EXCEPTIONAL LONGEVITY
Are socioeconomic conditions in childhood still important?

Valérie Jarry[1], **Alain Gagnon**[1], and **Robert Bourbeau**[1]

[1]Department of Demography, Université de Montréal

Introduction

IN THE LAST DECADES, a lot of attention has been paid to the influence of socioeconomic features during childhood on adult health and mortality. Most studies have shown that an adverse environment in childhood leads to levels of morbidity (Blackwell et al., 2001; Hass, 2008; Moody-Ayers et al., 2004) and mortality (Elo and Preston, 1996; Galobardes et al., 2004; Osler et al., 2005) higher than the average. In this perspective, life course studies examine a range of potential processes through which biologic, social or physical exposures acting at different stages of life can have long-term effects on disease risks in later life and lead to inequalities in mortality. There is thus, without a doubt, multiple mechanisms through which conditions in early life may affect one's health and mortality as an adult (Hertzman, 1999).

It is also well know that longevity has a strong familial component and that siblings and parents of persons with exceptional longevity have significantly lower mortality compared to population-based controls (Perls et al., 1998, 2002; Willcox et al., 2006; Mazan and Gagnon, 2007; Jarry et al., 2011). The correlation of ages at death among siblings can certainly be attributed in part to genetic background shared by 50 % of its members, but it can also be the result of the shared environment and same resources early in life. Therefore, do siblings of centenarians tend to live longer because they benefited the same favorable environment during childhood?

Less established in the literature is whether childhood conditions have the same effect within long lived families. Because genetic influence may be greater as one gets old, we believe that environment in childhood could be less predictive among sibling of centenarians than among siblings from the general population. Furthermore, the knowledge concerning determinants of human longevity might be expected to be well known, but little is understood about what keeps a person alive after the mean age. Thus, what makes a normal person live longer does not necessarily promotes living after middle age and therefore, achieving age 100.

In the first part of this study, we verified if early-life factors that influence a normal person's survival also have an effect on the longevity of long-lived persons, in that case, siblings of centenarians, after correction for the

possible bias induced by missing data. Then, in the second part, we wondered if early-life conditions played a role in longevity throughout all adult life : Does the influence of socioeconomic conditions in childhood diminishes or disappears completely in older age groups ?

Data and methods

This study relies on 806 centenarians and their families. We used individual and familial variables gathered from the 1901 and 1911 canadian census records and linked them to their subsequent age at death. Centenarians' information was obtained from a list of registered deaths provided by the Institut de la Statistique du Québec, which contains records on centenarians who died between 1985-2005 in the Province. Families were reconstituted by linking these centenarians to their family members through the 1901 and 1911 Canadian censuses, which are available on the Internet through Ancestry and Automated Genealogy. A total of 5,338 siblings of centenarians have been identified. Once the database was completed, we searched for the date of death of each of these individuals 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 1997-2004 provided by l'Institut de la Statistique du Québec. Linkage was made on the basis of information contained in both the censuses and death registers, particularly through the name(s) of the subject, his date and place of birth and the name(s) of his parents.

To compare the survival of siblings of centenarians to that of their birth cohort, we used a control sample extracted from the Canadian Families Project five-percent 1901 Canadian Census sample. We chose from this random sample, families with at least one child born between 1885 and 1901. Only French-Canadian who went on to live at least to age forty were selected.

We first performed gender-specific proportional hazard models with a Gompertz specification of the risk of mortality after age 40, controlling for a number of factors such as the year of birth and family size. Because siblings' survival experiences are likely to be clustered, we added a family-specific random effect that represents unobserved influences common to all member of a family and accounts for random unmeasured family-level traits shared by siblings. Early-life background was measured by the father's occupation, the father's literacy as well as the place of residence. We then ran a logit model that measured the effect of these variables on the odds of surviving, first from age 40 to age 75 and then, from age 75 to age 90. Analysis were done separately by sex and by sample.

Results

In general, we observe that childhood conditions affecting later-life mortality vary by gender, the effect being stronger for men than for women. For women, there are few childhood conditions that generate substantial shifts in their adult mortality risk. Being raised by a father who was an urban worker is the only aspect of

Table 1: Gompertz proportionnal hazard models of mortality risks after age 40 accounting for unobserved heterogeneity

| | Centenarian family | | General Population | |
| | Hazard ratio | | Hazard ratio | |
Gompertz model	Female	Male	Female	Male
Year of birth	0.996	1.005	0.985*	1.003
Family size	0.994	0.991	0.991	0.993
Father's literacy				
Father iliterate	1.055	1.068	1.144$^{\&}$	0.925
Unknown	1.000	1.000	1.451$^{\&}$	0.953
Father literate				
Father's occupation				
Urban worker	1.029	1.422***	1.180**	1.398***
Rural worker	0.969	1.081	0.991	1.037***
Urban white collar	0.951	1.215	1.097	1.529***
Rural white collar	1.156	1.284	1.517*	1.381
Unknown	1.207$^{\&}$	0.926	0.180	1.203
Farmer				

early life context that seems to have a significant negative effect on women survival in the general population (Table 1). Thus, the protective effect of living in a rural setting or of being raised by a father who was a farmer is less evident for women. Several hypotheses related to the historical context of the period could explain these results. First, it is not surprising to find that children raised in an rural setting rural and by a father that was a farmer experienced a lower mortality. At the turning of the 20th century, living on a farm provided a healthy environment whereas the urban populations were those facing the greatest health risks as a result of the overcrowding dwellings, difficult working conditions and poor sanitation.

However, the stronger protective effect of rural setting and farming experienced by men compared to women could also be attributed to a cumulative advantage of men becoming themselves farmers in adulthood. This could be associated to the Pathway model in which the parents socioeconomic status has an indirect influence on the health status, particularly through a transmission of socioeconomic status across different generations and, in this case, by preserving the protective effects of rural area. On the other hand, while males who grew up in the country side seem to have benefitted more of this favorable environment than females, males who grew up in the city might have been more affected by this adverse environment because they were probably more exposed to difficult and unsafe conditions of industrial and factory work than their sisters (Gossage, 1999; Bohnert and Gagnon, 2008). In contrast, females raised by farmers, who did not inherit farmland, where more likely to move to the city or to migrate on their spouse's familial land. These findings strongly agree with results observed by Preston et al. (1998), Bohnert and Gagnon (2008) as well as Gavrilova and Gavrilov (2005) who all found a stronger beneficial effect of farm childhood on longevity for males than for females.

We also observe that early-life estimates for late life traits vary significantly across our two samples and it seems that the influence of early-life conditions attenuates or vanishes when studied in male families of long-livers. Socioeconomic factors, particularly father's occupation, encourage longevity gain in the general population (Table 1). However, in centenarians families, influence of father's occupation was found to be much smaller compared to the general population most likely because genetic influence on life span may vary at different ages. Thus, mortality determinants among older individuals may be different from those among younger persons (Mitchell et al., 2001).

Furthermore, we compared the effect of childhood conditions on the odds of surviving, first from age 40 to age 75 and then, from age 75 to age 90, in both samples, men and women separately. We found that, for men, early-life factors had strong influence in achieving both age 75 and age 90. However, when looking at the odds of achieving age 90 (for those who survived to age 75), the influence of early-life conditions vanishes in the centenarian sample, while it remained present in the control group (Insert table 2).

Many studies suggested that people that achieve old age do so because of genetic variations that affect their basic mechanisms of aging and centenarians are believe to be a model of healthy aging:"What makes these people live a very long life is not a lack of genetic predisposition to diseases, but rather enrichment of longevity-associated variants that may be protective and may even cancel the genetic effects of disease-associated variants" (Perls et al., 2002). Christensen and Vaupel (1996) suggest that individuals surviving to extreme ages are particularly robust and either are not very susceptible to the health hazards of certain environmental risk factors or they have compensating characteristics. Indeed, researchers often wonder how much of longevity is due to genetic factors and how much is due to environment. In an article published in 2006, Hjelmborg and colleagues, using Danish and Finnish twin cohorts, confirmed that genetic influences on human life span are minimal before age 60 but increase thereafter (Hjelmborg et al., 2006). We can hypothesis that this could also be true for all members of long-lived families and thus long-lived siblings of centenarians may be less vulnerable to adverse environmental conditions, including early life environment, because of a favorable genetic background or biological robustness.

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