

Determinants of Exceptional Old Age: How Does Early Life and Marriage Operate on Spousal Concordance in Longevity?

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1 Introduction

THE SCIENTIFIC DEBATE ON LONGEVITY and its determinants has put considerable interest in the familial component of achieving very long lifespan. The family unit is the primary source of transmission of social, environmental, cultural, biological and genetic factors that may underlie differences in mortality. Siblings also share 50% of their genes on average and, to a large extent, the same environmental and social conditions during childhood. Family-based studies, which include genetically related individuals, have generally found that siblings and parents of persons with exceptional longevity had significantly lower mortality compared to population-based controls (Christensen and Vaupel, 1996; Perls et al., 2002; Willcox et al., 2006). Therefore, one of the strongest concepts remains one of a similar longevity between relatives, especially between parents and children and between siblings.

It is clear that the proclivity to a very long lifespan may be in part genetically and environmentally determined, but the relative importance of environment and genes is still not fully understood. An important contribution to assess the role of environmental factors in longevity could arise from the study of similarity in life duration between marital partners (Mazan and Gagnon, 2007; Jarry et al., 2012b). How life duration of an individual is shaped could thus depend not only on his genetic endowment transmitted by his parents or on the early-life environment but also on *who marries whom*. Despite the well documented literature on spousal concordance in health and despite the numerous

studies reporting empirical evidence for similarities in survival between spouses, there is virtually no previous research examining how spousal concordance in exceptional survival exactly operates: is homogamy primarily what drives the similarities in life duration, and thus, implies that couples are more alike in terms of lifespan than two individuals taken randomly because they have a similar social origin and have lived in a similar environment during childhood? Or, is concordance more a result of shared environment and behaviors, implying that living together induces a similar mortality risk? In this paper, we examine the mechanisms through which spousal concordance in longevity operates in particular in couples where one of the spouse is a centenarian. This paper builds upon our prior work with Alain Gagnon and Robert Bourbeau of familial influence on exceptional survival in centenarian families, which documents a significant survival advantage of spouses of centenarians compared to their birth cohort (Figure 1) (Jarry et al., 2012b,a). The question we wish to answer now is why do spouses are more alike in terms of life duration than two individuals taken randomly or why do spouses of centenarians benefit from having a partner that lived to age 100?

Research literature broadly supports the assertion that marital relationships can serve to expose individuals to common risks for poor or good health. In fields such as social epidemiology or medical studies, it is not uncommon to find evidence for spousal concordance in health. Different kinds of explanations have thus been put forward regarding the mechanisms through which the concordance operates. One of them, the *Shared Resources Hypothesis*, suggests that being exposed to the same socio-sanitary conditions, the same dietary habits and the same socio-economic environment leads to shared mortality risks. Therefore, spouse's concordance should depend on the duration of the marriage; the longer the marriage is, the greater the similarity of ages at death should be, suggesting a cumulative effect of the common marital environment (Sackett et al., 1975). Spousal concordance in health and survival may also be due to positive *Assortative Mating*, that is, the tendency of men and women of similar social origin and with similar characteristics to marry (Meyler et al., 2007). In this regard, spousal concordance in later-life mortality, in an early-industrialized society, would be the result of homogamy of social origin, often measured by the association between husband's father's and wife's father's occupation or by the socioeconomic status of both families in early-life.

2 Data and methods

2.1 Study Design

Our sample consists of 806 validated centenarians and their spouses. Table 1 reports the year of birth of centenarians by sex. Centenarians' information was obtained from a list of registered deaths provided by the Institut de la Statistique du Québec, which contains nominative death lists of centenarians for each year between 1985 and 2005. If the centenarian was married, his marriage and the date of death of his or her spouse was found through the Quebec Consolidated Deaths Index from the Société de généalogie du Québec. This database allows users to find dates of death and of birth, maiden names, etc. of persons who died in Québec between 1926 and 1996. For deaths occurring beyond 1996, we used a list of registered deaths over 85 years old for the years 1997-2005 provided by l'Institut de la Statistique du Québec. About 600 of the 806 centenarians were at least married once ¹. Furthermore, pedigrees and childhood details of the centenarian families as well as those of their spouse's families were elaborated based on the 1901 and 1911 Canadian censuses.

2.2 Statistical Analysis and Variables

Using a set of family background variables measuring the ses of the family, we first investigate whether there is a tendency for individuals to partner with individuals with similar background characteristics. We use homogamy models to estimate the odds that husbands and wives shared the same rather than different social background. The social origin of the family is measured by the main determinants of housing characteristics in the 1901 and 1911 censuses, which include the father's occupation, the father's literacy, the place of residence as well as maternal and paternal age at death. For families residing in rural areas, we also use homeownership as a marker of socioeconomic status (Gagnon and Bohnert, 2012; Baskerville, 2001). In addition we use the number of acres owned by the household head as a proxy for socioeconomic standing, presuming that a higher number of acres owned equated with a higher SES. In pre-industrialized and early-industrialized populations, the characteristics of the family of origin were especially good proxies for the spouse's future socioeconomic position. Because a high socioeconomic position is likely to be related to lower mortality and to higher chances to achieve very old age, we can hypothesize that both partners grew up in a similar and favorable socioeconomic background.

After investigating whether there is an homogamy mechanism behind the similarities in ages at death between spouses by taking into account both the early-life characteristics of the husband and those of the wife, we will search for

¹Data collection on spouses is still ongoing but is soon to be completed.

an association between the status of the groom and that of his father-in-law. If assortative mating is important, the husband is likely to be working in a similar set of occupations as his father-in-law, given his own social background and his own father's occupation. We then review concordance between spouses for longevity according to the duration of marriage by performing survival analysis. If assortative mating is the primary mechanism underlying concordance, we will find similar concordance in longevity across marriage duration. On the other hand, if shared household environment is the most important mechanism behind the concordance, we would anticipate a greater similarity in long-time married couples versus partners with shorter length of marriage.

3 Preliminary Results

In preparation for our main analyses, we can share a few preliminary results based on the data already collected. First, we confirm that spouses of centenarians do have a survival advantage compared with their birth cohort. Conditional on survival to age 40, the mean ages at death of wives and husbands were respectively 75.7 and 77.9 years. Husbands of centenarians lived almost 4 years longer than their contemporaries while the corresponding figure was 2.5 years for women. It was also found that husbands of centenarians were 1.8 times more likely to survive from age 40 to age 90 compared with men from their birth cohort. As for wives of male centenarians, they were found to be approximately 1.2 times more likely to survive from age 40 to age 80 and nearly 1.3 times more likely to reach 90 when compared to women from the general population. However, because the number of male centenarians is quite small, the number of wives who lived pass 90 years is also too small to warrant statistical significance.

Early life constitute one such critical period who is particularly sensitive to the familial environment. In order to compare the social origin of both partners, we had to find the familial childhood characteristics in the censuses. Preliminary to the main objective of this present study, we also wanted to know if the childhood environment in which the centenarian grew up in was different from the one of the average individual of the same birth cohort.² In comparing households that raised a child-future centenarian to those of the general population, we found that both the father's occupation and place of residence as well as the father's literacy were significant variables that affected the chances of a household producing a future centenarian (Table 2). Thus, rural and farm residence appeared to provide better survival to advanced ages which confirms Gavrilova and Gavrilov (2005) observations that suggest that

²To compare centenarians to individuals of the same birth cohort, we used a control sample extracted from the Canadian Families Project five-percent 1901 Canadian census sample. Then were selected from this random sample, families with at least one child born between 1885 and 1901.

farm background may be predictive for survival to age 100, as well as those of Preston et al. (1998).

So what we know as of now is that there is a survival advantage of spouses of centenarians compared to the general population. Also, we know that centenarians grew up in a favorable familial background that probably generated a great share of their exceptional survival. We are thus currently working to find why spouses of centenarians are more likely to live to exceptional old age and whether this spousal concordance is due entirely to marital sorting and social origin, thus suggesting that spouses also lived in a favorable environment, or whether a shared marital environment contributes to the correlation. As I mentioned in section 2.2, many more early life variables that are potential determinants of longevity will be included in our final analysis.

4 Motivations

There are three motivations for studying the spousal concordance in longevity in centenarian couples. First, it adds to the understanding of what determines exceptional human longevity. Second, studies on genetically unrelated spouses, sharing a common living environment, might provide valuable insights on environmental etiological factors of human longevity and may give us clues regarding the magnitude of the influence of environmental determinants in achieving exceptional lifespan. Third, if assortative mating is the main reason behind the concordance, it could indicate how early life factors can lead to healthy aging and longevity, through mate selection. It could also put forward the indirect impact of socioeconomic status on mortality later in life. However, if spousal similarities in longevity is found to increase with the marriage duration, then shared family environment might be an important factor for concordance. Consequently, health providers, medical researchers, epidemiologists and demographers should gather health histories not only from individuals and their genetic family members but also from spouses.

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