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Reproductive History and Mortality Later in Life for Austrian Women

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Abstract

How does a woman's reproductive history influence her life span? We find that parity and both an early and late birth significantly influence longevity. The impact of a woman's reproductive history on her life span is minor, however, compared to the influence of her level of education or family status. Differences according to reproductive history are not explained by differences in educational status or family status. The mortality advantage of women who gave birth in their forties (late mothers) mainly originates from their comparatively lower risk of heart disease, despite an increase in the risk of breast cancer. Do women who give birth later in life age at a slower rate or is their mortality proportionally lower at all ages? We present evidence that from age 70 onward late mothers age at a lower rate. This may be the result of both biological and social factors.

I Introduction

Death is a fundamental biological process influenced by both social and biological determinants. Little is known about the determinants of longevity and much of what is known has been learnt only in recent years (Christensen and Vaupel 1996). A recent study by Herskind et al. (1996) based on 2,800 Danish twin-pairs with known zygosity showed that approximately one-quarter of the variation in life span could be attributed to genetic factors and three-quarters to unknown environmental factors. But it is not well understood which genetic factors influence the variation in longevity and what the causal relationships between environmental factors and mortality might be. A large number of environmental and genetic factors have been proposed which may interact to determine life span (Christensen and Vaupel 1996).

This study is mainly concerned with the influence of a woman's reproductive history on her life span. Fertility itself may be viewed as both an environmental and a biological determinant of mortality. Although fertility, like mortality, is a biological process, in contemporary societies it is largely determined by social factors. Nevertheless, certain characteristics of one's reproductive history may be markers for biological determinants of longevity, in particular, early fecundity and late menopause. Research indicates that both are genetically determined to a high degree (Kirchengast 1994). In a recent paper by Vaupel et al. (1998) the authors argue that selection pressures push species to maximize reproductive success rather than optimizing longevity and come to the conclusion that “deeper understanding of survival at older ages thus hinges on intensified research into the interactions between fertility and longevity”.

The theory of antagonistic pleiotropy (Williams 1957) assumes that senescence may have evolved by the selection of genes that have different effects on fitness at different ages, i.e. pleiotropic genes may be beneficial at one age but deleterious at another. Rose and Graves (1989) pointed out that suppressed early reproduction and postponed senescence may be one example of antagonistic pleiotropy. There may also be a trade-off between early and late reproduction, as has been discussed by Kaplan (1997). Kaplan argues that the costs of extending the length of the reproductive period may be that the allocation of energy needed to increase follicle number and follicle viability may in turn reduce the amount of energy available for early reproduction.

Only a limited number of studies have analysed the influence of fertility on mortality later in life. A relationship between parity and life span was found by Kitagawa and Hauser (1975), and Doblhammer (1996). Both studies found a U-shaped mortality pattern: mortality is highest for childless women and women of higher parity, while it is lowest for parities two and three. Perls et al. (1997) found that female centenarians were four times as likely to have had children after age forty than those who survived only up to age 73. Voland and Engel (1986) and Le Bourg et al. (1993) analysed the relationship between reproductive history and longevity in historical populations in Ostfriesland, Germany, and of French-Canadian immigrants to Quebec. The first authors find a significant but minor correlation between longevity and age at last birth, as well as the number of surviving children; the latter authors did not find any relationship between fertility and longevity in their study population, specifically not between early fecundity and longevity.

The main questions we address in this study are, first, whether there is a relationship between reproductive history and longevity in general, and whether giving birth early or late in life has an impact on mortality risk later in life in particular. Second, we analyse the question of whether the mortality of women who gave birth while in their forties is different from those women whose last birth was before the age of forty or whether they age at the same rate but start from a lower biological age. We use a data-set that contains linked death and census records for Austrian women between the ages of 50 and 94 who died in the one-year period immediately following the 1981 census. This is a unique data-set for an entire contemporary population because it contains information on socio-economic characteristics as well as on the reproductive history of women up to the fourth child, together with information on the date and the cause of death.

II Data and Methods

Data

This study is based on the linkage of death and census records. The census records provide information not only about socio-economic and socio-demographic characteristics but also about the reproductive history of women, including the exact age of the mother up to the fourth birth. The death records provide the exact age at death, as well as information about the cause of death.

The 1981 census of the Austrian population counted 1,406,752 women aged 50 to 94, of whom 45,286 died during the one year period immediately following the census. We have linked 89 per cent (40,305 women) of the death records to census records by matching the date of birth and the last residential address in the two data sources. The merge-rate is generally higher among the middle-aged and the young old and it decreases with advancing age. This decrease is mainly the result of changes in the last residential address in the period between the census and the date of death. For elderly women admission to a nursing home is the main reason for a change of address shortly before death.

Our data set contains the census records of 926,852 women of parities one to four for whom the complete reproductive history is known; 23,463 of these women died in the given one-year period. It also comprises 351,538 women of nulliparity, of whom 12,873 died. The sample-proportion of childless women ranges from 20.8 per cent (50-54 year-olds) to 37.7 per cent (90-94 year-olds). The comparably large proportion of childless women at older ages is a result of the two world wars, and the economic hardships before and after World War II. Thus, a large proportion of these women may not have remained childless for reasons of health, but rather due to the absence of their husbands during the war, widowhood, and economic difficulties after the war. Women of parity five and higher are excluded from the analysis because the age of the mother at birth was given only up to the fourth child; between the ages of 50 and 94, 9.12 per cent of the female population belong to this group.

We divided our data set into three groups: women of nulliparity, women of parity one to four who gave birth at age 40 or above (late mothers), and women of parity one to four whose last birth was before the age of 40 (young mothers). Between 3.5 per cent (50-54) and 6.7 per cent (75-79) of the women of parity one to four gave birth in their fifth decade. The proportion increases among the very old, which partly results from delayed childbirth due to the difficult life-circumstances during their main reproductive phase. Altogether, our sample includes 863,058 women of parity one to four whose last birth was before the age of 40, of whom 21,632 died; 63,794 women gave birth after the age of 40, of whom 1.830 died.

This data set is unique because it combines detailed information on the reproductive history of nearly one million women with information about survival or death, and in the case of the latter, about the cause of death. Furthermore, it is the data set of a contemporary population. Previous studies on historical populations, for example, vital statistics available for 811 women from Ostfriesland, Germany, born in the eighteenth century (Voland and Engel 1986) and 694 French-Canadian women who lived in the seventeenth and eighteenth centuries (Le Bourg et al. 1993) are confined to a highly selected group of women: those who have survived the hazards of pregnancies and childbirth to old age. In historical societies it was often the case that death occurred long before the end of the reproductive phase. Therefore, in these populations the cost of reproduction may have lain in the risks of pregnancy and childbirth during the pre-menopausal phase of life rather than in risks at old age. It has been estimated that from 1780 to 1899 about 152 women per 10,000 live births died in Germany (Imhof 1981). By the twentieth century maternal death had been reduced dramatically: in the year 1946, 32.8 women per 10,000 life-births died in Austria, and ten years later 17.4. Thus, when analysing the costs of reproduction, the female population of 1981 is far less selected than any historical population. On the other hand, the 1981 female population has one big advantage compared to a more recent population: during the main reproductive period of the women in question, the use of hormonal replacement therapies and hormonal contraceptives was, if not entirely unknown, at least not widespread. Thus, our results most probably are not biased by endogenous hormonal intake during the reproductive period and after menopause, which may significantly influence the risk of morbidity and mortality.

Methods

In the process of data linkage eleven per cent of the mortality records could not be linked to the census records. We therefore cannot directly estimate probabilities of death for young (last birth before 49) and late mothers (last birth at 40+) from our data set. Instead we applied a procedure consisting of three steps. In a first step we distinguished childless women from those who had at least one child. We then applied equations (1), (2), and (3). In equation (1) $q(x)$ is the probability of death derived from the Austrian life table 1981/82 at exact age x. We assumed that this equals the sum of the proportions of women of parity 0 ($p_0(x)$) and of higher parities (1- $p_0(x)$) at exact age x, multiplied by their unknown probabilities of death $q_0(x)$ and $q_1(x)$. The proportions are calculated from the 1981 census. In equation (2) we assumed that the ratio of the unknown probabilities of death of the two groups of women equals their age-specific odds ratios $\psi(x)$, which are estimated by the logistic regression model given in equation (3).

$$p_0(x)q_0(x) + (1 - p_0(x))q_1(x) = q(x) \tag{1}$$

$$\frac{q_1(x)}{q_0(x)} = \psi(x) = \frac{\pi(z_1, z_2 = 1) / (1 - \pi(z_1, z_2 = 1))}{\pi(z_1, z_2 = 0) / (1 - \pi(z_1, z_2 = 0))} \tag{2}$$

$$\pi(z) = \frac{\exp(\beta_0 + \beta_1 z_1 + \beta_2 z_2 + \beta_{12} z_1 z_2)}{1 + \exp(\beta_0 + \beta_1 z_1 + \beta_2 z_2 + \beta_{12} z_1 z_2)} \tag{3}$$

In our notation $\pi(z)$ denotes the expected outcome of the regression model, which is either survival or death; $\pi(z)$ is linked to the explanatory variables age (z_1) and mother (z_2) using the logistic function with β as the unknown parameters. Variables z_1 and z_2 are both constructed as categorical variables: age is defined for five-year age groups; the variable z_2 has two categories: zero for women who have never given birth and one for all others.

In a second step, we distinguished between women who had between one and four children, and women who had five and more. We then assumed that in equation (1), $q(x)$ equals the probability of death for women who had at least one child (we estimated this probability in step 1). In equation (2) $p_0(x)$ now stands for the proportions of women with one to four children and 1- $p_0(x)$ for the proportions of women with five and more children; $q_0(x)$ and $q_1(x)$ are their unknown probabilities of death. The age-specific odds ratios $\psi(x)$ are estimated by the logistic regression model given in equation (3), with the two explanatory variables age and number of children. The latter variable consists of two categories: women who had between one and four children, and those who had more.

In a final step, we applied the same procedure for young and late mothers of parity one to four.

We wanted to test whether the death rates of young and late mothers at advanced ages (70+) differ due to differences in the rate of ageing, or whether the mortality risk of late mothers is lower by a certain factor while the rate of ageing is similar. Therefore, we fitted the Kannisto model (Thatcher et al. 1997)

$$\mu(x-70)=\frac{ae^{b(x-70)}}{1+ae^{b(x-70)}}$$

to the probabilities of death of young and late mothers derived from equations (1), (2), and (3). The Kannisto model consists of two parameters: the slope parameter b and the level parameter a. In our model the death rate at age 70 equals *a/(1+a)*. We assumed that a difference in the rate of ageing between young and late mothers implies two different slope parameters b in the Kannisto models; a reduction of the mortality by a constant factor, on the other hand, implies that the level parameter a differs for the two groups of women. We fitted four models. Model 1 fits one function to both groups of women: only one level parameter a and one slope parameter b are estimated for young and late mothers. At the opposite extreme, model 4 estimates each of the two parameters separately for the two groups of women. Models 2 and 3 estimate either different slopes or different levels. The models are fitted by the maximum likelihood method[1].

We applied a nested model test-procedure using both the likelihood ratio test and the Akaike Information Criteria (AIC) to determine the model that best conforms to our data with a minimum number of parameters.[2]

We used multivariate logistic regression models to analyse the simultaneous impact of education, family status, and reproductive history on the risk of mortality; we analysed

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[1] Maximum-likelihood estimates for the parameters a and b are calculated based on the likelihood function

$$L = \prod_{i=1}^{n} q_i^{D_i} \left(1 - q_i\right)^{\left(N_i - D_i\right)}$$

and the life table function

$$q(x) = 1 - e^{-\int_x^{x+1} \mu(u)du}.$$

[2] The likelihood ratio test is defined as -2*(log likelihood model 1 - log likelihood model 2) and it follows a $\chi 2$ distribution. The degrees of freedom (df) are defined as the difference in the number of parameters of the two models. The Akaike Information Criteria is defined as: -2*log likelihood +2*df.

causes of death by applying multivariate logit-models. All calculations were performed in SPSS and GAUSS.

III Results

The results of our study indicate that among women of parity one to four, those who gave birth in their forties experience a statistically significant lower mortality risk than those whose last birth was before the age of forty. In terms of further life expectancy at age 50, late mothers may expect to live 0.44 years longer than young mothers. Based on the 1980/82 life table up to age 94, the further life expectancy of a 50 year-old woman was 29.06 years. Those women who gave birth in their forties could expect to live another 29.66 years, while women who had their last child before the age of 40 had a further life expectancy of 29.22 years. In comparison, the further life expectancy of a childless woman was 28.14 years.

Results from the multivariate analysis (Table 1) suggest that the difference in mortality between young and late mothers is independent of differences in education, family status or parity. The correction for educational status does not affect the value and the significance of the parameter estimate for giving birth after age forty (model 2); the correction for family status reduces the difference in the mortality risk between young and late mothers from 6 per cent to 4 per cent and causes the parameter to become significant at the 90 per cent level only (model 3). However, the introduction of the covariates parity and age at first birth increases the difference in the mortality risk of young and late mothers; the difference is also significant at the 95 per cent level. Furthermore, we find that a woman's reproductive history affects not only mortality risks later in life through late motherhood, but also through the age of the mother at the time of her first birth. A first birth before the age of 20 and after the age of 40 significantly increases the risk of death. Indeed, the negative impact of an early or late first birth is larger than the positive impact of giving birth in the forties. According to our results, the best strategy for maximising longevity would be to get tertiary education, to get married and to have two children: one between the ages of 20 and 39, the other after age 40.

--------- Table 1 here ---------

A more detailed analysis of causes of death reveals that the mortality advantage of late mothers mainly originates from a reduction in the risk of death from ischaemic heart diseases (IHD) and cerebrovascular diseases (CVD). On the other hand, our data also suggest that giving birth in the fifth decade significantly increases the risk of post-menopausal breast cancer (Table 2).

--------- Table 2 here ---------

There are two possible explanations for the lower mortality risk of late mothers: first, they age at a slower rate from others; second, they age at the same rate but their mortality is lower by a constant proportion for all age groups.

Figure 1 presents the difference in the probabilities of death of young and late mothers in absolute terms and in per cent. The probabilities are estimated on the basis of equations (1)-(3). We find a mortality advantage of late mothers between ages 50 and 59 followed by a cross-over in the mortality of young and late mothers for age groups 60-64 and 65-69: in these latter two age groups young mothers do have a lower mortality risk than late mothers. Our data reveal that in absolute terms the number of death from breast cancer is largest between ages 60 and 69 which may explain the excess mortality found for late mothers. Starting with age group 70-75 the excess mortality of young mothers increases continuously when expressed in absolute terms; the difference is a constant age-independent factor when expressed as a percentage of the mortality of late mothers.

-------------Figure 1 here------------

In order to test which one of the two explanations is consistent with our data, we fitted the Kannisto model to the probabilities of death for ages 70 to 94. The χ^2 test statistics of the likelihood-ratio tests (p<0.01) and the Akaike Information Criteria (AIC) indicate that model 2, which estimates two different slopes *b1* and *b2* but only one level parameter a, fits our data best (Table 3). The slope parameter *b* is lower for late mothers than four young mothers (Table 4). Thus, our results support the hypothesis that for ages 70+ the rate of ageing of late mothers is significantly lower than that of young mothers.

------------Table 3 here -----------

------------Table 4 here -----------

IV Discussion

The present study evaluates the mortality risk of post-reproductive women between the ages of 50 and 94 in relation to their reproductive history. The results are based on a linked data set that combines the information of the 1981 census of the Austrian population with the information from the death certificates of those women who died during the year immediately following the census. Unlike previous studies that were based on small samples, this study analyses the costs and benefits of reproduction on the basis of 1,278,390 women. The advantage of analysing a contemporary rather than a historical population lies in the fact that contemporary post-menopausal women are a far less selected group. For historical populations the costs of reproduction lay mainly in the hazards of pregnancies and childbirth during the reproductive period – not in old age. Thus, those women who survived beyond menopause may have differed only marginally in the impact their reproductive history had on mortality at old ages. One disadvantage of a totally contemporary population is that modern hormonal replacement therapies and hormonal contraceptives may well influence the relationship between reproduction and longevity. In this regard our 1981 population is ideal, since women between the ages of 50 and 94 at that time most likely had never taken hormones endogenously (Kopera 1991).

In this study we have found a significantly increased mortality risk later in life for women whose first birth was before age 20, and after age 40. Furthermore, we find a U-shaped relationship between parity and longevity, a pattern that has also been described by Kitagawa and Hauser (1975) in their study using linked death and census records. Thus, our results support the idea of a trade-off between early reproduction and a high number of children on the one hand and longevity on the other. But the results also support the view that a late first birth not only increases the immediate hazards of childbirth but it also has negative long-term effects on life expectancy. Also, remaining childless seems to correlate with an increased mortality risk later in life.

We find a positive relationship between giving birth after age forty and longevity, which is consistent with the findings of two previous studies (Perl et al. 1997, Voland and Engel 1986). In addition, our data suggest that the longevity advantage of late mothers results from a reduction in the mortality risk from circulatory diseases, while at the same time their risk of breast cancer is significantly increased. One possible explanation may be that giving birth after age forty either delays the onset of menopause or is itself a biological marker that these women have always aged at a slower pace. Female senescence may correlate with female reproductive ageing, which is caused by the depletion of oocytes due to the process of follicle decay known as atresia (Leidy 1994). It is this follicle decay that ultimately leads to menopause. A variety of studies (Bromberg et al. 1997, Stanford et al. 1987, Whelan et al. 1990) demonstrate that, along with other factors, the age at menopause correlates positively with parity in general and with whether a woman ever had a live birth in particular. Bromberg et al. found that the median age at menopause is 1.3 years lower for women who never gave birth. On the basis of a study of 110 Austrian women Kirchengast (1992) reports a positive correlation between age at last and first birth and age at menopause. Snowdon et al. (1989, 1990) show that the mortality risk for women who had their natural menopause before the age of forty is nearly twice as high as for those who experienced menopause at age 50-54.

It could be that the positive impact of late menopause results from the extended period of endogenous oestrogen production. From the endocrine point of view, menopause is considered a permanent state of oestrogen-deficiency. A variety of studies have shown that post-menopausal oestrogen therapies, which restore the pre-menopausal endocrine milieu, are associated with a reduced risk of heart disease (Paganini-Hill 1997, Prelevic 1997), of osteoporosis (Seeman 1997) and of Alzheimer's disease (Kawas et al. 1997). On the negative side, however, a number of studies also discuss the possibility of an increase in the risk of breast cancer due to oestrogen therapies (Paganini-Hill 1997, Law et al. 1996). A positive correlation between age at natural menopause and breast cancer was found by Heck and Pamuk (1997).

From an evolutionary point of view the positive correlation between late childbirth and an increase in life span may facilitate the survival and reproduction of offspring. Voland and Engel (1986) have shown that in their historical population of Ostfriesland, longevity was positively correlated with the number of surviving children rather than with the number of children ever born. They also discovered the following tendency: women were more likely to die within the first three years after the marriage of their last-born daughter than before this marriage. This supports the hypothesis that the life span of the mother is closely related to her living long enough to help her daughter to establish her own family.

However, it is implausible that this close relationship is purely the result of physiological factors. It is reasonable to assume that psychological factors also play an important role here. It could well be that women gather all their remaining physiological strength to secure the survival of their children. Once this has been achieved the desire to go on living may then fade.

Such a causal relationship could also work in the opposite direction. Elderly women who gave birth while in their forties may receive more help from their late-born child. A late-born child is comparably younger and therefore more capable of providing care than the children of women who gave birth in their twenties or early thirties. Henretta et al. (1997, p. 117) found that “older children (…) are marginally less likely to help, suggesting that younger children (…) have stronger bonds with their parents”. Research on care arrangements for frail older women (Soldo 1990) stresses the importance of kin availability in general; the authors find striking differences between childless and other older women as regards their care arrangements. Among frail persons with children it has been found that the likelihood of receiving any help from children increases with the number of children (Spitze and Logan 1990). It is not just the number of caregivers that increases with the number of living children, but also the total hours of care. Wolf et al.(1997, p. 102) analyse care arrangements within a family network and find that a “child’s hours of parent care are reduced, but on much less than a one-for-one basis, as the parent-care hours of siblings increase”.

The fit of the Kannisto model to the probabilities of death for ages 70+ indicates that late mothers do have a significantly lower rate of ageing than young mothers. The mortality advantage of late mothers does not a priori imply biological differences. The lower rate of ageing may be the result of both social and biological factors that have different impacts on different age groups.

There are three limitations in our data that may introduce a bias into our analysis:

1. A merge-rate of 89 per cent implies that the corresponding census records for eleven per cent of the death records could not be found. Thus, eleven per cent of the women are coded as surviving, although they actually had died. As stated earlier, the main reason for this is a change in the last residential address between the time of the census and the time of death in cases where frail women entered nursing homes. As the likelihood of receiving any care increases with the number of surviving children, childless women and those of lower parity have a higher probability of being admitted to nursing homes in case of frailty and therefore of being mis-classified as surviving. In this case, our study would underestimate the differences in mortality based on reproductive history.
2. Our results are based on cross-sectional data: we therefore cannot rule out the possibility that giving birth after age forty increases the risk of mortality during or shortly after childbirth. Thus, those women who survive the possible hazards of a late childbirth may be a selected group themselves, especially during the first half of this century, where maternal death was still much more common than it is now.

3. Our data are restricted to a woman's reproductive history up to the fourth child. We therefore had to exclude the roughly nine per cent of women from our analysis who had five or more children.

Conclusions

The results of our study are consistent with the hypothesis that reproduction and longevity are closely related from an evolutionary point of view. However, we found that the differences in reproductive history do not explain much of the large variability in longevity. The influence of reproductive history on longevity, although statistically significant, is minor compared to differences in longevity stemming from environmental factors such as the level of education or family status. At advanced ages the rate of ageing of late mothers is slower than that of young mothers. This may be the result of both biological and social factors.

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Table 1 : Relative mortality risks for women of parity 1 - 4 aged 55-94, Austria 1981/82

	Relative Mortality Risks									
	Model 1		Model 2		Model 3		Model 4		Model 5	
young or late mothers										
last childbirth before age 40	1		1		1		1		1	
childbirth above age 40	0.94	**	0.94	**	0.96	*	0.94	**	0.92	**
education										
tertiary			1		1		1		1	
upper secondary			1.22	*	1.22	*	1.23	*	1.22	*
lower secondary			1.33	**	1.33	**	1.33	**	1.33	**
apprenticeship			1.49	**	1.49	**	1.49	**	1.48	**
basic			1.67	**	1.67	**	1.66	**	1.65	**
family status										
single					1		1		1	
married					0.75	**	0.74	**	0.74	**
widowed					0.92	**	0.92	**	0.92	**
divorced					1.01		1.01		1.01	
parity										
1							1		1	
2							0.99		0.99	
3							1.02		1.02	
4							1.06	**	1.06	**
age at first birth										
<20									1.11	**
20-24									1	
25-29									1.01	
30-34									0.97	*
35-39									1.01	
40>									1.16	**
-2 log likelihood	*189721*		*189571*		*189390*		*189381*		*189348*	
$\chi 2$	*29121*		*29272*		*29453*		*29462*		*29494*	
df	*9*		*13*		*16*		*19*		*24*	

all models are age-adjusted

** 95% significance level,* 90% significance level

Table 2: Relative mortality risk for young and late mothers by causes of death (reference group: young mothers)

Women of parity 1-4 corrected for age, education, and parity	Relative Risks young mothers	late mothers	Conf. Intervals lower 95%	upper 95%
Malignant Neoplasm excl. breast & uterus	1	0.94	0.84	1.16
Stomach & colorectum	1	0.81	0.66	1.00
Lung	1	0.95	0.63	1.43
All others	1	1.04	0.89	1.22
Uterus	1	0.98	-0.68	1.43
Breast	1	**1.42**	**1.09**	**1.84**
Circulatory diseases		**0.89**	**0.84**	**0.95**
IHD	1	**0.84**	**0.74**	**0.95**
CVD	1	**0.89**	**0.79**	**0.99**
All others	1	0.93	0.84	1.03
All other diseases (incl. infectious diseases)		0.98	0.84	1.16
Respiratory system	1	1.01	0.80	1.27
Digestive system	1	1.01	0.80	1.26
Accidents & Suicides	1	0.95	0.82	1.10

Table 3: Likelihood ratio test and Akaike Information Criteria for the four Kannisto models estimated for young and late mothers

Models					Likelihood-ratio test			
Model number	Same parameters for young and late mothers	Different parameters for young and late mothers	df	AIC	Model 1	Model 2	$\chi 2$	p
1		a1, a2 b1, b2	4	1071263	4	**3**	275	0.00
2	***a***	**b1, b2**	**3**	**1071261**	4	**2**	280	0.00
3	*b*	a1, a2	3	1071266	3	1	5	0.03
4	ab		2	1071539	2	1	0	1.00

df: degrees of freedom (number of parameter)

AIC: Akaike Information Criteria

Table 4: Parameter estimates of the Kannisto model for young and late mothers (model 2)

	Parameter Estimates (model 2) *(Standard Error)*	
	a	b
young mothers	.0238	.1275
	±.0001	*±.0005*
late mothers	.0238	.1205
	±.0001	*±.0005*

Figure 1. Mortality of young mothers compared to late mothers in absolute terms and in per cent.