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Impact of the global financial crisis on low birth weight in Portugal: a time-trend analysis

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ABSTRACT

Background: The 2007–2008 global financial crisis had adverse consequences on population health of affected European countries. Few contemporary studies have studied its effect on perinatal indicators with long-lasting influence on adult health. Therefore, in this study, we investigated the impact of the 2007–2008 global financial crisis on low birth weight (LBW) in Portugal.

Methods: Data on 2 045 155 singleton births of 1995–2014 were obtained from Statistics Portugal. Joinpoint regression analysis was performed to identify the years in which changes in LBW trends occurred, and to estimate the annual per cent changes (APC). LBW risk by time period expressed as prevalence ratios were computed using the Poisson regression. Contextual changes in sociodemographic and economic factors were provided by their trends.

Results: The joinpoint analysis identified 3 distinct periods (2 jointpoints) with different APC in LBW, corresponding to 1995–1999 (APC=4.4; 95% CI 3.2 to 5.6), 2000–2006 (APC=0.1; 95% CI −050 to 0.7) and 2007–2014 (APC=1.6; 95% CI 1.2 to 2.0). For non-Portuguese, it was, respectively, 1995–1999 (APC=1.4; 95% CI −3.9 to 7.0%), 2000–2007 (APC=−4.2; 95% CI −6.4 to −2.0) and 2008–2014 (APC=3.1; 95% CI 0.8 to 5.5). Compared with 1995–1999, all specific maternal characteristics had a 10–15% increase in LBW risk in 2000–2006 and a 20–25% increase in 2007–2014, except among migrants, for which LBW risk remained lower than in 1995–1999 but increased after the crisis. The increasing LBW risk coincides with a deceleration in gross domestic product growth rate, reduction in health expenditure, social protection allocation on family/children support and sickness.

Conclusions: The 2007–2008 global financial crisis was associated with a significant increase in LBW, particularly among infants of non-Portuguese mothers. We recommend strengthening social policies aimed at maternity protection for vulnerable mothers and health system maintenance of social equity in perinatal healthcare.

Key questions

What is already known about this topic?

► The 2007–2008 global financial crisis and sequel of economic recessions have resulted in adverse consequences on population health of affected European countries.

► Perinatal health outcomes are among the exacerbated indicators during previous economic depressions.

► During economic crisis, there are changes in low birth weight risk factors like childbearing practices (eg, fertility postponement), nutrition, substance use patterns and access to healthcare.

What are the new findings?

► Portugal has been experiencing an upward but unequal trend in singleton low birth weight (LBW), described by three distinct periods that escalated after 2007–2008.

► The general increase in LBW risk during the past two decades in Portugal affects the different strata of the population variables, with the exception of nationality, with non-Portuguese women experiencing a decrease in LBW risk before the financial crisis.

► The increasing risk in LBW was concomitant with declining birth rates and with worst macroeconomic indicators, such as an increased unemployment and a deceleration in gross domestic product (GDP) growth rate. There was a reduction in government expenditure on health as a proportion of GDP, percentage expenditure of social protection on family/children support and for sickness or healthcare.

BACKGROUND

The 2007–2008 global financial crisis and sequel of economic recessions have resulted in adverse consequences on population health of affected European countries.[1] The economic downturn and its health impact has intensified the vulnerability of children as detected in Greece, where stillbirths and infant deaths increased from 2008 to 2010, and in Iceland, where the proportion of children born small-for-gestational age increased from 2.0% to 3.4% 6 years after the banking collapse of October 2008.[2 3]

Key questions

Recommendations for policy

▸ The continuous monitoring of relevant risk factors, the quality assurance of the process and information on further indicators, as part of data routinely collected by the national birth registration system, are essential.
▸ There should be strengthening of social policies aimed at maternity protection for non-Portuguese, working and other vulnerable mothers.
▸ The health system should sustain its capacity to effectively maintain social equity in perinatal healthcare access, utilisation and quality

Birth weight is a major determinant of infant health and welfare that persists into later life.[4] Taking as example cognitive outcomes, so intensively valued in our societies, and considering individual and contextual changes, low birth weight (LBW) long-term effects seem more marked when birth weight reflects mainly the contribution of socioeconomic pathways than where pathways relate mostly to biological risk factors.[5][6] Hence, fetal growth and birth weight have been employed to evaluate social policies as indicators of social inequalities sensitive to macroeconomic choices.[7]

LBW is among the adverse health outcomes exacerbated during previous economic depressions.[8–10] Contextually, the heightening of LBW susceptibility during economic crisis denotes mediation through changes in the social profile of childbearing women and alterations in health behaviours.[11][12] Additionally, there may be environmental mediation, as health system responses are sensitive to reductions in funding of programmes or to general cost containment measures, which may constitute a constraint to healthcare access.[8–10] Economic recession affects differently those at the top or at the bottom of the social hierarchy, emphasising the importance of individual protection in promoting health.[12] Studies have recognised that during economic crisis, there are changes in childbearing practices, worsening nutrition, adoption of unhealthy coping strategies, modification of substance use patterns, decreased access to care and attention to health issues, as well as direct increases on stress.[11][12] All these aspects can influence pregnancy outcomes, although the consequences pointing into different directions. Evidence about the impact of the current economic recession on health equity is still inconsistent and there is no such information available for the perinatal period.[13]

Although several contemporary studies have examined the impact of the recent financial crisis on specific health outcomes, less often they looked at perinatal indicators such as LBW that might have a long-lasting influence on adult health.[14] There is paucity of research studies that consistently covered the link between health and key Portuguese socioeconomic problems.[15] Considering that the establishment of the universal

healthcare and perinatal health services over the last 30 years has improved maternal and child health indicators in Portugal.[16][17] It is appropriate to investigate the impact of adverse social and macroeconomic conditions on birth weight by monitoring time-based and social patterns of LBW.[9][10] Therefore, we examined time trends in LBW during the past two decades in Portugal, researching the impact of the 2007–2008 global financial crisis and taking into consideration individual and contextual changes.

METHODS

Data source

Annual individual data concerning births and birth characteristics were obtained from Statistics Portugal—*Instituto Nacional de Estatística* (INE)—for the period 1995–2014. Online supplementary data on migrations, crude birth rate, gross domestic product (GDP), unemployment and social security expenditure covering the period 1995–2014 were obtained from Statistics Portugal as well as the Ministry of Solidarity and Social Security.

Study population

The study population consisted of 2 045 155 singleton live births (mother–infant pairs) as recorded in the national birth registry. We excluded records for which birth weight (n=2976) and maternal nationality (n=109) were missing and those that, because of the possibility of error in data entry, were registered as <500 or >6000 g (n=3007).

Measures

Birth weight is recorded in grams and corresponds to the first measure of weight obtained after birth, preferably during the first hour. In the national statistics, birth weight is also classified in 500 g categories, but for our analysis, we used only four: <1500, 1500–2499, 2500–3999 and >3999. Specifically, the main outcome variable considered in our analysis was the prevalence of LBW, defined as the proportion of singleton babies with birth weight <2500 g.

The duration of gestation, which is expressed in completed weeks, is calculated from the first day of the last normal menstrual period or based on ultrasound data. During the study period, there have been changes in the national policy regarding the record of gestational age, so for analysis, we considered the categories 22–31, 32–36, 37–41 and >41 and classified as preterm babies those with <37 completed weeks. The infant sex is recorded as male or female and the male to female ratio was calculated. The maternal age at birth was registered as a continuous variable, but for the purpose of this study was categorised as ≤19, 20–34 and ≥35 years; maternal nationality referred to nationality at the moment of birth and, although recorded according to each individual country, was considered as Portuguese

Figure 1 Trend in low birth weight rates among singleton births in Portugal 1995–2014.
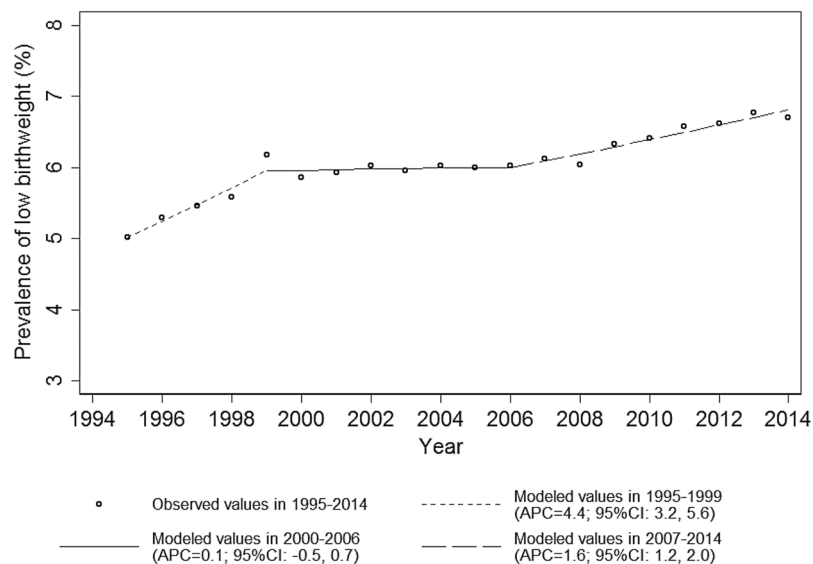
or other. Maternal or paternal employment status was recorded in 10 categories but for analysis classified as employed, unemployed or others (housewife, student, retired, incapacitated), and maternal education stratified as primary, secondary and tertiary.

Statistical analysis

To study trends in LBW and to estimate the annual percentage change, we employed a Poisson joinpoint regression model.[18] The procedure models the counts in the numerator and denominator for each time period rather than the precalculated rates. In essence, this approach is equivalent to having data at the individual level with sample size equalling the number of individuals in the denominators of the rates instead of the number of time periods for which rates are available. A joinpoint represents a knot at which an important change in the temporal trend occurs; joinpoints are estimated iteratively and do not require the specification of an a priori hypothesis about the location of the knots to be tested. Weighted least squares to account for heteroscedasticity was included to fit a loglinear Poisson joinpoint regression model that was used. We also allowed for autocorrelation of the residuals to account for the fact that the observed rates are not independent.[19]

The Poisson regression analysis was performed using the Joinpoint Regression Program, V.4.2.0.[20] The software fits the simplest joinpoint model that the data will allow using a series of permutation test. The estimated annual per cent change (APC) and their 95% CIs were computed by fitting a regression line to the natural logarithm of the rates using calendar year as a regressor variable (ie, given y=ln(number of LBW) and y=ln(total of birth)+a+bx and x=calendar year, the APC is estimated as $100 \times (e^b - 1)$).[20] The final number of joinpoints was determined by comparing the best model with each number of change points using permutation tests, with a Bonferroni correction to account for multiple hypothesis testing.[19] The resulting graph for the best model had two joinpoints and it is a scatter plot of LBW rate from 1995 to 2014 (figure 1).

Additionally, χ^2 test was used to compare maternal and infant characteristics at the three periods (1995–1999—reference period, 2000–2006 and 2007–2014). Considering that we are working with large samples, measures of effect size were preferred over significance tests to remove the dependence on sample size and the associated high probability of significant differences. We used Cohen's d effect sizes, which indicate the magnitude of differences between groups independent of sample size were values of 0.10, 0.30 and 0.50 or greater, which were considered small, moderate and large effect sizes, respectively.[21]

Log-binomial regression or log-Poisson regression was used to estimate the magnitude of the association between LBW and each variable considered (maternal nationality, age, education, employment status and infant sex), and expressed as prevalence ratio (PR) with corresponding 95% CIs.

The information on the contextual changes in sociodemographic and economic factors was provided by the trends in the net migration rate (difference of immigrants and emigrants in a period of time; a positive value represents more people entering the country than leaving it), crude birth rate (annual number of live births per 1000 population), GDP (monetary value of all the finished goods and services produced within a country's borders in a specific time period, measured in euros) and social security expenditure (comprises of budgetary allocation for social security with social purposes) from 1995 to 2014. The proportion of government expenditure on health over the study period was reported as budget execution per capita (euro—ratio) and budget execution as a percentage of GDP. The GDP is expressed

as growth rate (%) and per capita based on purchasing power standards (PPS). When the comparison of GDPs in PPS is repeated for at least two periods, it is possible to infer the relative growth rates between the two periods. The unemployment rate represents unemployed persons (persons aged between 15 and 74 who during the reference period neither had a job nor were at work; were available for paid employment or self-employment; or had actively sought work) as a percentage of the civilian labour force, defined as the proportion of all persons aged 15 or over (14 or over until 1997) who, during the reference period, made up the available labour force for the production of economic goods and services.

Two approaches were used to study the relationship between maternal or infant characteristics and LBW time changes. First, the effect of each characteristic on LBW in time was assessed, fitting several models stratified by the characteristic of interest (adjusted for all the other variables) taking time as independent variable. Subsequently, we tested the effect of each characteristic on LBW taking into consideration that this effect can change in time. So, we fitted each model including the interaction between time and the characteristic under study (adjusted for the other variables). We used the likelihood ratio test to assess any significant interaction between the period and the characteristic (p-interaction).

SPSS V.21 (SPSS, Chicago, Illinois, USA) was used to calculate descriptive statistics and to perform the regression analyses.

RESULTS

Trends in LBW in Portugal 1995–2014

During the study period, the prevalence of LBW increased in singleton births from 5.0% in 1995 to 6.6% in 2014. The joinpoint analysis (figure 1) identified three distinct periods (2 jointpoints) corresponding to 1995–1999 (APC=4.4; 95% CI 3.2 to 5.6), 2000–2006 (APC=0.1; 95% CI −0.5, 0.7) and 2007–2014 (APC=1.6; 95% CI 1.2 to 2.0). A distinct pattern was observed when looking separately to Portuguese born (figure 2) and migrant mothers (figure 3): for the babies of Portuguese mothers, the annual changes were positive though with only two different periods: 1995–1999 (APC=3.6; 95% CI 2.1, 5.0) and 2000–2014 (APC=1.0; 95% CI 0.8 to 1.2) while that in babies of mothers of other nationalities were three: 1995–1999 (APC=1.4; 95% CI −3.9 to 7.0%), 2000–2007 (APC=−4.2; 95% CI −6.4 to −2.0) and 2008–2014 (APC=3.1; 95% CI 0.8 to 5.5), with a significant increase after the crisis.

The annual number of singleton live births declined from 104 636 in 1995 to 79 918 in 2014. Table 1 presents the maternal and infant characteristics of the participants according to the three periods observed in the general sample. It is observed that the proportion of babies of native Portuguese mothers decreased from 97.8% (1995–1999) to 91.1% (2007–2014).

Furthermore, the mean maternal age increased from 27.6±5.49 years (1995–1999) to 30.1±5.63 years (2007–2014). This followed a reduction in the proportion of teenage mothers from 6.9% (1995–1999) to 4.0% (2007–2014). Women with tertiary-level education increased from 13.0% to 32.0% between 1995–1999 and 2007–2014, while the proportion of unemployed mothers varied from 4.4% (1995–1999) to 13.0% (2007–2014). The effect size of the change by the Cohen criteria was small (<0.10) for all characteristics except for maternal education that presented a moderate effect (0.21). However, all the comparisons of proportions and mean values were statistically significant at p<0.001.

Contextual changes of sociodemographic and economic indicators in Portugal 1995–2014

In table 2, we present values for some relevant social, demographic and economic indices in Portugal, according to the three periods considered from 1995 to 2014. In 1995–1999, there was a positive net migration, but in subsequent years, a negative net migration was recorded particularly from 2008 onward, reflecting the large emigration of young Portuguese adults. On the contrary, the foreign population in the country has been on a steady rise with a remarkable increase in the period between 2008 and 2012, but began to reduce afterwards. The crude birth rate has been declining over the years with an important reduction, especially in the post-2008 period. The GDP growth rate (%) has been sliding during the observation period; 1995–1999 (4.2), 2000–2006 (1.5) and 2007–2014 (−1.0). The average GDP per capita (PPS) increased from 12 872 in 1995–1999, to 17 513 in 2000–2006 and to 20 485 in 2007–2014. The unemployment rate increased in women from a maximum of 6.4 in the first period or 6.7 in the second to 16.0% after the financial crisis; a similar trend was seen for men among whom unemployment reached 16.4%. The relative increase in GDP was higher between the first and second periods than between the second and third. Precisely, the proportion of government expenditure on health (budget execution as a percentage of GDP) increased between the initial (1995–1999; 3.9%) and intermediate (2000–2006; 5.0%) periods but declined afterwards (2007–2014; 4.7%). It was observed that the social security expenditure as percentage of GDP has steadily been increasing, especially in the period 2007–2014. This is reflected in the rise of the percentage expenditure of social benefit on unemployment. However, there was a reduction in the percentage expenditure of social benefit on family and children support and in sickness/maternity. During the study period, the crude death rate had a maximum of 106 per 10 000 inhabitants from 1995 to 1999, 104 in 2000 to 2006 and 102 in the period 2007 to 2014. During the same periods, infant death steadily decreased from 7.4 per 1000 live births in 1995 to reach 2.5 in 2010, than increasing to 3.4 in 2012 and reaching 2.9 in 2014.

Figure 2 Trend in low birth weight rates among Portuguese singleton births in Portugal 1995–2014.
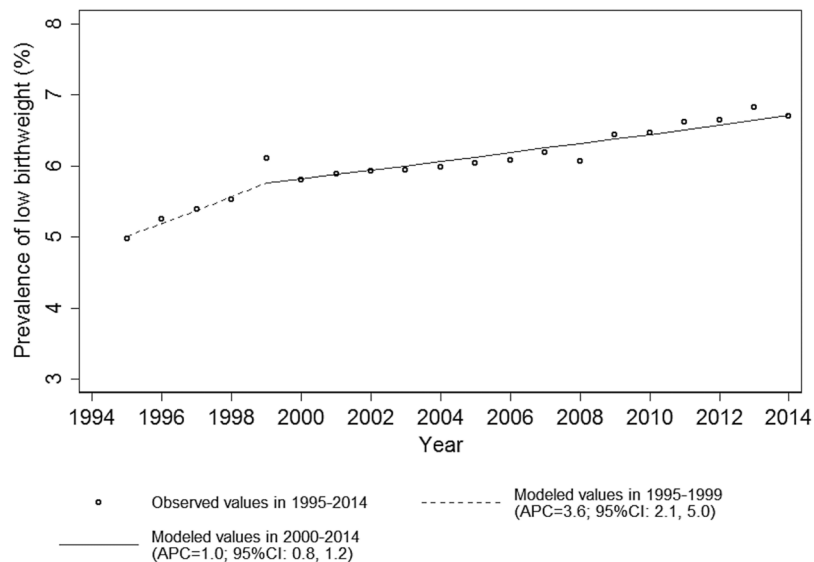
Trend of LBW risk according to maternal and infant characteristics

In a multivariate regression model, and considering 1995–1999 as the reference period, LBW risk increased, even after adjustment for maternal characteristics (table 3). It significantly increased in 2000–2006 (PR=1.119; 95% CI 1.103 to 1.135) and again in 2007–2014 (PR=1.229; 95% CI 1.103 to 1.235). We found a significant interaction with all characteristics except with infant sex. However, the change in risk was different across strata of some infant and maternal characteristics. It increased with time in Portuguese women, while in the non-Portuguese, the risk decreased and was still lower after the crisis although less than in the intermediate period. While in women with a maternal age higher than 20, the LBW risk increased, in the younger group, there was a decrease during the observation period. The increase in LBW risk in primiparous women was similar to the multiparous. For the other characteristics, when compared with 1995–1999, LBW risk increased in 2000–2006 of about 10–15% and a more pronounced increase was observed in 2007–2014 (20–25%).

DISCUSSION

Our findings indicate that between 1995 and 2014, Portugal has been experiencing an upward but unequal trend in singleton LBW, described by three distinct periods that escalated after 2007–2008. This development is concurrent with macroeconomic and sociodemographic transformations in the country. The broad interval of observation (1995–2014) enabled the detection of the transformation of LBW rate in babies of non-Portuguese mothers, which indicated a period of decline (2000–2006) and an upsurge (2007–2014). There was an overall increase in the proportion of LBW births, but its time-based distribution in babies of non-Portuguese mothers showed a gradient different from their Portuguese peers.

Figure 3 Low birth weight rates among non-Portuguese singleton births in Portugal 1995–2014.
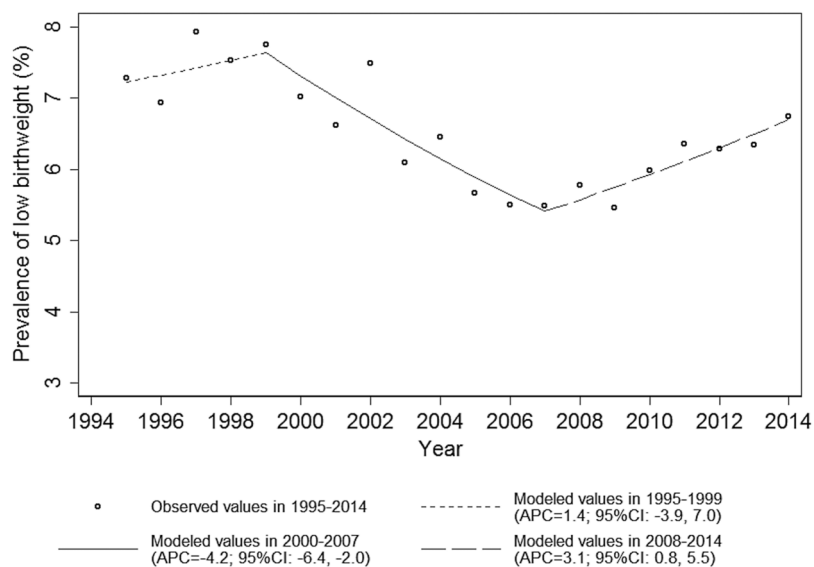
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Table 1 Maternal and infant characteristics of singleton live births in Portugal, 1995–2014

Variable	1995–1999 n (%)	2000–2006 n (%)	2007–2014 n (%)	Effect size (Cohen's d)*
Total live births	546 032 (26.7)	762 325 (37.3)	736 798 (36.0)	
Maternal nationality				
Portugal	530 430 (97.1)	709 199 (93.0)	663 963 (90.1)	0.11
Other country	15 602 (2.9)	53 126 (7.0)	72 835 (9.9)	
Paternal age, mean (±) years	30.4 (6.14)	31.5 (6.24)	32.6 (6.33)	
Maternal age (years)				
Mean (±)	27.6 (5.49)	28.7 (5.57)	30.1 (5.63)	
≤19	37 710 (6.9)	42 906 (5.6)	29 734 (4.0)	0.13
20–34	447 384 (81.9)	605 099 (79.4)	541 738 (73.5)	
≥35	60 938 (11.2)	114 320 (15.5)	165 326 (22.4)	
Parity				
Primiparae	292 274 (53.5)	415 066 (54.5)	399 175 (54.3)	0.01
Multiparae	253 756 (46.5)	347 038 (45.5)	336 564 (45.7)	
Maternal education				
Primary	375 555 (68.8)	420 124 (55.1)	284 270 (39.2)	0.24
Secondary	99 277 (18.2)	179 741 (23.6)	209 131 (28.8)	
Tertiary	71 200 (13.0)	162 220 (21.3)	232 626 (32.0)	
Maternal employment status				
Employed	342 306 (62.7)	544 958 (71.5)	511 140 (70.8)	0.18
Unemployed	24 088 (4.4)	47 093 (6.2)	93 950 (13.0)	
Others	179 638 (32.9)	169 635 (22.3)	116 416 (16.1)	
Paternal employment status				
Employed	509 082 (96.5)	707 149 (94.8)	634 764 (89.2)	0.13
Unemployed	9973 (1.9)	17 802 (2.4)	45 488 (6.4)	
Others	8655 (1.6)	20 652 (2.8)	31 723 (4.5)	
Infant sex				
Male	282 468 (51.7)	394 313 (51.7)	378 057 (51.3)	0.004
Female	263 564 (48.3)	368 012 (48.3)	358 741 (48.7)	
Male/female ratio	1.07	1.07	1.05	
Gestational age at birth (weeks)				
<32 (very preterm)	4013 (0.7)	4871 (0.6)	5637 (0.8)	0.08
32–36 (moderate–late preterm)	26 860 (5.0)	35 716 (4.7)	42 049 (5.7)	
37–41 (term)	497 387 (92.3)	691 779 (90.9)	679 439 (92.4)	
>41 (post-term)	10 685 (2.0)	28 743 (3.8)	8583 (0.9)	
Birth weight (g)				
Mean (±)	3262.7 (506.56)	3229.3 (498.66)	3197.3 (491.23)	
<1500	3722 (0.7)	5150 (0.7)	5073 (0.7)	0.04
1500–2499	26 366 (4.8)	40 346 (5.3)	42 268 (5.7)	
2500–3999	482 616 (88.4)	678 757 (89.0)	658 970 (89.4)	
>4000	33 328 (6.1)	38 072 (5.0)	30 487 (4.1)	

*The p value for the comparison of the three periods using the χ^2 test or analysis of variance, as appropriate, is <0.001 for all variables.

Generally, comparing with 1995–1999, a 10–15% increase in LBW risk was observed in 2000–2006 for most maternal characteristics and a 20–25% increase was observed in 2007–2014. This argues in favour of a general increase in risk observed in the 21st century and not in specific groups of the population.[22] Except the non-Portuguese women who experienced decreasing LBW risk that reversed after the crisis. For these women, the decreased risk reflects the overall decline in LBW prevalence in 2000–2006, although it increased again

Table 2 Sociodemographic and economic indices in Portugal, 1995–2014

Indicator	1995–1999	2000–2006	2007–2014
Net migration rate	42 000	32 300	−14 200
Proportion of females in foreign population (%)	41.8	44.8	49.8
Crude birth rate (per 1000 population)	11.1	10.6	8.9
Crude death rate (per 1000 population)	10.6	10.4	10.2
Infant death rate (per 1000 live births)	7.4	5.5	3.6
GDP per capita (PPS millions, Euros)	12 872	17 513	20 485
GDP growth rate (%)	4.2	1.5	−1.0
Government expenditure on health: budget execution per capita (Euro—ratio)*	396.3	714.6	783.8
Government expenditure on health: budget execution as a % of GDP*	3.9	5.0	4.7
Unemployment rate (%; highest value in the period)			
Men	6.4	6.7	16.0
Women	8.2	8.9	16.4
Total social security expenditure as % of GDP	9.4	11.6	18.5
Total social security benefit (Euros, 1000s)	8 002 079.0	13 468 539.0	20 487 826.3
% of total social security benefit for sickness/maternity	6.9	5.1	4.1
Social security payment for sickness/maternity (1000s, Euros)	549 839.9	688 814.0	830 629.9
% of total social benefit for family/children (%)	5.5	4.8	4.4
Social security payment on family/children (1000s, Euros)	439 383.1	640 032.3	895 293.9
% of total social benefit for unemployment (%)	8.6	10.1	10.5
Social security payment for unemployment (1000s, Euros)	691 724.0	1 364 001.7	2 148 857.4

Figures presented describe the mean value for the period except for crude and infant deaths as well as unemployment where the highest values were depicted.
Sources: Statistics Portugal (INE) and Instituto de Gestão Financeira da Segurança Social (IGFSS).
*Only data for 1995–2013 were officially documented.
†Social benefits/social security payments are transfers to households, in cash or in kind, intended to relieve them from the financial burden of a number of risks or needs, including: (a) sickness; (b) invalidity, disability; (c) occupational accident or disease; (d) old age; (e) survivors; (f) maternity; (g) family; (h) promotion of employment; (i) unemployment; (j) housing (k) education; (l) general neediness.

after the economic crisis (but not reaching the 1995–1999 levels). This pattern may represent differential selection to pregnancy, but also the heterogeneity within the group of migrant women and different migration flows over time, namely regarding the country of origin and women's social characteristics. Future research is fundamental to disentangle differences within migrants as well as between migrants and natives, and the impact of these differences on societies' health indicators, especially LBW.

The 2007–2008 global financial crisis triggered a negative impact on European economies that led to the introduction of strict economic austerity measures, as happened in Portugal.[23][24] In the Portuguese society, the impact of the crisis deepened after 2010, when a second phase of the financial and social crisis emerged, leading to more aggressive fiscal reforms that in turn worsened recession.[25] The health policy response included an increase in employer and employee contribution rates either across the board or for specific population subgroups, increased or introduced user charges for health services, and medicines were subjected to increased out-of-pocket user charges, although the prices tend to decrease, accompanying an increase in the use of generics.[25] This development had a negative impact on hospital care utilisation and no clear effect was evident on mortality figures.[26] However, maternal and child health services remained free of charge even for non-documented migrants post-2008 when there was diminishing budgetary allocation for health.

Presently, our study has no documented precedence of demonstrating parallel LBW trends for migrant and native European women before and after the 2008 financial crisis.[14] It is possible that the economic crisis affected them differently or they reacted differently to it. The plausible explanation for this variation may be in their contrasting LBW risk factors and the reactionary modification after recession. Possibly, there was a loss of the healthy immigrant effect in the context of a worse impact of the economic crisis on immigrants.[27] It has been proposed that the interaction of fiscal austerity with economic shocks and weak social protection is what ultimately seems to escalate health and social crises in Europe.[23] The vulnerable population including immigrants have been shown to bear greater burden of communicable diseases and there is disproportionate effect of austerity measures on migrant healthcare, even in countries that seem less affected by the economic

Table 3 Trend of low birth weight risk according to maternal and infant characteristics: results of multivariate regression analysis

	Prevalence ratio (PR) and 95% CIs			
	1995–1999	2000–2006 PR (95% CI)	2007–2014 PR (95% CI)	p interaction*
Crude	1	1.083 (1.068 to 1.098)	1.166 (1.150 to 1.182)	
Adjusted†	1	1.119 (1.103 to 1.135)	1.229 (1.103 to 1.235)	
Maternal‡				
Portuguese	1	1.128 (1.112 to 1.144)	1.256 (1.236 to 1.274)	<0.001
Non-Portuguese	1	0.863 (0.809 to 0.921)	0.833 (0.782 to 0.888)	
Maternal age (years)‡				
≤19	1	0. 958 (0.914 to 1.003)	0.937 (0.889 to 0.989)	<0.001
20–34	1	1.151 (1.132 to 1.170)	1.269 (1.248 to 1.291)	
≥35	1	1.066 (1.026 to 1.106)	1.199 (1.156 to 1.244)	
Parity‡				
Primiparous	1	1.130 (1.110 to 1.151)	1.243 (1.219 to 1.267)	<0.001
Multiparous	1	1.098 (1.073 to 1.123)	1.200 (1.172 to 1.228)	
Maternal education (years)‡				
Primary	1	1.114 (1.094 to 1.133)	1.209 (1.186 to 1.232)	0.034
Secondary	1	1.142 (1.105 to 1.181)	1.230 (1.190 to 1.271)	
Tertiary	1	1.102 (1.058 to 1.147)	1.260 (1.213 to 1.310)	
Maternal employment status‡				
Employed	1	1.121 (1.100 to 1.141)	1.248 (1.225 to 1.272)	<0.001
Unemployed	1	1.131 (1.066 to 1.200)	1.209 (1.144 to 1.278)	
Others	1	1.122 (1.094 to 1.150)	1.190 (1.157 to 1.224)	
Infant sex‡				
Male	1	1.114 (1.091 to 1.138)	1.209 (1.183 to 1.236)	0.878
Female	1	1.122 (1.101 to 1.145)	1.245 (1.221 to 1.271)	

*p Value for the comparison of a model with and without the interaction term between the variable and time.
†Adjusted for maternal nationality, maternal age (years), parity, maternal education, maternal employment status and infant sex.
‡Adjusted for all other variables and an interaction term between the variable and time.

downturn.[28 29] On a wider scale, the economic crisis has more effect on 'crisis-sensitive' measures of ill-health, particularly in the longer term. Mainly, it has been observed that the effects of this economic depression were more marked in nations with lower levels of social protection, compared with those with higher levels.[1] In Portugal, there has been an increase in the total expenditure for social protection as a response to the recession. But concomitant percentage expenditure of social protection on family and healthcare has been reduced over the crisis period.

Certainly, there are recognised sociodemographic and biological factors that mediate variations in LBW.[7] We observed an increasing maternal age and LBW risk among older mothers in Portugal during the economic recession (2007–2014). Although there is controversy as to whether age is an independent determinant of intrauterine growth or gestational duration, LBW and preterm births are generally more common after 35 years of age.[7 30] Assisted reproductive technologies are also more frequently present among older women, particularly primiparae, as it were the case in Portugal,

and it is also more frequently associated with twins and adverse pregnancy outcomes.[7 31 32] We partially avoided such effect by limiting our study to singleton births.

Since the 1970s, fertility trends in developed countries have been dominated by the shift in childbearing to ever-later ages.[33] This shift, often described as fertility postponement, may be partly or largely driven by period factors, such as economic ups and downs or sudden changes in the labour market and government policies.[33] The economic uncertainty coupled with waning social support for families during the recession can contribute to magnifying childbirth postponement.[34] Some recent studies expound that the association of economic decline (current and previous) and obstetric outcomes (eg, LBW) is intermediated by direct and indirect modification in fertility behaviour like childbearing postponement.[31 34 35] Given the socioeconomic advantages (higher education, employed and higher income) of those who postpone having children, some authors have argued that the disadvantage experienced by certain groups in the context of a heterogeneous population, as in the USA, would be reduced if

they postponed their births to improve their education and income.[36] It is known that childbearing postponement and child outcome is a complex and varied relationship, especially in heterogeneous populations, but that is not the case in Portugal, where annual registry of births accounted by more than 90% native Portuguese mothers.[35 36]

Fundamentally, socioeconomic circumstance of families provides an alternative causal approach for explaining the time-based variation of LBW. The proxy variables we used to tackle socioeconomic circumstances comprised maternal employment and education. Indeed, the economic crisis may result in adverse effect on population health consequent to heightened unemployment.[37] But the role of education and employment in the association between economic crisis and LBW is not fully understood. Nevertheless, it is known that increased total months worked during pregnancy, total daily working hours and time mothers spent standing up are significant aetiological factors of intrauterine growth retardation.[38] These are critical practices that are associated with an employed mother. In this study, we noted that a tertiary educated and employed mother had a greater LBW risk during the economic contraction. Contrary to our result, another study reports that women with higher education had lower risk of LBW after the onset of the economic crisis in Andalusia, Spain; an area accounting for 19% of births in the country.[39] The variation in maternal social characteristics, health behaviours and health system may explain the differences in maternal educational gradient and LBW relationship for Portugal and Spain during the recession.

The consequences of the economic crisis on population health occur suddenly or gradually.[23] This study showed that the alteration in LBW trend started even before the implementation of austerity measures later in the recession. This finding reaffirms that the impact of the economic crisis on LBW is mediated by the synergistic effect of multiple factors. A causal perspective that may explain the sudden change in the course of LBW trend infers that maternal exposure to stressful life events like economic crisis prior to conception or during pregnancy influences infant birth weight.[40–44] During the recent economic crisis, high levels of antenatal stress, anxiety and depressive symptoms have been documented among low-risk pregnant women, in an economically impacted area of Ireland.[43] Tragic events are also known to trigger communal bereavement, which lead to perinatal health outcome changes as illustrated by the significant surge in very LBW the months following the Swedish Prime minister Olof Palme's murder in 1986 or the sinking of a ferry in Estonia in 1994.[45]

The articulation of a comprehensive causal framework is important for a detailed investigation of the aetiological process of the impact of economic crisis on LBW. This would have augmented our explanation of LBW trend and its intermediary factors. Unfortunately, the Portuguese birth registry system we based our analysis does not collect information on LBW risk factors, such as maternal substance abuse, prenatal care and morbidity.[46] Maternal smoking has been identified as the most important and modifiable risk factor for LBW in developed countries. But there is an indirect evidence of a rise in smoking among women of childbearing age in Portugal that preceded the economic crisis.[47] Thus, we expect that the independent role of this factor on LBW might add complexity to the estimated association during the study period.

The initiation year of this study was selected to cover a sufficiently long period so that sustainable trends could be accommodated. Hence, the major strengths of our study were the large sample size and extensive observation time that was sufficient to our hypothesis. The duration had allowed a satisfactorily lengthy interval that enabled simultaneous observation of time-based variation of LBW and part of its potential mediators (maternal characteristics). The Poisson regression analysis we employed has the advantage of accounting for the fluctuation across time and the variability at each time point. In addition, it is useful in detecting abrupt changes and describing shifting time trends that are applicable to our aim of detecting variation, particularly due to the economic recession without forcing any prejudgement.

The prolongation of the economic crisis portends a threat to perinatal healthcare, especially for non-Portuguese and vulnerable mothers with increased LBW risks; older (>35 years), tertiary educated and employed. Therefore, it is necessary to improve labour conditions of pregnant mothers and minimise other stressful circumstances.[38] It is discernible that in times of financial hardship, there is a temptation to revise the universal health policy and cut services for minority populations.[28] Accordingly, the health system should effectively maintain social equity in perinatal healthcare access and outcomes. It is noteworthy that in a developed country setting, non-resident women without healthcare coverage are more susceptible to adverse perinatal outcome than their native counterparts.[48] Even though, the universal healthcare and perinatal healthcare system instituted over three decades contributed to the mitigation of adverse perinatal outcomes for all categories of mothers in Portugal.[16 17] The continuous reduction in public health expenditure constitute a detriment to assuring access, equity and quality of perinatal care because health systems require predictable sources of revenue to plan in a sustainable way.[25]

CONCLUSIONS AND POLICY IMPLICATIONS

The 2007–2008 global financial crisis is associated with increased LBW occurrence in Portugal that is more evident in infants of non-Portuguese mothers. It is not possible to conclusively propose a mediatory mechanism

on how the financial crisis resulted in a higher rate of LBW and to what extent the resilience of available health and social responses buffered the effect of adverse individual or social level exposures. Further research will be required to improve the understanding of the role of particular factors, such as maternal nationality, fertility behaviour and the amplification of late maternity, substance abuse and mental stress, in the variation of LBW during periods of economic depression. The continuous monitoring of relevant risk factors, the quality assurance of the process and information on further indicators, as part of data routinely collected by the national birth registration system, are essential. Finally, there should be strengthening of social policies aimed at maternity protection for non-Portuguese, working and other vulnerable mothers. The health system should sustain its capacity to effectively maintain social equity in perinatal healthcare access, utilisation and quality.

Contributors MAK and HB conceived and designed the study and analysis. SC, MAK and BP collected data and prepared the data sets. MAK, BP, MS and HB analysed the data. MAK drafted the manuscript. HB reviewed, edited and revised the manuscript as well as supervised all the processes. All authors interpreted data and revised the manuscript critically for intellectual content. Finally, all the authors read and approved the final version.

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