First phase of life in a coastal town of Sardinia (1866–1920)

Marco Breschi[1]
Massimo Esposito[2]
Stanislao Mazzoni[3]
Lucia Pozzi[4]

Abstract

In the decades following National Unification, mortality rates in Italy in the first phase of life underwent a considerable reduction, but this process was marked by great differences on a regional level. This pattern is particularly interesting in the context of Sardinia, where the mortality rate was lower than elsewhere in Italy in the first year of life, but steadily rose from the second year onwards, exceeding the national average, before declining slowly in the first half of the 20th century. Many social, economic, cultural, sanitary and environmental factors contribute to this trend, but it is difficult to evaluate their effects on mortality, especially in Sardinia, characterized by significant territorial differentials.

Given that the relationships between mortality, socio-economic conditions and environmental context are still largely unexplored in Sardinia, we have chosen to examine mortality patterns in Alghero, a coastal town in the North West of the island. This study employs a micro-analytical approach, which allows us to reconstruct the life-histories of the cohorts born between 1866 and 1920, in the aim of measuring mortality in the first years of life.

By combining civil records with other available sources, we are able to estimate how the socio-economic conditions of the family and short-term changes in environmental context influence mortality levels.

Keywords: Infant and child mortality, still-birth, Sardinia, micro-analytical approach, socio-economic and environmental differentials, education, seasonality

1 Dipartimento di Scienze economiche e aziendali, University of Sassari.
2 Dipartimento di Scienze economiche e aziendali, University of Sassari.
3 Dipartimento di Scienze economiche e aziendali, University of Sassari.
4 Dipartimento di Scienze economiche e aziendali, University of Sassari.

Fecha de recepción: mayo de 2013. Fecha de aceptación: enero de 2014
Revista de Demografía Histórica, XXXI, I, 2013, segunda época, pp. 25–56

Primera fase de la vida en una ciudad costera de Cerdeña (1866–1920)

Resumen

En Italia, las tasas de mortalidad infantil y juvenil se redujeron considerablemente en las décadas posteriores a la Unificación Nacional, pero este proceso estuvo marcado por grandes diferencias regionales. Este patrón es particularmente interesante en Cerdeña, donde se regístraban tasas de mortalidad más bajas que en otras regiones italianas en el primer año de vida, pero que crecían de forma constante sobre la media nacional a partir del segundo año, hasta disminuir lentamente en la primera mitad del siglo XX. Esta tendencia se puede explicar por la contribución de muchos factores de naturaleza diversa, social, económica, cultural, sanitaria y ambiental, cuyo efecto es, sin embargo, difícil de medir sobre la mortalidad, especialmente en Cerdeña, que se caracterizaba por significativas diferencias territoriales.

Las relaciones entre mortalidad, condiciones socio-económicas y contexto ambiental de la isla de Cerdeña siguen estando en gran medida inexploradas. En consecuencia, hemos elegido examinar los patrones de mortalidad en Alghero, una ciudad de la costa occidental del norte de la isla. Este estudio emplea un enfoque micro-analítico, que permite reconstruir las historias de vida de las generaciones nacidas entre 1866 y 1920, con el objetivo de medir la mortalidad en los primeros años.

Mediante la combinación de los registros civiles con otras fuentes disponibles, hemos calculado cómo las condiciones familiares, socio-económicas y los cambios ambientales a corto plazo influyeron en los niveles de mortalidad.

Première phase de la vie dans une ville côtière de la Sardaigne (1866–1920)

Résumé

En Italie, dans les décennies suivantes l'unification nationale, les taux de mortalité infantiles ont subi une réduction considérable, avec cependant des différences marquées selon les régions. Le cas de la Sardaigne est particulièrement intéressant, car le taux de mortalité y est plus faible dans la première année de vie, mais supérieur à la moyenne nationale à partir de la deuxième année, cette dernière différence s'estompant lentement à partir de 1900. De nombreux facteurs sociaux, économiques, culturels, sanitaires et environnementaux contribuent à cette tendance, mais il est difficile d'évaluer leurs effets sur la mortalité, sachant que les variations territoriales sont importantes.

Considérant que les relations entre la mortalité, les conditions socio-économiques et environnementales de la Sardaigne sont encore largement inexplorées, nous avons choisi d'examiner les tendances de la mortalité à Alghero, une ville côtière dans le nord-ouest de l'île.

Cette étude utilise une approche micro-analytique, qui conduit à reconstituer les histoires de vie de générations nées entre 1866 et 1920, l'objectif étant de mesurer la mortalité dans les premières années de la vie.

En combinant les actes d'état civil avec d'autres sources démographiques disponibles, on peut estimer comment la situation socio-économique des familles et les changements environnementaux à court terme ont influencé les taux de mortalité.

INTRODUCTION

In Italy, in the second half of 19th century, there was a considerable reduction in mortality in the first years of life starting from the cohorts born after National Unification (1861), which, if we exclude the period of the First World War and the Spanish flu, continued over the following decades (Istat, 1975; Somogyi, 1967; Ventisette, 1995). This downward trend, which became even more evident for children born in the 1890s, was accompanied by a relevant change in mortality structure. In fact, the ratio between infant and child mortality doubled, largely due to improvements in sanitary and environmental conditions (Del Panta, 1990 and 1994; Pozzi, 2000)[5].

On the national level, whereas only 60% of children reached the age of five in the 1860s, this figure had risen to 80% sixty years later. However, Italy was characterised by strong territorial differences, even

5 With the ratio between infant and child mortality we intend to highlight specific well known age patterns (Ramiro Fariñas and Sanz Gimeno, 2000) characterising the health transition process in the Mediterranean area. While in the Northern European countries infant mortality was usually higher than child mortality, in the Mediterranean ones, where the transition process started later, these rates were almost equal. Consequently the ratio in France and Belgium was more than double, in Italy 1.2 times, in Spain close to 1. Among the factors that could explain particularly high child mortality rates, Woods *et al* (1993) include the duration and diffusion of breastfeeding, hygienic conditions, environmental pollution and the prevalence of typically infant diseases.

In Italy strong territorial variations as well as different trends over time were measured. Indeed in the Southern regions the "Mediterranean" component was much higher. Furthermore, while the cohorts born after national unification experienced a stronger decrease in infant mortality, the contrary occurred at the beginning of the 20th century.

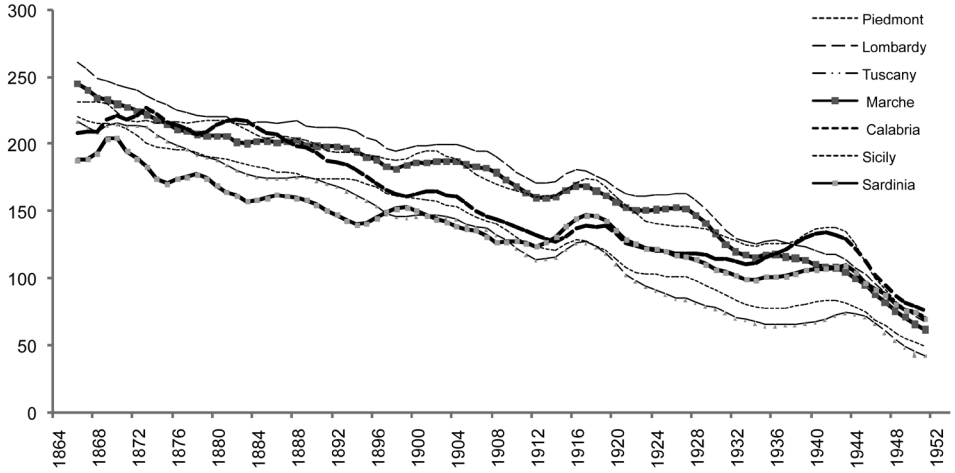
between neighbouring regions. For example, although mortality levels were relatively low in Piedmont, this was not the case in neighbouring Lombardy (Breschi and Fornasin, 2007).

The pattern of mortality decline observed in Sardinia is peculiar in being unlike that of any other Southern region. Its infant mortality rate was the lowest in Italy following National Unification, and although the island's primacy gradually attenuated towards the end of the century (surpassed by some Northern regions), it remained slightly below the average national value, with few exceptions, until the 1940s (Gatti, 2002) (figure 1). This advantage is largely attributed to neonatal mortality; although Sardinia's risk of post-neonatal death was close to the national average (Pozzi, 2000; Gatti, 2002), that of still-births was notably lower.

However, considering the problematic nature of measuring still-birth (Robles González and Pozzi, 1997; Pozzi, 2000; Breschi *et al.*, 2012) and the blurred distinction between still-birth and death in the first hours of life, it is possible that the disparity is attributable to differences in recording procedures. For this reason, great care should be taken when examining neonatal mortality and still-birth in Sardinia and their territorial differences. Sardinia's exceptionally low infant mortality was first examined by Coletti (1908), who, on the basis

FIGURE 1

Infant mortality rate (per thousand) in seven Italian regions, 1864-1953 (moving averages)



Source: Breschi and Fornasin, 2007

of his research, affirmed that prolonged breastfeeding, and the care provided by mothers not involved in extra-domestic work, considerably reduced the risk of death in the first year of life. It was during subsequent weaning process, with inappropriate food, that children were exposed to new and severe risks of death from gastrointestinal disease, and, in addition, the second birthday often coincided with the birth of a new sibling, who received the most maternal care (Gatti, 2002).

As suggested by several scholars (Reher *et al*., 1997; Derosas, 2003 and 2004; Oris *et al*., 2004; Tymicky, 2009), the mutable relationships between biological, epidemiological, environmental, familiar, economical, social and cultural factors and theirs effects on mortality suggest a disaggregate analysis. Given the difficultly in synthesising the complexities of the Sardinian context, all these considerations remain valuable over one hundred years later. By using individual and family biographies, this study aims to assess the impact of these various factors on infant survival for cohorts born between 1866 and 1920 in the community of Alghero, a coastal town in North-West Sardinia.

The use of micro-data and event history analysis techniques has allowed for formulating (Williams and Galley 1995; Robles and Pozzi 1997; Tymicki 2009) or re-adapting theoretical frameworks elaborated for the developing countries (Mosley and Chen 1984; van Norren and van Vianen 1986) on the determinants of infant mortality in the past. A number of scholars have also highlighted the importance of an analysis segmented by age, given that in addition to the phase of the transitional process under examination the impact and role of individual factors vary according to the age of the child, (Oris *et al* 2004; Bernabeu Mestre *et al*. 2007). For this reason, we have devised and applied a number of models to measure the risk of death in different phases during the first years of life. While biological determinants are most relevant early in life, these are subsequently supplanted by contextual factors and in particular the family's socio-economic conditions. However, the limitations imposed by the sources available remain particularly strong in studies on past populations, resulting in a significant gap between the theoretical models and their actual implementation, as proves true for the case-study of Alghero, where, for example, there is a lack of information on the cause of death in the civil status records.

Following a brief description of the socio-economic, sanitary and environmental context in Alghero, and the sources used in this analysis, we examine the mortality patterns in the first years of life for the period under study (second half of the 19th century to the first three decades of the 20th century). The main section of this paper then addresses the measure of the relevance of specific socio-economic factors affecting infant and child mortality, through the application of various statistical models.

1. SOCIO–ECONOMIC AND SANITARY CONTEXT

The first Italian Census (1861) records Alghero as having 8,891 inhabitants, making it the island's fourth municipality. Besides the town centre, the municipal territory included a large flat area, which was almost uninhabited and marshy until the 1920-30's. The relative isolation of the town was guaranteed by its geographical distance from and weak communications with neighbouring urban centres, and by the walls that completely surrounded the town until 1886, when their demolition was begun. Like the surrounding region, Alghero's economy was essentially based on the primary sector which engaged more than half of the male labour force (Coda, 1977), but, being a coastal town, there was also a significant presence of fishermen, sailors and coral fishers as well as artisans and traders. These two latter socio-professional groups were well balanced and amounted to 45% of the labour force. The socio-economic structure also included a limited (2%), but relevant group of wealthy individuals, formed by the few local representatives of the nobility and more numerous professionals and executives. As elsewhere in Sardinia, more than 75% of Alghero's population was almost completely illiterate.

The health status of Alghero's population was very poor as shown by the extremely high frequency of discharge (permanent and temporary) from military service, amounting to over 50% of the male cohorts born between 1866 and 1900 at first enrolment (Cau *et al*., 2007). The town's hygienic conditions were critical, as attested by various national surveys and documents (petitions, requests and protestations) kept in the local civic historical archive. On several occasions in the second half of the 19th century, the town's "Board of

Health" recorded the excess in number of deaths as attributable to "poverty" and "density of housing within the walls preventing free circulation of air, resulting in many diseases, particularly for children". Not only was the population dense[6], but the sewer system was also exceedingly poor – particularly in the dirty harbour-side alleys, where the quality and quantity of water provision was far from adequate. These hygienic problems were partially addressed at the close of the 19th century and improved further in the early 20th century.

Compared to the island's interior municipalities, Alghero was better served with medical facilities, but these were generally defective and insufficient (Gatti, 1999; Putzolu, 1993). Although the National Survey on the hygienic conditions of Italian municipalities carried out in 1885 by the General Directorate of Statistics (MAIC, 1886), recorded Alghero as having 6 medical doctors, 3 pharmacists and 3 registered midwives, this does in no way mean that they had adequate professional training. There was a contract between the municipal authorities and the local hospital, administered by the *Congregazione della Carità*, for the treatment of indigent citizens. Records held in the local municipal historical archive class around 40% of the indigent families as "poor". Beside the endemic presence of malaria, trachoma was widespread particularly amongst children (Melis and Pozzi, 2010) and tuberculosis was booming (Corbia, 1934; Collari, 1935). In this period, the population of Alghero was clearly afflicted by enduring and continuous health "stress".

Some progress was made with the Kingdom's new healthcare system following the introduction of the "Crispi law" in 1888, which obliged all Italian municipalities to provide free medical surgical and obstetric care for the poor. The role of the doctor was also strengthened by awarding him the status of health officer and delegated powers regarding public intervention on hygiene and preventive care. However, these advances were not generalized to all the regions and sub-regions of the Kingdom, and significant differences remained. In particular, the Sardinian countryside and the more isolated urban centres remained disadvantaged and often without medical personnel (Tognotti, 1996: 130-141; Melis and Pozzi, 2010: 31-33). Even in Alghero the hygienic

6 At the end of the 19th C., the population was around 8000 per square km within the town walls.

situation remained critical, notwithstanding the presence of medical personnel, health services and the town hospital. Suffice it to say at the time of the 1961 census, the vast majority of the urban population was still without toilets or drinking water in their homes.

2. SOURCES

The demographic information used in our analysis is based on civil records of birth, death and marriage, which were introduced in 1866 in accordance with the regulations of the newly formed Kingdom, and refers to the cohorts born from 1866 to 1920[7].

The data reported in the civil records were nominally digitised and standard cross-check procedures were then carried out to reconstruct individual and family histories. The information reported in the civil records was integrated and controlled for coherence with data from different sources, such as military enrolment records, some limited and partial records from the Population Register and original family sheets of the 1921 Alghero census. Lastly, the demographic information derived from the civil status registers was combined with data in the parish registers of baptisms, burials and marriages[8]. Cross-checking between these two source types is indispensable given the prolonged state-church conflict regarding marriage. From 1866, when the first National Civil Code of the Italian Kingdom established the exclusive legal authority of the State for the registration of vital statistics, religious marriages were no longer recognised by the state, which had a series of considerable consequences for civil registration[9].

Despite these inevitable imperfections, it is possible at the nominative level to follow the biographies of children born in Alghero between 1866 and 1920, particularly for those born to couples married

7 The civil status records in Alghero's local historical archive refer to the same years. We would like to thank the staff of the municipal archive, Baingio Tavera and Gianfranco Piras, for their help and kindness.

8 The parish confines correspond to those of the municipal territory.

9 For a more detailed analysis of this topic and the measures adopted to overcome the consequences of the new marriage legislation see: Breschi *et al*., 2009; Breschi *et al*., 2012; Mazzoni *et al*., 2013.

since 1866. Only for these children, who constitute around 71% of the total number of births, do we have information on the family of origin at our disposal. Below, we set out the micro-level analysis conducted on mortality in the first phase of life for this large set of individuals.

To measure the impact of socio-professional status, the father's occupation was taken into consideration, while that of the mother was disregarded, given that female professional classification was inadequate at the time, with the majority generically recorded as "housewife".

For the purposes of this study, our analysis adopts a simplified SES stratification, with the Alghero population divided into four broad occupational categories: "farmers" (accounting for around 50% of the total), including all fields of employment connected to agriculture; "fishermen", including coral fishers (a traditional activity of the town) and seamen; "artisans & traders", a composite group including craftsmen, shopkeepers and merchants; and "upper class", including the few local nobles and most prestigious professionals (doctors, pharmacists, lawyers, engineers, professors, etc.).

3. MORTALITY IN THE FIRST YEARS OF LIFE

In reconstructing mortality dynamics it was necessary to address the problem of the still-birth measure, which proves to be somewhat complex given the difficulties in classifying still-births when delivery occurred without medical assistance (Woods, 2009). Moreover, post-Unification the criterion of "legal vitality" was in force (Bodio, 1876), meaning that a new-born was declared alive if he/she was so when presented to the civil officer (within 5 days after birth), and classified as still-born if he/she had died at anytime before this registration, which clearly contrasts with ascertainment of viability at birth. The General Directorate of Statistics issued certain amendments in the 1870s (Maic, 1879), whereby new-borns who had died prior to registration were to be considered born alive if they had given signs of life at birth. This divergence between law and statistical criteria of data collection is likely to have caused a variety of different recording procedures amongst civil officers.

These problems also affected Alghero civil registers, with 4% of the birth records dating from 1866 to 1884 using the wording "not alive",

making it impossible to establish if the child was still-born or born alive and had died prior to registration. Moreover, for these new-borns, the death record, which could assist in clarifying this ambiguity, at least with respect to age at death, was not compiled. From 1884 to 1891, despite the new provisions in vigour, difficulties in ascertaining still-birth persist, with civil officers attempting to meet these new requirements by using additional definitions to "not alive", such as "born and dead during childbirth" and "still-born".

Some degree of clarity is possible after 1892, when the majority of birth records contain exclusively the wording "still-born", and those of new-borns who had died before declaration report the age at death (expressed in days and hours). However, it is notable that in entire period of analysis a mere 164 death records for new-borns who had died within 5 days were compiled, corresponding to a mortality selection between 6.1 and 6.4 per thousand according to the denominator selected (with or without "still-births"). These values are exceptionally low, being inferior to those recorded for the first day of life in Italy, and Sardinia, in the early 1970's.

This scenario suggests that there was an incomplete registration of deaths occurring soon after birth, which could partially account for the low levels of neonatal mortality recorded in Alghero and Sardinia. A previous study (Breschi *et al.*, 2012), aimed at an accurate reconstruction of deaths in the first days of life, led to a revision of neo-natal and thus infant mortality rates in Alghero. With this correction, the Sardinian infant mortality rates would be in line with the correspondent values observed in Piedmont and Tuscany of the time. While these initial findings require further validation, it is plausible that the recording of deaths occurring soon after birth was more defective in the south than in the northern and central regions of Italy (Woods, 2009).

The identification of still-births in Italy is a clearly a complex and partially irresolvable problem. For this reason, the micro-analytical models adopted in this study alternately include and exclude "still-births", whereas in the descriptive analysis, and calculation of neonatal and infant mortality rates, still-births were included[10]. To homogenise

10 On the one hand, the exclusion of all still-births (true and false) causes a severe underestimation of mortality, particularly for cohorts born in the nineteenth century, while on the other, the inclusion of all still-births tends to overestimate the mortality to around 5-10 points per thousand (Breschi *et al*., 2012).

the number of births and trace the phases of the evolution of mortality reduction, the 55 generations examined (1866-1920) were divided into three groups: 1866-1885, 1886-1905, 1906-1920. Table 1 contains the survivors (l_x) in the first five years of life, according to age (in months) and family SES, for each period.

Whereas death selection for the first cohorts is analogous to a pre-transitional regime, there is a marked increase in survival, especially after 12 months, for the last cohorts, as in the rest of Italy (Del Panta, 1994). The probability of survival at age 5 jumps from 61% to 69%, while the increase in infant survival is less striking (80% to 84%).

Distinguishing by SES (excluding the upper class), no significant differences emerge either in neonatal or infant mortality, although the artisans and traders group does tend to recover from an initial disadvantage, and mortality over the first 12 months appears to be higher for farmers and, to a certain extent, fishermen.

With regard to mortality structure, in the late 19th century infant mortality rate was higher than child mortality rate in most European countries, whereas in the Mediterranean where the health transition started later (Ramiro Farinas, Sanz Gimeno, 2000), they were almost

TABLE 1

Survivors (l_x per thousand) in the first years of life. Alghero, 1866-1920

	Birth cohort 1866-1885					*Birth cohort 1886-1905*				
Months	***Total***	*Farmers*	*Fishermen*	*Artisans & traders*	*Upper class*	***Total***	*Farmers*	*Fishermen*	*Artisans & traders*	*Upper class*
1	**925.9**	925.6	924.0	901.0	901.8	**925.4**	945.1	916.5	927.8	969.5
6	**866.1**	863.2	872.5	842.5	866.1	**870.9**	901.4	873.8	874.2	961.8
12	**800.0**	798.6	812.8	775.0	857.1	**808.8**	825.0	802.3	819.9	946.6
24	**689.7**	693.5	700.1	687.3	750.0	**705.7**	740.0	696.8	713.9	900.8
60	**605.6**	617.4	620.1	613.0	669.6	**632.6**	674.3	619.6	653.3	801.5
q_0/q_{1-4}	**0.82**	0.75	0.79	1.08	0.65	**0.88**	0.89	0.87	0.89	0.35

	Birth cohort 1906-1920				
Months	***Total***	*Farmers*	*Fishermen*	*Artisans & traders*	*Upper class*
1	**946.5**	934.5	943.9	951.2	966.3
6	**903.2**	877.3	902.6	901.5	966.3
12	**837.3**	807.5	845.9	843.3	943.8
24	**753.2**	704.6	755.6	767.1	921.3
60	**690.5**	627.9	689.9	713.2	876.4
q_0/q_{1-4}	**0.93**	0.96	0.84	1.02	0.79

equal (e.g. in France and Belgium the ratio between infant and child mortality was more than 2, while in Italy it was 1.2 and in Spain close to 1). In Italy strong territorial differentials are found, with this "Mediterranean" structural component particularly noticeable in the South (Pozzi, 2000).

As expected, this Mediterranean trait is strong in Alghero, with the ratio between infant and child mortality (q_0/q_{1-4}) remaining below 1 (table 1) even in the last cohorts, whose risks of dying in early childhood had started to fall. This is consistent with the hypothesis formulated by Coletti (1908) on the rule of breastfeeding in Sardinia. On the one hand, prolonged breastfeeding reduced the level of infant mortality, while on the other, weaning with inappropriate food and the removal of maternal immune components coincided with the increased exposure to gastrointestinal pathogens and favoured the rise of child mortality. This structural component of Mediterranean mortality is found in various social groups albeit with some differences. Whereas the ratio q_0/q_{1-4} is below 1 for the upper class in view of the low levels of infant mortality, this ratio (in 2 out of three cohorts) is slightly over 1 among artisans and traders.

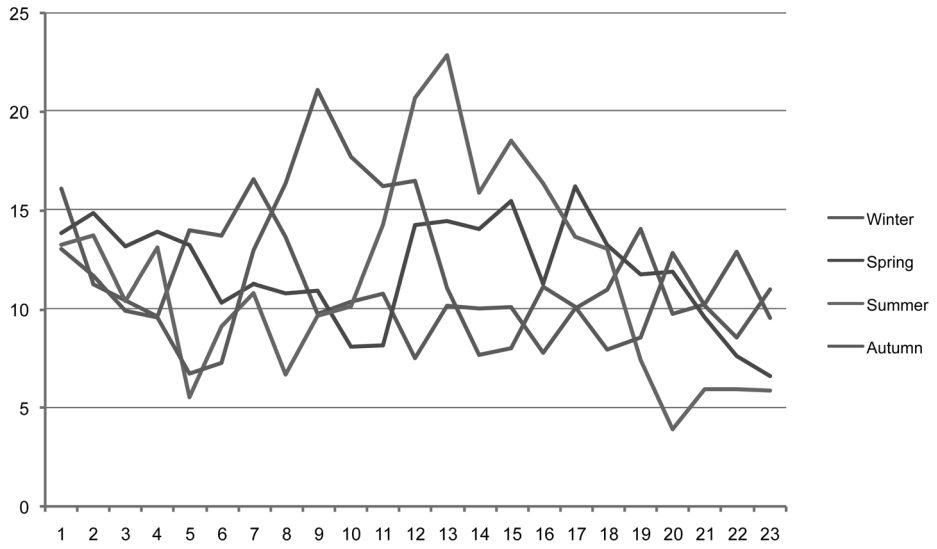
In Sardinia, as elsewhere in the South, infant and especially neonatal mortality was relatively low also partially due to the mild winters. Until the early 20th century, the influence of climate in determining the geography of mortality in Italy was strong and more accentuated than elsewhere in Europe (Breschi and Livi Bacci, 1986 and 1997). In the second half of the 19th century, babies born in the winter ran a considerably higher risk of death (30%) than those born during the summer. However, seasonal influence differed according to age; winter could be extremely dangerous in the first month of life, and the negative effects of summer were most apparent from the end of the first to the beginning of the second year, plausibly coinciding with weaning. However, this impact was most accentuated in Veneto (where the seasonal curve of death risk was U-shaped with the winter maximum three times higher than the summer minimum), less significant in Tuscany and almost absent in the South. Not surprisingly, neonatal mortality was more marked where winters were cold, even though better housing could attenuate these effects. Official statistics suggest that the Sardinian climate does not play a significant role in favouring seasonal differentials, with infant survival remaining around 82%. Likewise, in Alghero only a modest increase in infant

mortality is observed during the most extreme seasons, although we can observe that the first summer after birth frequently had a negative impact. This is most apparent for babies born in the summer who, about twelve months later encountered the following summer coinciding with the time of weaning, paying the highest toll in terms of mortality (see figure 2)[11]. In any case, independently of birth season, the second birthday was reached by 72% of children. While infant mortality was generally speaking higher for babies born in autumn and winter, their mortality selection went on to be lower in the second year of life, so these tendencies counter-balanced each other.

Lastly, joint analysis taking into account both seasonality and family SES shows some variability. Whereas babies born to famers experienced a higher neonatal mortality during the winter, those born to artisans-traders and fishermen experienced higher neonatal mortality risks during the summer. This could be partially explained by the fact that most of the latter tended to live near the port, which

FIGURE 2

Mortality in the first two years of life for birth season, cohorts 1866-1920



11 Mortality in the first month of life (significantly higher) was excluded to highlight the mortality gaps of the different seasonal birth cohorts at the following monthly ages.

was undoubtedly the unhealthiest area of the town; high temperatures and poor hygienic conditions would favour prenatal and neonatal infection, threatening infant survival.

4. MODELS AND RESULTS

The above considerations led us to formulate a series of models to estimate the specific and changing influence of various biological, socio-economic and environmental factors affecting mortality up to the age of six. A logistic regression was used with the response variable as death in different phases of life in early childhood. Due to the large population size, we put forward a model partitioned into twelve groups age groups to detect more precisely the different steps in mortality risk. A segmentation by age so detailed has been introduced to highlight, net of other covariates introduced, the influence of season and breastfeeding. As we mentioned, an extensive literature identifies the long duration of breastfeeding as one of – if not the main – factor responsible for the Sardinian low mortality selection in the first phase of life.

The choice of variables included in the models derives from the nature and quality of data at our disposal. It is especially difficult, particularly for past generations, to have regular information on gestation, delivery mode, health status of the new-born at birth, mother eventual depletion, etc. The influence of these variables is decisive and not surprisingly considered in great detail in the conceptual frameworks about the proximate determinants of early-life mortality proposed in the literature (Cramer, 1987; Shah *et al.*, 2000; Oris *et al.*, 2004). Unfortunately, these variables, which went on to be regularly recorded, were not included in the Italian civil records of the time (Istat, 1957)[12]. Equally regrettably also the information about the cause of death was not reported in the death records, as we shall recall later.

12 The "child birth" certificate was introduced in Italy in the late 19th C., but applied to hospital births only, which were few and mostly restricted to un-married mothers. Considering each woman's entire reproductive history is crucial to understand the health risk factors of her baby. See a recent study on the maternity case records of the S. Orsola Hospital in Bologna between 1880 and 1940 (Ward, 2006).

Given the characteristics of our data set described above, the births included in the analysis are a sub-set of the total number recorded between 1866 and 1920, referring to children born to the marriage cohorts formed since 1866. Only for these infants can we identify the following relevant demographic variables regarding new-borns: birth order; maternal age; mother's and father's literacy; and mother's previous reproductive history (birth interval and viability of previous child)[13]. The total number of children whose family of origin is known amounts to 16,423 (16,959, including the still-born category), which corresponds to around 71% of the total number of births recorded. The models allow for an estimation of the effect of biological, socio-economic and environmental factors on mortality in the first years of life. The covariates refer to the individual level (sex, year and order of birth, outcome of previous birth, mother's age), family level (presence and education of parents, SES), and environment level (current season).

Our results are reported in tables 2 and 3[14]. The first two models refer to neonatal mortality (0-29 days), with the first application excluding still-births and the second including them. The following eight models cover the period between one and twenty-four months, with each, except the first, covering a quarter. The last two models analyse the third to sixth year, considering the presence of a sibling aged over 8, who could substitute the mother in taking care of the index child, as a covariate.

Most of the results from our models confirm expectations regarding the effects of the variables in the first days and months of life, and are consistent with findings regarding other populations of central and northern Italy in recent studies using a micro-analytic approach (Breschi *et al*., 2000a, 2000b and 2004b; Derosas, 2002 and 2004; Manfredini and Pozzi, 2004; Samoggia and Scalone, 2013; Scalone *et al*., 2013). They would also appear to confirm the hypothesis of the predominance of bio-genetic factors in early life, of which empirical evidence is frequently reported even if not always for historical contexts (Reid, 2001; Oris *et al*., 2004).

13 Controlling all variables, results are similar when taking the total number and subset of births.

14 The percentages in Table 2 refer to time of birth only. Those in Table 3 refer to the first birthday (the presence of a sibling is measured at the age of 2). This choice is due to their small change over time.

TABLE 2
Parameter estimates of infant mortality, Alghero (1866-1920)

Covariates		%	*0-29 days with stillbirth*		*0-29 days with stillbirth*		*1-2*		*3-5*		*6-8*		*9-11*	
			Odds Ratio	*P>z*	*Odds Ratio*	*P>z*	*Odds Ratio*	*P>z*	*Odds Ratio*	*P>z*	*Odds Ratio*	*P>z*	*Odds Ratio*	*P>z*
Age							0.826	0.059	0.929	0.191	1.018	0.739	1.011	0.828
Sex	Male	51.7	1.000		1.000		1.000		1.000		1.000		1.000	
	Female	48.3	**0.784**	0.005	**0.793**	0.001	0.935	0.504	0.945	0.539	**0.834**	0.035	0.909	0.268
Year of birth			1.001	0.747	**0.988**	0.000	**0.991**	0.021	**0.990**	0.006	1.003	0.431	0.996	0.219
Birth order			**1.067**	0.01	**1.046**	0.027	**1.083**	0.006	1.001	0.964	1.019	0.420	1.025	0.291
Previous birth	ŁŸŸĽM□	54.2	1.000		1.000		1.000		1.000		1.000		1.000	
	ŁŸŁ□	11	**1.784**	0.000	**1.809**	0.000	1.205	0.265	**1.325**	0.045	1.004	0.977	1.102	0.485
	ŁŸŠPŁ	13.9	**1.667**	0.000	**1.690**	0.000	**1.393**	0.029	1.085	0.564	1.089	0.505	**1.417**	0.003
	First born	20.9	**2.253**	0.000	**2.399**	0.000	**1.924**	0.000	1.031	0.835	0.905	0.488	0.965	0.807
Mother's age	<25	30.9	1.000		1.000		1.000		1.000		1.000		1.000	
	ŁŸ□	49.1	0.997	0.978	1.128	0.198	0.942	0.656	0.954	0.694	1.038	0.749	**1.407**	0.004
	%ŁŸ□	20.0	1.139	0.456	**1.486**	0.005	0.800	0.266	1.073	0.685	1.108	0.534	1.177	0.343
Mother	ŠPŁŸŸĽM□	98.9	1.000		1.000		1.000		1.000		1.000		1.000	
	Dead	1.1					1.100	0.851	**2.827**	0.000	1.804	0.057	**2.134**	0.006
Father	ŠPŁŸŸĽM□	97.8	1.000		1.000		1.000		1.000		1.000		1.000	
	Dead	2.2					1.347	0.384	1.595	0.080	0.954	0.868	**1.732**	0.007
Current season	PUŁŸŸĽM□	28.2	1.000		1.000		1.000		1.000		1.000		1.000	
	Spring	23.8	0.878	0.277	0.961	0.677	0.958	0.759	1.093	0.507	1.330	0.053	1.266	0.088
	Summer	20.6	0.897	0.376	1.081	0.418	1.270	0.083	**1.483**	0.002	**2.209**	0.000	**1.963**	0.000
	Autumn	27.4	0.826	0.101	0.917	0.347	0.896	0.451	1.192	0.214	**1.399**	0.021	**1.346**	0.021
Education	5ŲŁŸŸĽM□	44.1	1.000		1.000		1.000		1.000		1.000		1.000	
	Father	12.7	0.904	0.521	0.905	0.470	0.716	0.053	0.919	0.573	0.850	0.268	1.102	0.471
	Mother	15.9	**0.717**	0.029	0.784	0.068	0.834	0.244	0.919	0.550	0.824	0.142	1.015	0.910
	Both	24.1	0.799	0.114	0.884	0.312	0.839	0.234	1.008	0.954	1.031	0.803	1.027	0.832
	Unknown	3.2	0.851	0.570	0.784	0.298	1.074	0.784	0.916	0.741	**1.536**	0.044	1.077	0.767
SES	÷ŸŁŸŸĽM□	52.8	1.000		1.000		1.000		1.000		1.000		1.000	
	Fisherman	22.7	1.064	0.610	1.169	0.140	**0.688**	0.006	0.864	0.226	0.963	0.723	0.863	0.181
	Artisan	21.0	0.985	0.913	1.052	0.653	0.896	0.440	0.975	0.841	0.826	0.124	0.864	0.224
	Upper class	1.9	0.512	0.142	0.708	0.269	**0.112**	0.030	0.458	0.092	**0.230**	0.013	**0.070**	0.008
	Unknown	1.6	0.396	0.077	0.678	0.225	0.388	0.105	0.470	0.136	0.322	0.052	0.473	0.100
Events			615		1,151		402		484		551		556	
Months-Person			16,423		16,959		31,141		45,338		43,844		42,178	
Log-likelihood							-2,115.530		-2,655.287		-2,916.961		-2,910.615	

TABLE 3

Parameter estimates of child mortality, Alghero (1866-1920)

Covariates		%	12-14		15-17		18-20		21-23		24-47		48-71	
			Odds Ratio	P>z	Odds Ratio	P>z	Odds Ratio	P>z	Odds Ratio	P>z	Odds Ratio	P>z	Odds Ratio	P>z
Age			**0.880**	0.019	**0.882**	0.029	**0.871**	0.035	0.997	0.964	**0.943**	0.000	**0.964**	0.000
Sex	Male	51.0	1.000		1.000		1.000		1.000		1.000		1.000	
	Female	49.0	**0.815**	0.022	0.842	0.067	1.067	0.545	1.171	0.161	0.943	0.359	1.098	0.393
Year of birth			0.998	0.530	**0.986**	0.000	**0.980**	0.000	**0.980**	0.000	**0.987**	0.000	0.995	0.200
Birth order			0.988	0.627	1.019	0.476	1.032	0.293	1.038	0.232	**1.069**	0.003	1.060	0.119
Previous birth	ŁŸŸLM□	55.1	1.000		1.000		1.000		1.000		1.000		1.000	
	ŁŸŁ□	10.6	1.201	0.202	1.046	0.768	0.795	0.216	1.161	0.403	1.004	0.977	1.102	0.485
	ŁŸ$PŁ	13.3	**1.463**	0.002	1.220	0.143	0.997	0.984	1.164	0.377	1.089	0.505	**1.417**	0.003
	First born	21.0	0.874	0.365	0.734	0.057	0.764	0,143	1.063	0.747	0.905	0.488	0.965	0.807
Mother's age	<25	31.0	1.000		1.000		1.000		1.000		1.000		1.000	
	ŁŸ□	49.1	0.981	0.870	1.090	0.493	1.274	0.096	1.205	0.228	**1.229**	0.013	0.933	0.617
	%ŁŸ□	19.9	1.149	0.407	0.982	0.920	1.006	0.976	1.513	0.051	1.025	0.847	0.925	0.710
Sister %ŁŸ□	łŁUŸŸLM□	69.7									1.000		1.000	
	Present	30.3									**0.781**	0.009	**0.752**	0.050
Brothers %ŁŸ□	łŁUŸŸLM□	67.6	1.000		1.000		1.000		1.000		1.000		1.000	
	Present	32.4									0.851	0.093	0.774	0.098
Mother	$PŁŸŸLM□	98.6	1.000		1.000		1.000		1.000		1.000		1.000	
	Dead	1.4	**2.204**	0.003	**2.006**	0.019	**2.202**	0.011	**2.353**	0.006	**1.710**	0.002	1.492	0.091
Father	$PŁŸŸLM□	96.9	1.000		1.000		1.000		1.000	0.002	**2.209**	0.000	**1.963**	0.000
	Dead	3.1	1.097	0.719	**1.553**	0.048	**1.910**	0.004	1.184	0.541	1.244	0.113	1.097	0.637
Current season	PŲŁŸŸŸLM□	27.4	1.000		1.000		1.000		1.000		1.000		1.000	
	Spring	27.8	1.290	0.056	**0.730**	0.024	1.088	0.623	**0.691**	0.047	**0.663**	0.000	1.170	0.314
	Summer	22.6	**2.035**	0.000	1.104	0.442	1.246	0.173	1.123	0.459	**0.655**	0.000	1.125	0.455
	Autumn	22.2	**1.331**	0.032	1.244	0.099	**1.381**	0.045	1.246	0.137	0.933	0.411	1.126	0.452
Education	5ŲŁŸŸLM□	43.7	1.000		1.000		1.000		1.000	0.741	**1.536**	0.044	1.077	0.767
	Father	12.8	0.894	0.459	0.896	0.477	0.992	0.966	0.819	0.301	0.888	0.257	0.781	0.196
	Mother	16.1	1.100	0.454	1.177	0.220	1.310	0.077	0.993	0.965	0.851	0.102	1.092	0.564
	Both	24.3	1.043	0.745	0.917	0.535	1.237	0.177	0.991	0.959	0.845	0.083	0.718	0.056
	Unknown	3.1	0.912	0.744	0.793	0.425	1.219	0.474	1.200	0.511	1.080	0.652	**1.641**	0.047
SES	-ŸŁŸŸLM□	52.1	1.000		1.000		1.000		1.000	0.136	0.322	0.052	0.473	0.100
	Fisherman	22.9	1.106	0.358	0.967	0.776	0.905	0.465	0.936	0.639	0.990	0.902	0.892	0.404
	Artisan	21.2	0.963	0.767	1.003	0.981	0.745	0.059	**0.696**	0.035	0.855	0.098	**0.679**	0.026
	Upper class	2.2	0.726	0.367	**0.191**	0.021	**0.285**	0.035	0.684	0.385	0.655	0.120	1.577	0.174
	Unknown	1.7	0.345	0.068	0.722	0.434	0.268	0.065	0.626	0.357	**0.532**	0.049	0.851	0.698
Events			518		465		357		319		971		331	
Months-Person			40,496		38,995		37,715		36,712		274,520		248,837	
Log-likelihood			-2,735.721		-2,484.615		-1,984.297		-1,801.149		-6,309.898		-2,551.045	

The effects of bio-demographic variables are evident and almost always statistically significant when the still-born category is included in the analysis. This same is true when the sex of the new-born is considered. The relative female advantage recurring in the aggregate statistics is confirmed at the individual level, reaching the maximum level (22%) in the first month of life.

The year of birth involves an annual reduction in the risk of dying of about 1% for most models adopted, adequately describing the progressive improvement in health conditions observed at the turn of the 19th century and in the following decades. However, this progressive reduction was only found in the model including still-births, as expected considering the general process of mortality decline, but not detected in the other model, confirming the limits of the official records of death. As mentioned above, the improvement in recording procedures brought about a reduction in the category of "false still-births" and a corresponding increase in the number of registered deaths soon after birth, with a consequent augmentation of early neonatal mortality rates.

The peculiar relationship between mother's age and her child's risk of death is widely recognised in the literature (Knodel and Hermalin, 1984; van Katwijk and Peters, 1998). Pregnancies "too early", as well as those "too late", could both be characterised by complications. Our data for Alghero show a lower death risk for babies born to mothers below the age of 25, particularly in the latter phase of breastfeeding and weaning. The importance of maternal characteristics for new-born survival emerges clearly, particularly in the model including "still-births". During the neonatal period (0-29 days), mother's age at childbirth, her state of health (approximated by age) and birth spacing and order result as particularly relevant. Medical literature strongly supports the bearing of strictly "biological" variables and the "congenital" weakness of children born to older mothers (Fretts *et al.*, 1995; van Katwijk and Peters, 1998).

These "biological" risks would be even more amplified in the past (van de Walle, 1986) by the precarious and compromised conditions of mothers whose health was depleted by numerous pregnancies and the hardships of working in rural areas (Rollet, 1995; Reid, 2001). In the model including "still-births", mortality among infants born to mothers aged over 35 was much higher than for those born to younger mothers, with the relative risk at around 1.49. If "still-births" are excluded from the analysis this effect is no longer statistically significant. The risk

also tends to increase –4.6%– with the order of birth, and becomes even more extreme if the index child belonged to a family where a previous sibling had been born and died in the previous two years. Clearly, a high number of births in a short period, in a difficult family context caused excessive maternal stress which directly affected the survival chances of her offspring (Casterline, 1989; Lynch and Greenhouse, 1994; Oris *et al*., 2004; Tymicki, 2009; van Poppel and Mandemakers, 1997).

In comparison to the clear role of bio-demographic factors, at least for the pre-transitional period, the influence of the socio-economic component in the first days of new-born's life is weak and at times puzzling. These results are affected by the comprehensiveness of birth registration procedures which is conditioned by the presence of a medical doctor or qualified midwife at delivery (Bengtsson, 1999; Woods, 2007; Gourdon and Rollet, 2009) – a condition more frequent for well-off families.

Our results for Alghero show that new-borns of more educated mothers experienced a lower neonatal mortality risk of at least _ (excluding still-births) compared to those whose parents did not sign their marriage certificate. Somewhat surprisingly, family SES does not appear to have any relevant effect. Previous studies on other Italian populations (Derosas, 2009; Breschi *et al*., 2000a and 2004b; Samoggia and Scalone, 2013) –at the micro-individual level– have found lower mortality risks in the first days of life for well-off children, but the reduced number of observations suggests great caution. We can also note that for Alghero, the inclusion or exclusion of still-births from the analysis has no change on the results in terms of social effects (father's occupation and parents' education).

In addition, no significant seasonal effect emerges in respect to neonatal mortality, either including or excluding still-births. Several studies have demonstrated strong seasonal differentials in neonatal mortality in particular environments and areas of Italy. For example, north and central regions characterised by low winter temperatures and high levels of humidity were potentially more dangerous, particularly when a family was indigent and were unable to cover the expenses of domestic heating, exposing babies to additional risks[15].

15 Heating was very expensive; in northern cities, 5.5 kilos of good firewood cost as much as 1 kg of grain (Breschi *et al*., 2000b).

While sub-zero temperatures were frequent in Venice and the Veneto and Emilia countryside (Derosas, 2009; Dalla Zuanna and Rosina, 2009 and 2011; Samoggia and Scalone, 2013), this was not the case in more Mediterranean locations like Alghero where the average minimum temperature, even in winter, was above 5° C and very rarely fell below 0° C (Pinna, 1954). Relationship between mortality and climate was taken into account considering current season[16]. The segmentation into detailed age groups should help to capture the relationships between season, age and breastfeeding duration. Our analysis shows an effect of the hot season from the third to fifth month of life. This result could lead to cast doubt on the hypothesis of a late weaning in Alghero. This result that deserves to be further investigated might be due to an effect of the heat itself or related to malaria. Maternal malaria infection, higher during the summer, is recognised as one of the major determinants of early life mortality, because it provokes maternal anaemia (Gilles *et al*., 1969; Shulman *et al*., 1996; Cot *et al*., 1998) and particularly because it favours low birth weight (Brabin 1983, 1991; Mc Gregor *et al,* 1983; Sullivan *et al*., 1999). Pre-term and full term low birth weight and maternal fever close to delivery have been associated not only with mortality in the first month but also later in life. Any maternal infection capable of reducing the quantity or quality of breast milk can directly affect a newborn's health and chances of survival.

A modest seasonal effect is observed with a greater selection during the summer, particularly when occurring around the first birthday, which probably coincided with weaning when the consequences of gastrointestinal diseases could become more critical. Death risks were also high in autumn, for babies aged from 6 to 14 months, as a consequence of the frequent hot waves observed in this season in Mediterranean areas like Alghero (Breschi and Livi Bacci, 1986). On the other hand, a modest protective effect is observed during the spring and summer months from the second year of life onwards. This suggests that children were at risk of respiratory diseases, whose

16 We have chosen to exclude temperature as a covariate given the lack of a series of daily temperatures for Alghero for the period under examination. The nearest town for which a complete temperature series is available is Sassari, the chief town of the province, 35 Km from Alghero. This series was reconstructed as part of the project ClimAgri (www.scia.sinanet.apat.it). For more details on the Sardinian series of temperatures, see Pinna, 1954; Brunetti *et al*., 2006.

effects were amplified by bad quality of housing and the total absence of heating systems[17]. Unfortunately, there is a lack of information on causes of death that, as a recent article (Reher, Sanz, 2004) effectively shows, is particularly important in explaining the seasonal variations of infant/child mortality at different stages of life.

Bio-demographic factors lose their primacy at the end of the neonatal period (0-29 days) and continue to diminish in relevance from then after. The relative risk for babies after the first month of life also progressively decreases over time (about 1% per cohort). Results from these post-neonatal models are also more reliable in being free from possible errors of identification of still-births. Female babies were subjected to lower mortality rates (less than _) compared to males, although the parameter is not consistently statistically significant. As expected, the children of women who had experienced short birth intervals and the death of the previous child resulted as more vulnerable. Birth order is also unsurprisingly positively correlated with death risk, since additional babies could thin out family resources to the point of becoming insufficient to ensure appropriate care (Modin, 2002). Higher order babies would also be more vulnerable to disease transmitted by other family members (Burnett, 1991), which is a relationship that emerges from all our models, including those referring to late childhood.

The outcome of previous birth could determine differing effects, given that a small lapse of time between two births could have negative consequences both for the "first" baby (due to short-lived breastfeeding), and the mother, owing to relevant physical stress (Lynch and Greenhouse, 1994). Our analysis took account of this aspect by denoting the presence of a living sibling aged 2 years or above, and alternatively the death of a sibling born less than 2 years before. Our results show that the index child did not experience a higher death risk if the previous child had died, but this risk became relevant if this sibling was alive, especially around the time of weaning, suggesting competition for food and general care. Finally, if the index child was the first born, he/she ran a higher risk of dying in the first few months of life, with a protective effect commencing after weaning.

17 At the 1961 census, less than 1 percent of the houses were equipped with a heating system.

A different perspective was adopted in the models referring to mortality from the third year onwards, on the hypothesis that the presence of a sibling aged 8 or above could act as a protective factor and increase the index child's chances of survival[18]. Our findings support this supposition, with the increase amounting to 15% for children aged 3 and above, and 25% for those aged 5, even if they are statistically significant only in the sisters' case.

As to be expected, the death of a parent emerges as very relevant, with the absence of the mother in particular having severe consequences on child survival, first and foremost in terms of insufficient nourishment, but also due to other subsequent physical and psychological repercussions on the child's health. The father's death could have a similarly devastating effect, because this event implied the loss of the main, if not sole, source of family income. Our models clearly demonstrate that a child's probability of dying doubled or more with the death of the mother, with the same effect occurring at times with that of the father (although not always statistically significant[19]).

The crucial relevance of the presence of mothers and, to some extent, fathers, also emerges from a number of recent studies (Breschi and Manfredini, 2002; Andreson *et al*., 1997; Derosas 2002; Reher and González-Quiñones, 2003). Reher and González-Quiñones (2003) not only provide "ample proof that a mother's presence is essential for the health and survival of her children", but also help to identify how mothers intervene "in seeking the well-being of their babies". These authors identify three main aspects interrelated by synergies whose effects changed as the child grew up. Firstly, they point out the maternal relevance for their children's *nutritional status*, through breastfeeding. Secondly, the mother's essential role emerges through *the control of infant and child feeding practices*. Thirdly, "at a more general level, mothers intervene in the daily life of their children as their protectors, their care-givers, firstly and perhaps most importantly

18 In the absence of continuous information on household composition, we are unable to assess the presence of grandparents. Recent studies have examined the improved survival of infants by the presence of extended family, particularly grandparents (Beise and Voland, 2002; Sear *et al*., 2000; Voland and Beise, 2001; for the Italian context, see Breschi *et al*., 2004a, 2004b).

19 In determining these results, the particular Sardinian family model (Oppo, 1990) may play an important role, in which a protective network often mitigated the effects connected with the father's absence.

as their educators, their nurturers and, as important, though indirect in effect, as maintainers of the household living standards" (Reher and González-Quiñones, 2003: 69). These speculations appear to be supported by other qualitative information reported in sources of the time (Coletti, 1908).

Our models also took account of the relevance of parents' level of education, using their signature on marriage and birth records as an indicator[20]. Parental, and especially maternal education can be related to health behaviours such as improved household and personal hygiene (Hobcraft, 1993; Preston and Haines, 1993; Hasegawa, 2001). According to Hammond (2002), the correlation between education and health can change across levels of education, and depend on the type of health condition and national context. Our findings for Alghero show that a condition of illiteracy did not on the whole have a negative effect on child survival, although this result lacks statistical significance. This result could be partially depend on the inadequacy of the variable used to capture the role of parents' education. However, some advantages did appear in late childhood if both parents signed, and in the first month of life when the mother affixed her signature.

Lastly, as might be expected, analysis of family SES confirms the advantages for children from the upper class, especially during breastfeeding and weaning. Those from the artisan-traders group also appear to run a lower risk in late childhood, probably due to a facilitated access to income, while the highest risk occurred in the farming families.

5. CONCLUDING REMARKS

This study employed a micro-analytical approach to measure the determinants of mortality risks for the frailest and generally speaking least valuable members of the pre-transitional society; children. While not complete groundbreaking, it is one of the few studies conducted at the individual level for a population at the centre of the Mediterranean or to be precise, in direct contact with the sea.

20 In most cases the father declared the birth. His state of illiteracy is deduced from the absence of his signature.

We have seen that although the population of Alghero was experiencing the first positive health effects during the initial phase of its slow demographic transition process, its mortality regime was still firmly anchored to the past with the endemic presence of malaria, widespread incidence of trachoma, repeated cholera outbreaks, the increasing occurrence of tuberculosis and the dramatic consequences of the Spanish flu. This picture of sufferance is clearly reflected in the modest decline in mortality rates compared to that experienced in northern and central regions in the same period (1866-1920).

Beyond a context which, at first glance, appears to be immutable, it is possible to appreciate some change. Our results suggest that a new-born's chances of survival were heavily conditioned by his/her mother's health status and age, birth spacing, and even more explicitly by maternal survival. However, this biological causality is modulated by social, economic and cultural determinants.

A detailed analysis, including the total number of births (still-births and alive births), demonstrates that neonatal mortality was not significantly affected by family SES, even though the children of the few mothers who signed the marriage register appear to experience lower risks of death. This suggests that these mothers were better able to overcome the difficulties of maternal depletion or poor and unsanitary environmental conditions. Whatever the explanation, the importance of the socio-cultural component emerges very early life which was, at least at that time in Alghero, strongly influenced by the bio-genetic variables, as testified by the strong sex mortality differentials.

Analysis of the results from our 12 models reveal a far more complicated situation than previously imagined, with a larger heterogeneity emerging in mortality levels than in the patterns of determinants. It was possible to reach a greater understanding of the differentials in the risks of death before the age of five by segmenting each "phase" of life. Notwithstanding the peculiar environmental differences, it was possible to observe many similarities with other Italian communities.

The interrelationship between season, age and breastfeeding remains puzzling and needs to be further explored. We have mentioned a possible effect of malaria which was endemic in Alghero as well as in the rest of the island, particularly during the summer, but we do not

have direct evidences supporting this hypothesis, because we do not have information about the causes of death at the individual level.

Of particular interest is the complex interaction between current season, child's age, age at weaning and father's SES. Mortality selection by both environmental and socio-cultural factors appears to emerge as soon as the child loses the immunity induced by breastfeeding. In addition, infants suffered notably higher risks of dying (more than double) at the age of 8-15 months during the summer period, with the few children of the higher SES families alone being able to escape, albeit partially, this drastic selection.

The local environment remains a crucial element whose importance has long been emphasised. In the early 1970s, Pierre Chaunu (1972, 1973) developed the theory of the "molecular territorial structuration of demographic behaviours," arguing that, prior to the health transition, ecology almost always outweighed social and economic differentials. We have seen that the influence of seasonality on young children's survival is indeed striking, with time of year being the strongest and most transversal factor of differentiation among those we tested (with the exception of mother's death).

In the case of Alghero, the pronounced excess of early life mortality experienced during the summer reveals that this Mediterranean population (like the large majority of Italian communities) suffered the negative effects of structural problems in housing conditions, poor sanitation and inadequate food conservation, especially when particular circumstances shortened the duration of breastfeeding. Infant and child mortality *levels* appear to be for the most part a product of social and family organisation in particular ecotypes.

REFERENCES

ANDERSON, R. and BERGSTROM, S. (1997): «Maternal nutrition and socio-economic status as determinants of birthweight in chronically malnourished African women», *Tropical Medicine & International Health*, 2, pp. 1080-1087.

BEISE, J. and VOLAND, E. (2002): «A multilevel event history analysis of the effects of grandmothers on child mortality in a historical German population (Krummhörn, Ostfriesland, 1720-1847)», *Demographic Research*, 7, 13, pp. 470-494.

BENGTSSON, T. (1999): «The vulnerable child, economic insecurity and child mortality in pre-industrial Sweden: A case study of Västanfors, 1757-1850», *European Journal of Population*, 15, pp. 117-151.

BERNABEU-MESTRE, J., PERDIGUERO, E. and BARONA, J. L. (2007): «Determinanti della mortalità infantile e transizione sanitaria. Una riflessione a partire dall'esperienza spagnola», in BRESCHI, M. and POZZI, L., *Salute, malattia e sopravvivenza in Italia fra '800 e '900*, Udine, Forum, pp. 175-193.

BODIO, L. (1876): «Del movimento della popolazione in Italia e in altri Stati d'Europa», *Archivio di Statistica*, 1, pp. 119-205.

BRABIN B. J., (1983): «An analysis of malaria in pregnancy in Africa», *Bull World Health Organ,* 61, pp. 1005-1016.

BRABIN B. J., (1991): *The Risks and Severity of Malaria in Pregnant Women*, Geneva, Switzerland, World Health Organization, Applied Field Research in Malaria Reports, No. 1.

BRESCHI, M., DEROSAS, R. and MANFREDINI, M. (2000a): «Fatal seasons in children's survival. Italy 19th century», in BIDEAU, A., BOURDELAIS, P. and LEGARE, J. (eds.), *De l'usage des seuils. Structures par âges et âges de la vie*, Paris, Société de Démographie Historique, pp. 73-88.

BRESCHI, M., DEROSAS, R. and MANFREDINI, M. (2000b): «Infant Mortality in 19th Century Italy. Interactions between Ecology and Society», in BENGTSSON, T. and SAITO, O. (eds.), *Population and Economy: From Hunger to Modern Economic Growth*, Oxford, Oxford University Press, pp. 457-489.

BRESCHI, M., and MANFREDINI, M. (2002): «Parental loss and kin networks: Demographic repercussions in a rural Italian village», in DEROSAS, R. and ORIS., M. (eds.), *When dad died: Individuals and families coping with distress in past societies*, Bern, Peter Lang, pp. 369-387.

BRESCHI, M., DEROSAS, R. and MANFREDINI, M. (2004a): «Mortality and environment in three Emilian, Tuscan, and Venetian communities, 1800-1883», in BENGTSSON, T., CAMPBELL, C., LEE, J. Z., et al., *Life under Pressure. Mortality and Living Standards in Europe and Asia, 1700-1900*, Cambridge, Mass., The MIT Press, pp. 209-251.

BRESCHI, M., ESPOSITO, M., MAZZONI, S. and POZZI, L. (2012): «The Sardinian experience of the lowest Italian infant mortality at the turn of the twentieth century. True or false empirical evidence?», *Annales de Démographie Historique*, 1, pp. 63-94.

BRESCHI, M. and FORNASIN, A. (2007): «La mortalità per genere nei primi cinque anni di vita, Italia 1864-1959», in BRESCHI, M. and POZZI, L. (edS.), *Salute, malattia e sopravvivenza in Italia fra '800 e '900*, Udine, Forum, pp. 243-272.

BRESCHI, M. and LIVI BACCI, M. (1986): «Saison et climat comme contraintes de la survie des enfants. L'expérience italienne au XIXe siècle», *Population*, 1, pp. 9-36.

BRESCHI, M. and LIVI BACCI, M. (1997): «Month of birth as a factor in children's survival», in BIDEAU, A., DESJARDINS, B. and BRIGNOLI, H. P. (eds.), *Infant and Child Mortality in the Past*, Oxford, Claredon Press Oxford, pp. 157-173.

BRESCHI, M., MANFREDINI, M., MAZZONI, S. and POZZI, L. (2009): «Fertility and socio-cultural determinants at the beginning of demographic transition. Sardinia, 19th and 20th centuries», in FORNASIN, A. and MANFREDINI, M. (eds.), *Fertility in Italy at the Turn of the Twentieth Century*, Udine, Forum, pp. 63-78.

BRESCHI, M., MANFREDINI, M. and POZZI, L (2004b): «Mortality in the first years of life: socio-economic determinants in an Italian nineteenth century population», in BRESCHI, M., POZZI, L. (eds.), *The Determinants of Infant and Child Mortality in Past European Populations*, Forum, Udine, pp. 123-137.

BRUNETTI, M., MAUGERI, M., MONTI, F. and NANNI, T. (2006): «Temperature and precipitation variability in Italy in the last two centuries from homogenised instrumental time series», *International Journal of Climatology*, 26, pp. 345-381.

BURNETT, J. (1991): «Housing and the decline of mortality», in SCHOFIELD, R., REHER, D. and BIDEAU, A. (eds.), *The Decline of Mortality in Europe*, Oxford, Clarendon Press, pp. 158-176.

CASTERLINE, J. B. (1989): «Maternal age, gravidity, and pregnancy spacing effects on spontaneous fetal mortality», *Biodemography and Social Biology*, 36, 3-4, pp. 186-212.

CAU, P., MERELLA, C. and POZZI, L. (2007): «Lo stato di salute della popolazione di Alghero fra '800 e '900. Uno studio condotto attraverso i registri militari», in BRESCHI, M. and POZZI, L. (eds.), *Salute, malattia e sopravvivenza in Italia fra '800 e '900*, Forum, Udine, pp. 135-156.

CHAUNU, P. (1972): «Malthusianisme démographique et Malthusianisme économique. Réflexions sur l'échec de la Normandie à l'époque du Démarrage», *Annales E.S.C.,* 27, 1, pp. 1-19.

CODA, L. (1977): *La Sardegna nella crisi di fine secolo. Aspetti dell'economia e della società sarda nell'ultimo ventennio dell'Ottocento*, Sassari, Libreria Dessì.

COLETTI, F. (1908): *La mortalità nei primi anni di età e la vita sociale della Sardegna*, Torino, Fratelli Bocca.

COLLARI, S. (1935): *Il problema tubercolare sardo*, Roma, Federazione italiana nazionale fascista per la lotta contro la tubercolosi, Stabilimento tipografico «Europa».

CORBIA, A. (1934): «La mortalità per tubercolosi nella provincia di Sassari. Resoconto critico statistico per gli anni 1926-30», Estratto da *Studi Sassaresi*, XII, II, Tipografia Gallizzi, Sassari.

COT, M., LE HESRAN, J. Y., MIAILHES, P., ROISIN, A., FIEVET, N., BARRO, D., ETYA'ALE, D., DELORON, P., CARNEVALE, P. and

BREART, G., (1998): «Effect of chloroquine prophylaxis during pregnancy on maternal hae-matocrit», *Ann Trop Med Parasitol,* 92, pp. 37-43.

CRAMER, J. C. (1987): «Social factors and infant mortality: identifying high-risk groups and proximate causes», *Demography*, 24, 3, pp. 299-322.

DALLA ZUANNA, G. and ROSINA, A. (2009): «The fatal season. An analysis of extremely high neonatal mortality», *Transylvanian Review*, 18, pp. 245-276.

DALLA ZUANNA, G. and ROSINA, A. (2011): «An analysis of extremely high nineteenth-century winter neonatal mortality in a local context of Northeaster Italy», *European Journal of Population*, 27**,** 1, pp. 33-55.

DEL PANTA, L. (1990): «Fattori e condizioni della mortalità tra 1880 e 1930: igiene, salute e ambiente. La situazione in Italia», in SOCIETÀ ITALIANA DI DEMOGRAFIA STORICA, *Popolazione, società e ambiente. Temi di demografia storica (secc. XVII-XIX)*, Bologna, CLUEB, pp. 245-273.

DEL PANTA, L. (1994): «Mortalité infantile et postinfantile en Italie du XVIII au XX siècle. Tendences à long tèrme et différences régionales», *Annales de Démographie Historique*, pp. 45-60.

DEROSAS, R. (2002): «Fatherless families in 19th century Venice», in DEROSAS, R. and ORIS., M., (eds.), *When dad died: Individuals and families coping with distress in past societies*. Bern, Peter Lang, pp. 421-452.

DEROSAS, R. (2003): «Watch out for children! Differential mortality of Jews and Catholics in nineteenth-century Venice», *Historical Methods*, 36, 3, pp. 109-130.

DEROSAS, R. (2004): «Socio-economic factors in infant and child mortality: Venice in mid nineteenth century», in BRESCHI, M. and POZZI, L. (eds.), *The Determinants of Infant and Child Mortality in Past European Populations*, Forum, Udine, pp. 105-122.

DEROSAS, R. (2009): «The joint effect of maternal malnutrition and cold weather on neonatal mortality in nineteenth-century Venice: An assessment of the hypothermia hypothesis», *Population Studies*, 63, pp. 233-251.

FRETTS, R. C., SCHMITTDIEL, J., MCLEAN, F. H., USHER, R. H. and GOLDMAN, M. B. (1995): «Increased maternal age and the risk of fetal death», *The New England Journal of Medicine*, 333, 15, pp. 953-957.

GATTI, A. M. (1999): «Nascita dell'ostetricia e mortalità materna in Sardegna (XVII-XIX secolo)», *Bollettino di Demografia Storica*, 30/31, pp. 79-94.

GATTI, A. M. (2002): «La mortalità infantile tra Ottocento e Novecento. La Sardegna nel panorama italiano», Cagliari, Quaderni del Dipartimento di Ricerche Economiche e Sociali dell'Università di Cagliari. Sezione di Statistica.

GILLES, H. M., LAWSON, J.B., SIBELOS, M., VOLLER, A. and ALLAN, N. (1969): «Malaria, anaemia, and pregnancy», *Ann Trop Med Parasitol,* 63, pp. 245-263.

GOURDON, V. and ROLLET, C. (2009): «Still-births in Nineteenth-Century Paris: Social, legal and medical implications of a statistical category», *Population*, 64, 4, pp. 601-634.

KNODEL, J. and HERMALIN, A. I. (1984): «Effects of birth rank, maternal age, birth interval, and sibship size on infant and child mortality: Evidence from 18th and 19th century reproductive histories», *American Journal of Public Health*, 74, pp. 1098-1106.

HAMMOND, C. (2002): «What is about education that makes us healthy? Exploring the education-health connection», *International Journal of Lifelong Education*, 21, pp. 551-571.

HASEGAWA, T. (2001): «Japan: Historical dimensions of health equity», in EVANS, T., WHITEHEAD, M., DIDERICHSEN, F., BHUYIA, A. and WIRTH, M. (eds.), *Challenging Inequities in Health: From Ethics to Action*, Oxford, Oxford University Press, pp. 90-103.

HOBCRAFT, J. (1993): «Women's education, child welfare and child survival: a review of evidence», *Health Transition Review*, 3, pp. 159-175.

ISTAT (1957): «Le rilevazioni statistiche in Italia dal 1861 al 1956», *Annali di Statistica*, Serie VIII, vol. 6.

ISTAT (1975): «Tendenze evolutive della mortalità infantile in Italia», *Annali di Statistica*, Serie VIII, vol. 29.

LYNCH, K. A. and GREENHOUSE, J. B. (1994): «Risk factors for infant mortality in nineteenth-century Sweden», *Population Studies*, 48, 1, pp. 117-133.

MANFREDINI, M. and POZZI, L. (2004): «Mortalità infantile e condizione socio-economica. Una riflessione sull'esperienza italiana fra '800 e '900», *Revista de Demografía Histórica*, XXII, 2, pp. 127-156.

MAZZONI, S., BRESCHI, M., ESPOSITO, M. and POZZI, L. (2013): «Widowhood and Remarriage in Sardinia, Alghero, 1866-1925», *Population* (E), 68, 2, pp. 237-264.

MC GREGOR, I. A., WILSON, M. E. and BILLEWICZ, W. Z., (1983): «Malaria infection of the placenta in The Gambia, West Africa: its incidence and relationship to stillbirth, birth weight, and placental weight», *Trans R Soc Trop Med Hyg*, 77, pp. 232-244.

MELIS, P. M. and POZZI, L. (2010): «Trachoma, health conditions and social change in Sardinia», in ANDRESEN, A., BARONA, J. L. and CHERRY, S. (eds.), *Making a New Countryside Health Policies and Practices in European History ca.1860-1950*, Bern, Peter Lang, pp. 27-50.

MINISTERO DI AGRICOLTURA, INDUSTRIA E COMMERCIO (MAIC), Direzione Generale della Statistica (1879): «Circolare del 27 febbraio 1879 ai signori Prefetti del Regno», *Annali di Statistica*, serie II, vol. 9, pp. 181-183.

MINISTERO DI AGRICOLTURA, INDUSTRIA E COMMERCIO (MAIC), Direzione Generale della Statistica (1886): «Risultati dell'Inchiesta sulle condizioni igieniche e sanitarie nei comuni del Regno. Parte seconda:

Notizie date per ciascun comune», Roma, Tipografia dell'Ospizio di San Michele.

MODIN, B. (2002): «Birth order and mortality: a life-long follow-up of 14,200 boys and girls born in early 20th century Sweden», *Social Science & Medicine* 54, 7, pp. 1051-1064.

MOSLEY, W. H. and CHEN, L. C. (1984): «An analytical framework for the study of child survival in developing countries», in MOSLEY, W. H. and CHEN, L. C. (eds.), *Child survival. Strategies for research*, *Population and Development Review*, 20, supplement, pp. 25-45.

OPPO, A. (ed.) (1990): *Famiglia e matrimonio nella società sarda tradizionale*, Cagliari, La Tarantola.

ORIS, M., DEROSAS, R. and BRESCHI, M. (2004): «Infant and child mortality», in BENGTSSON, T., CAMPBELL, C., LEE, J. Z., *et al.*, *Life under pressure: mortality and living standards in Europe and Asia, 1700-1900*, Cambridge, Massachusetts Institute of Technology Press, pp. 359-398.

PINNA, M. (1954): *Il clima della Sardegna*, Pisa, Goliardica.

POZZI, L. (2000): *La lotta per la vita. Evoluzione e geografia della sopravvivenza in Italia fra '800 e '900*, Udine, Forum.

PRESTON, S. and HAINES, M. R. (1991): *The Fatal Years: Child Mortality in Late 19th Century America*, Princeton, Princeton University Press.

PUTZOLU, F. (1993): «Prime tappe dell'ostetricia in Sardegna», in ORRÙ, L. and PUTZOLU, F. (eds.), *Il parto e la nascita in Sardegna. Tradizione Medicalizzazione Ospedalizzazione*, Cagliari, CUEC, pp. 25-66.

RAMIRO FARINAS, D. and SANZ GIMENO, A. (2000): «Childhood mortality in Central Spain, 1790-1960: changes in the course of demographic modernization», *Continuity and Change*, 15, 2, pp. 235-267.

REHER, D., PÉREZ MOREDA, V. and BERNABEU MESTR, J. (1997): «Assessing change in historical contexts, childhood mortality patterns in Spain during the demographic transition», in CORSINI, C.A. and VIAZZO, P. P. (eds.), *The decline of infant and child mortality. The European experience: 1750-1900*, The Hague, Martinus Nijhoff Publishers.

REHER, D. S. and GONZÁLEZ-QUIÑONES, F. (2003): «Do parents really matter? Child health and development in Spain during the demographic transition», *Population Studies*, 57, pp. 63-75.

REHER D. S., SANZ, A. (2004): «Childhood mortality patterns in Spain before and during the demographic transition: In search of new dimensions», in BRESCHI, M. and POZZI, L. (eds.), *The determinants of infant and child mortality in past European populations*, Udine, Forum, pp. 19-42.

REID, A. (2001): «Neonatal mortality and still-births in early twentieth century Derbyshire, England», *Population Studies*, 55, 3, pp. 213-232.

ROBLES GONZÁLEZ, E. and POZZI, L. (1997): «La mortalidad infantil en los años de la transición: una reflexión desde las experiencias italiana y

española», *Boletín de la Asociación de Demografía Histórica*, 15, 1, pp. 165-199.

ROLLET, C. (1995): «La construction d'une culture internationale autour de l'enfant », in *Comment peut-on être socio-anthropologue*? *Autour d'Alain Girard*, Paris, L'Harmattan, pp. 143-167.

SAMOGGIA, A. and SCALONE, F. (2013): «Le determinanti della mortalità neonatale in un'area rurale del suburbio bolognese nel corso dell'Ottocento», in BRESCHI, M. and POZZI, L. (eds.), *Mortalità e stato di salute dalla nascita alla prima adolescenza: indagini micro in Italia, secoli XIX-XX*, Udine, Forum, pp. 81-99.

SCALONE, F., AGATI, P., ANGELI, A. and DONNO, A. (2013): «Micronalisi delle tendenze nella mortalità infantile a Granarolo dell'Emilia tra il XIX e il XX secolo», in BRESCHI, M. and POZZI, L. (eds.), *Mortalità e stato di salute dalla nascita alla prima adolescenza: indagini micro in Italia, secoli XIX-XX*, Udine, Forum, pp. 51-79.

SEAR, R., MACE, R. and MCGREGOR, I. A. (2000): «Maternal grandmothers improve nutritional status and survival of children in rural Gambia», *Proceedings of the Royal Society of London B*, 267, pp. 1641-1647.

SHAH, N. M., SHAH, M. A., KHALAF, A., MUSTAFA, M. M. and AL-SAYED, A. (2000): «Searching for socioeconomic risk factors in perinatal mortality in Kuwait: a case-control study», *Social Science & Medicine*, 51, pp. 539-550.

SHULMAN, C. E., GRAHAM, W. J., JILO, H., LOWE, B.S., NEW, L., OBIERO, J., SNOW, R.W. and MARSH, K., (1996): «Malaria is an important cause of anaemia in primigravidae: evidence from a district hospital in coastal Kenya», *Trans R Soc Trop Med Hyg,* 90, pp. 535-539.

SOMOGYI, S. (1967): *La mortalità nei primi cinque anni di età in Italia, 1863-1962*, Palermo, Università di Palermo, Istituto di Scienze demografiche.

SULLIVAN, A. D., NYIRENDA, T., CULLINAN, T., TAYLOR, T., HARLOW, S.D., JAMES, S.A. and MESHNICK, S.R., (1999): «Malaria infection during pregnancy: intrauterine growth retardation and preterm delivery in Malawi», *J Infect Dis*, 179, pp. 1580-1583.

TOGNOTTI, E. (1996): *La malaria in Sardegna, Per una storia del paludismo nel mezzogiorno (1880-1950)*, Franco Angeli, Milano.

TYMICKI, K. (2009): «Correlates of infant and childhood mortality. A theoretical overview and new evidence from the analysis of longitudinal data of the Bejsce (Poland) parish register reconstitution study of the 18th-20th centuries», *Demographic Research*, 20, pp. 559-594.

VAN DE WALLE, F. (1986): «Infant mortality and the European demographic transition», in COALE, A. J., WATKINS, S. C. (eds.), *The Decline of Fertility in Europe*, Princeton, Princeton University Press, pp. 201-233.

VAN KATWIIJK, C. and PETERS, L. L. (1998): «Clinical aspects of pregnancy after the age of 35 years: A review of the literature», *Human Reproduction Update*, 4, 2, pp. 185-194.

VAN NORREN, B. and VAN VIANEN, H.A., (1986): *The malnutrition infection syndrome and its demographic outcome in developing countries: a new model and its application*, Programming Committee for Demographic Research, The Hague.

VAN POPPEL, F. and MANDEMAKERS, K. (1997): «Differential infant and child mortality in the Netherlands, 1812-1912: First results of the historical sample of the population of the Netherlands», in BIDEAU, A., DESJARDINS, B. and BRIGNOLI, H. P. (eds.), *Infant and Child Mortality in the Past*, Oxford, Claredon Press Oxford, pp. 276-300.

VENTISETTE, M. (1995): «La mortalità infantile in Italia: 1863-1992», *Bollettino di demografia storica*, 23, pp. 133-162.

VOLAND, E. and BEISE, J. (2001): *Opposite effects of maternal and paternal grandmothers on infant survival in historical Krummhörn*, Rostock, Max Planck Institute for Demographic Research (MPIDR working paper; WP-2001-026).

WARD, W. P. (2006): «Women's health, size at birth and socio-economic change in Bologna, Italy, 1880-1940», *Popolazione e Storia*, 2, pp. 85-108.

WILLIAMS, N. and GALLEY, C. (1995): «Urban-rural differentials in infant mortality in Victorian England», *Population Studies*, 49, 3, pp. 401-420.

WOODS, R. (2009): *Death Before Birth: Fetal Health and Mortality in Historical Perspective*, Oxford-New York, Oxford University Press.

WOODS, R., WILLIAMS, N. and GALLEY, C. (1993): «Infant mortality in England 1550-1950. Problems in the identification of long-term trends and geographical variations», in CORSINI, C.A. and VIAZZO, P. P. (eds.), *The decline of infant and child mortality. The European experience: 1750-1900*, The Hague, Martinus Nijhoff Publishers.