The effect of childbearing on mortality: A historical analysis of how number of children affected Utah women's longevity

Daniel Poole
University of Utah

This paper examines the mortality effect of childbearing on Utah women. More specifically, I explore how the number of children a woman had affected the number of years she lived. It is important to consider this relationship for many reasons. While issues of fertility such as abortion, birth control, one child policies, and many others become more and more debated and important in people's lives, it is helpful to look at historical trends which can shed insight into the reality. This particular study uses historical data from Utah women who have documented information regarding fertility and longevity. In short, I find that among this group of women, as the number of children increased, their life-years decreased.

Introduction

As we move into the twenty-first century, issues of fertility and mortality are consistently brought up in realms ranging from academia to every day life. One thing that we as human beings have in common is that we are all born and we all die. One's gender, race, ethnicity, class, or any other distinction makes no difference. There is no debate about that fact. Therefore, issues related to birth and death are important for everyone. With the increase of knowledge and technology we have seen heated debates arise concerning issues of both fertility and mortality. It has only been in the last several decades that contraception has allowed women and men to make consistent and reliable decisions about fertility, while engaging in physical relationships.

In this paper, I will explore the relationship that childbearing had on a woman's mortality. I hypothesize that as the number of children increases, the number of years a woman lives will decrease. It must be noted that the data I am working with is historical and does not necessarily reflect current patterns and trends. This is explained by the fact that contraceptives now give women more control over their fertility and medical advances have improved both reproduction and longevity. I am basing my ideas on evolutionary theories. These theories argue that there is some sort of trade-off between reproduction and longevity. It is explained that the body requires resources for conception, pregnancy, birth, breast-feeding, and simply raising children, that can not be replaced. When a woman gives birth to a child, these resources are used up and are no longer available to the body for healing, general repair, issues of aging, and other issues related to longevity. (Kirkwood and Holliday 1979; Smith et al. 2002)

Previous Research

There have been several studies which have explored similar relationships between fertility and longevity. It seems the only thing that most of them agree upon is that the effect for men is either non-existent or certainly not as powerful as the effect for women. The results for women vary depending on many important pieces of information. Hurt, Ronsmans, and Thomas (2006) conducted a thorough review of existing literature which explores the topic at hand. They essentially found that among historical cohorts, longevity decreased as fertility increased. However, they found that among contemporary cohorts, this relationship does not exist with the same strength and sometimes even direction. Again, this is explained by different patterns of fertility, life expectancy, and medical advancement in general. There are also some differences among different groups of women and in different locations. The previous mentioned authors site social, biological, and methodological factors when explaining the differences that have been found in the existing literature.

The most obvious difference in results can be explained by methods. Hurt et al. (2006) discussed several of the methodological discrepancies in their paper. Some examples include the fact that cut-off ages for examining women varied. Other problems arose because of the nature of data, especially within the historical context. Sometimes only male children were accurately recorded. Other times children were not recorded if they did not live long enough to be baptized. Other methodological issues included treating variables as linear vs. non-linear. The authors explain biological differences as basically inherent differences among women in general. Some women simply live longer and appear to have more resources available for both reproduction and longevity. Perhaps this might have something to do with nutrition, environmental conditions, and other physical circumstance.

Data and Methods

I have used data compiled in the Utah Population Database. Most of the dataset comes from the Utah Family History Library including data compiled from various sources such as Latter Day Saint (Mormon) genealogical records, Utah state birth and death certificates, various governmental records, and other historical documentation. The dataset includes approximately 60,300 Utah women, whose lives cover more than a one hundred year period. Their births range from the mid-eighteenth century into the better part of the nineteenth century.

I will be focusing on several variables which have been deemed appropriate based on relevant literature. My dependent variable is 'years lived past 50'. This variable ranges from 1 to 62. This means that women in question lived to be from 51 to 112 years old. One reason for limiting the study to women who made it at least to the age of 50 is mainly to control for accidental or other early-life deaths. It seems appropriate to consider 50 an arbitrary cut-off point for a natural life course among these women. All of the women in this dataset lived to at least 50 years old. Ultimately, the dependent variable is simply a measure of mortality. The key independent variable is 'number of children'. I also control for 'age at first birth', 'age at last birth', and 'number of spouses'. The number of children ranges from 1 to 22. Unfortunately I do not have information about women who did not have any children. There does appear to be significant thresholds to apply to the number of children. By this I mean that certain numbers of children can be meaningfully grouped together. I will discuss this further in the results section.

Based on the literature, the age at which a woman has her first and last birth can potentially have significant effects. Doblhammer found that women who had their first child at ages younger than 20 experienced higher mortality (2000). This can be theoretically explained that if a woman uses her given resources earlier than other women, she will experience the loss of those resources sooner as well. If a woman's resources are taxed at an early age for reproductive purposes, she will not have the same surplus to pull from later in life to aid in her aging. Again, in this situation, the lack of resources will result in a decrease of longevity or sooner death.

Doblhammer found a protective effect for women who had their last child at older ages (2000). Births at older ages were associated with older death ages. With regard to the evolutionary theories, this could have an interesting explanation. That is, stronger women have more resources from which to pull for reproduction as well as longevity (Khlat and Rosmans 2000). Women who are generally weaker will not be as successful at reproducing and will not live as long as their stronger counterparts. If a woman has this inherent surplus of said resources she will not only be fertile longer, but be able to carry a child full-term later in life. If we think of fertile years as a proportion of a woman's life, a stronger woman will have proportionally longer fertility which in turn will also equate to longer life years in general.

There were two main statistical methods used in this analysis. I first used ordinary least squares (OLS) regression to consider the linear effect of the number of children a woman has on her mortality. The dependent variable was number of years lived past 50. The key independent variable was number of children, controlling for woman's age at first and last birth. I then explored the question using survival analysis techniques. I modeled the risk of death in these women using a Cox proportional hazards model. The model considers number of children, age at first birth, and age at last birth as covariates with explanatory power. For the survival analysis, the time variable used was life years lived past the age of 50. The failure event, or event which eliminates the individual from the remaining pool, was the death of the woman. Log-rank tests were computed to determine if there was in fact statistical evidence between categories of each of the independent variables (number of children, age at first and last birth). I also created Kaplan-Meier estimates for number of children in order to provide a visual representation of the mortality rates for the women being studied. Kaplan-Meier survival estimates account for the proportion of women remaining alive across time. In this case, the time period being tracked is again life years after the age of 50. As previously mentioned, I found thresholds at which to divide the number of children into groups. This was done by testing to see which categories followed similar patterns. After combinations were exhausted, the categories were divided as follows: 1) 1-3 Children, 2) 4-5 Children, 3) 6-8 Children, 4) 9-12 Children, 5) 13-17 Children, and finally 6) 18-22 Children. All statistical analysis was computed using Stata version 9.

Findings

I will report the findings in the order that I described the methods. First, Table 1 shows the basic descriptive statistics of the variables. Table 2 shows the results of the ordinary least squares regression. We can see that holding all other variables constant, each additional child a woman had decreased the number of years she lived by .47 or almost 6 months. This was statistically significant at the less than 0.001 level. A woman's age at first birth was not statistically significant. Her age at last birth however, was. For each additional year increase of a woman's age during her last birth, she gained about .12 years, or about a month and a half. This was also significant at the less than 0.001 level. These findings support the theoretical argument that a) women lose life years for each additional child they have and b) the older a woman is at her last birth, the less dramatic the impact of childbearing is on her longevity. Again, these findings would make sense if we think about the distribution of resources being used up by reproduction.

The Kaplan-Meier survival estimates provide some interesting visual explanations. Table 3 is a basic curve showing the overall survival rates of all of the women in the sample. This provides us with a basic picture of the general life expectancy of these women. Table 4 shows us the survival curve for women by the number of children they had. This is where the grouping of categories is best demonstrated. By trimming the categories for number of children down from twenty-two (one for each child) to six, the data are more easily managed and interpretable. Again, this is justified because it was found that there was little or no difference between categories in each group.

We can see by looking at Table 4 that there is a clear distinction between number of children and life years lived. For the first two categories, 1-3 and 4-5 children, there is a lot of similarity in the mortality pattern. After about age 75, however, survival rates drop for the later category. Each subsequent category shows a clear drop in survival time as the number of children increases. The last category, 18-22 children does not follow the same pattern as the others. This is because this category can be considered an outlier. In other words, there were not very many women who had upwards of 22 children. Because of the small numbers, if one woman who had 22 kids lived to be 60 years old, the survival curve would be thrown off in comparison to the other groups with a much larger sample base. In the end, the group with the highest number of children still experiences the lowest survival rates. Again, all categories fit well with the theoretical argument that additional children decrease overall life expectancy. Table 5 shows the log-rank test for equality of survivor function for number of children. This test suggests that there is indeed evidence that differences exist between the categories of number of children in the survivor function. The more children a woman had, the lower her survival probabilities.

Table 6 displays the results of the Cox proportional hazards model. Only number of children and age at last birth are statistically significant. These are both significant at the less than 0.001 level. We first see that a woman's hazard rate of death increased by about 4% for each additional child that she had. Age at last birth, however, had a protective effect against mortality. For each additional year of age a woman had during her last birth, her hazard rate dropped by about 1%. These findings fit well with the theoretical expectations. A woman's total life years decreased as the number of children she had increased. We can assume that these women used up their resources in the reproduction process that would have otherwise aided their aging or longevity. By waiting until older ages to have their last child, a couple of things could have been happening. First, these said resources may have been reserved for a longer period of time, therefore granting these women extended periods of life. On the other hand, these women may have simply been stronger than their counterparts. If they were able to maintain fertility longer, this might be a demonstration of their overall well-being. In turn, these stronger women would be able to live longer. Perhaps they simply have access to more of the stated "resources" than other women.

Discussion and Limitations

When considering all of the analysis that I have conducted, some clear patterns have emerged. In general, it appears that the number of children a woman had had a significant negative effect on her overall mortality. Evolutionary theorists would argue that this makes logical sense because of the trade off between reproduction and longevity. The theoretical claims that some type of resources exist from which a woman draws to support both reproduction and longevity is supported by this study. As these resources are used up for the childbearing process, there is a diminished supply available to help with aging. This of course results in a sooner death. I also found that the age at which a woman had her children had an impact on her mortality. It does not appear that the age at which she had her first child had much impact, but the age during her last birth was important. The older the woman was during her last birth, the more time she had left to live. In other words, there seemed to be some sort of protective effect for older parous women. If we think again about the theoretical argument, this could be explained that women who do not use up their resources for reproduction until later in life have been able to use more of those resources to aid in the aging process along the way. This will have given her body more opportunity to repair itself and be sustainable for a longer period of time. I should also mention that it could simply be explained that every woman has a different level or amount of resources from which to pull. If a woman has more resources to draw from she will be able to have more children, have children later in life, and live longer than other women.

This brings me into the first limitation of the study. There was no way to measure, let alone control for, the level of "resources" a woman was able to draw from. Perhaps things such as nutrition, genetic make-up, environmental conditions, socio-economic status, as well as many other factors should be considered in order to accurately account for inherent differences among women. One of the biggest limitations of this study is generalizability. This study is only representative of the population from which the sample was pulled. Patterns may be significantly different outside of Utah. Also, fertility and mortality patterns have been changing dramatically over time. Medical advancement has played a huge role in life expectancy. In modern times we have successfully eliminated many of the infectious diseases that used to take a huge toll on historic populations. Contraception has also had a dramatic impact on fertility. Women are now able to make conscious decisions and take action to prevent (or encourage) pregnancy. Also, women who use contraception may likely be more aware of current medical practices and have more contact with doctors. Women who seek prevention methods, for example, may be visiting with a doctor and other health care providers on a regular basis and may therefore be more aware of her potential fertility problems as well as better able to manage them.

Far fewer children die at young ages in modern times. Because children were an asset rather than a liability in the past, parents often had many children. More children meant more physical labor around the house and on the farm, more security later in life for the parents, and frankly a better chance of survival for the family in general. Nowadays as situations have changed, children are more of a liability. Parents no longer count on children to contribute significantly to the familial economic gain. Kids cost parents money today, rather than help them earn it. There are many reasons why there has been a shift in both reproduction and mortality. While this paper does not focus on explaining those changes, it is worth noting because of the limiting generalizability consequence of that reality.

Another drawback of this study is that it does not include data on childless women. It can be argued that there are differences between women who bear children and those who do not, and that this is grounds for not comparing them. The reason non-parous women were not included in this analysis is a result of lacking data. The data only contained information on women who had borne children. This however does not invalidate this study as the intent was to draw conclusions about the links between numbers of children and mortality.

In general I have found results which support the evolutionary theorists view that there is a negative relationship between fertility and mortality. It makes sense that there is some sort of taxing effect that the reproduction process has on a woman, at the expense of her mortality. The best way to make sense of this process is to think of a woman as possessing an inherent pool of resources from which she draws to support her reproduction and aging processes. As the pool is depleted by the reproduction process, she will have less of this resource to support her longevity. This ultimately results in higher mortality. There are effects which can hinder or propel this process. The age at which a woman bears her children was the confounder explored most in this paper. Future research should consider this and other variables as well. It would be helpful to be able to control for overall access to resources such as nutrition, socio-economic status, and general quality of life. Comparisons between diverse groups of women would be able to provide insight into differences. Also, it would be important for future research to examine contemporary cohorts of women in order to be able to generalize to modern populations.

APPENDIX

Table 1

Summary of the variables:

Variable	Observation	Mean	Std. Dev.	Min.	Max.
Life Years Past 50	60,300	28.26	11.44	1	62
Number of Children	60,300	6.37	3.41	1	22
Age At First Birth	60,300	22.83	4.44	12	53
Age At Last Birth	60,300	37.00	6.24	13	55

Table 2

OLS regression results:

Variable	Coefficient	t	P-value	95% C.I.
Number of Children	-0.472	-17.70	0.000	(-.524 to -.419)
Age At First Birth	-0.010	-0.66	0.506	(-.039 to .019)
Age At Last Birth	0.119	9.43	0.000	(.095 to .144)

60,300 Observations

R-squared = 0.0110

Adjusted R-squared = 0.0109

Table 3

Kaplan-Meier survival curve for overall mortality of women in sample:

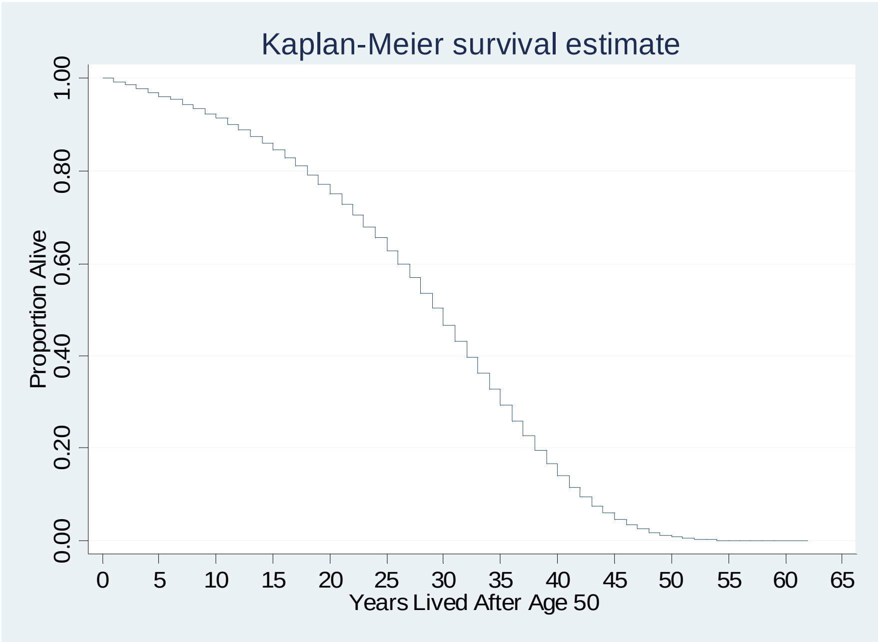

Table 4

Kaplan-Meier survival curves for number of children:

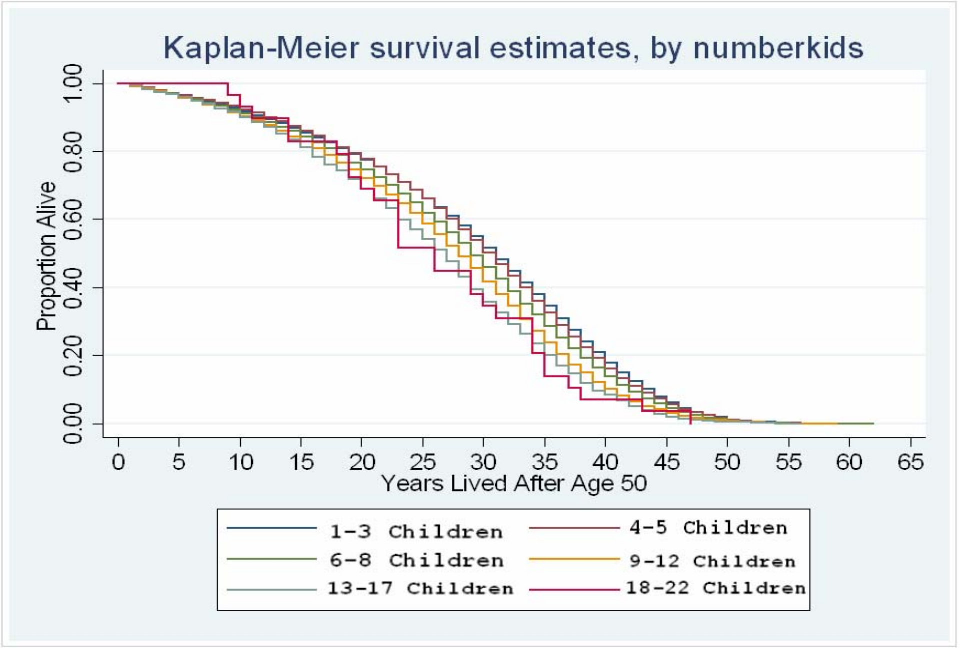

Table 5

Log-rank test for equality of survivor functions (number of children):

Number of Children	Events Observed	Events Expected
1 to 3	14250	15912
4 to 5	12102	13071
6 to 8	16985	16695
9 to 12	14566	12748

Chi2 (5)	720.51
Pr>Chi2	0.0000

Failure: death

Table 6

Cox Proportional Hazards Results

Variable	Hazard Ratio	Std. Error	Z	P>Z
Number of Children	1.043	0.002	17.99	0.000
Age at First Birth	1.000	0.001	0.05	0.962
Age at Last Birth	0.991	0.001	-7.76	0.000

Number of Subjects: 60,300 Log likelihood: -605802.18

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