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Stillbirth risk by maternal socio-economic status and country of origin: a population-based observational study in Spain, 2007–08

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Background: Socio-economic differences are a major determinant of perinatal outcomes. The impact of low socio-economic status on the risk of stillbirth, and the association between socio-economic status and stillbirth by maternal country of origin at a national level in Spain are unknown. We aimed to analyse the effect of maternal socio-economic status on the risk of stillbirth by maternal country of origin in Spain for the years 2007 and 2008. **Methods:** We designed a population-based observational study that included 970 740 live births and 2464 stillbirths from 2007 to 2008. Univariate risk ratios (RRs) of stillbirth were calculated by maternal education, country of origin, age, parity, and gestational age. Adjusted stillbirth RRs were calculated using a generalized linear model with the Poisson family. Then, adjusted attributable risks and aetiological fractions in the population were calculated as measures of impact. **Results:** Stillbirth rate ranged from 1.0 to 4.7 deaths per 1000 births. The stillbirth risk among mothers having secondary or lower education was double than that of mothers with a tertiary education with an adjusted RR of 2.13 [95% confidence interval (CI): 1.74–2.60]. African mothers, compared with mothers from Spain, showed an adjusted stillbirth RR of 1.75 (95% CI: 1.54–2.00). **Discussion:** This study confirms the differences of stillbirth risk by maternal socio-economic status. Regardless of socio-economic status, African mothers had the highest risk of stillbirth. These results point out the necessity to reduce factors related to social and health inequalities in perinatal mortality in Spain, and more specifically, to take into consideration the special vulnerability of African mothers.

Keywords: epidemiology, ethnic groups, foetal mortality, maternal age, socio-economic status, Spain

Introduction

Socio-economic differences are a major determinant of perinatal outcomes. Occupational status, educational achievement, income, poverty and wealth have been utilized as measures of socio-economic status, as determined by rankings in a social hierarchy.[1–4] Internationally, the risk of stillbirth is the highest among socially disadvantaged groups.[5,6] The high risk of stillbirth observed may stem from factors associated with socio-economic status, such as low maternal education attainment, unemployment and immigration.[7,8]

Low-educational maternal attainment has been suggested as a risk factor for stillbirth in a specific region of Spain, although results were inconclusive due to lack of statistical significance.[9] Thus, the impact of socio-economic status on the risk of stillbirth, and the association between socio-economic status and stillbirth risk by maternal country of origin at a national level in Spain are unknown.

This study aimed to analyse whether there was a higher risk of stillbirth among mothers with disadvantaged socio-economic status and whether there were differences in the risk of stillbirth by maternal country of origin in Spain, from 2007 to 2008.

Methods

We designed a national population-based observational study of babies born in 2007 and 2008 in Spain. We excluded multiple births and babies born before the 28th gestational week.

Data were drawn from the National Institute of Statistics in Spain. We used the vital statistics database, for which the official data source is the birth registration form.[10,11] This database contains information about the vital status of the baby at the moment of delivery, which is coded as either dead or alive. Our outcome variable was stillbirth, defined as the death of a foetus with ≥28 completed gestational weeks prior to complete expulsion or extraction from its mother. It should be noted that 'stillbirth' is not a technical term. In this article, 'stillbirth' refers to late foetal deaths to conform to the World Health Organization (WHO) recommendation that late foetal deaths be reported for purposes of international comparison. WHO classifies foetal deaths into late foetal deaths (≥1000 g or after 28 weeks) and early foetal deaths (500–1000 g or 22–27 weeks).[12,13]

We used maternal education attainment as an explanatory variable of stillbirth risk. Maternal education attainment has been used as a proxy of socio-economic status and is referred as the highest academic degree achieved by a woman at the time of

delivery, regardless of the time of residence in Spain and using the definitions of the International Standard Classification of Education (ISCE).[14] We classified maternal education attainment into three categories based on ISCE: (i) secondary education or lower, which corresponds with ≤12 years of obligatory school attendance in Spain; (ii) upper secondary education or first stage of tertiary education, which corresponds with >12 to ≤15 years of education; and (iii) tertiary education with >15 years of education.[14]

The following variables were considered as covariates: parity, maternal country of origin, maternal age in years and gestational age in weeks, both at the time of delivery. We dichotomized parity into nulliparous (women that had never given birth) vs. women who had given birth once or more times. Maternal country of origin, defined as the mother's country of birth, was aggregated in five macro regions [Africa, America and the Caribbean, Asia and Oceania, the European Union with 15 Members States (EU15) and other European countries] compared with Spain.[15] Maternal age was categorized into six groups following international recommendations: ≤19, 20–24, 25–29, 30–34 and ≥35 years.[15,16] Finally, we dichotomized gestational age into pre-term births (≥28–36 gestational weeks) and term births with ≥37 gestational weeks.

In the statistical analysis, we first described our population using counts and percentages for categorical data. Then, we calculated stillbirth rates under the assumption of a Poisson distribution. Stillbirth rates were calculated as the rate between the number of stillbirths at or after 28 completed weeks of gestation in a specific period and the total number of births (live births plus stillbirths) in the same period, expressed per 1000 births. Afterwards, we calculated univariate risk ratios (RRs) by each analysed variable. For explanatory variables, the category with the lowest rate was used as the reference.

To control for confounding at the analysis stage, we developed an explicative multivariate generalized linear model with a Poisson assumption, log linear link function and robust standard errors estimation. We built the model with stillbirth as the dependent variable, adjusted by maternal age, country of origin, education attainment, parity and gestational age. From this model, we derived RRs, including their 95% confidence intervals (95% CI). We explored interactions between socio-economic status and maternal country of origin and age, and evaluated the goodness of fit with the deviance statistic. Finally, we developed an analysis of standardized residuals.

Having identified a pattern of missing at random for maternal education, we developed a multivariate imputation using the chained equations method. We independently analysed 10 copies of data, each with suitably imputed missing values, in the multivariate regression analyses. Then, average estimates of the variables and adjusted standard errors were estimated according to Rubin's rules.[17,18] Finally, through a sensitivity analysis, we compared casewise and multiple imputation results.

To estimate population measures of impact, we calculated adjusted attributable fractions (AFs), preventive fractions (PFs) and population AFs (PAFs). Estimated AF 95% CI were based on standard errors of the generalized linear model that was used.[19] To estimate AF, PF and PAF, we used the following formulas: AR = RR − 1/RR, PF = 1 − RR and PAF = Pd × (RR − 1)/RR (where Pd = proportion of cases exposed to RF)

We used the Stata v.11.1 software (StataCorp USA) for statistical analysis.

Results

During the study period, there were 2464 stillbirths (late foetal death) and 970 740 live births. We excluded 36 139 multiple births and 2023 very pre-term births (22–27 gestational weeks). Among the multiple births and very pre-term births excluded, there were 326 cases of early foetal deaths. At the time of delivery, 63.6% of mothers were >30 years of age, 23.0% were of foreign origin and 15.0% had attained tertiary education. The prevalence of pre-term delivery for the period under study was 6.2%. Fifty-six percent of mothers were nulliparous. The stillbirth rate by variables in the analysis ranged from 1.0 to 4.7 deaths per 1000 births. However, in the case of premature births, the rate increased to 21.8 deaths per 1000 births (table 1).

Mothers from the EU15 showed the highest percentage of tertiary education with 20.8% followed by Spanish. On the other hand, African maternal origin presented the highest percentage of mothers with secondary or lower education attainment (94.6%) (Supplementary table S1).

The percentage of pre-term births by maternal age showed the highest prevalence of prematurity among mothers ≥19 years of age, accounting for 9.1% of all pre-term births during 2007 and 2008 (Supplementary table S2).

We found a significant trend between socio-economic status and stillbirth risk. A secondary or lower educational attainment compared with a tertiary educational attainment showed a higher risk of stillbirth (χ^2 for trend 68.0, 1 degree of freedom; $P < 0.001$). The risk of stillbirth among mothers with secondary or lower education attainment was double than that of mothers with tertiary education. In terms of impact, the lowest level of maternal education attainment (secondary or lower) was responsible for more than half (53.0%) of all stillbirths that happened in this group of women (table 2).

It should be noted that, regardless of maternal education attainment, mothers of African origin compared with those of Spanish origin, showed a 75% excess risk of stillbirth with a RR of 1.75 (95% CI: 1.54–2.00). The country of origin of mothers from regions other than Africa was not a risk factor for stillbirth compared with mothers born in Spain (figure 1).

Prematurity and a maternal age of ≥35 years were two factors strongly associated with the risk of stillbirth, with the highest association found for prematurity (table 2).

At a population level, the greatest impact on stillbirth was attributable to prematurity, followed by the lowest level of maternal education attainment (secondary or lower) and maternal age of ≥35 years (table 2).

The combined multiplicative effect of educational-level attainment and maternal country of origin, showed how the linear relationship is identified between education attainment and the risk of late foetal death is applicable to all maternal origins under study. Furthermore, the strength of the measures of association was the highest in the group of African mothers. Therefore, African mothers with secondary or lower educational attainment presented the highest risk of stillbirth (table 3).

Taking as reference Spanish mothers with tertiary education and comparing with mothers with the lowest level of education by maternal country of origin, African mothers with secondary or lower education attainment presented the highest risk of stillbirth with a RR of 3.74 (95% CI: 3.00–4.70) followed by Spanish women with the same level of education, with a RR of 2.13 (95% CI: 1.74–2.60). Moreover, mothers from all other origins with secondary or lower education attainment presented a higher risk of stillbirth compared with Spanish mothers with tertiary education (table 3).

Discussion

We have found that low socio-economic status was associated with an increased risk of stillbirth in singleton pregnancies of ≥28 weeks of gestation in Spain. This association remained significant following adjustment for age, maternal education, country of origin, parity and gestational weeks. In addition, maternal age and country of origin were independently associated with the risk of stillbirth.

Table 1 Stillbirth rate of singleton births with ≥28 gestational weeks by maternal age, country of origin, socio-economic status, parity and gestational age in Spain, during 2007–08 (2464 stillbirths and 973 204 total births)

Variables	Total births (*n*)	Stillbirths (*n*)	Stillbirth rate per 1000 births (95%CI)
Maternal age			
≤19	29 292	88	3.00 (2.41–3.70)
20–24	98 385	275	2.80 (2.47–3.14)
25–29	226 727	547	2.41 (2.21–2.62)
30–34	371 055	834	2.24 (2.10–2.40)
≥35	247 745	720	2.90 (2.70–3.12)
Maternal country of origin			
EU15	20 292	36	1.77 (1.24–2.45)
Other European countries	40 756	96	2.35 (1.90–2.87)
Africa	58 397	277	4.74 (4.20–5.33)
America	89 278	221	2.47 (2.16–2.82)
Asia and Oceania	12 583	28	2.22 (1.47–3.21)
Spain	751 898	1806	2.40 (2.30–2.51)
Maternal education attainment[a]			
Secondary education or lower	559 860	957	1.71 (1.60–1.82)
Upper secondary education or first stage of tertiary education	206 957	215	1.04 (0.90–1.20)
Tertiary education	146 293	106	0.75 (0.60–0.90)
Gestational age in weeks			
Pre-term birth (≥28–36 weeks)	60 103	1312	21.82 (20.66–23.04)
Term birth (≥37 weeks)	913 101	1152	1.26 (1.20–1.34)
Parity			
Nulliparous (first delivery)	547 981	1626	2.96 (1.83–3.11)
Multiparous (≥1 deliveries)	425 223	838	1.97 (1.84–2.11)

a: 6.2% (n: 60 094) missing values for maternal educational attainment

Table 2 Stillbirth risk and attributable fractions by maternal age, country of origin, socio-economic status, parity and gestational age in Spain, during 2007–08 (2464 stillbirths and 973 204 total births)

Variable	Casewise analyse		Multiple imputation		
	Unadjusted RR[a] (95%CI)	Adjusted RR[b] (95%CI)	Adjusted RR[b] (95%CI)	Attributable or preventible fractions (95%CI)	PAF[c]
Maternal age					
20–24	0.93 (0.73–1.20)	1.10 (0.80–1.54)	1.16 (0.91–1.48)	13.80 (1.42–41.82)	0.50
25–29	0.80 (0.64–1.00)	1.24 (0.91–1.70)	1.23 (0.98–1.55)	19.35 (8.68–47.40)	4.30
30–34	0.74 (0.60–0.93)	1.32 (0.96–1.80)	1.42 (1.13–1.78)	29.60 (2.54–61.74)	10.02
≥35	0.96 (0.77–1.20)	1.74 (1.26–2.40)	1.87 (1.48–2.35)	46.52 (5.00–88.10)	13.60
≤19	1	1	1	Ref.	
Maternal country of origin					
EU15	0.74 (0.53–1.03)	0.66 (0.41–1.06)	0.72 (0.52–1.00)	28.00 (4.30–51.80)[d]	
Other European countries	0.98 (0.79–1.20)	0.93 (0.70–1.24)	0.83 (0.67–1.02)	17.00 (−0.05–34.05)[d]	
Africa	2.00 (1.74–2.24)	2.02 (1.70–2.42)	1.75 (1.54–2.00)	42.90 (20.0–65.83)	4.82
America	1.03 (0.90–1.18)	0.75 (0.60–0.94)	0.96 (0.83–1.11)	4.00 (−9.52–17.52)[d]	
Asia and Oceania	0.92 (0.63–1.34)	0.76 (0.42–1.37)	0.82 (0.56–1.20)	14.00 (−16.71–44.7)[d]	
Spain	1	1	1	Ref.	
Maternal education attainment					
Secondary education or lower	2.36 (1.93–2.88)	2.20 (1.77–2.70)	2.13 (1.74–2.60)	53.05 (22.90–83.23)	39.25
Upper secondary education or first stage of tertiary education	1.43 (1.13–1.81)	1.44 (1.14–1.82)	1.40 (1.10–1.72)	28.60 (13.15–70.34)	5.00
Tertiary education	1	1	1	Ref.	
Gestational age in weeks					
Preterm birth (≥28–36 weeks)	17.66 (16.31–19.13)	16.75 (15.00–18.70)	16.60 (15.33–18.00)	94.00 (37.32–225.32)	50.05
Term birth (≥ 37 weeks)	1	1	1	Ref.	
Parity					
Nulliparous (first delivery)	1.50 (1.38–1.64)	1.44 (1.27–1.62)	1.67 (1.53–1.82)	40.12 (25.50–54.50)	26.5
Multiparous (≥1 deliveries)	1	1	1	Ref.	

a: Unadjusted RR
b: Adjusted RRs by maternal age, maternal education, country of origin, parity and gestational age
c: Population attributable fraction
d: Preventive fraction

To our knowledge, at a national level, this is the first study in Spain that shows the higher risk of stillbirth among mothers with low socio-economic status and that identifies a multiplicative effect on stillbirth risk between socio-economic status and maternal country of origin.

Over the past 10 years, Spain has experienced a significant population growth closely related to immigration. In little more than a decade, the population has grown by 13%, from 40 million in 1996 to 46 million in 2007. Eighty-six percent of these 6 million were foreign people. In 2007, 24% of the foreign population in

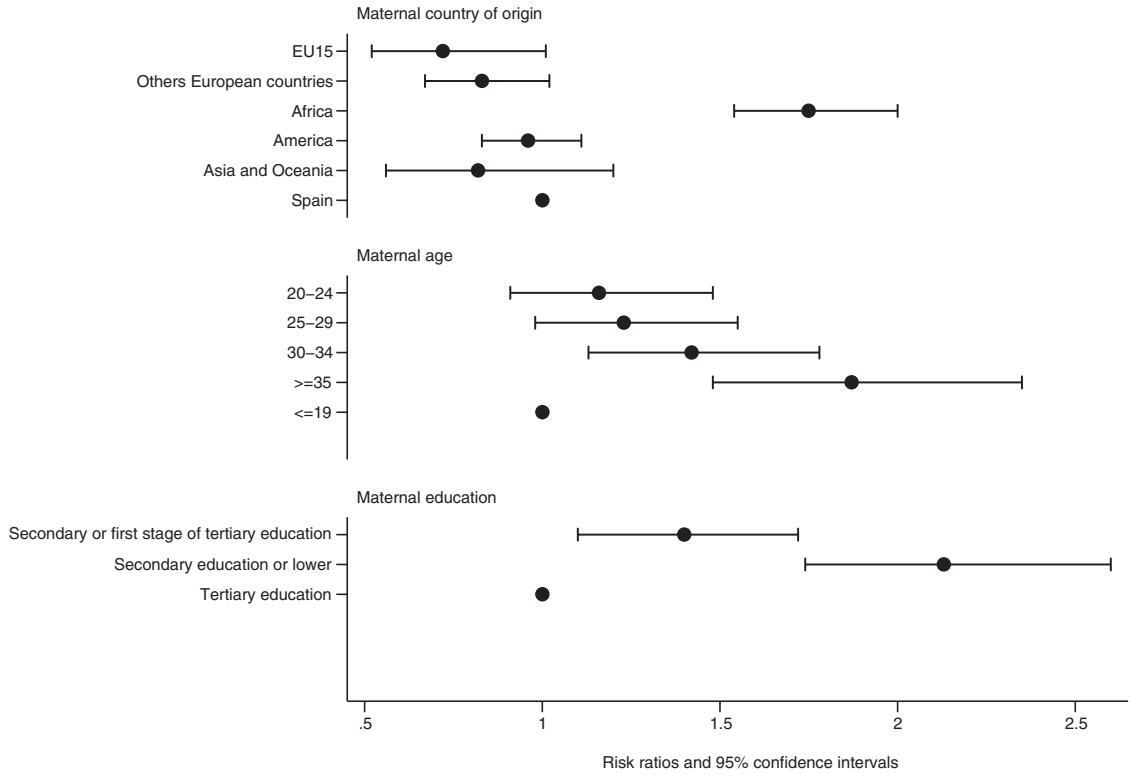

Figure 1 Pattern of stillbirth risk (adjusted RRs) in Spain from 2007 to 2008 by maternal age, country of origin and education attainment (2464 stillbirths and 973 204 total births)

Table 3 Stillbirth RRs by maternal education attainment and country of origin (multiplicative combined effect) in Spain, during 2007–08 (2464 stillbirths and 973 204 total births)

Maternal country of origin	Maternal education attainment		
	Tertiary, RR[a] (95%CI)	Upper secondary or first stage of tertiary, RR (95%CI)	Secondary or lower, RR (95%CI)
Spain	1	1.40 (1.10–1.72)	2.13 (1.74–2.60)
EU15	0.72 (0.52–1.01)	0.99 (0.66–1.48)	1.54 (1.07–2.27)
Other European countries	0.83 (0.67–1.02)	1.13 (0.83–1.54)	1.76 (1.33–2.34)
Asia and Oceania	0.96 (0.83–1.11)	1.32 (1.01–1.72)	2.05 (1.62–2.60)
America	0.82 (0.56–1.20)	1.12 (0.73–1.74)	1.75 (1.15–2.65)
Africa	1.75 (1.54–2.00)	2.41 (1.86–3.12)	3.74 (3.00–4.70)

a: Adjusted risk ratios by maternal age, education, country of origin, parity and gestational age

Spain were women of childbearing age.[20,21] In relation to this, the second important finding of this study is related to the identification of a clear excess in the risk of stillbirth among women of African origin during 2007–08 in Spain.

Recently, the Europeristat report recommended that a late foetal death rate should be used as an indicator to allow international comparisons.[15] Stillbirth risk provides information on avoidable mortality and reveals problems in the quality of perinatal care. Overall, perinatal mortality has been used as a public health indicator, as it is highly sensitive to social and health inequalities.[21,22]

The results of our study agree with international findings showing that risks for stillbirth are higher among older mothers, those with limited education and mothers belonging to ethnic minorities.[7,8,23–25]

In Spain, over the past years, a clear effect of age and period in the trends of stillbirth has been identified. Overall, stillbirth rates declined during 1996–2006, whereas specific stillbirth rates in mothers with advanced maternal age increased steadily during the study period.[26] Our study confirms that advanced maternal age is an independent risk factor of late foetal death, reinforcing national and international findings.

With regard to maternal education, our study is consistent with the results of the monitoring group of perinatal mortality in Canada, whereby women with <12 years of education had an increased risk for foetal death, compared with those with ≥14 years of education.[8] In USA, black women had more than twice the rate of stillbirth compared with white women and this increased risk could be attributed both to the access and quality of medical care.[7,27] Recently, a European study showed that in Brussels, perinatal mortality increased in African mothers independently of socio-economic status and maternal characteristics.[28]

Variation in the risk of perinatal mortality by ethnicity has been the subject of research in other countries. African women were found to have an increased risk of hypertension or pre-eclampsia, diabetes and obesity during pregnancy in different studies.[29,30] Medical information was not available in the Spanish birth registration form. Therefore, further studies would be needed to identify additional RF for the increased risk of stillbirth among African mothers in Spain taking into account this information.

Furthermore, to improve our understanding of the underlying causes of higher vulnerability to stillbirth among African women in Spain, more information related to immigrant background and culture, such as communication problems due to language skills, accessibility to the health-care system, acceptance of preventive interventions, use of pre-natal services and quality of health care received, is needed.[31]

Results of our study showed that at a population level, the greatest impact on stillbirth was attributable to prematurity, secondary or lower maternal education attainment and advanced maternal age. The prevention of these risk factors could have an important impact in the reduction of the stillbirth rate in Spain.

Stillbirth is particularly subjected to under-reporting at low gestational ages (20–27 weeks; early foetal death).[32,33] However, the exclusion of infants <28 gestational weeks allowed us to minimize the bias due to under-reporting of foetal deaths. Other restrictions to the study population applied in the study design, such as limiting the study to singleton births, allowed us to deal with confusion introduced by multiplicity.

Another limitation of our study was related to the presence of missing values. It is known that the classical analysis of data with missing values (casewise analysis, i.e. analysis of those cases only with complete data) that do not follow a 'completely at random' pattern, produces a biased estimate of the population of interest and a loss of precision.[17] However, to avoid this bias, we developed a multiple imputation procedure that allows the replacement of missing values by plausible values that differ among multiple copies of the main data set. This ensures that the mean and the variance of variables with imputed missing data reflect the uncertainty of the missing value. This procedure allows an analysis of the full data set to be undertaken, thereby minimizing biased population estimates.[18]

In conclusion, this study confirmed the existence of inequalities in stillbirth by socio-economic status and maternal country of origin in Spain. These results point out the necessity to reduce factors related to social and health inequalities in perinatal mortality, and more specifically, to take into consideration the special vulnerability of African mothers. There is a need for new policies to be developed to make the Spanish health system capable of responding to the special needs of the reproductive health of African women living in Spain.

Supplementary data

Supplementary data are available at *EURPUB* online.

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Conflicts of interest: None declared.

Key points

- Internationally, it is known that stillbirth risk is greatest for pregnant women of advanced age, with limited education, and belonging to ethnic minorities.
- This study confirms this pattern in Spain and identifies a higher risk of stillbirth among African mothers.
- Spain needs to develop a sensitive health-care system that is capable of responding to the special needs of the reproductive health of immigrant women in general and African mothers in particular.

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