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BIOMETRIC ANALYSIS AND CAUSES OF INFANT MORTALITY IN SPAIN (1975–1998)

ABSTRACT: The temporal change of the infant mortality rate, taking into account the contribution of endogenous and exogenous components is analyzed for the years 1975–1998. The above is made by a direct (registered causes of death) and by a biometric method (age distribution of infant deaths). In the period studied infant mortality decreased from 16.4 to 5.2 ‰, which is reflected in both components. But while the endogenous component provided by the biometric method began to decrease in 1980, values given by the direct method increased, mainly since 1985. The biometric method underestimates the endogenous component (1975–79 = 8.6%, 1995–98 = 30.1%) and, contrarily, overestimates the exogenous component. To study the influence of age on infant mortality, two groups were considered: less than 1 month and from 1 month to less than 1 year. From the first to the last period the percentage of the endogenous infant mortality respecting total deaths progressively increased. Simultaneously these causes of deaths were slightly less frequent in the neonatal period than in the post-neonatal. This change in the age pattern at death of endogenous infant mortality contradicts one of the assumptions required by the biometric method, the application of which is not here advisable.

KEY WORDS: Infant mortality – Endogenous – Exogenous – Biometric method – Spain

INTRODUCTION

The battle against infectious diseases and improvement in nutrition have been responsible for the decrease of deaths during the first year of life. Initially the reduction affected the neonatal mortality (that is the first month of life) more than the post-neonatal, but since 1960 this situation reversed in many populations (Lantoine, Pressat 1984).

Concerning Spain, infant mortality evolved from 1950 to 1962 as in other west European countries, with rates very close to the Italian and much lower than Portuguese values (Biraben *et al.* 1964). Since the 1960's demographic changes, such as population movement from rural to urban areas, demographic aging and fertility decrease, as well as socio-economic changes, producing improvement of life standards and health facilities took place in Spain, which reduced the present infant mortality rates to 4.87‰ (Fuster *et al.* 2002).

The infant mortality rate may be separated into two components: endogenous and exogenous; the first previous to or associated with birth; and the second including the remaining factors. This division may be achieved by a direct method which classifies deaths by groups of causes. Alternatively, the Bourgois-Pichat (1964) biometric method may be applied, which is based on the hypothesis that from a certain month of age all deaths are exogenous, and that the number of deaths occurring later depends only on age. This method provides a function for the distribution of infant deaths. It assumes that endogenous mortality is restricted to the first month of life. But although the endogenous factors probably predominate in the first days after birth, during the rest of this first month exogenous causes of death may be as important as in the subsequent months (Lantoine, Pressat 1984). When endogenous mortality extends through month 1 to 11 after birth, the exogenous component becomes overestimated by a

TABLE 1. Infant deaths per age in months. Partial infant mortality rate per age and total infant mortality rate (IMR). Total deaths and births per period.

Months at death	Deaths per 1000 births				
	1975–79	1980–84	1985–89	1990–94	1995–98
0	11.38	8.02	5.75	4.49	3.35
1	1.15	0.75	0.68	0.60	0.49
2	0.89	0.56	0.48	0.41	0.30
3	0.71	0.47	0.40	0.34	0.23
4	0.50	0.36	0.26	0.24	0.18
5	0.40	0.27	0.22	0.18	0.13
6	0.34	0.23	0.18	0.15	0.12
7	0.27	0.21	0.17	0.13	0.11
8	0.23	0.16	0.13	0.11	0.09
9	0.19	0.14	0.12	0.10	0.07
10	0.17	0.13	0.09	0.08	0.07
11	0.14	0.10	0.08	0.07	0.06
Total deaths	53,009	29,416	18,350	13,472	7,570
Total IMR	16.37	11.40	8.56	6.90	5.20
Births	3,238,087	2,576,272	2,146,560	1,948,818	1,458,202

TABLE 2. Endogenous and exogenous components of the infant mortality rate calculated by the biometric method and by the inscription of causes of death. Endogenous component estimated by the biometric/direct methods, in percentages. Infant mortality endogenous component by age at death.

Variable	Period				
	1975–79	1980–84	1985–89	1990–94	1995–98
Endogenous biometric	10.55	7.40	5.30	4.12	3.08
Exogenous biometric	5.82	4.00	3.26	2.78	2.12
Endogenous direct	11.54	8.63	6.38	5.64	4.41
Exogenous direct	4.83	2.76	2.19	1.29	0.80
% difference	–8.57	–14.25	–16.92	–26.95	–30.15
N endogenous	37,390	22,259	13,649	10,982	6,406
Neonatal endogenous	84.83	83.62	79.66	75.22	73.12
Post-neonatal endogenous	15.17	16.38	20.34	24.78	26.88

quantity proportional to the endogenous mortality during these months.

The objective of this work is to study the temporal change of the Spanish infant mortality rate and its two components in base to values provided by the direct as well as the biometric method, analyzing the changes in the relative contribution of each component respecting age at death. The results provided by the biometric method are compared to the data derived from the reported causes of death, and the deviation between both methods is quantified.

MATERIAL AND METHODS

The analysis utilizes information from a file of the Spanish Institute for Statistics (INE) including all deaths from 1975 to 1999, from which cases of infant mortality were segregated. In order to calculate rates, deaths were related to the yearly number of live births, the last available year of which was 1998 (INE). For each individual, the age in months was considered as well as the endogenous cause of death, certified according to the World Health Organization classification of diseases, revision 9.

Following the biometric method, the accumulated frequencies of deaths corresponding to every category of ages from 0 to 11 months were considered as the dependent variable, and as independent, the $\log^3 (n+1)$, where n are days (3.35, 5.74, 7.58, 9.11, 10.43, 11.60, 12.65, 13.61, 14.50, 15.33, 16.11 and 16.85). Once the obtained points fitted to a lineal regression, the value corresponding to the intercept (x=0) estimates the endogenous component, while the exogenous is calculated by subtracting the endogenous component from the total infant mortality rate (Bourgois-Pichat 1964).

RESULTS AND DISCUSSION

The rates relating the frequency of deaths to the number of live births taking place in each of the periods considered are shown in *Table 1*, according to age. Based on these data five lineal regressions were applied between the

accumulated infant mortality rate in each period and the log transformed age at death. In all periods, the coefficients defining the corresponding regression equations had significant intercepts as well as coefficients. Following the biometric method the endogenous component is underestimated, while the exogenous is overestimated. The temporal decrease of infant mortality is reflected in the two components whichever method is applied. However, differences increase as the infant mortality rate reduces, which is expressed numerically in *Table 2* as the percentage of underestimation of the endogenous component due to the biometric method. The underestimation has been progressively higher in each consecutive period, reaching in the last a value of as much as 30%. This undervalue is comparatively larger than reported by London (1993) regarding the United States, where a difference of 11.51% was found for the year 1985.

The progressively greater difference between these two estimations could be explained by a change in the age pattern of infant deaths in general or, particularly, in the endogenous mortality age pattern following better medical services. As a result, the endogenous mortality may persist through the entire first year of life. In Spain from the first to the last period, infant mortality in the first month decreased by 71% (*Table 1*, first line). At the same time, the reduction of mortality due to exogenous factors, together with an improvement in the treatment of illness of endogenous origin, may have caused a prolonged survival of children which finally resulted in an endogenous death in the post-neonatal period. To test this interpretation, both groups of causes of death were cross tabulated against the age at death (*Table 2*, bottom). Considering only 2 categories of ages: neonatal (less than 1 month) and post-neonatal (1–11 months), the percentage of endogenous infant deaths has progressively increased from the first to the last period, while these causes of deaths were slightly less frequent in the neonatal period. The above confirms that endogenous infant mortality may be present throughout the first year of life, as indicated by Nadot (1971).

From the present analysis, it is concluded that although the temporal decrease of infant mortality in Spain is reflected in both components (endogenous/exogenous) regardless of the method considered, the biometric underestimates the endogenous component, and the exogenous is thus overestimated. Differences increase progressively in each consecutive period, as the infant mortality rate reduces. Therefore, the biometric method is not adequate for determining the contribution to infant mortality of endogenous/exogenous causes of death in populations where the infant mortality rates fall below a certain level as a result of improved health services.

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