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RESEARCH PAPER

Factors determining the variation in birth weight in Spain (1980–2010)

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***Background*: Low weight and premature deliveries arouse clinical interest concerning the survival of newborns. The determinants of birth weight among Spanish natives and immigrants may differ. Research which considers maternal origin and associated factors such as age and parity is important.**
***Aim*: This study analyses and models the influence of the rapid and intense arrival of immigrants in Spain on birth weight variation.**
***Method*: Data on deliveries from the Spanish National Institute for Statistics ($n = 9\ 443\ 882$) are analysed regarding low birth weight, premature births and other variables. The inter-relation among these variables was interpreted by means of logistic regression models.**
***Results and conclusions*: The birth weight has decreased since 1980 in Spain, but has slightly recovered in recent years. Meanwhile the percentage of foreign maternities increased to 17.3% in 2010. Logistic regression models assess the different influence of variables known to determine low birth weight (weeks of gestation, sex, etc.) and other maternal characteristics (age at delivery, professional activity, etc.). The progressively greater contribution of foreign women to total births in Spain and their differential numerical input to the various risk groups have slowed the pattern of reduction in the mean weight of newborns in this country.**

Keywords: Premature births, low birth weight, maternal characteristics, logistic regression, immigration

INTRODUCTION

Birth weight varies according to changes in physiological, nutritional and socio-cultural factors influencing the reproductive pattern of women. An increase in the frequency of low weight or premature deliveries in a population arouses clinical interest in its effect on the chances of survival of the newborn (Wells 2002; Kirchengast and Hartmann 2003a, b).

Based on Spanish nationwide micro data, Rodríguez et al. (1995) studied socio-demographic factors associated with low birth weight using a sample of 52 200 births occurring in 1988. Bernis (2005, 2006) reported for the total deliveries occurring in Spain in the year 2000 that immigrants had infants with a significantly higher birth weight than natives. This author attributed this difference to non-uniform intra-uterine conditions which may reflect external circumstances affecting mothers from various geographic areas in different ways. Analysing aggregated data on births for the period 1981–2002, Alonso et al. (2005) indicated a gradual decrease in the temporal distribution of birth weight, considering several categories of weight, ranging from light to heavy.

Other antecedents on this subject in Spain include studies based on information from samples of deliveries occurring in maternity wards, each one usually restricted to a single locality. Thus, Alonso et al. (1999a, b) provided foetal growth tables and curves for weight and other metric measures corresponding to 24 823 newborns in Madrid. Pérez Cuadrado et al. (2004) studied a sample of 203 immigrant women delivering at a university hospital in the same city. A more recent study by Alonso (2008) is based on information on 1785 women who attended the main public maternity ward in Madrid (La Paz Hospital) with regard to their socioeconomic, demographic, metric, reproductive and health indicators and habits. Deliveries occurring at the same clinic were also assessed by Acevedo et al. (2009). In addition, Luque et al. (2010) studied the reproductive pattern according to maternal country of origin in Spain.

In a recent paper, Tsimbos and Verropoulou (2011) compared the determinants of birth weight in Greece among natives and immigrants, using data from the national

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register, as does this paper, and considering a single year (2006).

The aim of the present paper is to model the temporal change in trend in newborn weight in Spain, using information provided by the Spanish National Institute for Statistics. This information consists of individual mother–child data for total deliveries occurring in the period 1980–2010. Since 1996, when information on deliveries from non-Spanish mothers began to be available, their relative contribution increased from 2.3% in 1996 to 17.3% in 2010 and it became possible to add the immigration factor to the study. In order to explain the different temporal pattern according to the mothers' origin, an analysis was carried out to assess which categories of the variables considered represent possible risk factors for low birth weight and whether the proportions of Spanish and immigrant mothers in these categories are similar or different.

The main interest of this study lies in the recent phenomenon of mass immigration occurring in Spain and the fact that the public health system has so far provided universal assistance regardless of the irregular legal status of immigrants, thus creating comparable medical conditions for native and foreign mothers. The identification of risk categories and their change over time will make it possible to justify any differential evolution in birth weight in view of the mothers' origin.

MATERIALS AND METHODS

The most recent information available on 13 460 964 individual registers of live deliveries occurring between 1980 and 2010 was obtained as yearly text files from the Spanish National Institute for Statistics (INE). Consecutive changes in 1997 and 2006 in the structure of these files made it necessary to re-organize and re-classify certain variables to obtain a single file.

The quality of the registration was not uniform. A progressive temporal improvement in the recording of birth weight was evident from 1980 (62.8%) to 1996 (94%). Before 1996, 18.7% of birth weights were not recorded. Thereafter, misreporting remains close to 5%.

Only mothers having their residence in Spain and delivering live children were included in the analysis. The sample obtained after the elimination of discarded cases consisted of 9 443 882 valid entries, 70.16% from the original database.

In the present paper, single and multiple maternities were considered in order to obtain more accurate knowledge on weight variation in newborns, despite the well-known fact that double and triple deliveries tend to weigh less than singletons (Joseph et al. 1998; Moshin et al. 2003). A few extremely low weights (<400 g) registered as live newborns were considered invalid because of the incongruity between gestational age and survival. The minimum range for weeks of gestation was ≥ 20 weeks, following the same criterion applied by Moshin et al. (2003). Because in Spain only cases of 26 weeks or more are compulsorily registered, our selection constitutes an under-estimation. Omitted were outlier values, such as family sizes surpassing 17 or maternal ages of 55 or older. Absence of data or values out of range were considered as missing for the following variables: birth weight, duration of gestation, province of residence of the mother, parity, maternal age and the survival/stillbirth condition.

To provide a direct visualization of temporal trends, birth weight was treated as a categorical variable (low ≤ 2499 g; normal ≥ 2500 g). Duration of gestation was also grouped (premature ≤ 36; normal 37–41; post-term ≥ 42). Also categorized were the maternal age at delivery (<20 years; 20–24; 25–29; 30–34; 35–39; ≥ 40) and the parity (first: 1; non-first: ≥ 2). For the maternal origin two groups were analysed (Spanish; foreign).

Concerning the mother's professional and job activity, the 13 initial categories were reduced to four groups (unpaid or benefit recipients; low qualification; intermediate qualification; high qualification).

Temporal changes in birth weight were fitted by means of polynomial regression models which make it possible to determine the lowest value for the fitted curve.

Inter-population variability in average birth weight is mostly determined by the different proportions of low birth weight (LBW) with regard to total deliveries. For this reason logistic regression models were applied in the following analysis, taking low birth weight (<2500 g) as the dependent variable. To apply these models, new variables (dummy variables) were created with values equal to 0 or 1 and one was chosen as a reference.

Because there was a different temporal trend regarding the average birth weight of children born to Spanish (S) and non-Spanish (NS) mothers (see Figure 1), logistic regression analysis was performed separately for the two groups based on maternal origin. When a single regression model including the mother's origin as an explanatory variable was tentatively applied, the terms of interaction between mother's origin and the explanatory variables proved to be significant. With these interactions the expressions for the results of the odds are less immediate (Hosmer and Lemeshow 2000), making the interpretation of the results unclear. The R^2 Negelkerke coefficient was applied to assess the goodness of fit of the logistic regression models.

For each year, Chi-square tests were used to compare proportions between S and NS for risk categories.

The statistical analyses and graphic representations were done using SPSS19 and Statgraphics Centurion XVI.

RESULTS AND DISCUSSION

The mean maternal age for all parities in Spain has increased significantly since 1980, from 27.11 to 31.55. This increase was mainly the result of delayed first maternity, which, according to our own calculations based on the selected valid registers, went from the age of 24.08 in 1980 to 30.25 in 2010 (Table I, left). The same situation has been reported for most western countries and has been attributed largely to the change in women's roles in today's society (Surkyn and Lesthaeghe 2004; Billari et al. 2006). In Spain, the lack of

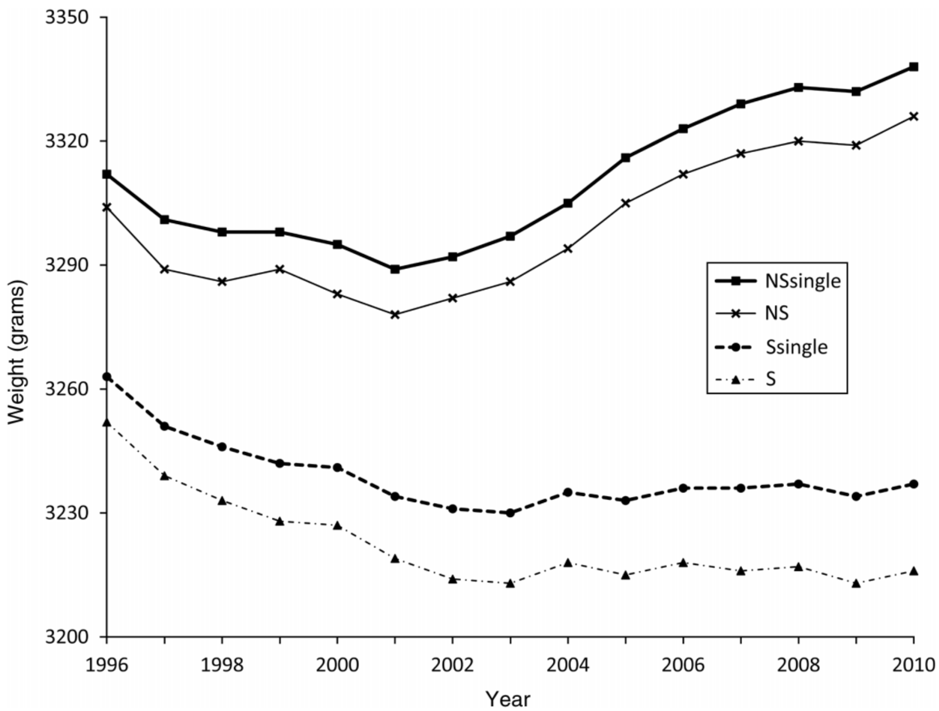

Figure 1. Yearly average birth weight (in grams) according to mothers' origin (S = Spanish; NS non-Spanish). Single = only single deliveries.

adequate social support and job instability are additional factors which make it difficult for women to combine maternity and work. These increased age patterns are reflected in a progressively larger proportion of mothers aged 30–39 years, while young pregnancies (20–24 years) have declined and, since 1993, pregnancies for women aged 25–29 have also decreased.

Associated with delayed first maternity and reduced family size, the proportion of newborns corresponding to the first parity increased from 43.24% in 1980 to 54.32% in 2010. Since 1989, first parities surpassed those of second or subsequent birth orders.

Weight at birth and the proportion of premature births (<37 weeks) are the variables most commonly used to predict the post-natal survival of the newborn (Cameron and Demerath 2002). In Spain the frequency of premature births was over 20% until 1983 and after that declined to values of ~ 7%, where they have been since the end of the 1990s (Table I, right). The same table shows the percentages for multiple deliveries and low birth weight. Percentages for these two variables have progressively increased, with the highest values recorded at the end of the past decade.

According to Kirchengast and Hartmann (2003a, b), the variation in mothers' ages influences newborn weight in diverse manners: heavy weights (≥4000 g) are associated with an elevated maternal age, but efficient obstetric monitoring of pregnancies may have reduced the incidence of heavy weight newborns caused by long-term pregnancies, as well as leading to changes in the proportion of premature deliveries. In Spain, since 1980 a downward trend can be observed in birth weight from 3394.92 g in 1980 to 3221.64 g in 2002 (Table I, middle). Subsequently, a slight recovery took place, reaching an average of 3235.48 g in 2010. This recovery fits a polynomial regression model, in which the second term is significant ($p = 0.000$) according to the equation Weight = 0.000 001 17 − 1166.89 Year + 0.291 Year^2 (coefficient of determination $R^2 = 0.985$). This equation also determines that the minimum value for the fitted curve corresponds to the year 2003 (Figure 2).

Studies regarding birth weight and gestational age are not always consistent. Thus, Barros et al. (2005) in Brazil found for the period 1982–2004 a reduction of the mean birth weight parallel to a higher frequency of < 2500 g deliveries and a lower proportion of pregnancies reaching 39 weeks; but Wen et al. (2003) in Canada and Bergmann et al. (2003) in Germany reported the opposite trend.

Maternal origin was first officially recorded by the INE in 1996. Table II shows the mean birth weight separately for Spanish and non-Spanish mothers. Low birth weight has always been more closely related to premature deliveries (<37 weeks) than to slow growth (≥37), especially among S mothers. Percentages of LBW with regard to total deliveries have progressively increased over time in both mothers' groups, regardless of maturation, but the earlier pattern linking maternal origin and premature-growth retardation remained (Table II, middle).

The differential behaviour of mean birth weight with regard to maternal origin (higher in NS than in S mothers) is shown in Figure 1. The differences are evident when both single and total deliveries are considered. This fact, together with the increase in the contribution of foreign mothers, must be taken into account when explaining the recovery in the average birth weight shown in Figure 2.

Table I. Yearly total number of deliveries (n). Descriptive statistics for average maternal age, first maternity age and birth weight in grams.

		Age all		Age first		Birth weight		Percentage		Maturity %		
Year	n	M	SD	M	SD	M	SD	MULT	LBW	<T	T	>T
1980	283 757	27.11	5.69	24.08	4.62	3394.92	501.05	0.80	3.18	36.49	61.60	1.90
1981	237 424	27.10	5.65	24.11	4.58	3383.81	504.45	0.96	3.31	24.26	73.40	2.32
1982	221 892	27.15	5.64	24.24	4.67	3375.36	504.61	1.09	3.47	22.07	75.30	2.62
1983	214 548	27.22	5.58	24.42	4.69	3354.64	506.39	0.77	3.75	20.53	76.12	3.33
1984	239 937	27.33	5.51	24.69	4.72	3336.41	500.57	0.76	3.91	17.28	79.17	3.53
1985	244 109	27.46	5.44	24.96	4.71	3320.65	497.34	0.78	4.09	15.70	80.12	4.16
1986	266 286	27.63	5.34	25.19	4.72	3303.64	501.48	0.87	4.36	13.48	80.90	5.61
1987	279 965	27.70	5.29	25.44	4.74	3302.74	501.93	0.91	4.46	13.17	82.63	4.18
1988	273 040	27.75	5.20	25.60	4.71	3296.76	499.18	0.89	4.47	11.76	84.31	3.91
1989	258 643	27.95	5.10	25.96	4.69	3284.24	497.74	0.95	4.72	10.44	85.27	4.28
1990	258 778	28.11	5.03	26.21	4.67	3281.81	498.23	0.98	4.73	9.50	86.11	4.37
1991	249 619	28.35	4.97	26.61	4.71	3273.69	499.65	1.01	4.95	10.26	85.25	4.48
1992	255 654	28.64	4.90	27.01	4.70	3272.74	495.53	1.01	4.93	9.88	85.96	4.15
1993	446 252	28.88	4.84	27.33	4.69	3275.24	496.48	1.06	4.98	8.56	86.82	4.61
1994	282 195	29.10	4.88	27.56	4.77	3263.76	489.51	1.13	4.79	8.01	84.66	7.31
1995	293 734	29.38	4.85	27.87	4.79	3251.58	494.84	1.21	5.37	7.86	86.23	5.90
1996	290 198	29.62	4.83	27.98	4.68	3254.29	488.34	1.23	5.14	6.56	88.14	5.28
1997	300 769	29.84	4.88	28.23	4.75	3241.53	491.62	1.32	5.54	6.53	88.28	5.18
1998	300 774	30.05	4.92	28.45	4.82	3235.74	495.53	1.41	5.76	6.82	88.51	4.65
1999	312 162	30.20	4.98	28.59	4.88	3231.21	498.48	1.52	5.98	6.95	88.19	4.84
2000	330 531	30.31	5.00	28.75	4.90	3230.52	500.11	1.59	5.99	6.94	88.85	4.19
2001	341 555	30.38	5.09	28.83	4.98	3223.82	500.80	1.64	6.26	6.84	88.98	4.17
2002	354 564	30.48	5.12	28.99	5.00	3221.64	505.30	1.77	6.46	7.18	88.71	4.09
2003	375 791	30.58	5.14	29.11	5.03	3221.84	504.88	1.80	6.46	7.16	88.73	4.09
2004	387 200	30.68	5.15	29.25	5.05	3228.21	507.83	1.79	6.43	7.12	89.18	3.69
2005	398 583	30.78	5.17	29.37	5.10	3228.16	509.21	1.84	6.50	6.66	89.65	3.67
2006	399 582	30.86	5.22	29.47	5.17	3232.47	511.95	1.89	6.53	6.96	89.73	3.30
2007	378 849	30.94	5.27	29.53	5.23	3233.47	521.99	2.04	6.89	7.24	89.59	3.15
2008	397 492	31.03	5.31	29.63	5.32	3236.26	531.00	2.02	7.06	7.19	89.72	3.07
2009	384 129	31.31	5.31	29.98	5.34	3232.04	529.94	2.20	7.09	7.11	89.87	3.01
2010	379 676	31.55	5.69	30.25	5.33	3235.48	527.36	2.14	7.02	6.90	90.27	2.82

M, average; SD, standard deviation.
Percentages of multiple deliveries (MULT) and low birth weight (LBW $<$ 2500 g). Maturity: percentage of Premature $<$ 37 weeks ($<$ T), at term (T) and post-term $\geq$ 42 weeks ($>$ T) deliveries.

Since the temporal evolution of birth weight was not the same for Spanish and non-Spanish mothers (the increase was more accentuated for the latter group), each group is studied separately in the analysis below.

The average birth weight reduction for the Spanish group fits the following equation: Weight $= 0.000\,001\,38 - 1382.57 \times \text{Year} + 0.344 \times \text{Year}^2$ with a coefficient of determination $R^2 = 0.920$. The minimum for the function corresponds to the year 2005 (Figure 3).

In the non-Spanish group, the average birth weight initially decreased but later recovered (Figure 4). For this group the equation obtained is: Weight $= 0.000\ 000\ 199 - 1991.51 \times \text{Year} + 0.497 \times \text{Year}^2$ and $R^2 = 0.8537$. The minimum for the fitted function occurred in the year 2000.

The minimum values provided by these quadratic equations (in 2000 for NS and in 2005 for S) indicate a change in the temporal trend which must be taken into account.

Low birth weight makes a significant contribution to the average variation in birth weight and points to the suitability of applying logistic regression models taking LBW as the dependent variable ($<$2500 g is the reference category) in order to interpret the differing evolutions reflected by the above two equations for S and NS mothers. Table III shows the odds ratios after the logistic regression and their corresponding p-values. Following the categories of reference for the variables analysed, the three first columns represent Spanish mothers for each of the periods considered and the remaining three represent non-Spanish mothers. Periods are defined by the minimum values corresponding to the quadratic equations (1996–2000, 2001–2005 and 2006–2010). At the bottom, the goodness of fit is given by the Negelkerke's R^2 coefficient.

Regarding sex, taking males as the reference category, the odds values are similar irrespective of period both for the S and the NS. Odds values greater than 1 mean an increased probability of low birth weight in females.

With respect to birth order, mothers with at least one previous child (non-first) were the reference category. Odds greater than 1 correspond to an increased probability of low birth weight in first deliveries, especially in the Spanish group.

For multiparity the reference category is assigned to single deliveries. Multiple deliveries show odds values above 1, which indicates a higher probability of low weight at delivery. Values have decreased over time, a fact that can be interpreted as a progressively lower influence of multiparity as a risk factor for LBW. This applies both to S and NS mothers.

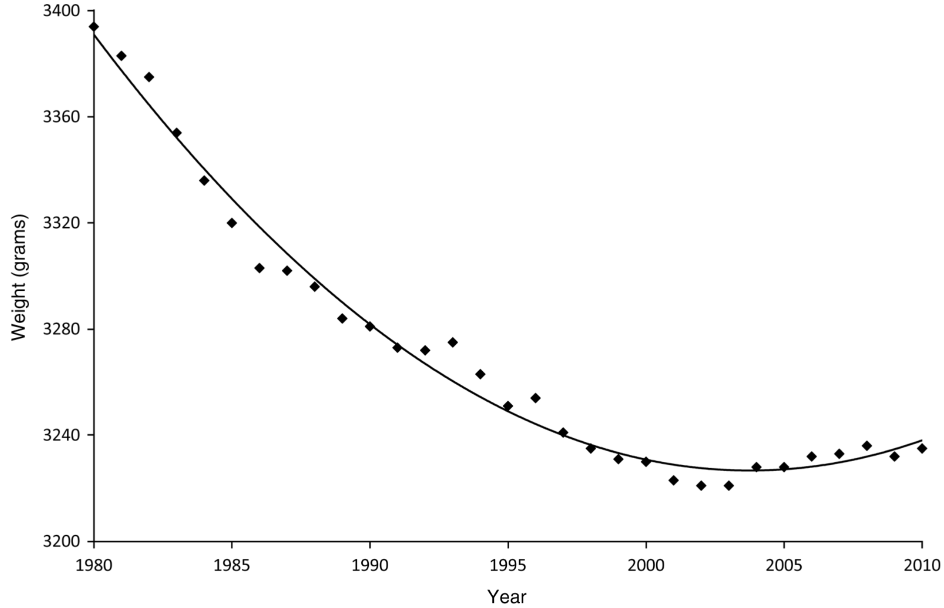

Figure 2. Yearly evolution of the average birth weight (in grams) in Spain: observed values and fitted curve.

For weeks of gestation, when the reference is ≤ 36 weeks, all odds have values of < 1. Moreover, they are very close in both groups of maternal origin.

For mother's age, the reference category was < 20. Only mothers aged 40 or older represented a risk regarding low weight at birth. The age categories of 20–24 and 35–39 are not significantly different from < 20 for Spanish mothers, while for non-Spanish mothers the above is true only for the 35–39 category.

Regarding maternal professional and job qualifications, the reference category was assigned to 'unpaid'. High qualifications are always a significant protective factor against low birth weight. Whatever the period, the odds are similar for S and NS mothers.

Although the variables mentioned above influence low birth weight over time in a similar way regardless of the maternal origin group (S-NS), Figures 3 and 4 show a differential evolution of birth weight (increase for NS and decrease for S). The next question is whether this divergent evolution can be explained by the variation over time in the proportion of mothers from the S and NS groups included in each of the risk categories.

The yearly percentage of female newborns with respect to maternal origin remained roughly constant. No significant

Table II. Left: Yearly total number of deliveries (n) and average birth weight (M).

	Birth weight (g)				LBW (< 2500g)				Duration of gestation					
	Spanish		Non-Spanish						Spanish			Non-Spanish		
Year	n	M	n	M	S < 37	S ≥ 37	NS < 37	NS ≥ 37	< T	T	> T	< T	T	> T
1996	281 625	3252.76	8573	3304.82	2.81	2.35	2.74	1.95	6.58	88.14	5.27	6.01	88.31	5.66
1997	290 387	3239.81	10382	3289.66	2.97	2.59	2.84	2.41	6.54	88.30	5.14	6.06	87.63	6.29
1998	289 479	3233.76	11295	3286.45	3.16	2.61	3.20	2.45	6.83	88.52	4.63	6.46	88.34	5.18
1999	298 342	3228.52	13820	3289.26	3.34	2.66	3.12	2.43	6.98	88.24	4.76	6.27	87.25	6.46
2000	311 780	3227.32	18751	3283.85	3.36	2.66	3.30	2.33	6.96	88.93	4.10	6.68	87.58	5.72
2001	315 384	3219.30	26171	3278.26	3.51	2.80	3.36	2.32	6.84	89.06	4.08	6.79	87.99	5.20
2002	319 617	3214.99	34947	3282.51	3.73	2.83	3.34	2.31	7.20	88.84	3.94	6.93	87.56	5.49
2003	332 595	3213.38	43196	3286.95	3.75	2.83	3.42	2.19	7.18	88.87	3.93	7.03	87.63	5.32
2004	337 326	3218.41	49874	3294.51	3.70	2.83	3.42	2.39	7.16	89.34	3.49	6.92	88.06	5.00
2005	342 398	3215.54	56185	3305.11	3.70	2.98	3.29	2.19	6.70	89.84	3.44	6.44	88.47	5.08
2006	339 671	3218.43	59911	3312.07	3.71	2.99	3.37	2.25	6.92	89.88	3.18	7.15	88.89	3.94
2007	315 660	3216.73	63189	3317.10	4.03	3.05	3.69	2.29	7.13	89.76	3.09	7.79	88.73	3.46
2008	325 549	3217.69	70619	3320.79	3.95	3.32	3.61	2.50	7.09	89.91	2.98	7.66	88.88	3.44
2009	315 371	3213.05	67387	3319.59	3.99	3.32	3.68	2.41	7.03	90.05	2.90	7.48	89.00	3.50
2010	313 056	3216.24	65264	3326.21	3.89	3.38	3.43	2.45	6.87	90.39	2.72	7.06	89.64	3.28

Middle: Low birth weight rates (<2500 g) for premature (<37 weeks) and births at term (≥37) per 100 deliveries (regardless of weight). Right: Percentage of premature (< T), at term (T) and post-term ≥ 42 weeks (> T) deliveries, according to maternal origin: Spanish (S) and non-Spanish (NS).

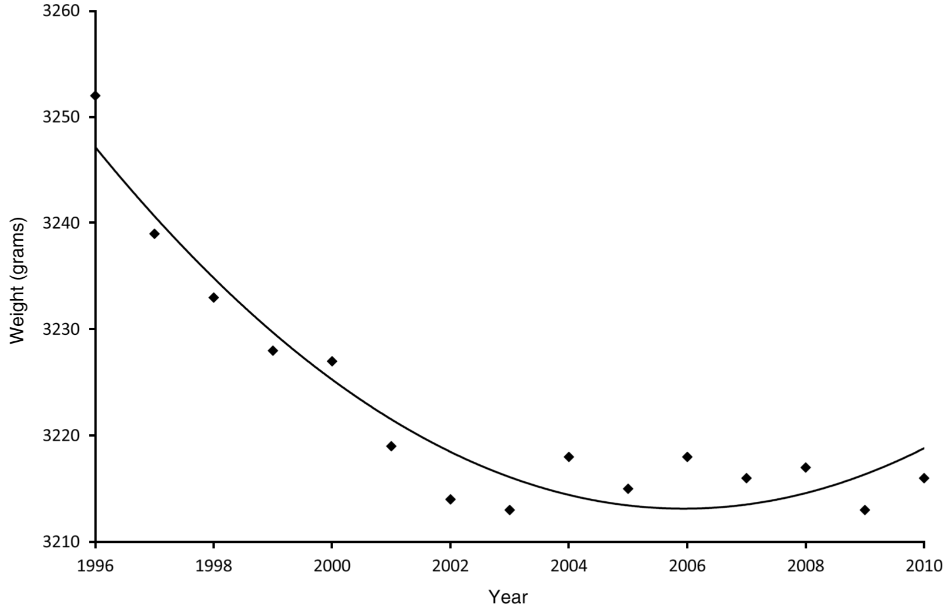

Figure 3. Spanish maternities: Yearly evolution of the average birth weight (in grams). Observed values and fitted curve.

differences were found between S and NS (all $p > 0.065$) for any year. Therefore, sex does not explain any differential behaviour regarding weight.

Figure 5 shows the percentages of first deliveries. Regardless of the year, significant differences occur between S and NS (all p-values < 0.000). For NS the proportion of first deliveries has decreased since 2006, which could partially explain the increase in birth weight in this group of mothers.

The yearly variation in multiple delivery rates is shown in Figure 6. Since 1999, differences between S and NS are significant (all p-values < 0.000). Multiple deliveries increased significantly in the Spanish group in comparison with the non-Spanish group (Fuster et al. 2008). To a certain extent, this could explain the reduction in birth weight over time in children born to Spanish mothers.

Table II gives the percentages of premature births. Since 2005, significant differences can be seen between S and NS (all $p < 0.025$). Moreover, the frequency of premature births declined in S but even more so in NS. This fact would explain the recovery in birth weight in both groups.

For maternal age, the two highest risk categories were grouped together (<20 and > 40 years). Figure 7 shows the corresponding frequencies per 1000 deliveries. In NS the

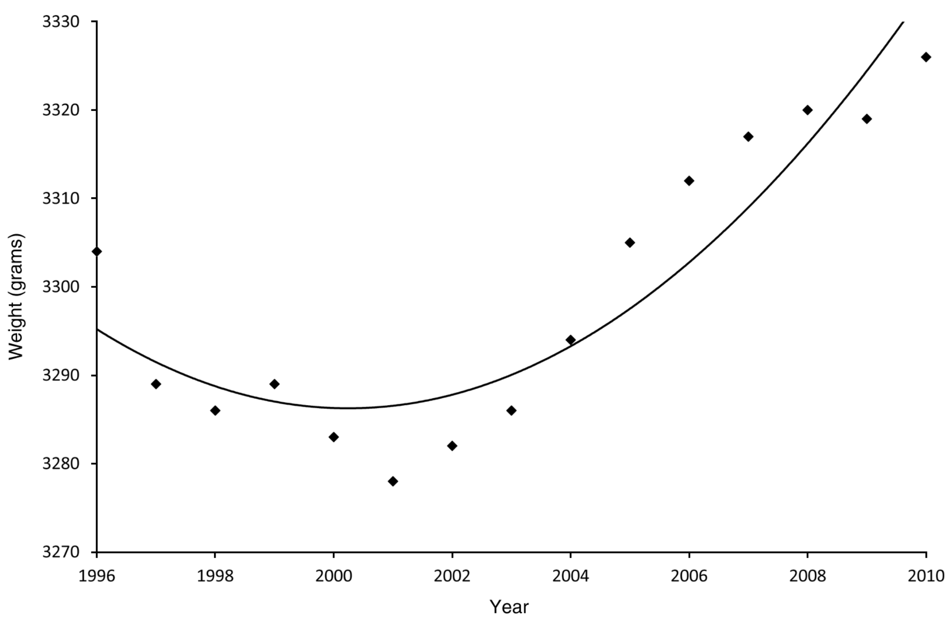

Figure 4. Non-Spanish maternities: Yearly evolution of the average birth weight (in grams). Observed values and fitted curve.

Table III. Odds ratios in logistic regression models. Dependent variable: LBW < 2500 g is the reference category. Explicative variables: sex, birth order, multiparity, maturation in weeks, mother's age at delivery and professional and job qualification. Spanish and non-Spanish mothers according to groups of years (P1: 1996–2000; P2: 2001–2005; P3: 2006–2010) and *p*-values. The reference category for variables is indicated by REF column.

		Spanish mothers			Non-Spanish mothers		
Variable	Ref	P1	P2	P3	P1	P2	P3
Sex, female	Male	1.390	1.453	1.454	1.391	1.333	1.340
		$p = 0.000$	$p = 0.000$	$p = 0.000$	$p = 0.000$	$p = 0.000$	$p = 0.000$
Parity, first	no-first	1.462	1.465	1.507	1.329	1.350	1.375
		$p = 0.000$	$p = 0.000$	$p = 0.000$	$p = 0.000$	$p = 0.000$	$p = 0.000$
Delivery, multiple	Single	16.816	15.295	12.040	17.608	13.604	11.690
		$p = 0.000$	$p = 0.000$	$p = 0.000$	$p = 0.000$	$p = 0.000$	$p = 0.000$
Weeks 37–41	(≤36)	0.042	0.037	0.036	0.003	0.033	0.035
		$p = 0.000$	$p = 0.000$	$p = 0.000$	$p = 0.000$	$p = 0.000$	$p = 0.000$
Weeks ≥ 42	(≤36)	0.010	0.010	0.009	0.006	0.007	0.013
		$p = 0.000$	$p = 0.000$	$p = 0.000$	$p = 0.000$	$p = 0.000$	$p = 0.000$
Age 20–24	(<20)	0.958	0.971	0.970	0.729	0.876	0.827
		$p = 0.068$	$p = 0.216$	$p = 0.250$	$p = 0.002$	$p = 0.004$	$p = 0.000$
Age 25–29	(<20)	0.888	0.867	0.904	0.710	0.854	0.838
		$p = 0.000$	$p = 0.000$	$p = 0.000$	$p = 0.000$	$p = 0.000$	$p = 0.000$
Age 30–34	(<20)	0.940	0.876	0.898	0.732	0.934	0.894
		$p = 0.005$	$p = 0.000$	$p = 0.000$	$p = 0.001$	$p = 0.143$	$p = 0.006$
AGE 35–39	(<20)	1.041	0.996	0.998	0.726	1.048	0.995
		$p = 0.092$	$p = 0.871$	$p = 0.938$	$p = 0.000$	$p = 0.363$	$p = 0.919$
Age ≥ 40	(<20)	1.201	1.146	1.175	0.865	1.369	1.166
		$p = 0.000$	$p = 0.000$	$p = 0.000$	$p = 0.026$	$p = 0.000$	$p = 0.000$
Job, low	Unpaid	0.911	0.975	0.937	0.861	0.894	1.016
		$p = 0.000$	$p = 0.023$	$p = 0.000$	$p = 0.002$	$p = 0.000$	$p = 0.518$
Job, medium	Unpaid	0.810	0.837	0.845	0.893	0.885	0.960
		$p = 0.000$	$p = 0.000$	$p = 0.000$	$p = 0.030$	$p = 0.000$	$p = 0.066$
Job, high	Unpaid	0.839	0.839	0.742	0.829	0.815	0.882
		$p = 0.000$	$p = 0.000$	$p = 0.000$	$p = 0.021$	$p = 0.000$	$p = 0.000$
Negelkerke's R^2		0.315	0.338	0.353	0.333	0.343	0.340

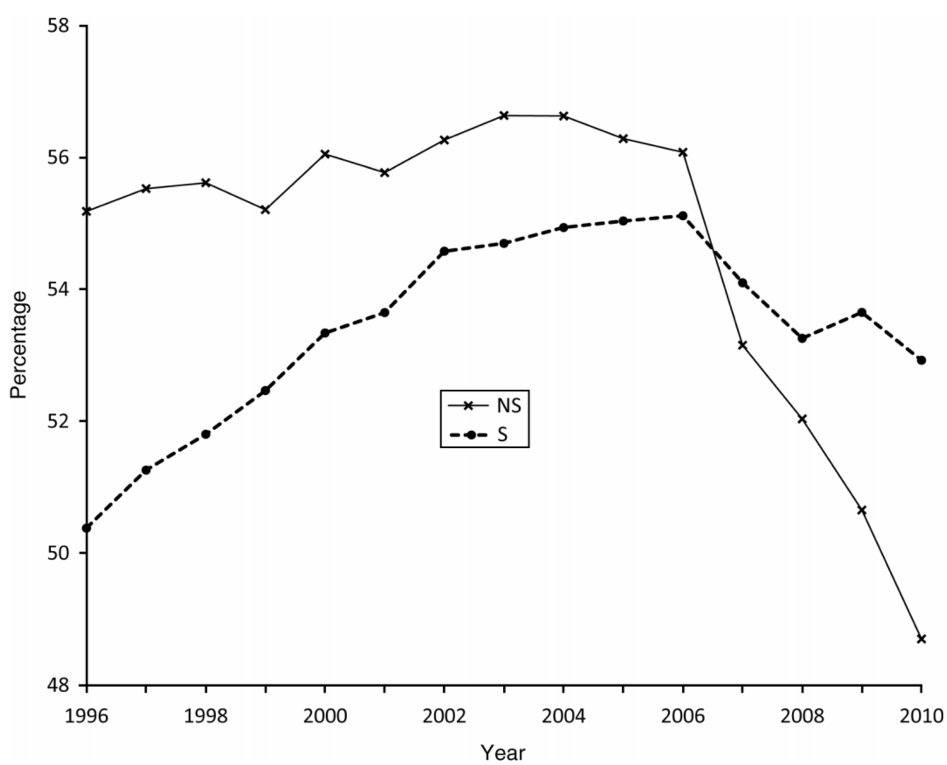

Figure 5. Yearly percentage of first parities according to mothers' origin (S = Spanish; NS = non-Spanish).

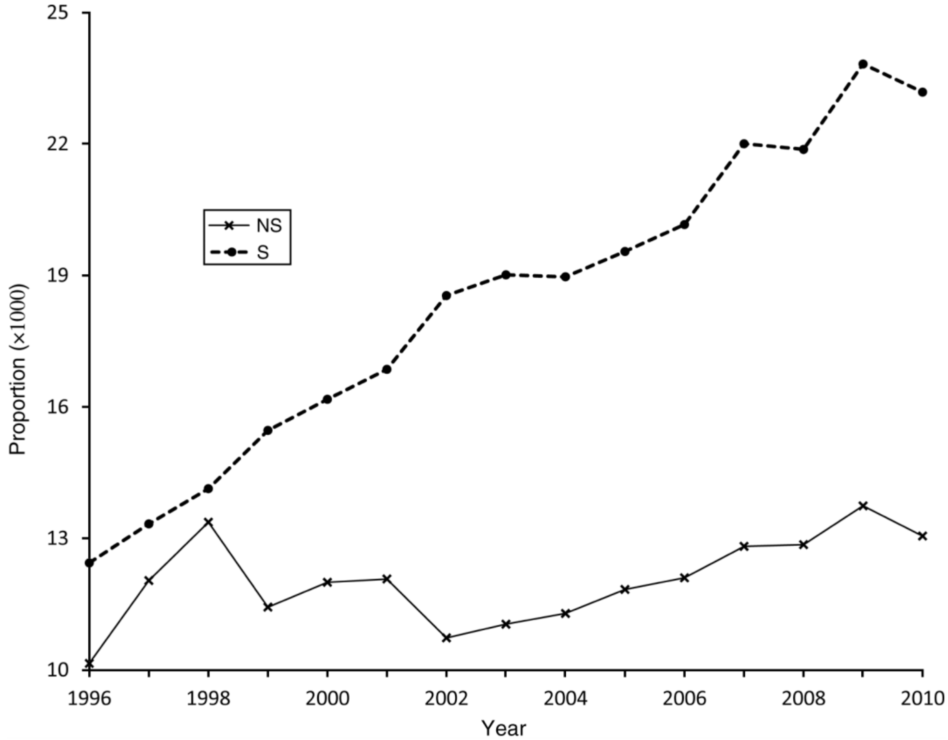

Figure 6. Yearly proportion of multiple deliveries of maternities (× 1000) according to mothers' origin (S = Spanish; NS = non-Spanish).

frequency for this new age grouping decreased, which would be compatible with an increase in the average birth weight. The opposite applies to Spanish mothers.

Only the category of high professional and job qualifications is significant in all of the logistic regression models, irrespective of maternal origin. Although from 1996–2010 the proportions for this category increased evenly over time, both in S (from 19.58–29.89) and NS (from 7.54–10.77), there were significant differences between both groups (all p-values < 0.000).

Variation in distribution of ages at maternity was observed between Spanish and non-Spanish mothers from 1996–2010. In the first group, the age increase was due to a progressively larger number of maternities in the age range

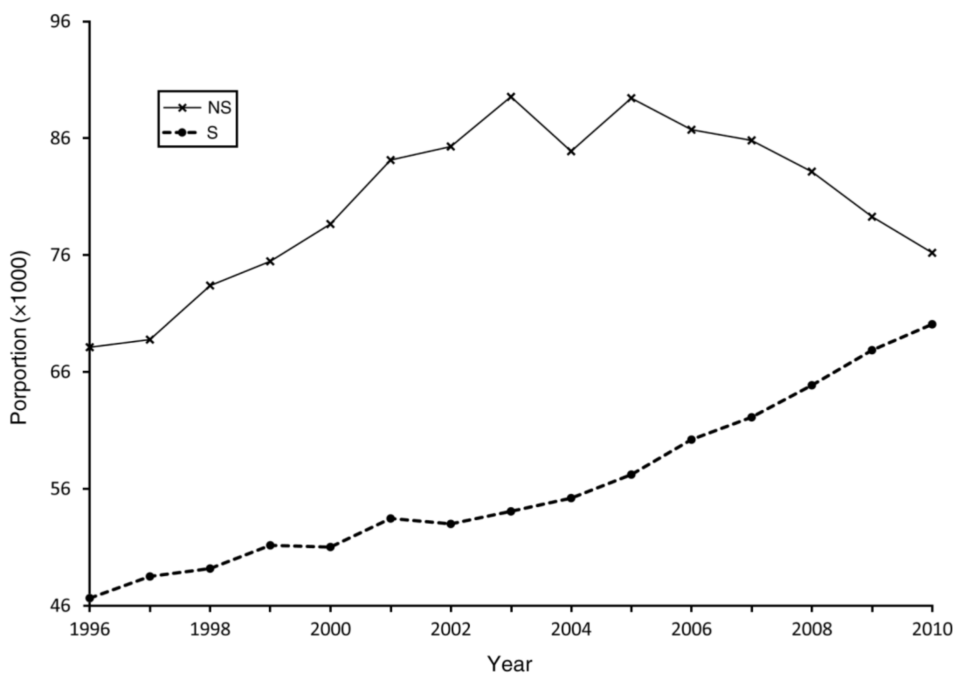

Figure 7. Yearly proportion of mothers aged < 20 or ≥ 40 years (× 1000 deliveries), with regard to maternal origin (S = Spanish; NS = non-Spanish).

of 30–39, while between 20–29 the number decreased. In non-Spanish mothers, maternities increased for ages 20–29, reaching a maximum in 2008; the opposite temporal change occurred for ages 30–39. The age gap in 1996 between both groups of mothers was 0.71 years, reaching 2.99 in 2010. This evolution agrees with the slowing of the reduction in birth weight shown in Figure 2.

In comparison to subsequent parities, less heavy children correspond to the first parity, a result coinciding with those reported by, among others, Mariotoni and Barros Filho (2000) and Rosenberg (1988). The temporal variation in weight (Table I) agrees with the change in these categories for parity. Both for Spanish as well as for non-Spanish mothers, the average weight for the first child is lower than the weights in subsequent parities. Regardless of parity, Spanish women have lower weight children, corresponding to the different ages of mothers at delivery.

Since 1996 the general tendency has been an increase in the rate of LBW for both premature births and newborns at term. The non-Spanish group differentiates from the Spanish group by a lower proportion of LBW for newborns at term (Table III, middle), while the rates of premature births in both groups are close, regardless of maternal nationality. In developed countries a more efficient prevention of pre-natal and neonatal mortality should produce a larger proportion of premature live deliveries (Barros et al. 2005).

The recent rapid arrival of immigrants to Spain and their increasing contribution to fecundity provides an interesting opportunity to determine whether external circumstances affect pregnant mothers from various countries in different ways (Bernis 2005). A study of 2053 infants born in a hospital in Madrid over 13 months (Alonso et al. 1999b) showed that their weights and other morphological measurements responded to possible race-related differences, sometimes consisting of a slightly lower weight among Spanish mothers. However, these results are not consistent, probably due to the small sample size. Non-uniform intra-uterine conditions may also explain heavier weight at birth among immigrants from certain countries (Bernis 2005). According to Alonso et al. (2005), 97.83% of the variability in birth weight was explained by the proportion of premature babies and by the variation in the total fertility rate. The period of residence in the country of destination has been reported to have a certain influence on birth weight. Thus, Acevedo-García et al. (2007) indicated that Latino women residing in the US and born abroad are at lower risk of having LBW infants than US-born Latino women.

Other variables that may influence birth weight are not provided by the INE database, thus leaving part of the variability in LBW unexplained (see the Negelkerke's R^2 in Table III). According to several studies, mothers' use of tobacco has negatively influenced weight at birth (Kirchengast and Hartmann 2003c; Moshin et al. 2003). Any change in the frequency of a mother's smoking during pregnancy could have an effect on newborn weight (Kramer et al. 2002; Barros et al. 2005). Regarding Spain, Martínez Frías et al. (2005) reported a temporal increase in the number of mothers smoking.

Although the incidence of LBW in developed countries is ~ 7.5%, half the worldwide rate of 15.5% (Wardlaw et al. 2004) and the fact that the contribution of foreign mothers to total deliveries in Spain increased very rapidly to over 17% in 2010, the results obtained in the present paper do not offer evidence that non-Spanish mothers are in an unfavourable position regarding birth weight. According to Bernis (2006), the comparison of Spanish and non-Spanish women may not reveal possible socio-economic, cultural or ethnic differences for some specific nationalities.

It was also reported that immigration is a selective process involving individuals that surpass the average socio-cultural level in their population of origin (Gould et al. 2003). In addition, these immigrant women may show a lower tendency to have habits which may negatively affect the newborn, such as use of tobacco, alcohol, etc. (Kelaher and Jessop 2002; Forna et al. 2003). In other opinions, immigration on its own can be considered a risk factor concerning pregnancies due to socio-economic disadvantages and more difficult access to obstetric monitoring (Forna et al. 2003), resulting in more perinatal mortality (Essén et al. 2000).

CONCLUSIONS

Newborn birth weight declined in Spain between 1980–2010; however, a slight recovery has been observed since 2003, as consigned by the minimum value provided by the fitted polynomial equation of degree 2. The percentage of NS mothers has gradually increased in recent years and since 2003 has exceeded 10%. The incorporation of NS mothers contributed to a certain recovery in the average birth weight due to the increased birth weight of children born to these mothers, although birth weight was in decline in S mothers. The reasons for the divergent evolution in birth weight according to the mother's origin were derived from the analysis of risk categories using logistic regressions and from the study of the dissimilar proportion of mothers (S and NS) included in each of the risk categories. From this it can be concluded that the reduction in birth weight among Spanish mothers is associated with a greater proportion of multiple deliveries and with more maternities at extreme age ranges. Furthermore, changes in the proportion of first maternities and a slightly lower proportion of premature births must also be considered. Concerning non-Spanish mothers, the increase in birth weight corresponds to fewer first maternities, better professional and job qualifications and a decrease in the number of low and high ages at maternity.

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