birth outcomes observed among immigrant mothers. Specific factors have become possible partial explanations such as healthier immigrant lifestyles and the cultural heritages of the immigrant countries (e.g., lower rates of smoking and alcohol consumption) [25, 33]. A study in Zaragoza [34] found that 37.3 % of Spanish women smoked before becoming pregnant, whereas the proportion of immigrants who smoked was 19.7 %. The study also showed that Spanish women were significantly more likely to continue to smoke. The selection bias of the migration process, which suggests that healthier people are more likely to leave their home countries, should also be considered [35].

With regard to the new contributions of this study, the analysis of characteristics such as maternal country of origin and education level overcomes the limitations of previous studies by using nationality to control for possible differential misclassification bias. With regard to the limitations, this study not analized BW and its conditioning in pretermin NB infants; only the five countries with the largest immigrant populations in Spain were selected for this study, although large populations of other nationalities live in this country. Furthermore, limitations are associated with the availability of certain variables such as complications of pregnancy, pre-conception nutritional status, maternal weight gain, socioeconomic status, the number of prenatal medical visits, and residence time outside the country of origin. These variables were not available in the database and might help to explain the BWs of the offspring born to these groups of women. Therefore, It is suggested the implementation of a surveillance system that includes these variables and allows complementary records for developing greater complex research. Longitudinal studies might indicate whether reproductive health changes over time among immigrant women compared with Spanish women via acculturation. Moreover, the influence of contextual and individual factors should be investigated using hierarchical or multilevel analyses.

In conclusion, the NBs born to Spanish mothers are more likely to be LBW and less likely to show macrosomía compared with immigrants from the aforementioned countries. Among immigrants, the lowest rates of LBW NBs and macrosomia were found among Bolivian mothers. Social and economic determinants must be taken into account in the analysis of LBW prevalence, beyond the factors related to maternal immigration status. Moreover, both the LBW and the macrosomía are important indicators that the health professionals have to consider and act preventively in order to prevent obesity and metabolic disease in later age groups.

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