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Birth Intervals and Infant Mortality in La Cabrera (Spain)

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ABSTRACT

Family reconstitution has provided knowledge about the reproductive performance of mates from La Cabrera (northwest Spain). The analysis of 2293 reconstituted families (7872 births corresponding to parities 2 to 10) was restricted to the period 1880 to 1929. The proportion of infant deaths (younger than 1 year) was calculated regarding the preceding birth interval and the death or survival of the previous sibling. Considering as dependent variables the neo and the postneonatal mortality, a logistic regression was obtained. From the present analysis it is concluded that in La Cabrera 45% of couples have the most effective reproduction with birth intervals of 24 to 36 months. Risk factors regarding neonatals were found to be intervals shorter than 17 months, the death of the preceding sibling and male sexuality. Neither maternal age nor the accumulated number of previous sibling deaths were significant risk factors.

Key words: *birth interval, neonatal, postneonatal infant mortality*

Introduction

In traditional societies where biodemographic factors are still more important than socioeconomic[1], it is possible to study the complex mechanisms by which those populations autoregulate. In these cases family reconstitution from parish registers provides optimal data on reproduction.

The relationships between fertility and infant mortality are complex and not necessarily the same in all circumstances[2]. However, irrespective of population a high fertility usually is associated with an elevated infant mortality. Their interrelation is often explained by a compensatory phenomenon[3], as parents tend to replace the dead child, thus shortening the birth interval corresponding to the following offspring. *A priori* this shortening propitiates an increased biological efficiency, but occasionally it does not achieve an adequate biological and psychological recuperation of the mother, thus increasing the risk of child mortality in the neonatal and postneonatal period[4–13]. Therefore, in terms of biological efficiency the advantage of shortened intervals is questionable.

Neonatal mortality is associated with endogenous causes[9] and certain biological variables, such as the previous interval, survival of the preceding sibling, mother's age, sex and parity are revealed as biological determinants[10]. However, these same variables may not be so influential during the postneonatal period in which exogenous causes are mainly affected by socioeconomic variables.

The objective of this paper is to analyze the influence of birth interval as a factor regulating fertility and infant mortality, and therefore the biological efficiency of the population. In addition, other factors that may cause increased risk of neonatal or postneonatal infant mortality are considered. For this purpose the following variables will be studied:

a. Biological efficiency as a function of the average birth interval, taking into account the existing relationship between fertility and infant mortality.
b. The compensatory effect of infant mortality considering for the various parities whether or not a delivery was preceded by infant mortality.
c. The effect of the mean birth interval on infant mortality rates in light of the preceding sibling death or survival.
d. Finally, the influence of certain biodemographic variables on neonatal and postneonatal mortality expressed as risk factors: duration of the birth interval, death of the previous sibling through the first month of life, mother's, sex and accumulated number of previous dead siblings.

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The population

La Cabrera, located in northwest Spain, is a mountainous area of 784 Km^2 including 37 parishes (4 municipalities). A depressed economy, an insufficient road network and the presence of elevated mountains have contributed to the isolation of La Cabrera until the end of the 20th Century. The resulting very high consanguinity (one of the highest in Europe)) as well as a large internal subdivision have been reported[14,15].

From 1887 to 1960 the population census remained stable (9526 and 8984 inhabitants, respectively) followed by a rapid process of depopulation because of emigration to business and industrialized regions of Spain (Madrid, Bilbao, Barcelona, etc.). During that period 1887–1960 the endogamy rate was at least 85%[16].

Material and Methods

Information was obtained for the period 1880–1989 from 37 parish registers (baptisms, weddings and burials). Following the Fleury & Henry[17] method, family reconstitution provided knowledge about the reproductive performance of mates, considering births and deaths of offspring and parental mortality. Families were studied in which either both mates were dead or the surviving mate remained in the area. Cases of women aged over 49 at marriage were discarded.

The number of reconstituted families available was 2813, representing 49.2% of the 5714 marriages celebrated.

In the present paper reconstituted families were analyzed only for the period 1880 to 1929 in order to prevent possible bias attributable to the Spanish Civil War (1936–1939). Prior to 1930 it may assumed that contraception was not frequent in La Cabrera. For the period considered the number of reconstituted families became 2293. Among these, infertile couples as well as families with only 1 or more than 10 children were excluded, providing 1697 families representing 74% of total families residing in La Cabrera from 1880 to 1936.

For children born to each family information was obtained on date of birth, sex, mother's age at delivery and the exact age for deaths occurring during the first year, and the following variables were defined:

BIRTHS: children born alive; NEOD: neonatal mortality during the first month of life; POSTD: postneonatal mortality from 1 to 12 months of age; INFD: mortality during the first year of life. % INFD: percentage of mortality throughout the first year; SURV: children surviving to the reproductive age (15 years); INT: mean birth interval period (number of months separating consecutive deliveries).

Intervals corresponding to 7872 offspring of parities 2 to 10 were obtained. For each parity intervals from the previous birth were analyzed according to the sex of the new born, age at death and mother's age at delivery.

In order to determine the factors influencing infant mortality (neo and postneonatal) two procedures were followed:

1. The proportion of infant deaths (younger than 1 year) was calculated in function of the previous birth interval. Cases which were preceded by the death of the previous sibling (less than 1 year) were distinguished from those surviving.
2. A logistic regression was performed using as dependent variables the neo and the neonatal mortality and as independent variables the following: a) the interval (2 categories: ≤ 17 months and >17 months). b) the survival status of the preceding sibling, making a distinction among neonatal mortality, postneonatal and survivors to the first year of life. c) the age at maternity (2 categories: ≤ 30 and > 30 years). d) Sex of the dead child. e) number of preceding deaths of siblings.

Results

Reproductive pattern

The average interval between two consecutive births was 36.50 months. 45.79% families had their complete descendency in a period of between 2 and 3 years; 25.93% between 3–4 years and in a period longer than 4 years 14.32%. Only 13.96% families completed it in a period shorter than 24 months (Table 1).

In the same Table are shown the main variables configuring the reproductive pattern for several categories of

TABLE 1
FERTILITY, INFANT MORTALITY AND NUMBER OF SURVIVORS TO THE REPRODUCTIVE AGE (15 YEARS) REGARDING BIRTH INTERVAL

Age category (N)	Number of Births Mean (SD)	Infd Mean (SD)	Surv Mean (SD)	%Infd/Birth
≤ 24 mo. (237)	4.51 (2.44)	1.10 (1.15)	2.66 (1.94)	25.00
24–36 mo. (777)	5.64 (2.32)	0,77 (0.93)	3.97 (2.07)	13.57
36–48 mo. (440)	5.00 (1.73)	0.55 (0.78)	3.73 (1.74)	11.25
> 48 mo. (243)	3.74 (1.39)	0.40 (0.70)	2.91 (1.44)	10.89
		....		
Total (1697)	5.04 (2.19)	0.70 (0.92)	3.57 (1.95)	14.18
Statistics	$F_{(3)}$=57.74, p=.00	$F_{(3)}$=30.90, p=.00	$F_{(3)}$=58.83, p=.00	

birth intervals. The average number of offspring (BIRTH) was 5.04 for the total sample of families. This value remains similar for intervals lower (24–36 months) or higher (36–48 months) than average: 5.64 and 5.00 offspring, respectively. The average number of births (Table 1, first column) was lower for mean intervals shorter than 24 months (4.51) or longer than 48 months (3.74) compared with intervals comprised between 24 and 48 months. Differences in the number of births among these four categories of intervals were statistically significant (F=57.74 d.f.=3, p=0.00).

The relative family mortality was described as the mean infant mortality throughout the first year of life (INFD). For total families INFD was equal to 0.70, but when intervals were short (less than 24 months) it became 1.10, while for intervals over 2 years, INFD was close to or even smaller than 0.70 (0.77; 0.55; 0.40, respectively for INT equal to 24–36, 36–48 and more than 48 months). Differences in INFD regarding intervals were also significant (F=30.90 d.f.=3, p=0.00).

Regarding survival to the reproductive age (SURV), significant differences (F=58.83 d.f.=3, p=0.00) were also found. Thus, families with intervals of 24–36 months showed maximum biological efficiency, providing 3.97 surviving offspring to the next generation. On the contrary, the lowest survival (2.66) corresponded to families with short mean intervals (less than 24 months).

Duration of interval, infant mortality and previous sibling survival

Information regarding 7872 births corresponding to parities 2 to 10 made it possible to calculate the percentage of deaths during the first year of life regarding the previous birth. In addition, the survival or death of the preceding sibling was taken into account. Figure 1 shows that the proportion of infant deaths decreased as the interval enlarged, remaining under 20% for intervals surpassing 17 months. For intervals shorter than 17 months, infant mortality was maximum (as much as 25% births). In cases where the previous sibling died, infant mortality

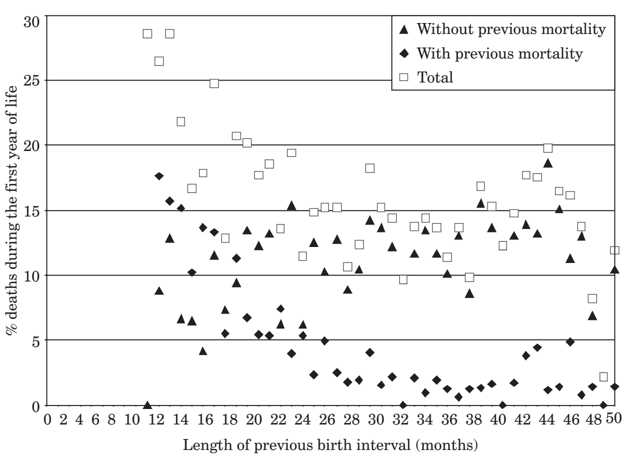

Fig. 1. Mortality during the first year of life regarding previous birth interval and the survival or death of the preceding sibling.

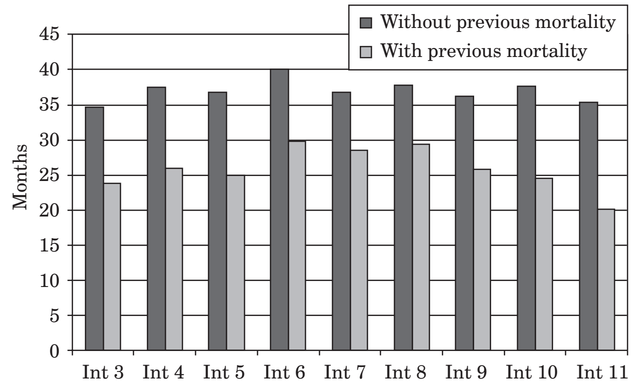

Fig 2. Mean birth interval for parities 2 to 10 regarding survival or death of the preceding sibling. Int 3= mean birth intervals between children born in parities 2 and 3....Int11 = intervals betweeen parities 10 and 11.

was higher than in other cases where the preceding child survived. At intervals of 17 months an inflexion occurred as the mortality of the preceding sibling did not affect infant mortality any longer: the percentage of deaths without previous mortality surpassed those with previous deaths.

The interval value corresponding to each parity (2 to 10) and previous sibling survival to the first year was also analyzed (Figure 2). Irrespective of parity, intervals were significantly shorter (t=15,30 df=8 p=0,00) when a birth was preceded by the death of a sibling (11 months on average with a range of 8.28–15.27 months).

Table 2 shows the estimations and odd ratios provided by a logistic regression for neonatal and postneonatal mortality. For neonatal, coefficients are significantly different from 0 regarding the interval duration (1.09–1.90), the survival status of the previous sibling (1.37–2.63) and sex (1.42–2.11). In this population, regarding intervals shorter than 17 months, the precocious death of the previous sibling and male sexuality represent risk factors regarding mortality during the neonatal period. On the contrary, neither maternal age nor the accumulated number of previous sibling deaths is a significant factor.

According to the logistic regression, for postneonatal mortality none of the variables considered here represent significant risk factors.

Discussion

A population adjustment to its surrounding is the result of a complex interaction among biological, environmental and socio-economic factors, which determine fertility and mortality and finally result in an optimal number of surviving offspring. As the factors involved are so many, the use of the number of surviving children is an oversimplification because identical values may result from varying reproductive patterns.

In natural fertility populations, births are spaced rather regularly throughout the whole reproductive pe-

TABLE 2
COEFFICIENTS OF THE LOGISTIC REGRESSION AND ODDS RATIOS (AND 95% CI) FOR INFANT MORTALITY (NEONATAL AND POSTNEONATAL)

Variable	Reference category	Neonatal		Post-neonatal	
		Coefficient	Odds ratio (95% CI)	Coefficient	Odds ratio (95% CI)
Constant		–2.521		–2.585	
Previous birth interval <17 months	17+	0.369*	1.44 (1.09–1.90)	0.210	1.23 (0.91–1.66)
Older sibling died in:					
0–30 days	Alive at 1 year	0.645**	1.90 (1.37–2.63)	–0.112	0.89 (0.60–1.33)
1–12 months	Alive at 1 year	–0.001	0.99 0.69–1.43)	0.196	1.21 (0.85–1.73)
Mothers'age 35 years	35+	0.064	1.06 (0.86–1.13)	–0.552	0.58 (0.45–0.73)
Male	Female	0.553**	1.74 (1.42–2.11)	0.119	1.12 (0.93–1.36)
Nº of previous sibling deaths	(Continuous)	0.140	1.15 (0.99–1.34)	0.017	1.02 (0.86–1.20)

**p<0.001/*p<0.01

riod[18], in populations with elevated fertility, birth intervals are therefore the main determinant of fertility[19]. In La Cabrera, association between the number of offpring surviving to the reproductive age (SURV) and the intergenesic interval (INT) was found (r=–0,07 p=0,002). The negative relationship between both variables indicates that brief intervals improved the reproductive process. However, under a certain limit shortening becomes a disadvantage. Thus, for intervals equal to or lower than 24 months (Table 1) 25% of newborns do not survive to the first year. This percentage reduces by half for intervals between 24 and 36 months (13.57%). For intervals longer than 36 months these percentages are very similar approaching 11% (11.25 and 10.89%).

Therefore, in La Cabrera the timing of deliveries influences the chance of child survival (Figure 1): the probability of infant mortality decreases as the interval becomes longer, similar to other populations[4,5,6,12]. In fact, when the interval surpasses 24 months, infant mortality stabilizes, affecting 10–15% new born. For these intervals, mortality is only a function of the socio-economic, epidemiological and environmental factors present in this community[16]. For intervals comprised of 17–24 months the percentages of mortality are slightly higher (15–20%) and transitional to the highest proportions (20–30%) which correspond to intervals under 17 months.

Two groups of factors explain the relationship between short intervals and increased mortality: first, the mother's biological and psychological depletion which may cause in later pregnancy prematurity, low new born weight and poor lactation; second, competition of siblings within the family for food and care[5,6].

With the exception of a few populations in which fertility is very high[3], an extended time period between births becomes advantageous in terms of reproduction effectiveness, while infant mortality produces a critical shortening of those intervals [20,21,22]. In la Cabrera parity intervals reduce significantly when the previous sibling has died (Figure 2). The birth of the subsequent child on average takes place 11 months earlier. Besides biological factors such as weaning, mother's behavior resulting in the replacement of the lost child has also been cited[20].

Child mortality may be the cause of more intense infant mortality as well as a consequence of a brief interval. When cause and effect coincide (short interval plus previous mortality) over mortality is produced due to their additive effect. Figure 1 illustrates that when a previous death occurs, the proportion of infant mortality widely surpasses cases in which the only factor of risk is a short interval. A short interval may increase the mortality up to 20%[7], and these percentages may increase more by psychological problems affecting the mother after her child's death, which may have even biological and social derivations[13].

In La Cabrera a brief interval (less than 17 months), the survival status of the preceding sibling and sex are factors of risk responsible for neonatal mortality (Table 2). Heritable endogenous causes of mortality may result in the death during the neonatal period of more than one sibling within a family [6,8,10,11,23].

In rural areas where health services are absent, inadequate systematic cultural practices surrounding pregnancies and delivery, may have negative results concerning the survival of the newborn. An increased risk of neonatal mortality following the death of a preceding sibling in the first month of life is due to both genetic and to cultural inheritance.

Regarding the sex of the new born in la Cabrera, as in other populations, the probability of death during the neonatal period is greater for males[5,24]. Biological variables are considered among the main causal factors involved in infant mortality[24]. Contrary to other studies[19] in which sexual differences regarding interval duration were found, in la Cabrera they were similar (35.01 months for males and 35.36 for females).

In contrast to other populations[5,11] no increased risk was found in La Cabrera associated with extreme maternal age because very young or old mothers are few regarding whole families; according to Blanco Villegas[16] age at marriage is elevated (never under 26) and the age at last maternity is 37–38 years.

The variables considered in the present paper do not relate to a greater risk of postneonatal mortality. Apparently, the endogenous causality attributed to neonatal deaths[5,9] do not extend to the postneonatal period. Instead, exogenous factors derived from environmental and socioeconomic variables are more important[9]. Unfortunately no information of this nature was available for La Cabrera.

From the present analysis it is concluded that in La Cabrera many couples (45%) achieve the most effective reproduction with average birth intervals of between 24 and 36 months. Shorter intervals result in increased infant mortality.

Irrespective of parity, the death of a child accelerates the birth of the next. This shorten interval is here interpreted as a compensatory effect of infant mortality.

The duration of the interval preceding birth is important concerning survival: irrespective of parity, the probability of death reduces as the interval increases. Over 24 months infant mortality values stabilize; they become influenced only by epidemiological and environmental factors. Intervals shorter than 17 months are at the same time the cause and consequence of a more intense infant mortality.

Short birth intervals have appreciable effect only during the neonatal period, and they relate to endogenous causality factors. In this sense male sexuality and the death of a previous sibling are risk factors concerning neonatal mortality, while the mother's age and the accumulated number of previous deaths of siblings in a family are not. After the first month of life, no biological variable appears in La Cabrera associated with postneonatal mortality which, instead, may be related to exogenous factors.

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INTERVALI ROĐENJA I SMRTNOST DJECE U LA CABRERI (ŠPANJOLSKA)

S A Ž E T A K

Rekonstrukcija obitelji omogućila je saznavanje reproduktivne uspješnosti partnera u La Cabreri (sjeverozapadna Španjolska). Analiza 2293 rekostruirane obitelji (7872 rođenja, broj rođenja po majci od 2 do 10) ograničena je na period od 1880. do 1929. godine. Udio smrti novorođenčeta (mlađeg od 1 godine) izračunat je u odnosu na interval od prethodnog potomka te njegove smrti ili preživljavanja. Obzirom na zavisne varijable neonatalnog i postneonatalnog mortaliteta, koristila se logistička regresija. Iz dosadašnje analize, zaključeno je da u La Cabreri 45% parova ima najuspješniju reproduktivnu sposobnost ako se rađanja odviju u intervalu između 24 i 36 mjeseci. Rizični faktori za novorođenčad su: rođenja u intervalu kraćem od 17 mjeseci; smrt prethodnog potomka i muški spol. Niti dob majke niti broj prethodnih potomaka nisu značajni rizični faktori.