Temporal and Territorial Analysis of Multiple Deliveries in Spain (1900–2006)

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Temporal variations in the frequency of multiple maternities in many Western European countries have been described. However, within a single country, regional differences are observed. Urban industrialized regions and rural agricultural areas have experienced in recent decades a distinct decline in multiple deliveries, which in cases have been related to maternal age and parity changes. Research on multiple deliveries in Spain is scarce and none of the studies go back to the beginning of the 20th century or consider regional variation over an extended period of time. The present paper is a yearly study on multiple deliveries in Spain since 1900 including a geographical analysis. Rather than dealing with recent changes in multi-parity, this paper is concerned with Spain's long-term national variation (between 1900 and 2006). The changing pattern of double and triple deliveries was analyzed using data from the Spanish National Statistics Institute (INE). Twinning rates in Spain are low in comparison to those of equivalent periods in other countries, and the minimum rates correspond to the 1980s decade. Results were interpreted by taking into account the influence of age at maternity and reproductive variation up to 1990. A good fit between observed and predicted rates was obtained after the application of models, which besides maternal age and parity, include their interaction. Regarding territorial variability, the values corresponding to southern, northern and insular Spanish provinces are consistent with an earlier reduction of the crude birth rate in the north-east regions and latter in the southern regions and the Canary Islands.

Keywords: twins, triplets, regional-temporal analysis

Studies on multiple deliveries in Spain are scarce in number and limited to brief periods of time due to the irregular availability of National Vital Statistics files and to the lack of their uniformity.

In a study of several countries, Bulmer (1960) reported multiple birth rates for Spain covering the years 1951–1953. Later, Valls (1972) and Bertranpetit and Marín (1986) published values for the periods 1951–1967 and 1975–1979, respectively. Using micro-data provided by the Spanish National Statistics Institute (INE) Fuster et al. (2006; 2008) considered the variation of rates and the factors involved in the present rise of double and triple deliveries in Spain in association with the use of subfertility treatments. Other recent studies are limited to specific regions or small rural areas (Bertranpetit and Marín, 1988; Hernández et al., 2004).

Twinning rates show national and regional heterogeneity mainly because of differences in the frequency of dizygotic twins. An early reduction of twinning was reported in some European populations (Hajn, 1997). There was a worldwide decline in twinning rates, especially in Western Europe throughout the 1960s and the 1970s (James, 1982). In Europe, twinning rates become progressively lower from north to south showing maximum values among Nordic and minimum values among Latin countries (Astolfi et al., 2003; Eriksson et al., 1995). However, data on southern European countries are scarce (Parazzini et al., 1991). Without exception, this maternal-age specific twinning decline is attributed to dizygotic more than to monozygotic twins (James, 1986). As a consequence of the marked correlation between maternal age and parity, birth order has also been related to twinning (Fellman and Eriksson, 1987), though maternal age and parity cannot satisfactorily explain the temporal and regional differences in the twinning rates (Fellman & Eriksson, 2003; Eriksson et al., 1995; Eriksson & Fellman, 2004). Decreasing endogamy and demographic changes affecting age at maternity and parity as well as urbanization have been used as arguments to explain the reduction in twinning rates (Fellman & Eriksson,1990). Referring to Sweden, Eriksson and Fellman (2004) proposed that the twinning rate reduction was a consequence of the intense demographic and socioeconomic changes with

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increased urbanization, industrialization, internal migration, improved communications and exogamy.

Caution is necessary when comparing long past rates. One may suspect that occasionally the rates reported have been arbitrarily increased or decreased by changes made from births which count maternities, to those which count infants (James, 1986).

In several European countries since the 1980s, the frequency of multiple deliveries has elevated following the use of ovulation inductors in assisted reproductive treatments (Eriksson & Fellman, 2004), an increase which occurred later than 1990 in Spain (Fuster et al., 2008).

The following analysis is not concerned with small-scale recent changes of twinning in Spain, which has been the subject of previous papers (Fuster et al., 2006; 2008). Instead, its goal is to fill the gap in information on double and triple deliveries in Spain from the beginning of the 20th century to the present. In order to achieve this aim, a continuous yearly analysis is performed of double and triple deliveries occurring in Spain between 1900 and 2006 (last year for which information was available), complemented by the study of factors associated with multiple maternity and its provincial variation pattern up to 1990.

Materials and Methods

Yearly data were transcribed from issues of the Vital Statistics published by the Spanish National Statistics Institute (INE). Historical demographic yearbooks and contemporary databases available at the INE official web were also consulted.

The temporal analysis is based on the absolute frequencies of deliveries (singletons, twins, triplets and higher degree multiples) occurring in Spain between 1900 and 2006. In all cases, live and stillbirths were counted. From 1900 to 2006 a total number of 62,766,352 deliveries were registered in Spain. The yearly range of variation was between 359,309 (1996) and 703,766 (1964).

Results are presented as crude rates of double and triple maternities per 1000 and 10.000 deliveries, respectively. Standardization of rates according to maternal age was not possible because the available information consisted of pooled data with no indication of individual age of mothers only annual averages. Though standardizing of the twinning rates reduces the magnitude of temporal fluctuations, the temporal pattern remains the same (Eriksson & Fellman, 2004).

Spanish rates for 1981 and 1982 diverge remarkably from the years immediately preceding and posterior to them. Since the nature of this divergence is without apparent explanation, reported rates for these years were eliminated and replaced by estimated values provided by their lineal tendency after the application of the procedure provided by SPSS 15.0.

In the present study, for the period 1970 to 1990, twinning rates were related to the mean maternity age. The mean number of children born alive per mother, including the last delivery which is the one we have considered in the multiparity analysis, was used here as an indicator of parity. Before 1970, there was no information on family size.

The geographic variability of the 50 Spanish provinces regarding multiple deliveries was studied for a sample of alternate periods of 10 years (1900-1909, 1920-1929, 1940-1949, 1960-1969 and 1983-1989), excluding maternal residence abroad. Before 1928, the two provinces Santa Cruz de Tenerife and Las Palmas de Gran Canaria appear grouped as 'Canarias', thus the corresponding data were merged.

The final period (1983-1989) of the provincial analysis includes only seven years: 1980 was excluded because of the lack of corresponding data on late fetal deaths in multiple deliveries.

Results

Temporal Tendencies in Twinning and Triple Deliveries

Table 1 shows the evolution of rates corresponding to double and triple maternities for the period 1900–2006. Throughout the first 80 years of the 20th century, twinning remained relatively stable in Spain with rates from 7.3 (1920) to 10.1 (1940 and 1946) per thousand. Minimum rates were followed by a quick increase from 1983 to 2006 (Figure 1).

As with twins, no temporal tendency regarding triplets is noticeable before 1980, despite important changes affecting age at maternity and family size. Since the 1990s there has been a continuous increase of triplets, reaching maximum rates in 2001 followed by a later decrease (Figure 1).

Factors Related to Multiparity

In a previous analysis of individual maternities, Fuster et al. (2008) found that mother's delivering older than 30 were responsible for the increase of twinning in Spain after 1994, mainly associated with the first parity. Unfortunately, the present analysis was limited to the availability of grouped data only and their corresponding mean values. In addition, some relevant information was absent, which made necessary the use

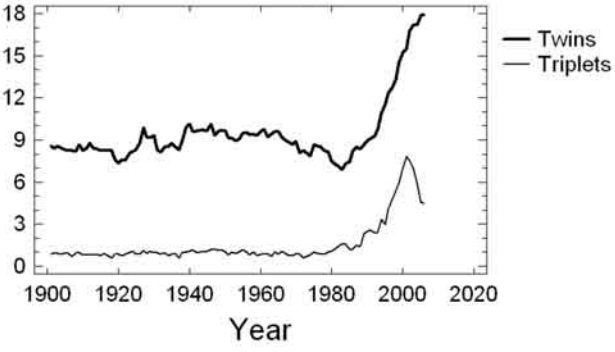

Figure 1

g (× 1,000) (× 10,000) (1900 2006).

Table 1

	N	D			*N*	D			*N*	D	
1900	622409	8.72	0.66	1936	628101	8.50	0.88	1972	675576	8.26	0.58
1901	660469	8.59	0.82	1937	578156	8.32	0.55	1973	675193	8.10	0.68
1902	677345	8.38	0.97	1938	516238	8.94	0.97	1974	690146	7.86	0.77
1903	697469	8.56	0.92	1939	429505	9.85	1.00	1975	670983	8.70	1.03
1904	661471	8.38	0.83	1940	640290	10.12	1.06	1976	678810	8.57	0.88
1905	682258	8.31	0.94	1941	519281	9.58	1.19	1977	657321	8.51	0.82
1906	661314	8.23	0.89	1942	539371	9.63	0.96	1978	637382	8.25	0.83
1907	656445	8.25	0.70	1943	617014	9.70	1.00	1979	602193	8.15	1.03
1908	668829	8.19	0.96	1944	612125	9.68	1.03	1980	571090	7.47	1.07
1909	660834	8.68	0.97	1945	631675	9.65	1.04	1981*	531916	7.28	1.25
1910	657628	8.23	0.79	1946	590254	10.11	1.17	1982*	513494	7.09	1.43
1911	638938	8.42	0.81	1947	595177	9.31	1.21	1983	484997	6.91	1.61
1912	648752	8.78	0.82	1948	649700	9.60	1.12	1984	472565	7.33	1.54
1913	629026	8.39	0.78	1949	608989	9.72	1.15	1985	455719	7.41	1.16
1914	619711	8.37	0.82	1950	572073	9.66	1.01	1986	437638	8.18	1.21
1915	626193	8.26	0.75	1951	574765	9.18	0.78	1987	425235	8.52	1.48
1916	610445	8.22	0.90	1952	601746	9.13	1.03	1988	417370	8.37	1.41
1917	613563	8.23	0.73	1953	598623	8.93	0.92	1989	406516	8.66	2.31
1918	624817	8.22	0.58	1954	587331	9.06	1.02	1990	399258	8.97	2.45
1919	594842	7.65	0.84	1955	608238	9.47	1.17	1991	393757	9.12	2.57
1920	635348	7.33	0.87	1956	617146	9.53	1.00	1992	394494	9.27	2.36
1921	661481	7.58	0.74	1957	655841	9.36	0.78	1993	383289	9.77	2.40
1922	668475	7.56	0.87	1958	662744	9.42	1.03	1994	367272	10.92	3.35
1923	675707	8.01	0.96	1959	663155	9.31	0.74	1995	360339	11.56	2.94
1924	666875	8.19	1.08	1960	672075	9.66	0.82	1996	359309	12.34	4.09
1925	658434	8.32	0.85	1961	662624	9.74	0.83	1997	365564	12.72	4.71
1926	677459	8.81	0.86	1962	666708	9.23	0.90	1998	361393	13.34	5.40
1927	649290	9.85	1.14	1963	678684	9.41	0.66	1999	375673	14.50	5.94
1928	681055	9.23	0.90	1964	703766	9.60	1.02	2000	392584	15.22	6.95
1929	668571	9.16	1.05	1965	681881	9.58	0.84	2001	401054	15.54	7.80
1930	676211	9.31	0.95	1966	675005	9.15	1.07	2002	412753	16.79	7.56
1931	664526	8.31	0.93	1967	685011	9.00	0.88	2003	435261	17.23	7.01
1932	687014	8.16	0.83	1968	672237	8.85	0.74	2004	447784	17.22	5.94
1933	684217	8.54	0.95	1969	670389	8.69	0.73	2005	459265	17.91	4.55
1934	653397	8.53	0.73	1970	666879	8.87	0.88	2006	475635	17.89	4.46
1935	648531	8.76	0.86	1971	675378	8.07	0.87				

N *: ; *N*: ; D: ; : .

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of alternative data. Even grouped data concerning the number of children born per mother were not available before 1970 in Spain.

Parity, as correlated with maternal age, may be related to twinning. The number of children per mother may also be an acceptable means of estimating parity in absence of the corresponding data. Information on the mean yearly maternity age and number of children per mother (parity) shown in Figure 2 refer to all deliveries occurring in Spain regardless of multiparity (single or multiple).

In order to clarify interactions among age at maternity, fertility and year, it is necessary to consider the fact that in any particular year the same mean maternal age may correspond to different reproductive situations. Thus, a large number of children may be born throughout a wide maternal reproductive period or a reduced number of births may occur close to the maternal mean age. An elevated mean maternity age also may be due to extended reproduction during the fertile period or to a restricted and delayed maternity, all of which are reflected in various maternal age distributions. As an example, the same mean maternal age (28.5 years) corresponds to different percentages of maternities at ages < 20, 20–24, 25–29, 30–24, 35–39 and > 40 in two selected years: 1976 and 1986. These percentages were

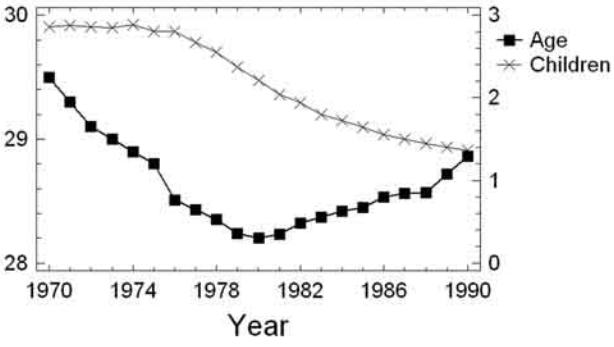

Figure 2

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5.52, 27.36, 33.88, 19.94, 9.23, 4.07 in 1976 and 6.09, 24.04, 37.33 21.34, 8.73 and 2.47 in 1986. Moreover, the mean number of children may vary despite the same maternal age: 2.55 in 1976 and 1.55 in 1986. While the number of children per mother decreases with time, the mean age at maternity may not (Figure 2). Therefore the interaction between age at maternity and parity (number of children per mother) is necessary for a correct analysis.

For the period 1970–1990 a correlation coefficient equal to 0.839 was obtained following the application of a model including mean age at maternity (Age), the parity (Parity) and their interaction (Age*Parity):

Twinning rate = –258.973 + 9.328* Age + 94.866* Parity – 3.309* Age*Parity

Figure 3 shows the good correspondence between the observed and predicted twinning rates according to the model.

Regarding triplets (Figure 4), an even better fit (R = 0.900) was obtained:

Triplets = –90.292 + 3.253* Age + 32.738* *Parity* – 1.168* Age*Parity

In these two models the negative signs of the constants, as well as coefficients which are positive for maternal age and parity and negative for their interaction, are consistent both for twins and triplets. Strictly speaking, statistical inference should not be applied to these data since the information does not correspond to a sample but to the whole registered 'population' of deliveries. However, to provide some perspective on the goodness of the fit, it can be indicated that all the regression coefficients obtained have significant probabilities comprised between 0.0000–0.0001 for twins and 0.0089–0.0165 for triplets.

If attention is paid to the years 1976 and 1986, a good agreement is obtained between the empirical and estimated rates for double and triple deliveries, despite the different maternal age distribution and number of children (Figures 3 and 4, respectively). This fit indicates that differences in the age distribution are reflected in the models.

Regional Variation in Multiple Maternity

In order to know whether the described temporal variation in double and triple deliveries has been uniform in Spain or whether regional patterns can be distinguished, the average provincial rates of twins and triplets were obtained for five alternate 10 year periods between 1900 and 1989 (Table 2) and they were compared to the crude birth rate of each province. In the absence of information on family size, these rates were the best available substitute for parity values. The interpretation of Table 2 matrix of data is complicated by the high inter-provincial and temporal variability of the rates for twins and triplets. Three standardized indexes were calculated for each province and period based on its twinning, triplet and crude birth rates. Standardized indexes were obtained analogously for twin, triplet and crude birth rates. For instance, the provincial twinning rate for each of the 5 periods was first standardized according to the average and standard deviation (z-score) of all provinces. Next, the average of these 5 z-scores was calculated for each province. A positive index assigned to a province indicates that the Spanish average was surpassed. A negative index indicates that this average was not reached.

By means of factorial graph (SPad 6.0 statistical software package) the relationships of the twinning

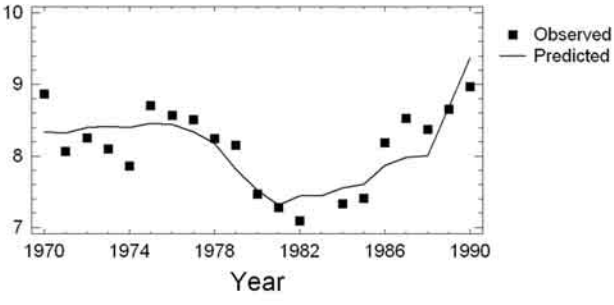

Figure 3

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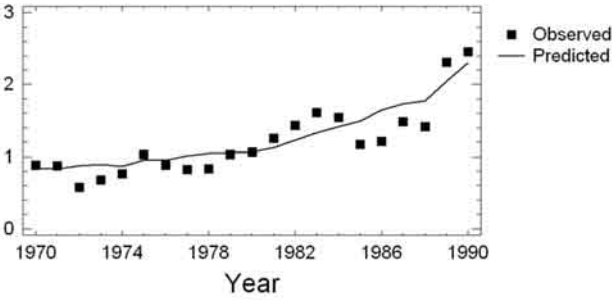

Figure 4

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Table 2

_ g e (× 1,000) e e (× 10,000) e e e d(* S C e e e e L P m G C e m e g e). e e e _ e e e m e m e e d(e d M e M e)

				_ g e					e e		
P e e	C e	1900 9	1920 9	1940 9	1960 9	1980 9	1900 9	1920 9	1940 9	1960 9	1983 9
A	B 1	4.38	10.37	8.89	8.74	8.91	0.00	1.34	1.74	0.55	1.81
A e e e	CM 2	10.47	8.37	10.20	11.36	7.49	0.83	0.56	1.37	0.59	1.12
A e e	3	9.60	10.24	8.87	9.31	7.72	0.91	1.33	0.80	0.40	1.39
A m e	A 4	9.91	10.19	10.12	9.50	7.44	0.58	1.05	1.28	0.88	2.09
A	CL 5	7.32	9.41	6.42	10.86	7.73	1.09	1.04	0.92	1.27	0.72
B	E 6	9.13	9.20	14.08	10.79	8.25	1.13	0.89	2.71	0.84	1.27
B e e	BI 7	8.69	7.63	6.10	7.48	8.36	0.78	0.94	1.38	0.65	2.85
B e e	C 8	5.61	7.55	9.33	8.57	8.55	0.74	0.48	0.57	0.69	2.60
B g	CL 9	9.66	9.63	10.89	10.42	8.14	0.97	0.75	0.94	0.89	1.48
C e e e	E 10	9.45	9.65	10.59	11.35	7.74	0.82	1.31	1.06	0.73	1.47
C	A 11	9.08	9.50	11.03	10.26	7.86	1.28	0.56	1.02	1.18	1.68
C e	12	9.65	11.84	10.87	10.46	8.43	0.84	1.64	0.55	0.64	0.80
C e	CM 13	11.47	8.63	11.57	11.58	7.80	1.64	0.92	1.52	1.38	1.01
C	A 14	10.62	9.49	12.82	12.54	8.02	1.08	0.80	1.57	1.22	1.34
C (L)	G 15	9.16	8.13	5.91	10.33	6.51	0.92	0.83	0.78	0.88	1.40
C e	CM 16	8.33	10.20	10.71	10.39	5.71	0.79	0.98	0.60	0.73	1.70
G e	C17	9.80	6.24	7.08	9.52	8.93	0.81	0.70	0.22	0.63	2.64
G	A 18	8.97	7.14	8.63	10.72	7.28	0.43	0.34	0.87	0.74	0.94
G	CM 19	6.89	9.34	11.17	10.05	7.14	1.05	1.27	0.92	0.39	1.68
G e	B 20	9.85	7.20	7.82	6.45	8.71	1.48	0.66	1.71	0.39	2.02
H e	A 21	8.24	9.20	11.14	10.57	7.26	1.36	1.12	0.85	1.53	1.90
H e	A 22	9.77	8.87	9.88	9.58	7.18	0.93	0.78	1.03	0.90	1.34
J	A 23	8.90	6.97	12.40	11.86	7.71	0.73	0.26	1.22	1.21	0.97
L e	CL 24	8.96	8.51	9.67	9.59	7.76	0.75	1.34	0.92	1.15	0.25
L	C 25	8.14	8.89	9.00	8.82	7.91	0.83	1.10	0.82	1.00	1.49
(L)	26	9.91	8.06	9.69	9.76	8.21	0.90	1.28	1.40	0.47	1.95
L g	G 27	7.56	8.43	9.70	10.57	5.96	1.11	0.91	0.84	1.02	0.37
M	M 28	6.55	8.78	9.68	8.95	8.68	0.57	0.47	0.97	0.57	1.70
M g	A 29	5.98	10.01	12.48	11.50	8.73	0.38	0.69	1.05	0.75	1.71
M e	M- 30	7.59	8.14	8.67	8.24	7.50	0.75	0.89	0.87	0.63	2.45
N	N 31	8.07	8.46	10.35	10.75	9.84	0.71	1.64	1.37	0.36	0.73
O e e	G 32	8.65	5.98	5.43	3.10	4.63	1.05	0.63	0.77	0.00	0.00
A	A S33	8.49	5.25	6.62	5.79	7.22	0.85	0.51	0.75	0.28	1.42
P e	CL 34	6.43	5.31	8.56	9.54	8.23	1.21	0.81	1.17	1.94	0.00
C I.*	CI 35=38	9.31	10.05	9.27	9.41	6.64	0.81	0.52	1.13	0.56	1.53
P e e	G 36	8.33	5.88	9.76	7.61	6.08	0.79	0.52	1.02	0.60	1.29
S m e	CL 37	6.45	8.93	8.72	9.48	8.83	0.64	1.18	1.06	0.52	1.82
C	CA 39	6.88	7.73	7.11	9.90	8.20	0.90	1.17	1.09	0.89	0.70
S g	CL 40	11.01	9.19	10.08	10.15	10.55	0.31	1.50	1.00	1.17	0.86
S e	A 41	7.94	10.08	9.77	7.77	8.48	1.00	1.24	1.21	0.56	1.76
S	CL 42	10.03	10.11	8.95	10.25	7.06	0.16	1.00	0.78	2.42	2.88
g	C43	10.07	8.32	9.13	7.36	8.33	1.87	1.11	1.10	0.84	1.31
e e	A 44	9.31	8.99	11.45	9.58	7.26	1.08	1.18	2.31	1.30	0.00
e	CM 45	9.59	6.92	9.15	11.37	7.94	0.68	0.83	0.89	0.75	1.49
e	46	8.48	8.15	9.56	7.86	8.31	0.81	0.85	1.11	0.51	1.91
	CL 47	7.70	8.84	9.18	9.17	7.09	0.73	0.90	1.63	0.87	1.30
e	B 48	9.94	5.51	9.59	7.86	8.56	1.10	0.46	1.14	0.43	1.75
m	CL 49	6.38	8.02	9.14	10.76	7.43	0.72	0.35	1.12	1.63	0.63
g	A 50	8.75	9.24	9.77	8.99	8.17	0.60	0.53	0.85	0.92	2.40

N e C e _ e e d m e e e g e e e d(A: A ; A : A g ; A S A ; B: B e BI; B e e; C: C ; CA: C ; CI: C ; CL: C -L e ; CM: C -L M e ; E: Ex e m ; G: G e ; M: M ; M- : M e ; N: N ; : ; : e).

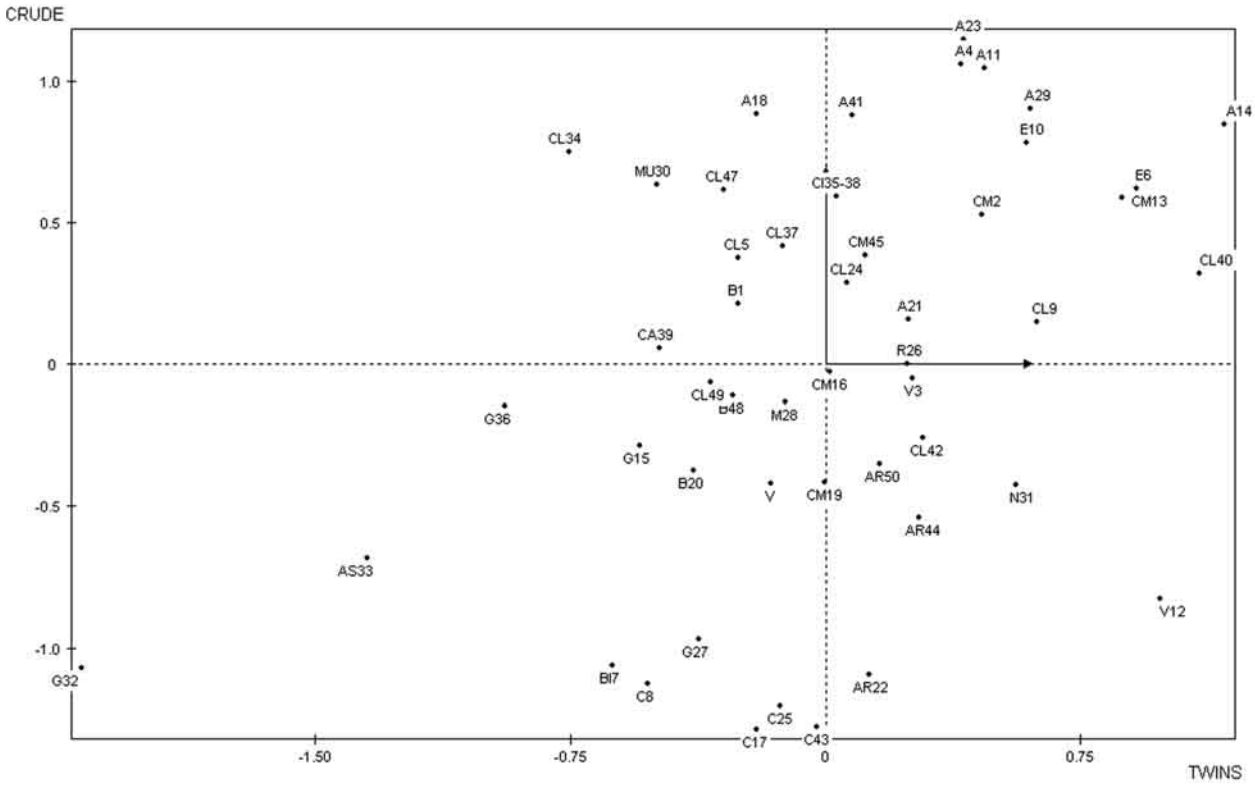

Figure 5

P e ⁄3 _ g ⁄2 ⁄3 g⁄2 ⁄3 ⁄4 ⁄3⁄2e ⁄3 ⁄4g e⁄3 , ⁄2 F g ⁄5⁄ e ⁄3).

and the triplet rates to the crude birth rate are represented in Figures 5 and 6. In these figures each province is designated by an alphanumeric code, including the initials of the autonomous community to which the province belongs (see Table 2 footnote). With the exception of a few, these communities coincide with the Spanish traditional administrative regions. The Pearson correlation of the 49 pairs of twin and triplet rates averaged for the five periods of each province was positive (R =0.426). However, in Figures 5 and 6 the relationship of the twinning and the triplet rates to the crude birth rate is not obvious because rates are transformed into z-scores. However, most provinces of Andalusia and Extremadura (southern Spain; see Figure 7), show above average twinning and crude birth rates. Although northern provinces display twinning rates generally below the national average, cases of crude birth rates over the mean (Castilla-León) combine with other regions which are below average (Basque country, Galicia, Catalonia). The Canary Islands appear close to Andalusia. Rates for the Balearic Islands, however, approximate those of Catalonia. An extreme case is Orense province (northwest), which although occupying the same sector as the remaining Galician provinces, displays the lowest twinning rates of the country. Regarding regions with low rates, such as Galicia, the relationship of multiparity to the crude birth rate is less clear for triplets than for twins (Figure 6).

Discussion

The present results obtained regarding the temporal change of twinning in Spain throughout the first 80 years of the 20th century (Table 1 and Figure 1) are concordant with Bulmer (1960), who reported a rate of 9.10 ‰ between 1951 and 1953, Valls (1972), 9.49‰ for the period 1951–1967 and Bertranpetit and Marín (1986) for later years (1975–1979 = 8.44%).

In general, twinning rates in Spain are low in comparison to those of equivalent periods in other countries. Thus, Eriksson and Fellman (2004) found very high twinning rates for Sweden with minimum values of 7.9‰ in 1969. Eriksson and Fellman (2007) reported rates for England and Wales above 10 (from 1935 to 1965). For specific years studied (1933–1935, 1956–1958 and 1965–1967) Katsouyiannopoulus (1981) found twinning rates for Greece of between 11.49 and 14.33, higher rates than those of Spain. Pison and D'Addato (2006) compared the twinning rates in France, Denmark, Netherlands, Sweden, Italy, England and Wales throughout the 20th century. Before 1970, France displayed lower rates than Denmark and other countries. In many of these an appreciable decrease occurred following the fifties and in France about ten years later. Regarding France and Denmark, rates sharply increased in the 1980s.

Figure 1 displays the minimum rates of twinning in Spain in 1983. Since then, a rapid increase of rates has

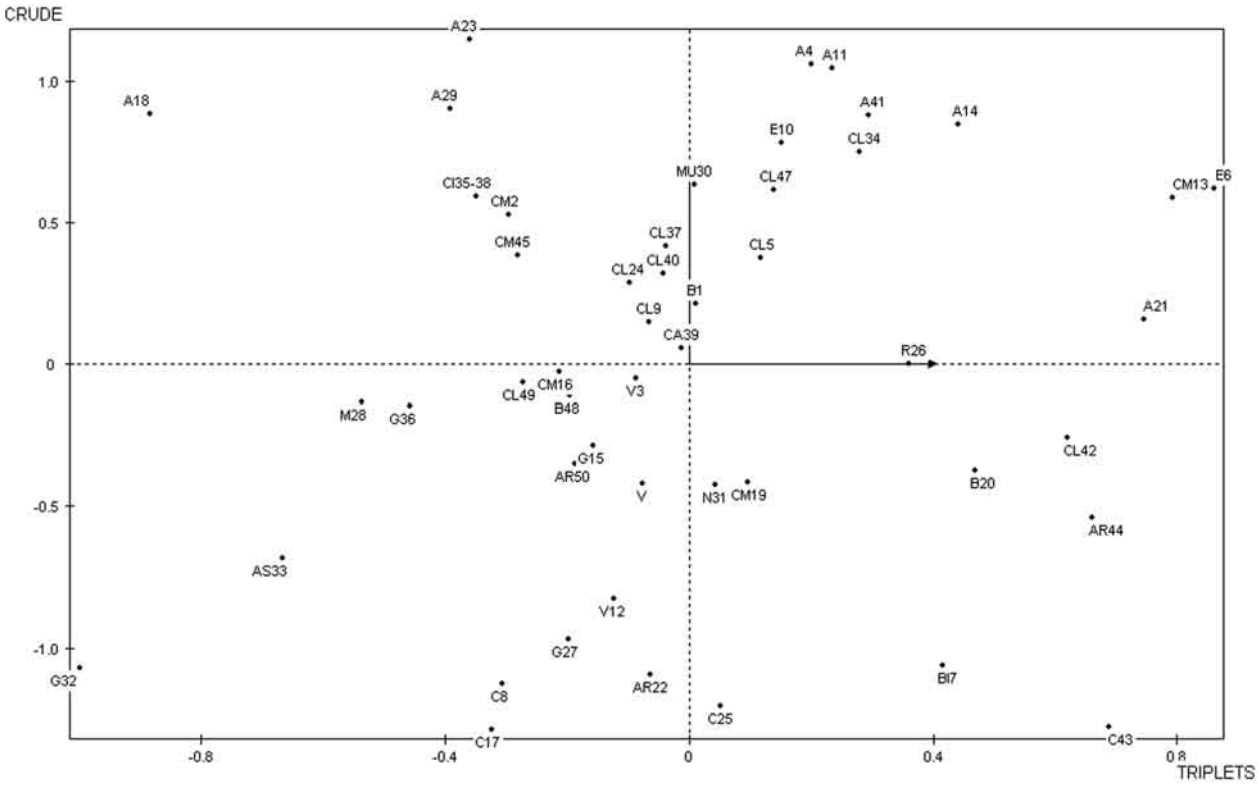

Figure 6

P e [illegible]).

been attributed to the use of assisted reproduction treatments (Fuster et al., 2008), an elevation that had occurred earlier in Northern Europe (Eriksson & Fellman, 2004).

For triplets, temporal variation did not follow a clear pattern prior to 1980 despite the current important changes affecting age at maternity and family size (Figure 1). Maximum rates were reached in 2001. A clear decrease was later appreciable. This variation is related to the number of embryos transferred during treatments of assisted reproduction. The reduction of embryos transferred was officially regulated in 2003 to prevent excessive multiple maternities (Bruna Catalán et al., 2005). Although according to Hellin's Law a double/triple proportion of deliveries equal to 89 is expected, this proportion is very rarely observed (Fellman & Eriksson, 1993, 2009a). For Spain, the comparison of the yearly rates of twin and triplet deliveries gave a wide range of values comprised between 19.92 and 151.27. But small proportions accumulated since 1989 (mean = 31.38; range = 19.92–40.71) as a reflection of a larger number of triplet compared to twin deliveries after the use of reproductive treatments (Fellman and Eriksson, 2009b).

For triplets the comparison with long-term series is complicated because most studies consider only twins. In addition, rates were sometimes given distinguishing them by zygosity, as done by Imaizumi (2003). The temporal trend reported by Eriksson and Fellman (2004) for Sweden shows rates of triplets falling in 1961–1970 to their minimum values. For Italy (1950–1995), Astolfi et al. (2003) found that multiple (≥3) rates had the lowest values in the seventies. In the case of Spain, although low triple rates were found for a few years (1972–1974), no overall period characterized by a reduced frequency of triplets can be indicated (Table 1).

Concerning the association of maternal age with multiple delivery, Pison and Couvert (2004) found that during the World War I a high twinning rate in France coincided with elevated age of maternity. Greater twinning rates regarding older mothers is explained by more elevated levels of FSH hormone in women over 35 (Pison & Couvert, 2004). At present, however, the high rates of multiple deliveries are attributed to the techniques of assisted reproduction. According to Eriksson and Fellman (2004), only those series before artificial reproduction techniques can be used for studies of the frequencies of multiple maternity under natural conditions. For this reason the present analysis regarding age at maternity only extends to 1990, when the effects of those techniques were expected to have had limited impact.

The mean number of children per mother, is used here as an indicator of parity in the absence of more adequate information. This variable could be related to multiple maternities only since 1970 (Figure 2). When specific reproductive values as indicators of

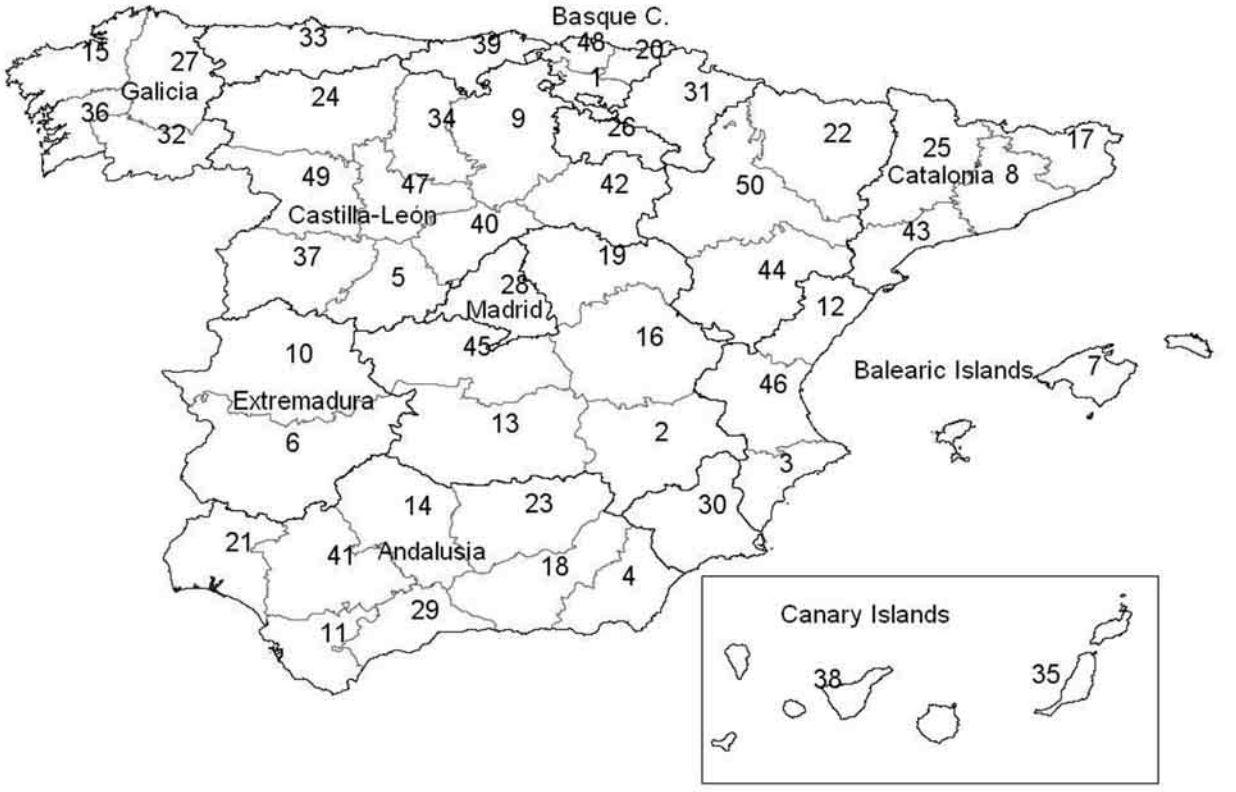

Figure 7

M – S e g e e e g (e 2).

parity are not available, Eriksson and Fellman (2004) suggested that other estimates could be used because of the correlation existing among most measures of reproductive performance (GRR, TFR and CBR).

The elevated coefficients of correlation (R = 0.839 for twins and R =0.900 for triplets) made possible a good fit between observed and predicted rates (Figures 3 and 4) obtained after the application of models that include, besides age and number of children, their interaction. These results prove that the independent consideration of maternal age and parity (number of children), without taking into account their interaction and temporal change, might have masked the relationship of age and number of children to multiple maternity.

Correspondence between maternal age and twinning does not always occur. Pison and Couvert (2004) reported for France a low maternity age between 1960 and 1970 coinciding with a low twinning rate. However, in previous years (1940–1969), maternal age was also low, but not the twinning rate. According to Fellman and Eriksson (1987, 2003) and Eriksson and Fellman (2004) maternal age and parity cannot explain satisfactorily the temporal and regional differences in the twinning rates. In Spain, the consideration of years following 1990 revealed a positive association with maternal age because of the greater number of older women receiving treatments of assisted reproduction after 1991 (Fuster et al., 2008).

With respect to the geographical variation of multiple deliveries in Spain, previous studies have considered brief periods of time (Bertranpetit & Marín, 1986; Bulmer, 1960; Fuster et al., 2006; Valls, 1972). They failed, however, to demonstrate regional patterns. In the present analysis the Spanish provinces were considered for the period between 1900 and 1989 (Table 2). In some provinces the rates of multiple deliveries may be underestimated due to underreporting because of the definition of 'born alive' before 1975: survivors for the first 24 hours. This legal definition has probably had a greater effect on triplet than on twin deliveries because of the higher probability of late fetal and perinatal mortality in the first group. Sampling variations per period due to the heterogeneity in the total number of provincial deliveries must also be taken into account: the province with the smallest total number of deliveries was Alava (N = 23053 in 1940–1949) and the largest was Madrid in 1960–1969 (N = 717848). Regarding each period, mean values for twins, triplets and crude birth rates were transformed into an index for each province. Positive indexes indicate a general tendency to surpass the average rate. The first quadrant of Figures 5 and 6 shows provinces with higher birth rate as well as more double and triple deliveries than the Spanish averages. Provinces appearing in the second quadrant surpass the Spanish crude birth rate but have fewer double

or triple deliveries than average. Quadrants 3 and 4, however, reflect birth rates below the average.

Because the results reported in Figures 5 and 6 do not represent either exact twin or triplet rates or crude birth rates but rather *z* scores, a precise correspondence between multiparity and birth rate is not expected to be evident. Instead, regional grouping of provinces according to estimated similar living conditions are looked for. For this reason the correlation of twin and triple deliveries with the birth rate in each province is not given. The values corresponding to southern, northern and insular provinces reported in Results (Figures 5 and 6), may be explained by the fact that during the 20th century the crude birth rate reduced first in the northeast regions (Catalonia, Baleares) and much later in the southern regions (Andalusia and Extremadura) and the Canary Islands. The rates of these regions at present remain above the average. In these agricultural regions the living standard has been low in comparison to industrialized areas that already had reduced crude birth rates. Temporal variation regarding age at marriage and first maternity also took place as the crude birth rate reduced. This is in agreement with the suggestion of Eriksson and Fellman (2004) that isolated and mainly rural areas in both Sweden and Finland show a much later onset of the decline in the twinning rate than urbanized locations.

From this analysis it is concluded that in Spain, during the first 80 years of the 20th century, twinning rates remained stable and low in comparison to those of other European countries. Minimum rates were followed by a quick increase from 1983. Despite important changes affecting age at maternity and family size, no noticeable temporal tendency regarding twins and triplets was observed before 1980.

For the period 1970–1990 a correlation coefficient equal to 0.839 was obtained following the application of a model including age at maternity, number of children and their interaction. Regarding triplets the fit was even better ($R = 0.900$).

Concerning the geographical variation of multiple deliveries, the high values corresponding to southern, northern and insular Spanish provinces may be explained by the fact that during the 20th century a reduction of the crude birth rate took place first in the northeast regions, and the later in the southern regions and the Canary islands. In these two agricultural regions the birth rate remained elevated because of a living standard lower than that of the northeast industrialized areas.

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