

Unemployment and stillbirth risk among foreign-born and Spanish pregnant women in Spain, 2007–2010: a multilevel analysis study

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Abstract We describe stillbirth and unemployment rates by autonomous region in Spain and analyse whether women who gave birth in regions with high unemployment rates were more likely to have a stillborn. We designed a multilevel population-based observational study of births from 2007 to 2010. We defined stillbirth as the outcome, individual maternal socioeconomic and pregnancy-related characteristics as covariates, and maternal autonomous region of residence as the contextual covariate. We used mixed-logistic regression models to account for differences across regions. In total, 1,920,235 singleton births and 5,560 stillbirths were included in the study. Women

residing in autonomous regions with the highest rates of unemployment had a two-times-greater chance of delivering a stillborn (adjusted OR 2.60; 95 % CI 2.08–3.21). The region where women resided explained 14 % of the total individual differences in the risk of delivering a stillborn. The odds of stillbirth were 1.82 (95 % CI 1.62–2.05) times higher for African-born women than for Spanish-born women and 1.90 (95 % CI 1.68–2.15) times higher for women with low educational attainment than for women with higher education. In conclusion, regional disparities in stillbirth rates in Spain in the period 2007–2010 were mainly associated with mothers who had low levels of education, were African-born, and lived in regions with higher unemployment.

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Introduction

Socioeconomic differences are major determinants of perinatal outcomes. Occupational status, educational attainment, income, poverty, and wealth have been utilised as measures of socioeconomic status, as determined by rankings in a social hierarchy [1–4].

Globally, the risk of stillbirth is highest among socially disadvantaged groups [5, 6]. The high risk of stillbirth observed among some socially disadvantaged groups may stem from factors associated with low socioeconomic status, such as low maternal educational attainment, unemployment, and immigration [7, 8].

In Europe, disparities in perinatal mortality and causes of perinatal deaths vary according the maternal country of origin [9–11]. Overall, compared to native-born European

women, immigrant women have higher perinatal mortality; however, the risks are lower in countries with a strong integration policy and lower rates of unemployment, such as Sweden, the Netherlands, Norway, and Denmark [3, 12].

Many stillbirths in the world's richest countries are linked to avoidable conditions related to access and quality of care and lifestyle factors such as nutrition, obesity, smoking, and advanced maternal age [3].

Socioeconomic and health disparities among geographical or administrative regions within a country are the result of structural and historical factors associated with migration, discrimination, political decisions, and public-health policies [3, 13, 14]. Socioeconomically disadvantaged regions (as measured in terms of poverty, unemployment, or income) generally have poor perinatal outcomes and a higher rate of stillbirths [3, 15–17]. In Spain, maternal country of origin and educational attainment are related to adverse perinatal outcomes, with mothers born in sub-Saharan Africa having the highest risk of stillbirth [9].

Spain can be considered a federal country, comprised of 17 autonomous regions and 2 autonomous cities (Ceuta and Melilla). Each region differs in terms of socioeconomic and health outcomes as a result of structural and historical factors. In addition, disparities related to maternal outcomes vary according to the autonomous region [18]. It is, however, unknown whether stillbirth rates differ by region and whether more economically disadvantaged regions with higher unemployment also have higher stillbirth rates. Stillbirth refers to all pregnancy losses after 22 weeks of gestation and it has to be distinguished from “artificial stillbirths” or those related to abortion [19, 20].

Our objectives were to describe stillbirth and unemployment rates by autonomous region in Spain from 2007 to 2010 and to analyse whether women who gave birth in autonomous regions with high unemployment have a higher probability of delivering a stillborn.

Methods

Study design and data source

We designed a multilevel population-based observational study of singleton births from 2007 to 2010 in Spain. Data were drawn from the National Institute of Statistics (NIS) in Spain. We used the vital-statistics database, for which the official data source is the birth-registration form. This database contains information about the vital status of newborns at the time of delivery. Unemployment data were extracted from the quarterly survey of the active population, also conducted by the NIS.

Structure of the dataset, outcome, exposures, and variable specification

We defined two structural levels in our dataset: maternal socio-demographic and pregnancy-related characteristics (the first, individual level) and maternal autonomous region of residence (the second, hierarchical level).

We considered stillbirth as the outcome variable and defined it as the death of a foetus with ≥ 22 completed gestational weeks or weighing ≥ 500 g prior to complete expulsion or extraction from its mother [19, 20].

First level: maternal individual characteristics

We used maternal educational attainment and country of origin as explanatory variables for stillbirth risk at an individual level. Maternal educational attainment was used as a proxy for maternal socioeconomic status.

As individual-level covariates, we considered parity, marital status, maternal age in years, and gestational age in weeks, all at the time of delivery. We excluded multiple births, infants born before the 22nd gestational week, and infants born weighing < 500 g.

We categorized parity into nulliparous women (i.e., women who had never given birth), primiparous (i.e., women who had given birth once) and multiparous (i.e., women who had given birth two or more times). We dichotomised gestational age into ≥ 22 to < 37 gestational weeks and ≥ 37 gestational weeks.

Educational attainment referred to the highest academic degree achieved and was classified in three categories based on the International Standard Classification of Education: (1) secondary education or lower, which corresponds to ≤ 12 years of obligatory school attendance in Spain, (2) upper secondary education or first stage of tertiary education, which corresponds to > 12 to ≤ 15 years of education, and (3) tertiary education, which corresponds to > 15 years of education [21].

We defined maternal country of origin as the mother's country of birth, categorising this variable into five macro-regions (i.e., Africa, America and the Caribbean, Asia and Oceania, the European Union with 15 member states (EU15), and other European countries) to facilitate international perinatal comparisons [11].

Finally, we categorised maternal age into six groups, following international recommendations: ≤ 19 , 20–24, 25–29, 30–34 and ≥ 35 years [22].

Second level: maternal autonomous region of residence

We used general unemployment by autonomous region as explanatory contextual variable at a population level [23, 24]. Following international conventions, the unemployment was

defined as the percentage of unemployed individuals, including those ≥ 16 years of age seeking work for the first time, from the total active population. The active population was defined as all persons aged ≥ 16 and ≤ 64 years who are actively employed or seeking employment and hence furnish the supply of labour for production. We categorised unemployment into quartiles: very high, high, moderate, and low (Q4–Q1).

Statistical analysis

Descriptive analysis

We first described the number and percentage of stillbirths and the total number of births in relation to maternal individual characteristics. Then, we computed stillbirth rates and univariate stillbirth rate ratios, taking the category with the lowest risk as the reference.

Stillbirth rates were calculated as the ratio between the number of foetal deaths at or after 22 completed weeks of gestation in a specific period and the total number of births (live births and stillbirths) in the same period, expressed per 1,000 births.

Subsequently, we described the total number and percentage of births and stillbirth by maternal contextual factors and autonomous region (second-level analysis). Then, we computed stillbirth rates and univariate stillbirth rate ratios using the overall stillbirth ratio in Spain for the whole period as a reference. We presented stillbirth rates by maternal origin and calculated the rate ratio between the stillbirth rates for foreign-born and Spanish women. We also presented general unemployment rates by autonomous region.

To describe unemployment and stillbirth over the period of interest, we used time-series plots of stillbirth and unemployment rates by maternal autonomous region of residence.

Multilevel analysis

Prior to computing logistic mixed models, we developed a fixed model (model 0), using stillbirth as the dependent binary indicator variable and maternal age, country of origin, educational attainment, parity, and marital status as individual independent variables. This model constituted the fixed part for all of the following models. We also replicated this model (model 0) stratified by gestational weeks (preterm and term deliveries as separates outcomes) as it was found to be an effect modifier. Afterwards, to determine whether women in regions with a high unemployment are at increased risk of stillbirth, we developed three generalised logistic mixed models.

We fitted the first mixed model adding a random intercept related to the maternal autonomous region of residence (model 1). Subsequently, we added unemployment by autonomous region as a contextual variable (model 2), and we finally introduced unemployment as a random coefficient, assuming that the percentage of unemployed people varies between regions (model 3). We tested interactions between the quartiles of the unemployment rates with maternal educational attainment.

While models 0, 1 and 2 served as references to explore whether incorporation of the contextual level adds any value, model 3 was our main model of interest and was specified as follows:

$$\text{Log} \left(\frac{P(\text{Stillbirth})}{1 - P(\text{Stillbirth})} \mid u_{0j}, u_{1j} \right) = \eta_{ij}$$

$\eta_{ij} = \beta_0 + \beta_{1j} (\text{Maternal Age}) + \dots + \beta_{6j} \times (\text{Unemployment rate}) + U_{0j} + U_{1j}$, $U_{0j} = \text{Random Intercept: Autonomous Region}_j$, $U_{1j} = \text{Random Slope: unemployment variation across region}_j$.

For all of the models, we derived adjusted odds ratios (aOR) with their corresponding 95 % confidence intervals (CI) and presented their respective log-likelihood statistic. To evaluate the fraction of total stillbirth variance that is attributable to differences across regions after adjusting for maternal individual factors and the contextual effect of unemployment, we computed the intraclass correlation coefficient (ICC) [25].

Maternal educational attainment presented 5.5 % of missing information. On the assumption that data were missing at random, we used multiple imputation by chained equations. We imputed (5 times) maternal educational attainment. The multiple-imputation model included stillbirth, year, marital status, maternal age, country of origin, educational attainment, and parity. The results of the statistical model were combined using Rubin's rules [26–29].

We used Stata v.12 for statistical analysis (StataCorp LP, College Station, TX, USA).

Results

Over the 4 years of analysis, 1,920,235 singleton births were recorded, and 5,560 (0.3 %) of these fetuses died prior to complete expulsion or extraction from their mothers.

Stillbirth by women's socioeconomic and pregnancy related characteristics

As shown in Table 1, maternal individual socio-demographic risk factors of stillbirth included advanced maternal age, foreign (specifically African) origin, low educational attainment, multiparity, and nulliparity. Regarding the maternal country of

Table 1 Stillbirths by maternal socioeconomic status, age, parity and gestational age, Spain, 2007–2010 (total births: 1,920,235 and stillbirths: 5,560)

Variables	Total singleton births, n (%)	Stillbirths, n (%)	Stillbirth rates per 1,000 births
<i>Maternal age</i>			
≥35	516,682 (26.91)	1,711 (30.77)	3.31
30–34	731,568 (38.10)	1,837 (33.04)	2.51
25–29	430,067 (22.40)	1,217 (21.89)	2.83
20–24	187,615 (9.77)	614 (11.04)	3.27
≤19	54,303 (2.83)	181 (3.26)	3.33
<i>Marital status</i>			
Married	1,275,896 (66.29)	2,929 (52.68)	2.29
Single	584,263 (30.43)	2,502 (45.00)	4.28
Divorced	59,663 (3.11)	122 (2.19)	2.04
Widowed	3,413 (0.18)	7 (0.13)	2.05
<i>Maternal country of origin</i>			
European Union of 15 member states	29,094 (1.52)	83 (1.49)	2.85
Other European countries	75,638 (3.94)	223 (4.01)	2.95
Africa	120,819 (6.29)	652 (11.73)	5.39
America and the Caribbean	137,263 (7.15)	438 (7.88)	3.19
Asia and Oceania	25,565 (1.33)	78 (1.40)	3.05
Foreign-born, unknown country	5,594 (0.29)	24 (0.43)	4.29
Spain	1,520,702 (79.19)	4,062 (73.06)	2.67
<i>Maternal education attainment^a</i>			
Secondary education or lower	937,035 (48.80)	2,109 (37.93)	2.25
Upper secondary education or first stage of tertiary education	570,239 (29.70)	766 (13.78)	1.34
Tertiary education	304,966 (15.88)	330 (5.94)	1.08
<i>Gestational age in weeks^b</i>			
≥22–<37 weeks	118,900 (6.19)	3,294 (59.24)	1.83
≥37 weeks	1,801,335 (93.81)	2,266 (40.76)	1.34
<i>Parity</i>			
Nulliparous (first delivery)	1,028,258 (53.55)	3,542 (63.71)	3.44
Primiparous (1 delivery)	681,275 (35.48)	1,363 (24.51)	2.00
Multiparous (≥2 deliveries)	210,702 (10.97)	655 (11.78)	3.11

Data source: INE in-house

^a Maternal education attainment: 5.5 % missing information

^b The denominator of the stillbirth rate only contained the number of fetuses alive at the specific gestational age (only ongoing pregnancies) based on Yudkin et al. [45]

origin, women who were born in sub-Saharan countries showed the highest risk of stillbirth. Among the 20 countries of origin with the highest stillbirth rates, 60 % (n = 12) were sub-Saharan countries (Supplementary Table 1).

Stillbirth risk showed a clear trend by maternal age with the highest risk being among women aged ≥35 years (test for linear trend, *p* value <0.001). Women aged ≥35 years with term pregnancies (≥37 gestation weeks) had 3 times higher stillbirth risk than younger women (≤19 years) with term pregnancies (≥37 gestation weeks) (Supplementary Table 2).

Stillbirth by autonomous region and time

Stillbirth rates among the 17 autonomous regions and both autonomous cities ranged from 1.87 to 8.10 cases per 1,000 births. Ceuta and Melilla had more than twofold higher stillbirth risk rates than the rest of the regions, with a rate ratio (RR) of 2.82 (95 % CI 2.30–3.44; Table 2).

Stillbirth and unemployment by time

Unemployment increased consistently among all the Spanish regions, but only a few outlying autonomous regions (Spanish islands, autonomous cities of Ceuta and Melilla in Northern Africa and Northern regions of Basque Country, Navarre and Rioja) experienced an increase in stillbirth rates. By 2010, Andalusia and Canary Islands reached over 30 % unemployment (Supplementary Figure 1, 1A and 1B).

Stillbirth among foreign-born women

Nearly all of the autonomous regions had higher stillbirth rates among foreign-born mothers than the Spanish mothers, although rates in Cantabria were significantly lower than in the other regions. Autonomous regions with higher stillbirth rates also showed higher rates of stillbirth among foreign-born women and vice versa. This pattern was confirmed statistically (Pearson correlation coefficient = 0.70; 95 % CI 0.34–0.88; *p* = 0.001; Supplementary Table 3).

Stratified analysis by gestational weeks showed different stillbirth risk among foreign-born women with unknown country of origin. Among the group of women who delivered at ≥22 to <37 gestation weeks, foreign-born women showed higher stillbirth risk whereas among the group of women at ≥37 gestation weeks, foreign-born women showed a non-significant protective effect. Stillbirth risk did not differ among African mothers in stratified analysis, showing an adjusted Odds Ratio (aOR) two times higher than Spanish women for both preterm (≥22 to <37

Table 2 Stillbirth rates by maternal autonomous region of residence in Spain, 2007–2010 (total births: 1,920,235 and stillbirths: 5,560)

Autonomous region	Stillbirths		Total singleton births		Stillbirth rates Per 1,000 births	Stillbirth rate ratios ^a RR (95 % CI)
	No.	%	No.	%		
Andalucía	1,190	21	370,030	19.27	3.22	1.14 (1.07–1.21)
Aragón	166	3	50,529	2.63	3.29	1.13 (1.00–1.33)
Asturias	145	3	31,133	1.62	4.66	1.62 (1.38–1.91)
Baleares	176	3	46,913	2.44	3.75	1.35 (1.12–1.52)
Canarias	195	4	75,203	3.92	2.59	0.90 (0.77–1.03)
Cantabria	48	1	21,742	1.13	2.21	0.76 (0.57–1.01)
Castilla La Mancha	235	4	85,111	4.43	2.76	0.95 (0.83–1.08)
Castilla y León	199	4	79,434	4.14	2.51	0.86 (0.74–0.99)
Cataluña	1,009	18	330,559	17.21	3.05	1.06 (1.00–1.14)
Ceuta y Melilla	97	2	12,012	0.63	8.08	2.82 (2.30–3.44)
Comunidad Valenciana	532	10	206,817	10.77	2.57	0.87 (0.80–0.95)
Extremadura	113	2	40,283	2.10	2.81	0.96 (0.80–1.16)
Galicia	162	3	86,583	4.51	1.87	0.63 (0.54–0.74)
Madrid	634	11	292,306	15.22	2.17	0.71 (0.65–0.77)
Murcia	240	4	72,013	3.75	3.33	1.15 (1.01–1.31)
Navarra	64	1	26,118	1.36	2.45	0.84 (0.66–1.08)
País Vasco	300	5	80,448	4.19	3.73	1.30 (1.16–1.46)
Rioja (La)	55	1	13,001	0.68	4.23	1.46 (1.12–1.91)
Total	5,560	100	1,920,235	100	2.90	1

Data source: INE in-house

^a Univariate stillbirth rate ratios using the overall stillbirth ratio in Spain for the whole period as a reference (the region under study was not included in the denominator of the ratio)

gestation weeks) and term pregnancies (≥ 37 gestation weeks) (Supplementary table 2).

Stillbirth risk after adjustment by individual and contextual factors

Multilevel analysis confirmed higher odds of stillbirth among foreign-born low-educated nulliparous women aged ≥ 35 years. The average odds of delivering a stillborn were 1.82 times higher for African-born women than for Spanish-born women and 1.90 times higher for women with low educational attainment than for women who had completed tertiary education. Marital status and the year of delivery were not statistically significant associated with the risk of stillbirth after multivariate adjustment (Table 3: model 3).

The stillbirth risk trend observed over the period in analysis, disappears after adding a random coefficient assuming that unemployment varies between regions (Table 3: model 2 and 3).

Women residing in autonomous regions with higher unemployment showed on average two times higher odds of delivering a stillborn, with an aOR of 2.60 (95 % CI 2.08–3.21; Table 3: model 3).

Our main model (model 3) showed the lowest Akaike information criteria among all candidate models (models 0–2), confirming the relevance of unemployment as contextual variable. Multivariate results, after imputing 5.5 % of the missing data for maternal educational attainment using a multiple imputation strategy by chained equations, showed consistent results to those of models 0–3 (Table 3: model 4).

Fourteen percent of the total variability in the risk of delivering a stillborn was explained for the region where women resided. In addition, autonomous regions with higher unemployment also had higher stillbirth rates. However, no significant differences were found when assessing the cross-level interaction between maternal educational attainment and the level of unemployment by region (Table 3: model 3).

Discussion

We have shown that from 2007 to 2010, there were regional disparities in stillbirth rates in Spain, mainly associated with African-born women, advanced age, low

Table 3 Stillbirth risk by maternal sociodemographic characteristics and unemployment by regions, Spain 2007–2010 (total births: 1,920,235 and stillbirths: 5,560)

Variables	Model 0	Model 1	Model 2	Model 3	Model 4
	aOR (95 % CI)	aOR (95 % CI)	aOR (95 % CI)	(main model) aOR (95 % CI)	aOR (95 % CI)
<i>Year</i>					
2010	1.39 (1.25–1.54)	1.38 (1.24–1.53)	1.16 (0.99–1.36)	1.14 (0.99–1.30)	0.93 (0.51–1.34)
2009	1.38 (1.24–1.53)	1.37 (1.24–1.52)	1.15 (0.99–1.34)	0.99 (0.84–1.19)	0.90 (0.42–1.38)
2008	1.27 (1.14–1.41)	1.27 (1.14–1.41)	1.14 (1.01–1.30)	0.96 (0.81–1.14)	0.89 (0.40–1.37)
2007	1	1	1	1	1
<i>Marital status</i>					
Married	1.97 (0.63–6.13)	1.91 (0.61–5.94)	1.91 (0.62–5.83)	1.65 (0.52–5.25)	1.35 (0.12–2.56)
Single	2.14 (1.00–9.76)	2.09 (0.99–9.62)	2.10 (1.01–9.48)	2.16 (0.99–9.84)	2.50 (1.01–3.62)
Divorced	1.65 (0.52–5.24)	1.70 (0.53–5.34)	1.70 (0.55–5.30)	1.97 (0.36–6.13)	1.09 (0.15–2.33)
Widowed	1	1	1	1	
<i>Maternal age</i>					
≥35	1.97 (1.59–2.41)	2.14 (1.73–2.64)	2.17 (1.76–2.68)	2.15 (1.74–2.66)	2.53 (1.96–3.08)
30–34	1.40 (1.14–1.72)	1.51 (1.22–1.86)	1.52 (1.24–1.88)	1.50 (1.22–1.85)	1.72 (1.15–2.27)
25–29	1.26 (1.02–1.55)	1.32 (1.08–1.63)	1.33 (1.08–1.64)	1.32 (1.07–1.62)	1.42 (0.86–1.97)
20–24	1.09 (0.88–1.36)	1.11 (0.89–1.39)	1.12 (0.90–1.39)	1.11 (0.89–1.38)	1.18 (0.61–1.75)
≤19	1	1	1	1	1
<i>Maternal country of origin</i>					
European Union of 15 member states	0.86 (0.63–1.16)	0.84 (0.62–1.14)	0.84 (0.62–1.14)	0.84 (0.62–1.13)	0.92 (0.27–1.58)
Others European countries	0.99 (0.83–1.19)	1.05 (0.88–1.26)	1.06 (0.88–1.27)	1.04 (0.87–1.26)	1.04 (0.51–1.55)
Africa	1.96 (1.75–2.21)	2.17 (1.93–2.44)	2.18 (1.94–2.45)	1.82 (1.62–2.05)	1.93 (1.50–2.35)
America and the Caribbean	0.78 (0.67–0.90)	0.91 (0.78–1.05)	0.92 (0.80–1.07)	0.90 (0.78–1.04)	1.01 (0.56–1.45)
Asia and Oceania	0.78 (0.53–1.13)	0.92 (0.63–1.33)	0.93 (0.64–1.35)	0.85 (0.58–1.24)	1.10 (0.43–1.76)
Foreign-born, unknown country	1.73 (1.05–2.82)	1.87 (1.14–3.06)	1.90 (1.16–3.12)	1.78 (1.08–2.92)	1.57 (0.68–2.46)
Spain	1	1	1	1	1
<i>Maternal educational attainment</i>					
Secondary education or lower	2.12 (1.88–2.40)	1.92 (1.70–2.17)	1.89 (1.67–2.14)	1.90 (1.68–2.15)	1.99 (1.55–2.42)
Upper secondary education or first stage of tertiary education	1.29 (1.13–1.47)	1.22 (1.07–1.39)	1.21 (1.06–1.38)	1.18 (1.04–1.34)	1.28 (0.83–1.73)
Tertiary education	1	1	1	1	1
<i>Parity</i>					
Nulliparous (first delivery)	1.45 (1.33–1.57)	1.46 (1.35–1.59)	1.47 (1.35–1.59)	1.47 (1.36–1.61)	1.76 (1.40–2.12)
Multiparous (≥2 deliveries)	1.17 (1.03–1.32)	1.15 (1.02–1.29)	1.14 (1.01–1.29)	1.29 (1.15–1.44)	1.24 (0.80–1.67)
Primiparous (1 delivery)	1	1	1	1	1
<i>Contextual level</i>					
Unemployment by regions (quartiles)					
Very high (Q4)	–	–	1.33 (1.12–1.55)	2.60 (2.08–3.21)	1.30 (1.04–1.79)
High (Q3)	–	–	1.24 (1.09–1.42)	1.75 (1.48–20.7)	1.09 (0.64–1.50)
Moderate (Q2)	–	–	1.11 (0.96–1.28)	1.26 (1.09–1.45)	1.02 (0.55–1.49)
Low (Q1)	–	–	1	1	1
<i>Variance</i>					
Random intercept: unemployment by regions	–	0.13	0.11	0.54	–
Random coefficient: unemployment between regions	–	–	–	0.02	–
Intraclass correlation coefficient (ICC) ^a	–	0.04	0.03	0.14	–
<i>Estimation</i>					
AIC	46,332	45,971	45,957	45,880	–

Table 3 continued

Variables	Model 0	Model 1	Model 2	Model 3 (main model)	Model 4
	aOR (95 % CI)	aOR (95 % CI)	aOR (95 % CI)	aOR (95 % CI)	aOR (95 % CI)
Log-likelihood estimation	-23,145	-22,963	-22,953	-22,913	–
N	1,815,445	1,815,445	1,815,445	1,815,445	1,920,235

Data source: INE in-house

Model 0: Logistic model

Model 1: Mixed logistic model: random intercept (regions)

Model 2: Mixed logistic model: random intercept (regions) with unemployment as contextual covariate

Model 3: Mixed logistic model: random intercept (regions) and coefficient (regions) with unemployment as contextual covariate. We refer to this model when explaining the results (main model)

Model 4: The same as model 2 but including averaged estimates of the variables and adjusted standard errors according to Rubin's rules' after a multiple imputation of maternal education (5.5 % missing values)

aOR adjusted odds ratio

^a Percentage of stillbirth variability explained by the regions

educational attainment, nulliparity, prematurity and residence in regions with higher unemployment.

Women residing in autonomous regions with higher unemployment showed on average higher odds for delivering a stillborn than those living in regions with lower unemployment. The social environment and access to health care have been described as determinants of the differences in stillbirth rates between regions and countries. One of the most important factors is inadequate antenatal care attendance, mostly among immigrant women with low educational attainment [30, 31].

We have found that one of the poorer autonomous regions in Spain affected by high level of unemployment (Andalusia) showed relatively lower stillbirth risk among foreign-born women than richer regions with lower unemployment. We argue that this paradox could be the product of variability in the quality of antenatal care and integration policies focusing on immigrant populations; or because the differences between groups are diluted by higher stillbirth rates among native-born women or a smaller presence of foreign-born women due to the lack of opportunities and low employment.

In contrast, one of the wealthier Spanish regions (Navarra) had the lowest rates of stillbirth and unemployment in the country and one of the lowest stillbirth ratios among foreign women (along with Galicia and Cantabria). Navarra is one of the wealthiest autonomous regions, with the best healthcare system and best integration policies in Spain [32].

Over the last 10 years, Spain has experienced a dramatic demographic change due to immigration. In 2007, 24 % of reproductive-age women in Spain were foreign-born. In addition, foreign-born women presented a specific reproductive pattern mainly characterised by higher fertility.

From 1996 to 2006, foreign-born women had twice the fertility rate of Spanish women [33]. This specific demographic change could also explain why Spanish autonomous regions with higher stillbirth rates also showed higher ratios of stillbirth among foreign-born women.

Globally, stillbirth rates are inversely correlated with the wealth and development of nations [34]. Moreover, a large body of evidence supports a link between socioeconomic inequality and adverse perinatal outcome [3, 10]; however, only a few studies have focused on the relationship between unemployment and perinatal mortality in Europe. In the Netherlands and Germany, two studies described an association between unemployment and increased stillbirth risk [35, 36]. Thus, externally validated results support our conclusions about the correlation between unemployment and stillbirth risk.

There is some evidence relating immigration and socioeconomic status with poor perinatal outcomes in Spain [37]. Recently, it has been shown that neighbourhood inequalities and unemployment were associated with higher risk of low birth weight and prematurity in Barcelona [38, 39]; however, to the best of our knowledge, our study is the first to show the contextual effect of unemployment on stillbirth at a national level.

Spanish autonomous regions are responsible for the organisation and provision of healthcare systems. Therefore, an analysis of stillbirth rates based only on individual characteristics would obscure the contextual effect of policies, healthcare-system organisation and provision on perinatal and maternal outcomes of women residing within the same region. Had we restricted our analysis to the simple description of stillbirth rates aggregated by autonomous region, we would have neglected important individual components. Therefore, the multilevel approach

allowed us to model stillbirth variability between regions accounting for maternal individual factors and unemployment by regions.

Some limitations must be considered when interpreting the results of our study. First, although we have adjusted for multiple potential confounders, there is a possibility of residual confounding at the individual level related with history of subfertility and duration of unemployment. Second, data concerning maternal medical conditions (e.g., nutrition, hypertension, diabetes, infections, syphilis, malaria, HIV) and life-style factors (e.g., eating behaviour, illicit drug use, smoking, drinking) are not available in the records used for this analysis. We restricted our study to singleton births and used multivariable modelling techniques to account for confounding by parity, maternal socioeconomic characteristics and age.

Our study is consistent with previously published evidence [3, 15–17]. Meanwhile, we encourage the development of further research in datasets that allow careful assessment of the influences of maternal medical conditions and behavioural factors on the risk of stillbirth.

We hypothesise that pre-existing medical conditions, such as malnutrition, malaria, HIV, and other infections, contribute to the higher risk of stillbirth among newly arriving foreign-born women, particularly those emigrating from sub-Saharan African countries to Spain. In addition, if we were to combine medical conditions with language difficulties and illegal-immigrant status, which limit access to established antenatal care, we could obtain a portrait of preventative factors. Prenatal care has been associated with significantly better perinatal outcomes. In the USA, women with prenatal care had an overall stillbirth rate of 2.7 per 1,000, compared with 14.1 per 1,000 for women without prenatal care [40–42]. For each dollar spent on prenatal care, there were estimated savings of \$1.49 in newborn and postpartum costs [43].

It is difficult to determine the exact mechanism explaining the association between residence in a region with high unemployment rates and the individual risk of deliver a stillborn. Nevertheless, complex mechanisms involving lack of access to preventative and curative health services and suboptimal antenatal care are associated with approximately 10–60 % of stillbirths and neonatal deaths [31]. It has been shown that the risk of stillbirth is markedly increased for women of low socioeconomic status. Even if the causes rest unclear, unemployment, material deprivation, lack of social support, low education attainment, lack of access to information and immigration are mechanisms that may mediate the increased risk of stillbirth among women of poor socioeconomic status [37, 44].

Moreover, we have shown that the observed stillbirth trend in Spain over the last 4 years was confounded by the variability of unemployment between regions. This could

be explained because the increase of stillbirth was mainly due to foreign-born women who in addition had higher unemployment rates than Spanish-born women. This is why; in general, regions with high immigration rates had higher stillbirth rates in Spain.

To address the complexity inherent in the stillbirth disparities found in Spain, we need more comprehensive information regarding contextual and individual determinants to understand the causes of stillbirth and regional disparities in stillbirth rates.

In summary, we highlighted regional disparities in stillbirth risk in a country undergoing a longstanding economic crisis. Stillbirth risk was mainly associated with African-immigrant status and residence in regions with high unemployment.

Conflict of interest The authors of this manuscript declare no competing interests.

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