Matern Child Health J (2014) 18:1814–1822
DOI 10.1007/s10995-013-1425-4

Maternal Education and Perinatal Outcomes Among Spanish Women Residing in Southern Spain (2001–2011)

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Published online: 29 December 2013

Abstract Evidence suggests that educational differences in perinatal outcomes have increased in some countries (Eastern Europe) while remained stable in others (Scandinavian countries). However, less is known about the experience of Southern Europe. This study aims to evaluate the association between maternal education and perinatal outcomes derived from birthweight (low birthweight and macrosomia) and gestational age (pre-term and post-term births) among Spaniards living in the Autonomous Community of Andalusia during the period 2001–2011 (around 19 % of births in Spain); and to evaluate whether the educational differences narrowed or widened during that period, which includes both an economic boom (2001–2008) and the global economic crisis (2009–2011). This study uses the Andalusian Population Longitudinal Database and the Vital Statistics Data provided by the Spanish National Statistics Institute. We study live and singleton births of Spanish mothers who lived in Andalusia at the time of delivery (n = 404,951). ORs with 95 % confidence intervals (crude and adjusted) were estimated using multinomial regression models. A negative educational gradient is observed in all perinatal outcomes studied (i.e., the higher the educational status, the lower the risk of negative perinatal outcomes). However, when disaggregating the sample in two periods, the gradient is only statistically significant for pre-term birth during 2001–2008, while a full gradient is observed in all perinatal indicators in the period 2009–2011 with an increase in the educational inequalities in macrosomia and post-term. Further studies are needed in order to confirm whether there is a causal association between the widening of the educational differences in perinatal outcomes and the onset of the economic crisis in Spain, or the widening can be explained by other factors, such as changes in childbearing patterns and the composition of women accessing motherhood.

Keywords Birthweight · Macrosomia · Pre-term · Post-term · Spain

Introduction

Birthweight and gestational age are key variables to monitor perinatal health. Although low birthweight and pre-term birth have been the most studied predictors in early life, post-term birth and macrosomia are also important indicators, since all of them are associated with a higher risk of experiencing mortality and suffering specific morbidities later in life [1–5]. Birthweight and gestational age are conditioned by parents' genes, lifestyles, nutritional status, age, as well as by maternal access to health care [6, 7]. Most of these determinants, in turn, depend on the parent's material conditions and socio-economic status in general, which are related to their education and occupation [8, 9].

Education has been considered to be among the most important social determinants of mother and child health [10], operating through different pathways. Highly

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educated mothers do not only have, on average, a better position in the labour market, guaranteeing material resources, but also greater access to health information and, more importantly, they are more likely to act following it, showing in consequence healthier lifestyles [11, 12]. Smoking is a good example of this, as is shown by the educational gradient that exists in the prevalence of tobacco consumption among pregnant women [13], in the intensity of consumption (heavy among the low educated), and in the probability of quitting smoking during pregnancy [13, 14].

In the last decades, educational differences in perinatal outcomes have increased in some parts of Eastern Europe [15–17], while stability has characterized some Scandinavian countries [18], but less is known about Southern Europe. In Spain, while there is ample literature on the effect of occupation on perinatal outcomes [9, 19, 20], there is a general lack of knowledge about the effect of maternal education on them, and especially on how that effect changes over time, as vital statistics have not shown the variable education until very recently. Consequently, the studies that have explored this association have hitherto only dealt with the recent past [21].

The aim of this study is (1) to evaluate the association between maternal education and perinatal outcomes derived from birthweight (low birthweight and macrosomia) and gestational age (pre-term and post-term babies) among Spaniards residing in the Autonomous Community of Andalusia during the period 2001–2011 (which represents 18 % of the country's population and around 19 % of births); and (2) to evaluate whether educational differences have narrowed or widened over time. The period under study is of particular interest since it covers Spain's period of economic growth (2001–2007), and the onset of an economic recession (2008–2011).

Population and Methods

We used publically available microdata from the Spanish Vital Statistics provided by the Spanish National Statistical Institute (INE, Instituto Nacional de Estadística) for the period 2007–2011. We restricted the analysis to this period because maternal education was introduced for the first time in 2007 and we selected births for mothers resident in the Andalusian Autonomous Community, as that is the only context for which we can get comparative earlier data.

Data for 2001 was obtained from the Longitudinal Database of the Andalusian Population (LDAP), a data source created by the Institute of Statistics and Cartography of Andalusia in collaboration with the Spanish National Research Council through a project funded by the European Social Fund [22]. The LDAP contains information from several administrative sources for the population residing in Andalusia. For this study, we use only the information from the Vital Statistics corresponding to 2001, linked to the Spanish 2001 Population Census (87 % of record linkage success) to obtain socioeconomic information. This sample has been found to be representative in socio-demographic terms for the population of Spanish women.

We selected live births and singleton births (n = 22,333 excluded) to reduce heterogeneity as multiple births have a different intrauterine growth pattern from gestational weeks 28–30 [23]. We selected only newborns from Spanish mothers residing in Andalusia (n = 67,245 excluded), as the composition of the group of immigrants may have changed substantially over time. Spanish mothers in 2001 were identified by their citizenship but the relatively low influx of migrants at that time guarantees that few immigrants may have obtained Spanish citizenship (based on Spanish residential and labour regulations). Vital Statistics from 2007 onwards distinguish between Spanish-born and those who obtained citizenship. In our study we keep immigrant fathers, who represent only a marginal amount in the whole sample (1.94 %). This selection resulted in a total number of 465,672 subjects.

Assessment of the Variables

The outcome variables were low birthweight, LBW (<2,500 g), macrosomic birth (>4,000 g), pre-term birth, PB (<37 weeks), and post-term birth, PTB (>42 weeks). The number of cases with missing information was 17,721 (2.95 %) for birthweight and 93,451 (20.07 %) for gestational age. This information was included in a category of missing data.

Maternal education was the main variable of study. The education classification both in the 2001 census and in the new birth bulletin include the same ten categories, which were collapsed into primary studies (including illiteracy, <5 years of schooling and more than 5 years of schooling but incomplete secondary studies); secondary education (complete high school, vocational or professional training); college education (including 3 and 5 years degrees, engineering degrees and PhD studies); and a final missing category (which for 2001 captures all the unmatched cases to the census).

Potential confounders included in the models were: new-born's sex (male, female), parity (first born, second born, third parity onwards), maternal age (<20, 20–35, >35 years), marital status (married, unmarried), father's origin (Spanish, migrant, missing) and maternal and paternal occupation. Occupations were re-classified into five categories to adjust for the changes in the classification between 2001 and 2007–2011: white collar (comprises

professionals, technicians and similar jobs; business and public companies directors and clerical and similar workers for 2001 and directors of business and public administration; technical, professional, scientific and intellectuals, technical and professional support staff; and clerical workers for 2007–2011), blue collar (comprises retail services; agriculture, fishing and hunting industries; and industry workers in the 2001 classification; and workers in restaurants and hotel industries; qualified workers in agriculture and fisheries, artisans and qualified workers in manufacturing industries, machinery and installation operators and non-qualified workers for 2007–2011), army, students and individuals with independent means, homemakers (they are fully comparable over time), plus an additional category comprising the missing cases. We also included additional controls for year of birth, province of birth (Almeria, Cadiz, Cordoba, Granada, Huelva, Jaen, Malaga and Seville). In the models for birth weight, we also included gestational age.

Statistical Analyses

We carried out a descriptive analysis of all variables, computing the distribution of births in the different categories and the prevalence of each of the four perinatal indicators. For the study of the association between maternal education and perinatal outcomes, we computed multinomial logistic regressions to simultaneously include all categories derived from birthweight and gestational age. We used normal birthweight and babies born at term as the reference category.

We performed the following analysis: (1) a crude model to assess the impact of maternal education without any confounders or compositional adjusting. (2) an extension of the previous model, adjusting for year and maternal occupation; (3) an adjusted model including all potential confounders; and (4) the adjusted model replicated for two time periods to explore whether there were changes in the associations over time. The division between 2001–2008 and 2009–2011 tried to capture the potential differences arising as a consequence of the great changes occurred in the period and was supported by sensitivity analyses.

The odds ratio represents the difference in the risk of delivering a child with one of the above mentioned perinatal outcomes for individuals in one category (i.e., women with university education) in comparison with the reference category. We use women with secondary education as the reference category to test for the existence of a full gradient (differences between the three occupational levels). All analyses were performed with Stata 12.1.

The authors declare that this study was conducted in accord with prevailing ethical principles.

Results

The total prevalence for pre-term birth was 6.37 % and for post-term birth 4.05 % (Table 1). The estimation for the different years indicates that pre-term birth prevalence declined during most of the period but stabilized around 2010–2011. The prevalence of post-term declined but experienced a temporary increase in 2009. The total prevalence for low birthweight was 6.04 % and for macrosomia 0.77 %. Low birthweight prevalence increased during the period but macrosomia declined. The largest proportion of children was from Seville and Malaga (26.19 and 17.09 %), the two largest provinces.

In our sample 51.60 % of births were male and 51.95 % were first-borns. Maternal characteristics indicate that 29.16 % of women were not married at the time of delivery; at least 54.49 % had secondary education and 25.39 % had college education; 62.56 % were in the range 25–34 years; those describing their occupation as homemakers (29.58 %) were only surpassed by those declaring to have a white collar occupation (33.99 %). The fathers of the children were predominantly Spanish (96.45 %). Most fathers reported a blue collar occupation (56.43 %), followed by those reporting white collar occupations (27.57 %).

In relation to perinatal outcomes, low birthweight and preterm birth are more prevalent among the non-married categories, primary education, students and persons of independent means and homemakers. Macrosomia and post-term birth are more prevalent among males and children born of migrant fathers. The only category associated with higher risk in all perinatal indicators is Primary education.

In the crude models, maternal education is inversely associated with the prevalence of negative perinatal outcomes (Table 2). Women with college education show ORs of 0.81 for pre-term birth, 0.72 for post-term birth, 0.85 for low birthweight and 0.85 for macrosomia compared to women with only secondary education. Women with primary studies show systematically higher ORs for pre-term birth (1.42), post-term birth (1.10), low birthweight (1.40) and macrosomia (1.15). The adjusted odds ratio (including year and occupation) and the fully adjusted model (with the full set of confounders) decrease slightly, but there are no changes in significance or direction. Missing data in education is associated to LBW in the crude model (OR 1.07) and in the adjusted models (OR 1.09 and 1.07).

The analysis of the two periods shows important differences (Table 3). In the fully adjusted model for the period 2001–2008, maternal education is inversely associated with all negative perinatal outcomes studied but not all the associations are statistically significant. The full gradient, that is statistical differences in both Primary and College education when compared with Secondary education, is only found for preterm birth (1.21 for Primary and 0.86 for

Table 1 Prevalence of perinatal indicators for different characteristics (2001–2011)

	N	%	Pre-term birth (%)	Post-term birth (%)	Low birthweight (%)	Macrosomia (%)
Years						
2001	75,328	16.18	7.73	4.97	6.04	0.77
2007	80,238	17.23	6.43	4.26	6.24	0.76
2008	82,785	17.78	6.14	3.77	6.28	0.73
2009	77,660	16.68	6.03	4.03	6.36	0.69
2010	75,766	16.27	5.86	3.78	6.47	0.68
2011	73,895	15.87	5.87	3.39	6.52	0.65
Province						
Almeria	32,568	6.99	6.24	2.30	6.60	0.71
Cadiz	74,726	16.05	6.36	4.34	6.04	0.76
Cordoba	44,076	9.47	5.79	3.72	5.99	0.63
Granada	48,486	10.41	6.01	3.59	6.61	0.63
Huelva	28,702	6.16	6.25	5.97	6.08	0.76
Jaen	35,570	7.64	5.55	6.21	6.36	0.75
Malaga	79,566	17.09	6.89	3.26	6.85	0.68
Seville	121,978	26.19	6.68	4.20	6.10	0.75
Sex						
Male	240,291	51.60	6.81	4.07	5.76	0.95
Female	225,381	48.40	5.9	4.03	6.92	0.46
Parity						
1	241,908	51.95	6.43	4.75	7.11	0.54
2	175,213	37.63	5.84	3.30	5.13	0.85
3+	48,544	10.42	7.95	3.13	6.66	1.05
Marital status						
Married	329,860	70.84	6.13	3.93	5.81	0.74
Not married	135,809	29.16	6.93	4.35	7.56	0.64
Mother's education						
Primary	74,812	16.07	8.64	4.58	8.44	0.81
Secondary	253,754	54.49	6.26	4.30	6.18	0.72
College	118,253	25.39	5.18	3.19	5.28	0.62
Missing	18,853	4.05	7.16	4.32	6.56	0.79
Mother's occupation						
Blue collar	121,478	26.09	6.31	4.47	6.49	0.73
Army	1,554	0.33	5.49	1.78	5.49	0.26
Students and ind. means	6,992	1.50	7.79	4.57	7.74	0.63
Homemakers	137,766	29.58	7.24	4.30	6.95	0.78
Missing	39,594	8.50	7.19	4.29	6.56	0.72
White collar	158,288	33.99	5.46	3.48	5.54	0.64
Mother's age (years)						
<20	16,795	3.61	9.27	4.67	9.26	0.50
20–24	46,571	10.00	6.97	4.84	7.19	0.63
25–34	291,315	62.56	5.93	4.14	5.90	0.69
>35	110,990	23.83	6.87	3.38	6.63	0.84
Father's origin						
Spanish	449,156	96.45	6.33	4.04	6.26	0.71
Migrant	9,275	1.99	6.31	4.27	6.13	0.81
Unknown	5,932	1.27	9.2	4.52	10.3	0.58

Table 1 continued

	N	%	Pre-term birth (%)	Post-term birth (%)	Low birthweight (%)	Macrosomia (%)
Father's occupation						
Blue collar	262,760	56.43	6.57	4.40	6.57	0.74
Army	11,735	2.52	5.57	2.68	5.35	0.56
Students and ind. means	3,800	0.82	7.11	4.70	7.22	0.79
Homemakers	3,436	0.74	7.26	3.83	7.72	0.70
Missing	55,573	11.93	7.25	4.29	7.00	0.71
White collar	128,368	27.57	5.65	3.38	5.56	0.66
Birthweight						
Low birthweight	28,558	6.13	48.79	0.68		
Normal weight	420,172	90.23	3.46	4.20		
Macrosomia	3,221	0.69	1.5	12.3		
Missing	13,721	2.95	8.39	5.19		
Gestational age						
Pre-term	4,574	0.98			49.14	0.17
Term	352,564	75.71			3.60	0.68
Post-term	15,083	3.24			1.08	2.16
Missing	93,451	20.07			6.05	0.73
Total	465,672	100	6.37	4.05	6.32	0.71

Source MNP (2007–2011) and LDAP (2001)

Table 2 Crude, adjusted and fully adjusted odds ratios and confidence intervals for birth outcomes according to education of mothers

	Prevalence	OR	95 % CI	ORa	95 % CI	ORfa	95 % CI
Pre-term birth							
Ref: secondary	6.26	1.00		1.00		1.00	
Primary	8.64	1.42	[1.38, 1.47]	1.37	[1.33, 1.42]	1.21	[1.16, 1.26]
College	5.18	0.81	[0.78, 0.84]	0.85	[0.82, 0.89]	0.88	[0.85, 0.92]
Missing	7.16	1.16	[1.08, 1.24]	1.07	[1.00, 1.15]	1.04	[0.96, 1.12]
Post-term birth							
Ref: secondary	4.30	1.00		1.00		1.00	
Primary	4.58	1.10	[1.05, 1.15]	1.08	[1.03, 1.13]	1.10	[1.04, 1.15]
College	3.19	0.72	[0.69, 0.75]	0.78	[0.74, 0.82]	0.81	[0.77, 0.85]
Missing	4.32	1.01	[0.93, 1.10]	0.94	[0.86, 1.02]	0.94	[0.86, 1.02]
Low birthweight							
Ref: secondary	6.18	1.00		1.00		1.00	
Primary	8.44	1.40	[1.36, 1.45]	1.37	[1.33, 1.42]	1.21	[1.16, 1.26]
College	5.28	0.85	[0.82, 0.87]	0.87	[0.84, 0.90]	0.92	[0.89, 0.96]
Missing	6.56	1.07	[1.00, 1.14]	1.09	[1.03, 1.16]	1.07	[1.00, 1.16]
Macrosomia							
Ref: secondary	0.72	1.00		1.00		1.00	
Primary	0.81	1.15	[1.04, 1.26]	1.12	[1.02, 1.23]	1.15	[1.04, 1.28]
College	0.62	0.85	[0.78, 0.93]	0.90	[0.81, 0.99]	0.89	[0.80, 0.98]
Missing	0.79	1.11	[0.92, 1.31]	1.08	[0.91, 1.29]	1.11	[0.93, 1.32]

Source MNP (2007–2011) and LDAP (2001)

OR crude, *ORa* adjusted by mother occupation and year of birth, *ORfa* fully adjusted model (maternal occupation, sex of newborn, marital status, mother's age, parity, father origin, province of birth, year of birth, father occupation; the birthweight models control also for gestational age)

Table 3 Fully adjusted odds ratio and confidence intervals for birth outcomes according to the education of mothers in two periods (2001–2008 and 2009–2011)

	2001–2008			2009–2011		
	Prevalence	ORfa	95 % CI	Prevalence	ORfa	95 % CI
Pre-term birth						
Ref: secondary	6.62	1.00		5.85	1.00	
Primary	9.13	1.21	[1.14, 1.28]	8.05	1.23	[1.15, 1.32]
College	5.40	0.86	[0.81, 0.91]	4.99	0.89	[0.84, 0.95]
Missing	7.36	1.13	[1.04, 1.23]	6.58	1.06	[0.91, 1.24]
Post-term birth						
Ref: secondary	4.59	1.00		3.98	1.00	
Primary	4.74	1.06	[0.99, 1.13]	4.39	1.17	[1.08,1.26]
College	3.44	0.81	[0.76,0.87]	2.99	0.79	[0.73, 0.84]
Missing	4.50	1.03	[0.94, 1.14]	3.77	0.94	[0.78, 1.12]
Low birthweight						
Ref: secondary	5.98	1.00		6.38	1.00	
Primary	8.33	1.24	[1.17, 1.30]	8.56	1.17	[1.10,1.25]
College	5.11	0.95	[0.89, 1.01]	5.43	0.91	[0.86, 0.96]
Missing	6.40	1.01	[0.92, 1.10]	6.95	1.08	[0.93, 1.24]
Macrosomia						
Ref: secondary	0.77	1.00		0.68	1.00	
Primary	0.78	1.03	[0.89, 1.18]	0.84	1.32	[1.13,1.54]
College	0.69	0.97	[0.84, 1.12]	0.57	0.81	[0.70, 0.93]
Missing	0.82	1.14	[0.93, 1.41]	0.70	1.07	[0.76, 1.51]

Source MNP (2007–2011) and LDAP (2001)

ORfa odds ratio in a fully adjusted model (maternal occupation, sex of newborn, marital status, mother's age, parity, father origin, province of birth, year of birth, father occupation; the birthweight models control also for gestational age)

College). For post-term birth, the differences are only significant for college educated women (0.81) and for low birthweight, only Primary education (1.24). For macrosomia, there are no statistical difference are different levels of education.

In the period 2009–2011, there is a full statistically significant gradient in the association between education and perinatal outcomes. Thus, women with primary studies show ORs of 1.23 in pre-term, 1.17 in post-term, 1.17 in low birthweight and 1.32 in macrosomia, while women with college education show ORs of 0.89, 0.79, 0.91 and 0.81 respectively compared to women with only secondary education. The association between missing data in education and low birthweight is no longer significant.

Discussion

Our study shows the existence of a maternal education gradient in perinatal outcomes derived from birthweight and gestational age (i.e., higher risk of delivering pre-term, post-term, low birthweight and macrosomia for women with Primary education, and lower risk for university educated mothers compared to those with secondary education) among Spanish women residing in the Andalusian Autonomous Community during the period 2001–2011. When disaggregating the analyses in different periods, we found that in the period 2001–2008 the gradient is only significant for pre-term birth. However, for 2009–2011, the full gradient is significant for all four perinatal indicators, even when the prevalence of some outcomes declined moderately (i.e., macrosomia and post-term birth). Furthermore, compared the OR in different years, we observed that the inequalities have increased mainly for macrosomia and to less extent for post-term while not for low birthweight and preterm.

We performed a sensitivity analysis to see whether the same trend is observed when disaggregating the information annually and we found that most of the ORs for each year show the same gradient captured in the pooled sample

although it is not significant in all of them. Year 2010 shows the greatest differences in all four perinatal indicators, but its exclusion from the 2009–2011 pooled sample does not change the results. Our periodization is preferred, as it does not mask internal differences within years and allows us to study trends, something not possible with annual data. In fact, annual data is more likely to capture temporary oscillations and does not really have complete internal coherence, as it mixes conceptions occurring in successive years.

These results are of great interest since the period we cover includes both Spain's periods of economic growth (from 2000 to 2007) and of economic recession (2008 onwards). The increase of the educational gradient during the recession in all perinatal outcomes and the increase of the inequalities in macrosomia and post-term may suggest an adverse effect of the financial crisis on health. The crisis was met with a reduction in public expenditure, particularly serious in health care and education, although access to both public systems was still universal (though access to health care would be restricted in mid-2012) [24]. Thus, effects on perinatal outcomes could have worked through the fundamental role that education has on labour market attachment and job sector ascription. Public sector employees' salary reductions, worsening labour market conditions together with salary cuts, and a high—and on the rise—unemployment rate (from 11 % in 2008 to 21.7 % in 2011)[1] would in turn condition nutrition, lifestyle choices, and living standards (i.e., the determinants of birthweight and gestational age). In fact, the increase of educational inequalities in macrosomia could be related to the replacement of higher quality nutrients by other cheaper hypo-caloric products. However, proving a causal relationship between macroeconomic conditions and our outcomes is beyond the scope—and possibilities—of this paper, as data on the potential causal pathways is lacking. While health care remained universal for our period, consequences of cut-backs at the local level may have been important factors. At the same time, it is impossible to capture the impact of job losses with the occupation variable available through the vital statistics, as it only captures the the general situation in the sector where an individual tends to work, and not the specific labour market conditions. Finally, the crisis may have affected perinatal health through changes in selection into motherhood that we are unable to study. In fact, incentives to childbearing, the "cheque bebé" (the baby cheque), disappeared in 2011. Additionally, in a context of economic crisis, it is much more likely that pregnancies will be deterred in vulnerable groups, so an over-representation of highly educated, white collar and older mothers, and of first parities (resulting from individuals unable or unwilling to postpone childbearing) is to be expected.

Beyond these potential and un-measurable effects of a strained economic situation, other processes may have been at work, changing the composition of mothers across educational levels and, therefore, being potentially responsible for the observed situation. As part of a rising participation of women in higher education, the proportion of mothers with a university degree has increased in the period 2001–2010 by 1.5 % points annually, making women with primary education become a minority group among pregnant women.

Additionally, there have also been changes in composition within educational groups, that is, a differential increase in the share of women with risk factors associated to adverse outcomes across occupational levels. First, regarding occupation, while university-educated women are increasingly more likely to be employed in white collar occupations (associated with better reproductive outcomes), women with primary education have the same percentage of homemakers but an increased share in low-qualified employment, categories closely associated with worse perinatal outcomes [19]. Second, regarding marital status, the proportion of non-married women (including those cohabiting), associated with increased likelihood of adverse perinatal outcomes [21] has risen from 7 to 20 % for university-educated mothers, and from 32 to 67 % for women with primary studies. Third, regarding the distribution of parity, the change is in the opposite direction: while first parity births (associated with worse perinatal outcomes) have increased for university educated women (from 41 to 46 %), they have decreased (from 56 to 50 %) for women with primary education. And, fourth, as we have seen for parity, increasing differences in age at motherhood have arisen from the association between higher education and higher age at childbearing. While mean childbearing age for women with at least secondary education has increased 1.4 years, it has decreased 1.26 years for those with only primary education. Deliveries from women >35 years (more likely to be more educated) are correlated with poorer perinatal outcomes and with a higher probability of experiencing other risk factors, such as gestational diabetes, hypertension, induced delivery, higher need for fertility treatment, etc.

The main pathway between maternal education and adverse perinatal outcomes is through behavior. Higher education contributes with knowledge-related assets, agency and efficacy skills [25, 26] that are expressed in the adoption of healthy lifestyles and avoidance of acknowledged risk factors [27]. In that sense, some of the risk factors for perinatal outcomes with a clear relationship with

[1] Data from Eurostat. http://epp.eurostat.ec.europa.eu/statistics_explained/index.php?title=File:Unemployment_rate,_2001-2012_(%25).png&filetimestamp=20130627102805

education are: smoking, physical and emotional stress, inadequate weight gain during pregnancy for PB [10–28]; obesity and diabetes for PTB [29–31]; smoking, alcohol consumption, diabetes, insufficient weight gain during pregnancy for LBW [10]; and obesity, low physical activity, excessive weight gain during pregnancy and diabetes for macrosomia [32, 33].

Our study offers important contributions. First, we have offered a comparison in the national context, as no similar data including maternal education was available before 2007 for Spain, and, secondly, we have focused on a particularly important period, the onset of an economic crisis. Although no causal associations can be implied, a discussion about the possible consequences of the economic crisis on perinatal health is opened. Our study has some data limitations that should be mentioned. Data for vital statistics in Spain is self-reported by parents at the time of birth registration at the Civil Registry. Although validation studies have concluded that in aggregate terms the INE data is quite reliable, the authors underline that the missing information is not randomly distributed in relation to perinatal health [34], but it depends on the birthweight and gestational age of the child. The substantive number of cases with missing data, especially in gestational age (20 %), might affect the results in relation to pre-term and post-term, and also the proper adjustment of the birthweight outcomes. Moreover, the probability of being reported with missing data in birthweight and gestational age might be associated with education, which might affect the discriminative accuracy of the variable.

The limitations of available data make our study not entirely representative of the whole country (we have only linked the information from the vital statistics and the census for the year 2001 for Andalucía). However, our findings are of great interest since that Community comprises 18 % of Spain's population and 20 % of births. Moreover, Andalusia is the poorest region of the country (with also shows the poorest perinatal outcomes), and there the economic recession has had the strongest effects, which has made it the recipient of large amounts of structural European funds in the past.

To summarize, our results indicate the existence of educational differences in perinatal health, widening in the last years of the period studied (2009–2011). These results suggest that more efforts are needed to explain why they are so large and even increasing in the period 2001–2011 in the Andalusian Region. We suggest considering the distribution of risk factors across maternal education (especially concerning smoking and obesity) in addition to the described changes in the socio-demographic composition of mothers.

Our region of study is in similar situation to that of other southern European regions in countries also affected by the crisis. Thus, the monitorization of the effect of the economic crisis and the study of socioeconomic differences in health become very relevant and call for similar studies to be undertaken in those countries to further test whether the same patterns arise. Perinatal inequalities are large and are not narrowing, so it is necessary to inquire further into the risk and protective factors that give them rise in order to reduce them. As perinatal indicators are predictors of an individual's later health, the consequences of the current inequalities are not limited to today's infant health but will fully unfold in the next decades.

This study has made the case for more research to be conducted on proving causal effects, as their effects beyond 2011 will need to be assessed. Aside from the possible effect of the economic crisis on perinatal health, our findings underlines the importance of education to promote reproductive and perinatal health equality.

Acknowledgments This work was financially supported by the Spanish Ministry of Economy and Competitiveness (Grants CSO2010-11485-E and CSO2011-29970), the Centre for Economic Demography at Lund University and SIMSAM Early Life (Lund University).

Conflict of interest The authors do not have any potential conflict of interest in relation to this work.

References

1. Barker, D. (2006). Birth weight and hypertension. *Hypertension, 48*, 357–358.
2. Godfrey, K., & Barker, D. (2007). Fetal programming and adult health. *Public Health Nutrition, 4*(2B), 611–624.
3. Risner, K. R., Vatten, L. J., Barker, J. L., et al. (2011). Birthweight and mortality in adulthood: A systematic review and meta-analysis. *International Journal of Epidemiology, 40*(3), 647–661.
4. Leon, D. A., Lithell, H. O., Vagero, D., et al. (1998). Reduced fetal growth rate and increased risk death from ischaemic heart disease: Cohort study of 15000 Swedish men and women born 1915–1929. *BMJ, 317*, 241–245.
5. Gillman, M. W. (2004). A life course approach to obesity. In K. Diana & Y. Ben-Shlomo (Eds.), *A life course approach to chronic disease epidemiology*. Oxford: Oxford University Press.
6. Coria-Soto, I. L., Bobadilla, J. L., & Notzon, F. (1996). The effectiveness of antenatal care in preventing intrauterine growth retardation and low birth weight due to preterm delivery. *International Journal for Quality in Health Care, 8*(1), 13–20.
7. Kramer, M. S. (1987). Determinants of low birth weight: Methodological assessment and meta-analysis. *Bulletin of the World Health Organization, 65*(5), 663–737.
8. Juárez, S., & Revuelta Eugercios, B. (2013). Socio-economic differences in low birth weight: Revisiting epidemiological approaches. *REIS, 144*, 73–96.
9. Rodríguez, C., Regidor, E., & Gutiérrez-Fisca, J. L. (1995). Low birth weight in Spain associated with sociodemographic factors. *Journal of Epidemiology and Community Health, 49*, 38–42.
10. Kramer, M. S., Seguin, L., Lydon, J., & Goulet, L. (2000). Socio-economic disparities in pregnancy outcome: Why do the poor fare so poorly? *Paediatric and Perinatal Epidemiology, 14*, 194–210.

11. Caldwell, J. C. (1979). Education as a factor in mortality decline. An examination of Nigerian data. *Population Studies, 33*(3), 395–413.
12. Ross, C., & Mirowsky, J. (1999). Refining the association between education and health: The effects of quantity, credential, and selectivity. *Demography, 19*, 445–460.
13. Villalbí, J. R., Salvador, J., Cano-Serral, G., Rodríguez-Sanz, M., & Borrell, C. (2007). Maternal smoking, social class and outcomes of pregnancy. *Paediatric and Perinatal Epidemiology, 21*, 441–447.
14. Torrent, M., Sunyer, J., Cullinan, P., et al. (2004). Smoking cessation and associated factors during pregnancy. *Gaceta Sanitaria, 18*(3), 184–189.
15. Brzezinski, Z., & Szamotulska, K. (1994). The widening gap in low birthweight rates between extreme social groups in Poland during 1985–1990. *Paediatric and Perinatal Epidemiology, 8*(1), 373–383.
16. Koupilova, I., Bobak, M., Holcik, J., Pikhart, H., & Leon, D. (1998). Increasing social variation in birth outcomes in the Czech Republic after 1989. *American Journal of Public Health, 88*(9), 1343–1347.
17. Koupilova, I., Rahu, K., Rahu, B., Karro, M. B., & Leon, D. (2000). Social determinants of birthweight and length of gestation in Estonia during the transition to democracy. *International Journal of Epidemiology, 29*(1), 118–124.
18. Mortensen, L. H., Diderichsen, F., Arntzen, A., et al. (2008). Social inequality in fetal growth: A comparative study of Denmark, Finland, Norway and Sweden in the period 1981–2000. *Journal of Epidemiology and Community Health, 62*(4), 325–331.
19. Ronda, E., Hernández-Mora, A., García, A. M., & Regidor, E. (2009). Ocupación materna, duración delagestación y bajo peso al nacimiento. *Gaceta Sanitaria, 23*(3), 179–185.
20. Speciale, A. M., & Regidor, E. (2011). Understanding the universality of the immigrant health paradox: The Spanish perspective. *Journal of Immigrant Minority Health, 13*, 518–525.
21. Castro Martín, T. (2010). Single motherhood and birthweight is Spain: Narrowing social inequalities in health? *Demographic Research, 22*, 863–890.
22. Merlo, J., Viciana-Fernández, F., & Ramiro Fariñas, D. (2012). Bringing the individual back to small-area variation studies: A multilevel analysis of all-cause mortality in Andalusia, Spain. *Social Science and Medicine, 75*(8), 1477–1487.
23. Cunningham, F. G. (2005). *Williams obstetrics* (3rd ed.). New York: McGraw-Hill.
24. Baylos Trillo, A., Trillo Párraga, F. (2012). The impact of anti-crisis measures and the social and employment situation in Spain: The Workers' Group of the European Economic and Social Committee.
25. Cutler, D., & Lleras-Muney, A. (2010). Understanding differences in health behaviors by education. *Journal of Health Economics, 29*(1), 1–28.
26. Lynch, J., & Kaplan, G. (2000). Socioeconomic position. In L. F. Berkman & I. Kawachi (Eds.), *Social epidemiology* (pp. 13–35). Oxford: Oxford University Press.
27. Jansen, P. W., Tiemeier, H., Looman, C. W. N., et al. (2009). Explaining educational inequalities in birthweight: The generation R study. *Pediatrics and Perinatal Epidemiology, 23*, 216–228.
28. Savitz, D. A., Harmon, Q., Siega-Riz, A. M., Herring, A. H., Dole, N., & Thorp, J. J. M. (2012). Behavioral influences on preterm birth: Integrated analysis of the pregnancy, infection, and nutrition study. *Maternal and Child Health Journal, 6*, 1151–1163.
29. Caughey, A. B., Stotland, N. E., Washington, E., & Escobar, G. J. (2009). Who is at risk for prolonged and postterm pregnancy? *American Journal of Obstetrics and Gynecology, 200*, 683.e1–683.e5.
30. Oberg, A. S., Frisell, T., Svensson, A. C., & Iliadou, A. N. (2013). Maternal and fetal genetic contributions to postterm birth: Familial clustering in a population-based sample of 475,429 Swedish births. *American Journal of Epidemiology, 177*(6), 531–537.
31. Campbell, M. K., Ostbye, T., & Irgens, L. (1997). Post-term birth: Risk factors and outcomes in a 10-years cohort of Norwegian births. *Obstetrics and Gynecology, 89*(4), 543–548.
32. Voldner, N., Froslie, K., Bo, K., et al. (2008). Modifiable determinants of fetal macrosomia: Role of lifestyle-related factors. *Acta Obstetricia et Gynecologica Scandinavica, 87*(4), 423–429.
33. Bergmann, R. L., Richter, R., Bergmann, K. E., Plagemann, A., Brauer, M., & Dudenhausen, J. W. (2003). Secular trends in neonatal macrosomia in Berlin: Influences of potential determinants. *Pediatrics and Perinatal Epidemiology, 17*, 244–249.
34. Juárez, S., Alonso Ortíz, T., Ramiro Fariñas, D., & Bolúmar, F. (2012). The quality of vital statistics for studying perinatal health: The Spanish case. *Paediatrics and Perinatal Epidemiology, 26*(4), 310–315.