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Differences in Preterm and Low Birth Weight Deliveries Between Spanish and Immigrant Women: Influence of the Prenatal Care Received

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OBJECTIVES: To compare the risk of preterm and low birth weight among newborns from native and immigrant women and to assess the role of prenatal care in the association between the ethnic origin of the women and their reproductive outcomes.

METHODS: Cross-sectional study of 21,708 women giving birth between 1997 and 2008 in a region of Spain. Multinomial logistic regression models were adjusted to evaluate associations between mother's area of origin and adverse reproductive outcomes and to assess the role of prenatal care in the occurrence of adverse reproductive results.

RESULTS: Our results indicate a worse prenatal control in immigrants than in natives. Very preterm birth (VPTB) and very low birth weight (VLBW) were greater among immigrants (odds ratio [OR], 1.78; 95% confidence interval [95% CI], 1.14-2.79 for VPTB and OR, 1.73; 95% CI, 0.89-3.33 for VLBW) but after adjustment for prenatal care the differences were substantially reduced (OR, 1.43; 95% CI 0.85-2.42 for VPTB and OR 1.15; 95% CI 0.53-2.52 for VLBW).

CONCLUSIONS: Given the positive impact of prenatal care on reproductive results, strategies to improve it among immigrant women should be implemented. The difference found in the direction of the association between area of origin and different categories of low birth weight and preterm suggest that very and moderate categories should be analyzed separately in immigrant studies.

KEY WORDS: Birth Weight, Emigrants and Immigrants, Gestational Age, Low Birth Weight, Premature Birth, Prenatal Care, Very Low Birth Weight.

INTRODUCTION

Migratory processes can generate unfavorable social and medical care conditions, placing immigrant women's health at risk. In developed countries, research analyzing the adequacy of the prenatal care received during pregnancy and the reproductive outcomes in immigrant women is considered a key activity to identify and reduce potential inequalities with native-born populations.

In general, studies from different countries identify a greater frequency of inadequate prenatal care (later initiation and/or low number of medical visits) in immigrants than in natives, irrespectively of their ethnic origin (1-5). Regarding their reproductive outcomes, the so-called "Hispanic paradox" is mentioned in the literature referring to the fact that Hispanic immigrants in United States experience overall better outcomes than other ethnic groups with similar socioeconomic status (6-8). Studies conducted in Europe have also identified this advantage not only in Hispanic immigrants but in those from North Africa (9-11). One of the possible explanations proposed for this paradox is the repeatedly observed "healthy migrant" effect: Only healthy individuals migrate whereas the individuals at greatest risk stay behind. Regarding other immigrant groups as Sub-Saharan or Asiatic women, there is not a similar agreement in the literature; in some studies authors identify increased risk of adverse reproductive outcomes (12-15) whereas others dismiss such hypothesis (16-18).

During the last decade, Spain has become one of the main receiving countries of immigrant women, mainly from Maghreb, Latin America, Eastern Europe, and Sub-Sahara. Most are young women that begin or continue their reproductive life after their arrival, making delivery the first cause of hospitalization for immigrant women in Spain (19,20).

Despite the increasing contribution of immigrant women to the total number of births, data about their country of origin have just started to be collected in health registers in Spain, and studies analyzing reproductive and perinatal health indicators in foreign women are still rare (21,22). Differences with other North American or European countries in access to health care and in the ethnic composition of the immigrant populations could make the conclusions reached in those countries not fully applicable to the Spanish context and highlights the need for research in this area in our country.

The increase in workforce demand related to agriculture has favored the settlement of a great concentration of immigrant women in rural areas such as Almeria, a province in the South of Spain with the biggest concentration of green-houses in Europe and approximately a 33% of immigrant population (23). Deliveries from immigrants have increased significantly during the last years in the reference hospital from the south of this region, going from 5% in 1997 to nearly 47% of the total births in 2007. In addition, data about the country of origin of the mother have been systematically collected for all births during this period, which allows for the comparison of reproductive and perinatal health indicators between natives and different ethnic groups of immigrant women.

The aim of our study was, first, to compare the level of prenatal care received by natives and immigrants, as well as the risk of very or moderate preterm birth and very or moderate low birth weight among their newborns and, second, to assess the role that the prenatal care received plays in the association between the ethnic origin of the women and their reproductive outcomes.

METHODS

A cross-sectional study of women giving birth between January 1, 1997 and April 21, 2008 was conducted in Almeria, an area in southern Spain with a high proportion of births from immigrant women. Only live-born singleton births of native-born and immigrant women were included. Following the regional classification for low and middle income countries provided by the United Nations immigrant women were classified as coming from Latin America (Ecuador, Bolivia, Colombia, Peru, Argentina, Brazil), Maghreb (Morocco), Eastern Europe (Rumania, Russia, Lithuania, Bulgaria, Ukraine), and Sub-Saharan Africa (Senegal, Guinea Bissau, Nigeria, Ghana, Malawi).

In addition to country of origin, information on maternal age (<20, 20–35, and >36 years), parity (primiparae/multiparae), type (vaginal/caesarean), and mode of delivery (spontaneous/induced) and previous adverse obstetric outcomes (yes/no) was also available. Regarding the characteristics of the newborns, data about sex (male/female), gestational age (determined by ultrasound and classified in <32, 33–36, and >37 weeks), and weight at birth (<1500, 1500–2499, and >2500 g) were available.

Data about gestational week of prenatal care initiation, number of medical visits during pregnancy, and gestational age of the newborn were used to calculate a prenatal care index. After a careful revision of the most important indexes proposed in the last two decades (24–29), we decided to use the modified version of Kotelchuck index (28) proposed by VanderWeele et al. (29), (“Modified Adequacy of Prenatal Care Utilization”; APNCU-1M). This index allows the evaluation of the prenatal care received classifying women in four levels of prenatal care: adequate plus, adequate, intermediate, and inadequate (including no care) after taking into account two basic components, one referring to the level of adequacy of the initiation of the prenatal care and the other one referring to the level of adequacy of the number of visits according to the gestational age at birth. For this study, cut-points to define each one of the four categories of prenatal care above mentioned were set up according to the Spanish prenatal care calendar (30). The adapted index was called “Modified Adequacy of Prenatal Care Utilization Spanish Index” (APNCU2M- SP), and its construction is summarized in the Appendix. Comparisons of the distribution of the prenatal care received by native-born and immigrant women were carried out taking into account each one of the two index components mentioned and also the resulting classification of the whole index combining the two components. Statistical differences between native-born and the different immigrant groups of women were assessed using chi-square tests. Because no data about socioeconomic status (SES) were available in hospital records, we used data on the progenitor’s profession, reported to the Spanish official birth registry for all births occurring in the region under study and during the same period, as a proxy to estimate the SES. Similarly to previous studies (31, 32), skilled jobs were considered a proxy of high SES

and unskilled a proxy of low SES. Because individual identification in the birth registry of those mothers selected from the hospital records was not possible, aggregated data were imputed. We assigned to each mother the proportion of couples with low SES giving birth in the same year, coming from the same country and within the same age group. Once imputed, SES was included in the regression models.

Multinomial univariate and multivariate logistic regression models were fitted to explore crude and adjusted associations between mother's area of origin and four different reproductive outcomes: very preterm birth (VPTB), that is, 22-32 weeks; moderate preterm birth (MPTB), 33-36 weeks; very low birth weight (VLBW), 500-1500 g; and moderate low birth weight (MLBW), 1500-2499 g. We included mother's area of origin first as a two categories variable (Spain vs. immigrant) and, in a different model, as a five-category variable (Spain vs. Eastern-Europe, Maghreb, Sub-Sahara, and Latin America). Sample size was too small to estimate stable associations for VPTB and VLBW with the use of so many immigrant groups, and results of the analysis of these two outcomes are only showed comparing natives and immigrants as a whole. For both gestational age and birthweight, three different multivariate models were fitted: a crude model, a second model adjusting by sex of the newborn, maternal age, parity, previous adverse outcomes and mode of delivery and a third model also including prenatal care, to assess the influence of the prenatal care received in the association between mother's origin and each one of the adverse reproductive outcomes considered. Odds ratios (OR) and 95% confidence intervals (95% CIs) were used as a measure of association. All analyses were performed with STATA software, version 11.

RESULTS

During the period analyzed 21,708 single deliveries were recorded, corresponding 72.7% to native-born mothers and the rest to mothers coming from Maghreb (12.2%), Eastern-Europe (9.9%), Sub-Sahara (2.8%), and Latin-America (2.4%). Registers were quite complete for all variables used in the study except for the gestational week of first prenatal visit that was missing for around 11% of the cases and the number of prenatal visits that was missing for around 10% cases.

Table 1 summarizes the distribution of the newborns and mothers characteristics according to area of origin. Prevalence of VPTB was significantly greater in neonates of immigrants (0.57%) than in those of native-born women (0.30%), with the exception of sub-Saharan women (0.17%). Comparisons regarding the prevalence of MPTB indicated quite similar proportions among Spanish mothers and women from all the immigrant groups. VLBW was more frequent among neonates from immigrant women and, as in the case of VPTB, neonates from Eastern-European mothers (0.37%), followed by those from Maghrebian mothers (0.23%) showed the greatest proportions. However, frequency of MLBW was found to be lower in the whole immigrant group when compared with Spanish mothers.

No significant differences in the distribution of maternal age were found between native and immigrant women as a whole, although mothers coming from Eastern Europe and Latin America were significantly younger than the other groups. The proportion of primiparous was greater among Eastern-European and Latin-American women than for the Spanish group, whereas Sub-Saharan mothers were mostly multiparous. Previous adverse reproductive outcomes were more frequent among immigrants than among Spanish. Compared with Spanish women, induced delivery or caesarean delivery was less frequent among East-European and Maghrebian women and more frequent among Sub-Saharan and Latin-American mothers.

Adequacy of Prenatal Care

The level of adequacy of prenatal care received during pregnancy by Spanish women and by mothers from each one of the immigrant groups is shown in Table 2. Comparisons regarding specifically the start of care showed a greater prevalence of inadequate start (late or absent) among immigrants as a whole than among natives (9.82% vs. 1.19%, respectively), particularly in mothers from Eastern-Europe (11.72%) and Maghreb (9.53%). This pattern was also observed when comparing the level of adequacy in the number of visits done during pregnancy, showing the immigrants a greater frequency of inadequacy than the natives (2.73% vs. 0.55%), being Maghrebian and Eastern-European groups the ones with greater percentages (3.10% and 2.73% respectively). Results combining both components of the prenatal care in a global indicator (APN- CU2M-SP index) showed that Spanish mothers had a better prenatal control, being mostly classified in the adequate and adequate plus categories and with only a 4.25% classified in the inadequate level of care. This percentage increased to 24.34% among immigrant mothers. Eastern-European and Maghrebian women showed the highest prevalence of inadequate care, with 27.85% and 24.09%, respectively.

Risk of Very or Moderate Preterm Birth

Results from the crude and the adjusted logistic regression models evaluating the association between area of origin of the mother and VPTB and MPTB are summarized in Table 3. Crude analysis showed a significant greater risk of delivering VPTB newborns in immigrant women than in natives. After adjusting by sex of the newborn, maternal age, previous adverse reproductive outcomes, type and mode of delivery and parity, the risk decreased but still remained significantly higher (OR, 1.78; 95% CI, 1.14–2.79). When the prenatal care received was included in the model the odds ratio decreased substantially (OR, 1.43; 95% CI, 0.85–2.42). Regarding the risk of MPTB, no differences were found between population groups either in the crude or in the adjusted models. However, the inclusion of the prenatal care received in the model resulted in a modest reduction in the risk for immigrants as a whole when compared with the Spanish group, especially in the case of East-European and Sub-Saharan women.

Risk of Very or Moderate Low Birthweight

Table 3 also shows the results from the crude and the adjusted logistic regression models evaluating the association between area of origin of the mother and VLBW and MLBW. In the crude model, the immigrant women as a whole had a greater risk of having VLBW newborns than native mothers. This risk decreased moderately after adjusting by the set of variables already mentioned (OR, 1.73; 95% CI, 0.89 3.33) and practically cancelled when introducing prenatal care index in the model (OR, 1.15; 95% CI, 0.53 2.52).

Compared with native women the crude risk of delivering newborns with MLBW was found to be lower among immigrants as a whole and for each ethnic group. Similar results were obtained after adjustment. Introduction of the prenatal care received in the adjusted models had no effect considering immigrant mothers as a whole as well as for the majority of ethnical groups except for the case of Eastern- European and Sub-Saharan women showing a minor reduction in the OR.

DISCUSSION

Our results indicate that immigrant women have a worse prenatal control than native-born mothers, both in the proportion of pregnant women with a late start of prenatal care and in the frequency of inadequate number of visits during pregnancy. A greater risk of VPTB and VLBW was identified in immigrants compared with Spanish citizens, whereas the risk of MLBW was greater in this last group and no significant differences were found in the risk of MPTB. An inadequate prenatal care was associated to a greater risk of having very preterm neonates among immigrant women and especially to their greater risk of having infants with very low birth weight. Our results on the inadequacy of prenatal care in immigrants are consistent with those from previous studies (1 5), suggesting the existence of greater barriers for this population group when trying to access prenatal care services.

Regarding the reproductive outcomes, studies with migrant populations usually examine the risk of prematurity or low birth weight as absolute indicators without differentiating between very and moderate categories. Thus, it is difficult to know whether the increased risk of VPTB and VLBW for immigrants as a whole identified in our study conflicts with results of previous studies. Regarding MLBW and MPTB, our results are in agreement with studies showing comparable or even better reproductive outcomes in Latin-American or Maghrebian immigrants than in native population groups (6 11). However, not overall agreement exists for the case of Sub-Saharan or Eastern- European migrants because some studies identify similar or lower risks for these groups (4,16), whereas others show an increased risk of adverse reproductive results for women from these origins when compared to natives (12 15). On the other hand, the fact that most of the VLBW cases are mainly a consequence of very short gestations (82% of infants with VLBW are also VPTB) but only part of the observed MLBW cases are related to moderate prematurity (48% of infants with MLBW are MPTB) explains the agreement in differences among immigrants and native-born women found for the most extreme outcomes but disagreement in the existence of differences for MLBW but not for MPTB.

Our results indicate that inadequate prenatal care underlies the increased risk of extreme adverse reproductive outcomes such as VPTB and VLBW. However, it influences very little, if any, the risk of MPTB or MLBW. A comparable lack of influence has been reported by Gould et al. (33), who analyzed the association between time of initiation of prenatal care and risk of low birth weight among Mexican women. Thus, the relationship between migration, prenatal care and the risk of adverse reproductive outcomes seems complex.

Our study has several limitations. First, information on the week of initiation of prenatal care and the total number of visits was incomplete in all groups. Because women with missing values for prenatal care showed a higher prevalence of adverse reproductive outcomes than those with complete information, differences between native-born women and immigrants in the proportion of missing values might affect the results. However, such differences were practically the same for Spanish and Immigrants and therefore it is doubtful that counting with missing information would affect the magnitude of our estimations.

Second, because SES has been associated to both a greater risk of inadequate prenatal care and a higher risk of adverse reproductive outcomes, a presumably lower SES in immigrants might explain the differential risk for some adverse reproductive outcomes, being the apparent effect identified for prenatal care purely artifactual. Because no data about socioeconomic status were available in hospital records and based in previous studies (31,32), we used data on the progenitor's profession to impute the proportion of couples with low SES by year of birth, mother's country of origin and mother's group age in our database. No significant differences in the risks were observed when imputed SES was included in the models. It could be argued that this could be a consequence of the imputation using aggregated data. However, we run crude models relating adverse reproductive outcomes to mother's origin using individual vital statistics no significant changes were found in the magnitude of the risks when including SES in the model. A likely explanation is that the economy of Almeria is based in intensive labour agriculture and therefore it is very uniform in terms of SES (72% of couples in this region have low SES).

Information about other factors with known influence on reproduction, such as smoking, drug consumption or nutritional factors was also unavailable in our database. It could be said that the observed effect of inadequate prenatal care in reproductive results could be attributable to worse lifestyle habits of immigrant women in this category of adequacy when compared with native-born women. However, in a recent study performed in Spain, investigators showed that the prevalence of unhealthy lifestyles in pregnant women is much lower in immigrant than in Spanish women (34), and it is unlikely that this situation changes in the specific category of inadequate prenatal care. Finally, time from arrival in the host country has proven to be an important factor influencing the reproductive health of immigrants in other countries (35). Time of residence in the country was not available in our study. Nevertheless, given that immigration in Spain is still a very recent phenomenon, it can be assumed that it will not influence the results to a large extent.

Given the positive impact of medical care during pregnancy on reproductive indicators, strategies to improve prenatal care of immigrant women should be implemented in Spain in order to ensure that all women receive the full benefits of a planned care and to reduce the risk of very preterm and very low weight births in this population.

TABLE 1. Distribution of mother and newborn characteristics according to area of origin

	Spain	All Immigrants	Eastern Europe	Maghreb	Sub-Saharan	Latin America
	<u>n (%)</u>	<u>n (%)</u>	<u>n (%)</u>	<u>n (%)</u>	<u>n (%)</u>	<u>n (%)</u>
Gestational age, weeks						
22–32	47 (0.30)	34 (0.57)*	15 (0.70)*	15 (0.57)*	1 (0.17)	3 (0.57)*
33–36	905 (5.74)	329 (5.55)	119 (5.51)	145 (5.48)	37 (6.15)	28 (5.34)
>37	14802 (93.80)	5528 (93.25)	2008 (93.05)	2467 (93.05)	561 (93.19)	492 (93.89)
Unknown	26 (0.16)	37 (0.62)*	16 (0.74)*	17 (0.64)*	3 (0.50)	1 (0.19)
Birth weight, g						
500–1500	22 (0.14)	16 (0.27)*	8 (0.37)*	6 (0.23)	1 (0.17)	1 (0.19)
1500–2499	795 (5.04)	249 (4.20)*	90 (4.17)	108 (4.08)*	26 (4.32)	25 (4.77)
>2500	14958 (94.79)	5662 (95.51)*	2060 (95.46)	2530 (95.69)*	574 (95.35)	498 (95.04)
Unknown	5 (0.03)	1 (0.02)*	0 (0.00)	0 (0.00)	1 (0.17)	0 (0.00)
Sex of newborn						
Male	8134 (51.55)	3055 (51.54)*	1112 (51.53)	1364 (51.59)	307 (51.00)	272 (51.91)
Female	7640 (48.42)	2871 (48.43)*	1045 (48.42)	1280 (48.41)	294 (48.84)	252 (48.09)
Unknown	6 (0.04)	2 (0.03)*	1 (0.05)	0 (0.00)	1 (0.17)	0 (0.00)
Maternal age						
■ 20 years (6.64)	1048	424 (7.15)*	178 (8.25)*	164 (6.20)	36 (5.98)	46 (8.78)*
20–35 years	132304922 (83.84)	922 (83.03)*	1884 (87.30)*	2132 (80.64)*	483 (80.23)*	423 (80.73)
≥35 years	1440 (9.13)	553 (9.33)*	83 (3.85)*	333 (12.59)*	83 (13.79)*	54 (10.31)*
Unknown	62 (0.39)	29 (0.49)*	13 (0.60)*	15 (0.57)*	0 (0.00)	1 (0.19)*
Parity						
Primiparae	67742816 (42.93)	2816 (47.50)*	1264 (58.57)*	1138 (43.04)	138 (22.92)*	276 (52.67)*
Multiparae	88243098 (55.92)	3098 (52.26)*	889 (41.20)*	1498 (56.66)	464 (77.08)*	247 (47.14)*
Unknown	182 (1.15)	14 (0.24)*	5 (0.23)*	8 (0.30)*	0 (0.00)*	1 (0.19)*
Previous adverse reproductive outcomes						
No	110313298 (69.90)	1298 (55.61)*	1006 (46.62)*	1644 (62.18)*	352 (58.47)*	296 (56.49)*
Yes	47492633 (30.10)	2633 (44.39)*	1152 (53.38)*	1000 (37.82)*	250 (41.53)*	228 (43.51)*
Unknown	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Mode of delivery						
Spontaneous and vaginal	95273710 (60.37)	3710 (62.58)*	1404 (65.06)*	1680 (63.54)*	327 (54.32)*	299 (57.06)
Induced or caesarean	62532218 (39.63)	2218 (37.42)*	754 (34.94)*	964 (36.46)*	275 (45.68)*	225 (42.94)
Unknown	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)

*Statistically significant ($p < .05$).

TABLE 2. Adequacy of prenatal care received by Spanish and immigrant women using APNCU2M-SP index

	Spain	All Immigrants	Eastern Europe	Maghreb	Sub-Sahara	Latin America
Variable	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)
Start of care						
Adequate Plus	9858 (62.47)	2180 (36.77)*	731 (33.87)*	990 (37.44)*	217 (36.05)*	242 (46.18)*
Adequate	3507 (22.22)	1845 (31.12)*	681 (31.56)*	787 (29.27)*	220 (36.54)*	157 (29.96)*
Intermediate	411 (2.60)	766 (12.92)*	319 (14.78)*	334 (12.63)*	77 (12.79)*	36 (6.87)*
Inadequate	188 (1.19)	582 (9.82)*	253 (11.72)*	252 (9.53)*	36 (5.98)*	41 (7.82)*
Unknown	1816 (11.51)	555 (9.36)*	174 (8.06)*	281 (10.63)*	52 (8.64)* -	48 (9.16)-
Number of visits						
Adequate Plus	6896 (43.70)	2376 (40.08)*	904 (41.89)*	968 (36.61)*	271 (45.02)-	233 (44.47)-
Adequate	674 (4.27)	500 (8.43)*	175 (8.11)*	264 (9.98)*	32 (5.32)-	29 (5.53)-
Intermediate	6423 (40.70)	2388 (40.28)	849 (39.34)*	1082 (40.92)	245 (40.70)-	212 (40.46)-
Inadequate	87 (0.55)	162 (2.73)*	59 (2.73)*	82 (3.10)*	16 (2.66)*	5 (0.95)
Unknown	1700 (10.77)	502 (8.47)*	171 (7.92)	248 (9.38)*	38 (6.31)*	45 (8.59)
Prenatal care						
Adequate Plus	6542 (41.46)	1686 (28.44)*	635 (29.43)*	669 (25.30)*	190 (31.56)*	192 (36.63)*
Adequate	6129 (38.84)	1880 (31.71)*	633 (29.33)*	860 (32.53)*	207 (34.39)*	180 (34.35)*
Intermediate	612 (3.88)	352 (5.94)*	109 (5.05)*	191 (7.22)*	27 (4.49)-	25 (4.77)-
Inadequate	671 (4.25)	1443 (24.34)*	601 (27.85)*	637 (24.09)*	126 (20.93)*	79 (15.08)*
Unknown	1826 (11.57)	567 (9.56)*	180 (8.34)*	287 (10.85)*	52 (8.64)*	48 (9.16)-

*Differences with natives statistically significant ($p < .05$).

TABLE 3. Odds ratios (OR) and confidence intervals (95% CI) of very preterm (VPTB) or moderate preterm births (MPTB), and very low (VLBW) or moderate low birth weight (MLBW) by mother's origin

	OR	95%(CI)	OR	95%(CI)	OR	95%(CI)
VPTB*						
Spain	1	1	1			
Immigrant	1.94	(1.24-3.01)	1.78	(1.14-2.79)	1.43	(0.85-2.42)
MPTB						
Spain	1	1	1			
Immigrant	0.97	(0.85-1.11)	0.97	(0.85-1.10)	0.9	(0.77-1.04)
	0.97	(0.80-1.18)	0.98	(0.80-1.20)	0.89	(0.71-1.11)
	0.96	(0.80-1.15)	0.95	(0.80-1.15)	0.91	(0.74-1.11)
	1.08	(0.77-1.51)	1.03	(0.73-1.44)	0.92	(0.63-1.33)
	93	(0.63-1.37)	0.89	(0.60-1.31)	0.84	(0.55-1.27)
VLBW*						
Spain	0.93	1	1	1		
Immigrant	1.92	(1.01-3.66)	1.73	(0.89-3.33)	1.15	(0.53-2.52)
MLBW						
Spain	1	1	1			
Immigrant	0.83	(0.72-0.96)	0.82	(0.70-0.95)	0.8	(0.68-0.95)
Eastern Europe	0.82	(0.66-1.03)	0.82	(0.65-1.03)	0.77	(0.60-0.99)
Maghreb	0.80	(0.65-0.99)	0.81	(0.66-0.99)	0.82	(0.66-1.04)
Sub-Sahara	0.85	(0.57-1.27)	0.8	(0.54-1.20)	0.77	(0.50-1.19)
Latin America	0.94	(0.63-1.42)	0.87	(0.57-1.31)	0.86	(0.56-1.33)

ORa = odds ratio adjusted by sex, maternal age, previous adverse reproductive outcomes, mode of delivery and parity; ORapc = odds ratio adjusted by sex, maternal age, previous adverse reproductive outcomes, mode of delivery, parity and prenatal care received; ORc = odds ratio crude.

*Specific area of origin results not shown for VPTB and VLBW because of the sample size was too small to obtain valid estimations.

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APPENDIX. CREATION OF APNCU2M-SP

Step 1: Classification of care according to gestational week in which prenatal care is initiated.

	Weeks
Adequate plus	1-2 month = "1-11 weeks"
Adequate	3-4 month = "12-19 weeks"
Intermediate	5-6 month = "20-28 weeks"
Inadequate	7-9 month = "≥29 weeks"
	or
	no visits

Step 2: Classification of care according to the expected number of visits. (Spanish prenatal care calendar)

2.1 Expected number of visits according to gestational age at birth.

Gestational age at birth (weeks)	Expected prenatal visits
< 11	0
11-15	1
16-18	2
19-22	3
23-27	4
28-31	5
32-36	6
37-38	7
39	8
40	9
41	10
42	11
43	12
44	13
≥45	14

2.2 Correction that should be applied to the expected number of visits according to gestational age at birth (2.1) depending on gestational week on which mother did the first prenatal visit.

Week of first visit	Expected prenatal visits modified (add or subtract)
1-6	+1
7-11	0
12-15	-1
16-19	-2
20-24	-3
25-28	-4
29-32	-5
33-37	-6
38-41	-8
≥42	-10

2.3 Calculate ratio (no. visits observed/no. visits expected) 100 and classify according to:

	Ratio		Other criteria
Adequate plus	$\geq 110\%$	and	Observed-Expected ≥ 2
Adequate	80%–109%		
	$\geq 110\%$	and	Observed-Expected < 2
	No requirements	and	no. visits ≥ 7 and nonadequate plus
Intermediate	50%–79%		
Inadequate	Under 50%		

Step 3: Calculate global APNCU2M-SP index as a combination of two previous classifications

	First prenatal visit		Ratio		Other criteria
Adequate plus	1–4 months	and	$\geq 110\%$	and	Observed-Expected ≥ 2
Adequate	1–4 months	and	80%–109%		
	1–4 months	and	$\geq 110\%$	and	Observed-Expected < 2
	1–4 months	and			no. visits ≥ 7 and nonadequate plus
Intermediate	1–4 months	and	50%–79%		
Inadequate	1–4 months	and	Under 50%		
	5 month-birth	or	Under 50%		

Weeks

		Gestational age at birth (weeks)	Expected prenatal visits
		¶ 11	and 0
		11–15	and 1
Adequate plus	1–2 monthZ “1–11 weeks”	16–18	and 2
		19–22	and 3
Adequate	3–4 monthZ “12–19 weeks”	23–27	and 4
		28–31	and 5
Intermediate	5–6 monthZ “20–28 weeks”	32–36	and 6
		37–38	and 7
7–9 monthZ “>29 weeks” or		39	and 8
no visits		40	and 9
		41	and 10
		42	and 11
		43	and 12
		44	and 13
		>45	and 14

Step 2: Classification of care according to the expected number of visits. (Spanish prenatal care calendar)

2.1 Expected number of visits according to gestational age at birth

2.2 Correction that should be applied to the expected number of visits according to gestational age at birth (2.1) depending on gestational week on which mother did the first prenatal visit.

Week of first visit

Expected prenatal visits modified (add or subtract)

1–6	p1
7–11	0
12–15	–1
16–19	–2
20–24	–3
25–28	–4
29–32	–5
33–37	–6
38–41	–8
>42	–10

2.3 Calculate ratio (no. visits observed/no. visits expected) × 100 and classify according to:

Step 3: Calculate global APNCU2M-SP index as a combination of two previous classifications

Ratio

Other criteria

First

	Adequate plus	>110%	and	Observed-Expected >2		prenatal visit	Ratio	Other criteria
	Adequate plus	80%–109%		Observed-Expected >2	Adequate plus	1–4 months	and >110%	and Observed-Expected > 2
	No requirements	>110%	and	Observed-Expected ! 2	Adequate plus	1–4 months	and 80%–109%	and Observed-Expected > 2
				no. visits >7 and nonadequate plus	Adequate plus	1–4 months	and >110%	and Observed-Expected > 2
	Intermediate	50%–79%						Expected ! 2
	Inadequate	Under 50%				1–4 months	and	no. visits > 7 and nonadequate plus
					Intermediate	1–4 months	and 50%–79%	
					Inadequate	1–4 months	and Under 50%	
						5 month-birth	Under 50%	