THE RELATIONSHIP BETWEEN REPRODUCTIVE LIFE SPAN AND LONGEVITY: THE CASE OF NINETEENTH CENTURY GERMANY

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Research Issue

Is the length of the reproductive life span related to longevity? The purpose of our project is to explore the relationship between reproductive life span and longevity, by using a longitudinal women's sample of German historical village populations.

The relationship between childbearing and longevity has been long studied (see Dorn & McDowell, 1939; Freeman, 1935, Bell, 1918) and continues to be studied during present (see Alter, Dribe & van Poppel, 2007; Smith, Mineau & Bean, 2002, Gavrilov & Gavrilova, 1999), yet the evidence is inconclusive in terms of the direction of the relationship and even of whether childbearing and longevity are related at all. As described in Alter, Dribe and van Poppel (2007), (1) some view childbirth and childrearing as stressful experiences with long-lasting consequences for the mother's health, (2) others see childbearing as an indicator of good health, implying that women with later births will be more resistant to disease at later ages, and yet (3) others suggest that human evolution resulted in a genetic trade-off between reproduction and longevity. Moreover, the results from empirical studies are at least as diverse and contradictory as the theoretical perspectives speculating on the relationship between childbearing and longevity. For instance, Smith, Mineau and Bean (2002) found that in general women who had fewer children as well as those who were fertile late had lower rates of mortality. In contrast, Friendlander (1996) found that the childless women and those with fewer children had better survivorship than those with a higher number of children, and that late childbearing increased the risk of dying. Yet, Alter, Dribe and van Poppel (2007) have found no relationship between age at last birth and longevity, and mixed results on the relationship between the children ever born and the post-reproductive longevity.

Our study uses a dataset from a historical population of 14 German villages with complete fertility histories of 19,124 married women to test the specific link between the length of the reproductive life span and post-reproductive longevity. We also include in our models important factors that were missing in many studies, such as a control variable for the place of residence (which might capture variation in practices related to marriage, fertility, and childrearing) in addition to the commonly used variables in previous studies such as parity, age at first birth, age at last birth, measures of socio-economic status, and marital status as a time varying covariate.

Data

In this study, we are using a sample of historical life histories coming from parish registers data collected by Knodel (1988). Two datasets are available from Knodel (1988), but we only use one of them ("343" Database) due to the absence of important covariates in the "344" database. These data were created in the period between 1969 and1980 and cover a time span between 1550 and 1950 from six German villages (14 villages in both databases).

Variables to be used & how they are to be measured

Table 1: Variables include in the analysis

Variable	Description
Dependent variable	
Longevity	The duration in years between age 55 and death.
Main Independent variable	
Reproductive life span	A continuous variable counting the number of

	years between first birth and last birth
Control variables	
Number of children ever born	A continuous variable counting the number children ever born
Total number of dead children	A continuous variable counting the total number of dead children.
Age at first birth	A continuous variable measuring the age of the women at the first birth in years
Age at Last Birth	A continuous variable measuring the age of the women at the last birth in years
Marital status	A dummy variable accounting for widowhood versus married status.
Religion	A series of dummy variables (*Catholic, Protestant, OtherRelig*)
Place of residence	A dummy variable accounting for South or North Germany.
Period	A dummy variable taking the value of 0=Year of birth < 1850, 1=year of birth >1850.
Socioeconomic status	Husband's occupation, measured as a series of dummy variables
*Reproductive life span * Parity*	Interaction between a continuous variable measuring the Reproductive life span and Number of children ever born
*Religion*North*	

Methods

Our methodological strategy includes the following steps:

(1) Explore our main independent and dependent variables by graphing the Kaplan-Meier estimates of the survivor function (1) for different percentiles of women based on the length of their reproductive life span (2) for different time periods (before and after women started to control their fertility) to capture differences in longevity between a natural fertility population versus a population displaying parity-related fertility control.

(2) Estimating three simple Cox models (one with the main independent variable as the only covariate, one with all the covariates except the interactions, and one with all covariates and all interactions) taking the following form:

$$h(t|\mathbf{x}_j) = h_0(t)exp(\mathbf{x}_j\boldsymbol{\beta}_x)$$

in which $h(t / x_j)$ is the hazard rate at time *t* for an individual with characteristics x_j.

We start examining our topic with Cox models because they are semi-parametric models, that do not make assumptions about the shape of the hazards, and can incorporate censored observations (in our case, women for whom we do not know the date of death). One drawback of the basic Cox proportional hazards model is its assumption that, for any two individuals, the ratio of their hazards stays constant over time.

(3) Estimating a Cox model with family shared frailty (including all our variables and interactions as covariates), taking the following form:

$$h_{ij}\left(t / x_j\right) = ho(t)\alpha_i \exp\left(x_{ij}\beta_x\right)$$

The difference between this shared frailty Cox model and the previous models is α_i, a latent random effect that enters multiplicatively on the hazard function, accounting for the unobserved population heterogeneity. In our case, it is plausible to think that individuals within the same family (sisters) have unobserved common characteristics (learned health-related behavior, some genetic commonality, etc.) that affects their mortality, and that makes them different from individuals in other families.

(4) In addition to the above models, we also intend to estimate several parametric models (e.g., Gompertz, Weibull, log-normal) with and without frailty and compare these different model specifications to test the stability of our estimates.

Expected outcomes

Our hypothesis is that a long childbearing span "depletes" women's bodies and leads to shorter post-reproductive life or increased hazard of dying. In addition, we hypothesize that the effect of childbearing span on the risk of dying would be much stronger in the period before women started to control their fertility than in the later period, due to the possible beneficial effects of the social security and improved nutrition and life conditions for the later cohorts of women.

References

Alter, G. Dribe M. and Poppel van F. 2007. "Widowhood, Family Size, and Post-Reproductive Mortality: A Comparative Analysis of Three Populations in Nineteenth Century Europe" (Forthcoming).

Bell, A. 1918. "The duration of life and conditions associated with longevity. A study of the Hyde Genealogy". Washington, DC: The Genealogical Record Office.

Doblhammer, G. 2000. "Reproductive history and mortality later in life: a comparative study of England and Wales and Austria", Population Studies 54(2): 169/176.

Dorn, H. and A. McDowell. 1939. "The relationship of fertility and longevity". American Sociological Review 4(2): 234-246.

Freeman, B. 1935. "Fertility and longevity in married women dying after the end of the reproductive period", Human Biology 7(September): 392-418.

Friedlander, N. 1996. "The relation of lifetime reproduction to survivorship in women and men: a prospective study", American Journal of Human Biology 8(6): 771-783.

Gavrilov, L. and N. Gavrilova. 1999. "Is there a reproductive cost for human longevity?", Journal of Anti-Aging Medicine 2(2): 121-123.

Jelliffe, D.B. & Maddocks, I. 1964. "Notes on Ecologic Malnutrition in the New Guinea Highlands". *Clin. Ped.,* 3(7): 432-438.

Knodel, J. E. 1988. "Demographic behavior in the past. A study of fourteen German village populations in the eighteenth and nineteenth centuries". Cambridge University Prees.

Smith, K., G. Mineau, and L. Bean. 2002. "Fertility and post-reproductive longevity", Social Biology 49(3/4): 185-205.