The contribution of familial component in Sardinian longevity: measuring unobserved heterogeneity

Authors: Luisa SALARIS[1], Nicola TEDESCO[1], Michel POULAIN[2]

(1) DRES - Dipartimento di Ricerche Economiche e Sociali, Università degli Studi di Cagliari (Italy)
(2) GéDAP - Groupe d'études de démographie appliquée, Université Catholique de Louvain-la-Neuve (Belgium)

Corrispoding author: Luisa SALARIS
e-mail: salaris@unica.it

Abstract
The aim of this contribution is to investigate further the possible determinants of the exceptional level of longevity detected among Sardinian population in the Blue Zone (Poulain et al. 2004). In particular the focus of this study is on contribution on individual survival of the familial component, which is operationalized considering a set of variables.
The village of Villagrande Strisaili is chosen for detailed analysis as for this municipality it is available a family reconstructed database build following survival of newborns from 1866 to 1915 until 2006 (VILD, Salaris 2009).
The analysis of the data investigates the role of familial variables on longevity, estimating mortality trajectories aware of the changes occurring in the composition of the birth cohorts due to selective mortality at early ages (Vaupel and Yashin 2001). Unobserved heterogeneity and the existence of subpopulations within the population of Villagrande Strisaili are therefore considered by means of multilevel and frailty models for survival data (Wienke 2003, Skrondal and Rabe-Hesketh 2004). The analysis considers that there is dependency between single units as different individuals are at the same time members of the same family, and this is particularly true in a village as Villagrande where the rate of geographical endogamy in the past was considerably high.

Introduction
The familial transmission of longevity is a complex subject of study as it has two distinct interpretations. There is in fact: i) a familial genetic component, meaning that the favourable traits for survival are inherited as well as part of the shared family DNA; ii) a familial environmental component, which refers to the influence that specific characteristics of the household, shared familiar environments, daily habits and so on, have on individuals' survival.
Specific traits favourable to longevity may be directly detectable through the analysis of individual data such as blood sample or other biological material, or might also be indirectly investigated looking at survival resemblance, integrating individual information with that of parents and siblings.

However, a variable such as family can not be exclusively considered as a gene-transmitter, as it also represents the social environment where individuals lived the first part of their lives until they formed a new family. For this reason, disentangle the contribution on survival of the two familial components is not an easy task.

Data and Methods

According to the work of Poulain et al. (2004), which identified in Sardinia the so called Blue Zone – an area of exceptional longevity – the municipality with the highest value of ELI (Extreme Longevity Index, which measures the probability to become a centenarian) is that of Villagrande Strisaili. For this reason, this village was selected for detailed analysis at individual level. A family reconstructed database, denominated the Villagrande Longevity Database (VILD) was built. Newborns in the village during a period of 50 years – from 1866 to 1915 – constituted the core of the individual database, where information on related family members was also included. Individual included in the database are followed from birth to death, as they go through marriage and family formation (Salaris 2009).

The role of familial variables on longevity is preliminary investigated applying conventional survival analysis methods. Subsequently, mortality trajectories are calculated considering unobserved heterogeneity (Vaupel and Yashin 2001). The existence of subpopulations within the population of Villagrande Strisaili is taken into account by means of multilevel and frailty models for survival data (Wienke 2003, Skrondal and Rabe-Hesketh 2004).

Preliminary results

The following are preliminary results on the role of the familial component on longevity for Villagrande Strisaili newborns which were obtained applying non parametric survival estimations. This first analysis of the data emphasises that selected familial variables proved to effect individual survival. The contribution of the familial component on longevity emerges both when considering proxy of genetic characteristics and information on family shared environment. In this case, family survival resemblance and family support were selected for analysis

The non-parametric investigation (Kaplan-Meier estimation) focusing on survival resemblance between family members shows that according to maternal age at death individuals having mothers surviving after 80 years old generally recording higher survival estimates than their peers in the other groups (figure 1). While with regard to the age at death of the father, differences between groups were not significant.

Preliminary investigation of the effect of the variables concerning the shared environment show interesting results. For example, with regard to familial support, its role was investigated looking at the effect on survival of age at loss of parents, considering separately the loss of father and the loss of mother. *Group 1* – Loss of father before 5 years of age; *Group 2* – Loss of the father when aged 5 and over. The same grouping was adopted also for the loss of the mother.

Figure 1 – Kaplan-Meier survival curve estimates for fifty-year-old VILD newborns, by age at death of the mother [Peto and Prentice p-value = .138; Log Rank p-value = ***.029***]

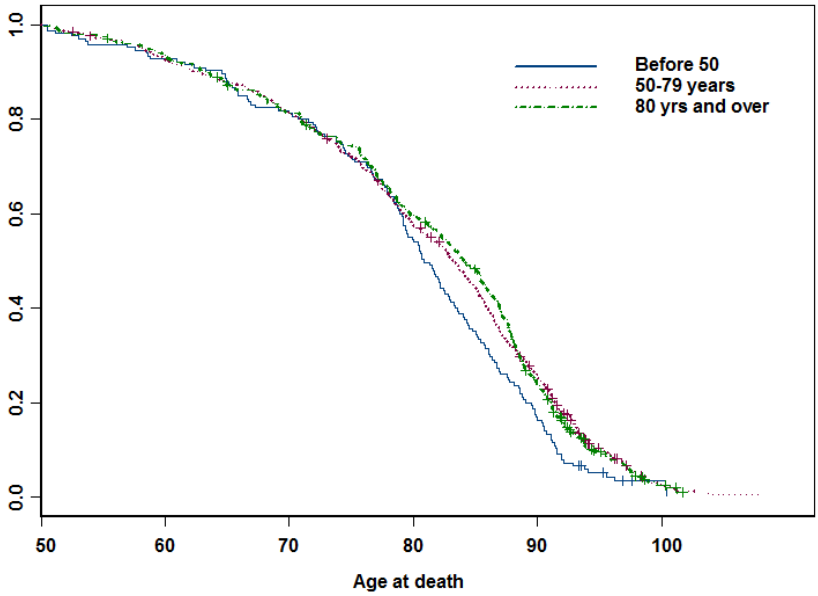
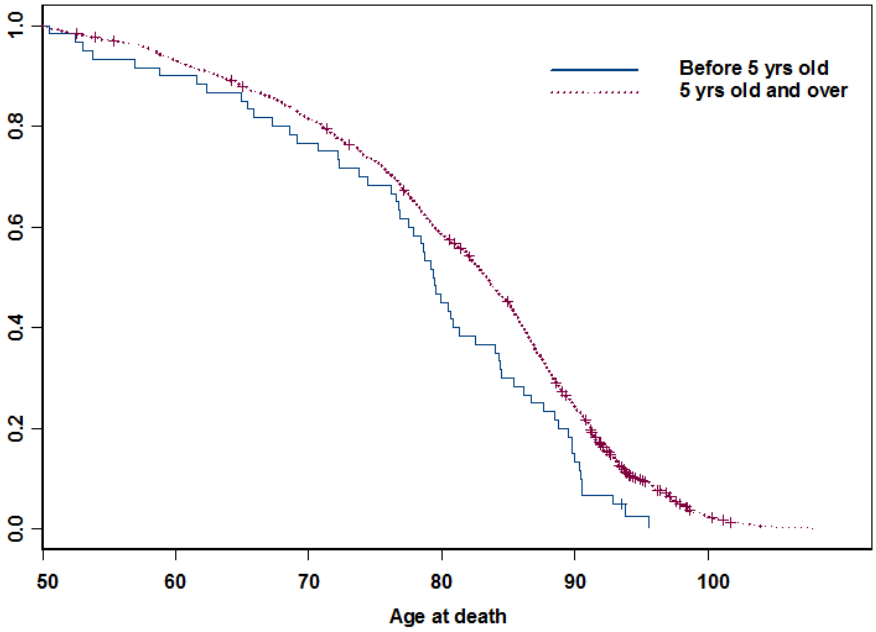


Figure 2 – Kaplan-Meier survival curve estimates for fifty-year-old and over VILD newborns, according to the age at loss of the mother [Peto and Prentice p-value = ***.030***; Log Rank p-value = ***.006***]



According to the age at loss of father, differences were detected among groups of survivors, while it emerged that the age loss of the mother carried more important consequences at all ages and particularly for later survival, as pointed out by the Log rank test score (p= .006). Individuals who lost their mother at younger ages recorded lower estimates than their peers belonging to the other group (figure 2).

This latter result points out that the presence of the mother during childhood proves to be crucial for subsequent survival. However, whereas in prior studies its effect was largely detected as influencing survival in subsequent early stages of life, among fifty-year-old and over VILD newborns this variable is shown to affect survival at adulthood and, in particular, at more advanced ages.

These preliminary results enforce the assumption that the familial component plays an important role in longevity both in its genetic and environmental dimension.
However, they provide only an indication of its effects on individual survival. Further analysis needs to be developed considering that there is dependency between single units as different individuals are at the same time members of the same family. Moreover, the existence of subpopulations within the population of Villagrande Strisaili should be further investigated by means of multilevel and frailty models for survival data in order to have a more precise estimation of the effect a set of variables related to family, controlling for unobserved heterogeneity.

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