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DO SONS REDUCE PARENTAL MORTALITY?

Genevieve Pham-Kanter and
259 Wallace Hall, Office of Population Research, Princeton University, Princeton, NJ 08544 USA, Tel (609) 258-5514, Fax (609) 258-1039

Noreen Goldman
243 Wallace Hall, Office of Population Research, Princeton University, Princeton, NJ 08544 USA, Tel (609) 258-5724, Fax (609) 258-1039

Genevieve Pham-Kanter: gpkanter@princeton.edu; Noreen Goldman: ngoldman@princeton.edu

Abstract

BACKGROUND—Although sons are thought to impose greater physiological costs on mothers than daughters, sons may be advantageous for parental survival in some social contexts. We examined the relationship between the sex composition of offspring and parental survival in contemporary China and Taiwan. Because of the importance of sons for the provision of support to elderly parents in these populations, we hypothesized that sons would have a beneficial effect on parental survival relative to daughters.

METHODS—We used data from the Chinese Longitudinal Healthy Longevity Survey (CLHLS) and the Taiwan Longitudinal Study of Aging (TLSA). Our CLHLS sample consisted of 4132 individuals ages 65+ in 2002. Our TLSA sample comprised two cohorts: 3409 persons aged 60+ in 1989 and 2193 persons aged 50–66 in 1996.These cohorts were followed for 3, 18, and 11 years, respectively. We used Cox proportional hazards models to estimate the relationship between the sex composition of offspring and parental mortality.

RESULTS—Based on 7 measures of sex composition, we find no protective effect of sons in either China or Taiwan. For example, in the 1989 Taiwan sample, the hazard ratio for maternal mortality associated with having an eldest son is 0.979 (95% CI (0.863, 1.111)). In Taiwan, daughters may have been more beneficial than sons in reducing mortality in recent years.

CONCLUSION—We offer several explanations for these findings, including possible benefits associated with emotional and interpersonal forms of support provided by daughters and negative impacts of conflicts arising between parents and resident daughters-in-law.

Keywords

Mortality; parents; adult children; Taiwan; China

INTRODUCTION

From a physiological perspective, sons are thought to impose greater costs on mothers than daughters: male fetuses have higher intrauterine growth rates and birth weights, impose greater demands on maternal energy, and generate greater levels of testosterone.[1–3] Many recent studies have examined the hypothesis that these additional physiological burdens have long-term effects on maternal mortality that continue beyond menopause. These

COMPETING INTERESTS
None declared.

studies generally relied on data from either historical or contemporary non-industrialized populations that did not have modern medical care which could have reduced or eliminated these sex differences.[4–10] Some of these analyses also examined associations with paternal mortality with the view that the absence of effects for the father, combined with the presence of these impacts for the mother, would provide additional confirmation of the physiological costs of bearing sons.[8,9,11]

The findings generated a lively debate in the literature. Although Helle and colleagues' pioneering study found decreases in maternal longevity associated with additional sons in northern Finland,[7] others have since failed to find the same relationship in similar historical populations (pre-industrial Germany, Canada, Sweden, and Belgium)[4–6,10] and in more recent rural populations (late 19th century and early 20th century Utah, early and late 20th century Poland, and 20th century Bangladesh)[8,9,11] and some have questioned the methodological approaches used in these studies.[5] The issue remains unresolved.

In this paper, we pose the reverse question: are there situations in which the presence of sons *reduces* maternal, as well as paternal, mortality? We consider this question in Taiwan and China, two populations with strongly embedded cultural preferences for sons over daughters. Because our goals are to assess the overall social, economic and cultural impacts of sons vs. daughters in the family rather than the biological effects, we examine the number of *surviving* offspring.

Patrilineal descent, patrilocal ties, and a focus on father-son relationships have been key features of the Chinese family historically. In both China and Taiwan, households in which parents cohabit with one of more married sons and their families have been the predominant living arrangement. Recent surveys document the persistence of multigenerational households and patrilocal residence despite rapid social and economic change.[12–15] Sons in Chinese societies continue to bear the primary responsibility for providing financial, material and other types of support to elderly parents, with particular responsibilities and privileges accruing to the eldest son, especially if he is the family's firstborn child.[16,17]

In light of the Confucian patriarchal orientation of Chinese culture, it is not surprising to find widespread evidence of son preference, often expressed as parental desire for a minimum number of sons, [18] in both Taiwan and China.[19–22] For example, surveys of married women in Taiwan during the period 1965–1985 reveal that most women at that time desired at least two sons, with proportions as high as 90 percent in 1970.[23, 24] Correspondingly, a national survey conducted in China in 1982 identifies significant associations between the sex composition and patterns of receipt of a one-child certificate, contraceptive use, and abortion prevalence, suggesting pervasive son preference.[19]

Although son preference appears to have been declining, likely in response to improved educational opportunities and social status of women,[21,25] there is some evidence that son preference persists in both societies.[25–27] The importance of sons for parents' life satisfaction, social position, living arrangements, and provision of labor and old-age support, combined with relatively weak institutional supports for the elderly in Taiwan and China, [28,29] suggest potentially significant impacts of their presence on parental longevity.

In this study, we examine the link between the sex composition of surviving offspring and maternal and paternal survival at older ages. We consider the longevity of Chinese and Taiwanese men and women who primarily had their children between the 1940s and the 1970s, a period in which there was still pervasive gender inequality and strong son preference. Surprisingly, we find that there has been no protective effect of sons in either China or Taiwan, and that in Taiwan, daughters may have been more beneficial than sons in reducing older age mortality in recent years.

METHODS

(a) Data

The analysis is based on data from two surveys: the Chinese Longitudinal Healthy Longevity Survey (CLHLS) and the Taiwan Longitudinal Study of Aging (TLSA). Launched in 1998 to study longevity in China, CLHLS interviewed individuals who were 80 and older. Individuals were chosen from a randomly selected sample of counties and cities in 22 Chinese provinces; these 22 provinces account for 85% of the population in China. In 2002, CLHLS expanded to include individuals who were 65 or older. For this study, we use data from the 2002 sample together with three-year mortality follow-up information obtained from proxy interviews in 2005.

TLSA is a nationally representative survey of Taiwanese men and women who were age 60 or older in 1989. In 1996, the original TLSA cohort was augmented with a younger cohort ages 50–66. We use data from both TLSA cohorts together with mortality follow-up information through 2008 (an average of 18 years of follow-up for the 1989 cohort and 11 years for the 1996 cohort). The respondents' vital status and date of death were determined by linking information collected by the survey with the household registration file maintained by the Ministry of Interior and the national death certification file managed by the Department of Health.

Because this research involved the study of existing data, documents, and records that are publicly available, and the investigators cannot identify subjects either directly or through identifiers linked to the subjects, this research was exempt from review by the Institutional Review Board for Human Subjects at Princeton University.

We restrict the samples for this analysis to respondents with surviving children who contribute exposure to the age range 60–85 in Taiwan and 65–85 in China during the respective follow-up period. We exclude respondents who have only one child since, in these relatively high fertility cohorts, they are likely to be very different from other respondents in terms of family arrangements and underlying health status. We also exclude the small number of respondents who report having adoptive children. These criteria result in the following sample sizes of eligible respondents: 4825 for CLHLS, 3456 for TLSA 1989 and 2199 for TLSA 1996. From the set of eligible respondents, we exclude those respondents who have incomplete household and child rosters (because the sex composition of children within the family could not be determined), missing covariates, or missing vital status. The final sample sizes are 4132 (CLHLS, 85.6% of the eligible sample), 3408 (TLSA 1989, 98.6% of the eligible sample), and 2193 (TLSA 1996, 99.7% of the eligible sample). Almost all of the exclusions result from missing vital status information. Summary statistics of the final samples are shown in Table 1.

(b) Statistical analyses

We use survival analysis to estimate the effects of child sex composition on mortality because age at death for many respondents is censored at the end of the follow-up period (i.e., respondents are still alive at that time). Specifically, we estimate a Cox proportional hazards model, where the underlying hazard rate (mortality rate at a given age among those who have reached that age) is allowed to vary over age, and each explanatory variable (the sex composition of children or a control variable) is assumed to have a constant multiplicative effect on the hazard rate.[30] Formally, the Cox model for the hazard rate h(t) can be expressed as:

$$h(t)=h_0(t)\exp(x'\beta), \quad (1)$$

where $h_0(t)$ is the underlying hazard rate which is allowed to vary non-parametrically with age, x is a vector of explanatory variables, and β is a vector of coefficients. An underlying assumption of this model is that the hazard rate for respondents with, for example, an eldest son (x_k=1, where x_k is a variable indicating the sex of the eldest child) is proportional to the hazard rate for those with an eldest daughter (x_k=0).

Because the age pattern of mortality generally differs by sex, we estimate separate models for fathers and mothers. We focus on mortality during older ages (65+ for CLHLS, 60+ for TLSA), ensuring that our estimates of the effect of child sex composition on female survival are not confounded by pregnancy-related mortality.

Since different aspects of offspring sex composition can affect longevity, we look at the effect of seven distinct measures of sex composition. In line with most previous studies assessing the potential physiological effects of having sons, we examine the number of (surviving) sons. We also consider the effect of six dichotomous measures used in related studies that may better reflect the benefits of sons, or the detrimental effects of the absence of sons, in Chinese culture: (1) whether the eldest surviving child is a son; (2) having mostly sons (≥75% sons); (3) having mostly daughters (≥75% daughters); (4) having at least one son; (5) having at least two sons; (6) having at least one daughter.[9,29,30] All of the measures are based on surviving offspring at the time of the baseline survey. Because we examine multiple (correlated) outcomes, we estimate effects with and without Benjamini and Yekutieli adjustments [31] for false discovery rates. We report our main results without adjustment in Table 2, and discuss the findings with adjustment in the results section.

We estimate these models without any control variables, as well as with two sets of control variables. The first set, similar to those used in previous studies, comprises the total number of surviving children (linear and quadratic terms) and indicators for the highest level of education attained (education categories listed in Table 1); the second set of controls includes the first set together with several variables that may mediate longevity effects: marital status, co-residence with adult children, and household (respondent and spouse) income. We note, however, that these mediating variables are likely to be endogenous (i.e., determined in part by the sex composition of children). In addition, their inclusion resulted in a significant loss of degrees of freedom (due to item non-response and additional control and interaction terms) and hence substantially larger standard errors than in the model with the first set of controls. Thus, we report the results from the model with the first set of controls. The point estimates are for the most part similar among the three models; estimates from the other two models are available upon request.

RESULTS

Figure 1 shows, as an illustration, the unadjusted hazard rates (i.e., age-specific death rates) plotted on a logarithmic scale for each of the three samples according to whether the eldest child is a son or daughter. Overall, there is little difference in mortality risks between having an eldest son relative to having an eldest daughter. The graphical patterns for the other sex composition measures are similar to Figure 1.

Table 2 reports hazard ratios from Cox proportional hazard models, estimated separately by sex for each of the three samples and for each of the sex composition measures. The hazard ratios can be interpreted as the relative risk associated with a particular measure of child sex composition. For a dichotomous measure of sex composition, a ratio of one indicates no effect on mortality risk relative to its complement or omitted category.

From Table 2, we see that there is no evidence of a protective effect among either fathers or mothers of having sons, regardless of whether we consider an additional son, an eldest son,

mostly sons, at least one son, or at least two sons. We do see, however, three instances in which sons appear to have an adverse effect, relative to daughters, on fathers. In particular, having an eldest son increases mortality risk among fathers by a factor of 1.350 relative to having an eldest daughter in the younger Taiwan cohort; having at least one son increases mortality risk among fathers by a factor of 1.411 relative to having no sons in the older Taiwan cohort; and having at least one daughter decreases the mortality risk of fathers in China by 0.720 relative to having only sons (the last result is only marginally significant, $p<0.10$).

Given that only two of the 21 coefficients for fathers in Table 2 are significant at $p<0.05$ (close to what we would observe by chance), the results do not provide unambiguous evidence of beneficial effects of daughters relative to sons. In addition, when we control for the false discovery rate of multiple testing, these hazard ratios are no longer significant at the 5% level (full set of results available upon request). Nevertheless, the findings are suggestive of an emerging shift in mortality risks in Taiwan. In particular, estimates from TLSA show no effect on mortality of having an eldest daughter (relative to an eldest son) or of having mostly daughters (relative to not having mostly daughters) in the older cohort but protective effects associated with these measures for both fathers and mothers in the younger cohort. Most of these results are not statistically significant, but are consistent with recent declines in son preference and improvements in women's social status in Taiwan.[21,25]

For all but three of the models (indicated by † and ‡ in Table 2), the proportional hazards assumption appears to be valid. In these three cases, we estimated a piecewise model to allow the effect of sex composition to vary by five-year age groups (estimates not shown). In Taiwan, the effect of these three son measures shifted from having an adverse effect relative to daughters when parents were younger to having a beneficial effect when parents were older, but few of the coefficients were statistically significant.

Some of the estimates in Table 2 should be interpreted with caution and may not reflect causal relationships. In particular, whereas sex of the firstborn is likely to be exogenously determined (e.g., tabulations not presented here indicate that sex of the eldest child is unrelated to observed characteristics of the mothers and fathers), this is less true for the other measures, especially having at least one son. Almost all Taiwanese couples in our samples have at least one son – i.e., couples without surviving sons comprise only 4% of the TLSA 1989 cohort and 3% of the TLSA 1996 cohort – making it likely that those without sons differ in many ways from their more numerous counterparts and rendering the confidence intervals for these estimates very large relative to the other sex composition measures. Nevertheless, the general consistency of the estimates across the seven measures supports our conclusion that sons are not protective of parental survival in China and Taiwan.

DISCUSSION

Given the institutional and cultural expectations of sons providing for and conferring higher status to their parents, why do we not see a protective effect of sons on parental survival?

One hypothesis is that support provided by daughters, much of which may be relatively intangible, is at least as important as the material and financial support generally provided by sons. These forms of emotional and interpersonal support provided by daughters are often not well-documented in surveys. For example, in Chinese families, a daughter may be more likely than a son to help an older parent cope with an ill spouse or other emergencies, elicit cooperation from siblings or relatives, maintain social ties and activities, and offer emotional support.[32] In addition to providing the types of assistance generally expected

from daughters, eldest daughters or daughters in families with few sons may also be more likely to assume typically male activities in caring for older parents.[28] If the increasing socioeconomic status of women in Taiwan has made such forms of daughter involvement more common, then these shifting gender roles may underlie the apparent (but not significant) beneficial effect of having an eldest daughter or having mostly daughters in the 1996 cohort.

Another interpretation of our results is that the advantageous effects of sons for older parents are mitigated by tensions between parents and their daughters-in-law. The relationship between a mother-in-law and her daughter-in-law is a frequent source of conflict in the Chinese family and household.[14,33] The resulting stress is likely to have a negative impact on the health of parents, especially in the common stem family arrangement in which older parents live with a married son and his nuclear family.

Finally, it is possible that these results are affected by biological factors. Although both China and Taiwan experienced rapid gains in life expectancy during the second half of the 20th century, some of the children of respondents in these surveys were born during periods of inadequate medical care and high infant mortality, particularly in China prior to the late 1960s. Consistent with the hypothesis that sons impose greater physiological costs on mothers, it is plausible that some mothers experienced detrimental impacts of bearing sons during the early part of the time frame of this analysis, thereby offsetting any protective effects of surviving sons. Still, it is doubtful that these physiological effects would have persisted into the older ages examined here and, in any case, would not have affected paternal survival.

Most of the earlier studies examining the links between sex composition of children and parental survival have focused on these physiological consequences of bearing sons under conditions of high mortality. Some studies have used data from the Matlab region in rural Bangladesh, collected during the 1980s or early 1990s, to analyze these relationships in modern societies with strong son preference. Findings from Bangladesh differ from our results for China and Taiwan. Hurt et al. concluded that, in the presence of controls for the number of sons born, an increasing number of surviving sons was associated with better survival among middle-aged men and women.[11] Rahman similarly found a beneficial impact of sons on elderly men and women, but the effect was significant only when there were at least two surviving sons.[34] Consistent with our expectations for China and Taiwan, Rahman speculated that the protective impact of sons operated through improved economic status of the parents, better provision of instrumental support, and reduced social isolation but did not find empirical support for any of these three specific mechanisms.[35]

Our findings are consistent with those of Yi and Vaupel, who used the CLHLS to evaluate the effects of having only sons and only daughters on the emotional, cognitive, and physical well-being of elderly parents.[36] They found no benefits associated with having only sons in contrast to various positive outcomes associated with having only daughters, including significantly lower risks of mortality for the oldest-old living in rural areas. These results suggest that, despite continued son preference in all of these populations, women's roles may be evolving more rapidly in China and Taiwan than in Bangladesh. It is also plausible that the protective effects of sons on survival are diminished under the conditions of relatively low mortality in China and Taiwan as compared with the high mortality regime in Bangladesh.

Surprisingly, there have been no comparable studies looking at the effect of the sex composition of adult children on parental longevity or parental health in modern Western populations, which do not report preferences for sons (for example, Europe or North

America). Pham-Kanter finds indirect beneficial health effects among American mothers of having a resident teenage daughter,[37] while Powdthavee and colleagues find that British mothers and fathers smoke less when they have a daughter in the household,[38] but there have been no studies looking at how the sex composition of adult children directly affects parental health. However, numerous studies in the United States indicate that daughters assume the bulk of care in providing for elderly parents,[39] offering both money and time to their parents.[40] Moreover, even in families with no daughters, sons sometimes fail to take on caregiving responsibilities.[41] These findings support our earlier contention that the positive effects of daughter suggested by the data in Taiwan may result from instrumental and interpersonal forms of support that are much more likely to be provided by daughters than by sons.

A notable strength of our analysis is the availability of high quality, relatively large population-based data sets for two societies that share a cultural history that includes strong son preference. Nevertheless, some of the confidence intervals for the hazard ratios are fairly wide for China, which has a large sample size but a short follow-up period, and for the younger Taiwan cohort, which has a modest sample size, a younger age distribution and lower mortality than the other samples. Our estimates for China are also potentially biased by loss-to-follow-up (LFU) in CLHLS. LFU was likely to have been selective – e.g., a larger proportion of higher SES respondents, some of whom may have migrated outside the country, were missing vital status data than their lower SES counterparts – although the impact of LFU on the coefficients for sex composition is ambiguous.

Unlike many other longitudinal data sets which lack information on sex composition of families and dates of death, the Taiwan and China surveys permit us to estimate the link between the sex composition of children and parental survival. Nevertheless the sample sizes are not sufficiently large to obtain precise estimates of these sex composition effects. With further follow up of these sample populations, we will not only be able to estimate the relationship between sex composition of offspring and parental mortality with greater precision, but we may be able to derive estimates for the specific subpopulations (for example, those of lower socioeconomic status or living in a particular region) that are most likely to be affected by imbalanced sex compositions. If we are able to find firmer evidence of sex composition effects, we can then explore the various pathways (for example, types of transfers) through which these mortality effects may be mediated. Data that include recent follow-up information are also likely to provide additional insights into whether, as women’s status improves in these societies as part of a secular change toward increasing human rights, daughters may confer more longevity benefits than sons to their aging parents.

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What this paper adds

What is already known on this subject?

Sons and daughters contribute to the well-being of their parents in different ways. Daughters tend to provide emotional and interpersonal support to their parents, while sons provide more material and financial support, especially in countries with strong son preference. There have been no studies on how sons versus daughters might affect parental mortality in cultural contexts like China and Taiwan, where there are strong norms regarding male responsibility for supporting elderly parents.

What does this study add?

Our study is one of the first to assess whether, in the context of strong cultural and institutional norms that emphasize the importance of sons for the provision of support to elderly parents, sons have a beneficial effect on parental survival relative to daughters.

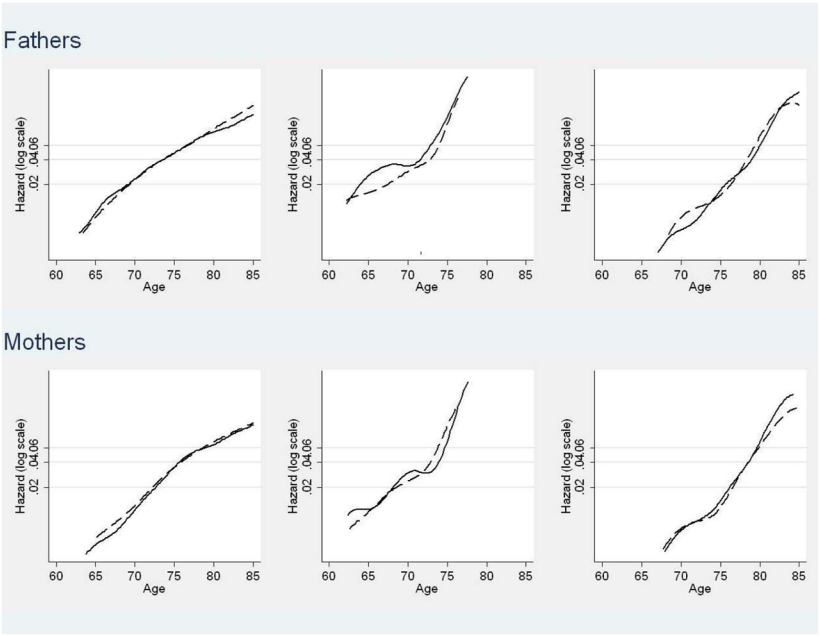

Figure 1.

Unadjusted hazard rates for fathers and mothers, by whether eldest child is son. First column is the TLSA 1989 sample, second column is the TLSA 1996 sample, and third column is the CLHLS sample. Hazard functions smoothed with Gaussian kernel of bandwidth=1.5. ___ Eldest child is a son _ _ Eldest child is a daughter

Table 1

Summary statistics

	Mean or percentage		
	CLHLS	**TLSA 1989**	**TLSA 1996**
% Female in initial survey year	50.1	45.2	50.3
Mean age at initial survey year	72.8	67.9	58.0
% No formal education	49.9	49.6	29.4
% Completed primary school	36.8	31.3	46.5
% Completed junior high or high school	11.0	14.0	18.6
% Attended or completed college	2.2	5.1	5.5
% Working on family farm or business	..	33.0	55.2
% Keeping house	..	22.4	23.1
% Not working/doing any of the above	..	44.5	21.7
% Married	62.9	69.8	86.1
% Widowed	36.8	28.4	11.4
Mean number of children ever born	4.91	5.92	4.11
Mean number of surviving children	4.40	5.10	3.98
% Eldest surviving child is son	54.2	46.8	44.9
% Mostly (≥75%) sons	22.8	16.8	21.2
% Mostly (≥75%) daughters	14.8	13.8	16.2
% Living with children, incl. eldest son	49.7	77.0	82.8
% Living with eldest son	..	37.1	58.0
% Died by last follow-up	13.4	68.5	17.4
Mean follow-up period (years) for decedents	1.7	9.8	7.4
Mean follow-up period (years) for survivors	2.0	17.8	10.7
Number of individuals in analytic sample	4132	3408	2193

Table 2

Estimated hazard ratios for effect of child sex composition on death rate of fathers and mothers

	Number of sons	Eldest is son	Mostly sons	Mostly daughters	At least 1 son	At least 2 sons	At least 1 daughter	No. of individuals (no. of deaths)
China								
Fathers	0.941 (0.719,1.232)	0.924 (0.742,1.150)	1.088 (0.839,1.411)	1.024 (0.759,1.382)	1.232 (0.682,2.223)	0.954 (0.730,1.248)	0.720 * (0.515,1.009)	2061 (290)
Mothers	1.178 (0.841,1.651)	1.099 (0.873,1.385)	1.167 (0.898,1.517)	1.125 (0.822,1.541)	1.429 (0.762,2.679)	1.108 (0.824,1.489)	0.906 (0.625,1.314)	2071 (265)
Taiwan 1989								
Fathers	1.090 (0.956,1.244)	0.958 ‡ (0.862,1.066)	0.931 (0.805,1.078)	0.925 (0.791,1.083)	1.411 ** (1.022,1.948)	1.034 (0.895,1.196)	1.179 (0.922,1.507)	1868 (1360)
Mothers	1.017 (0.864,1.196)	0.979 (0.863,1.111)	0.919 (0.774,1.090)	1.070 (0.899,1.274)	0.931 (0.646,1.342)	0.953 (0.802,1.113)	1.193 (0.876,1.623)	1540 (974)
Taiwan 1996								
Fathers	1.004 (0.684,1.475)	1.350 ** (1.045,1.744)	1.129 (0.837,1.525)	0.776 (0.527,1.142)	1.403 (0.622,3.166)	1.166 (0.849,1.600)	0.797 † (0.499,1.273)	1091 (228)
Mothers	1.362 (0.730,2.544)	1.134 (0.826,1.156)	0.969 † (0.636,1.476)	0.646 (0.389,1.074)	1.603 (0.388,6.615)	1.494 (0.970,2.300)	1.012 (0.561,1.825)	1102 (153)

[a] All regressions include number of surviving children and its quadratic and dummy variables for highest education level attained. 95% CI are reported in parentheses.

*** p<0.01

** p<0.05

* p<0.10 statistical significance of coefficient/hazard ratio.

‡ p<0.01

† p<0.05 statistical significance of Schoenfeld residuals test[42] of the proportional hazards assumption.