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Research Article

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Research Article

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Kieron J. Barclay [1]

Abstract

BACKGROUND
This study tests the recently proposed hypothesis that the contextual sex ratio at sexual maturity is related to longevity. Previous empirical research in the United States has shown that a higher proportion of males at the age of sexual maturity increases the risk of mortality for males both before and after the age of 65.

METHODS
I use Swedish administrative register data, linking the 1960 census to individual-level mortality data over the period 1960 to 2007. I calculate the sex ratio at two geographic levels, municipalities and parishes. Two different specifications of the sex ratio are calculated: males aged 18 to 27 over females aged 15 to 24, and males aged 18 to 22 over females aged 16 to 20. I conduct piece-wise constant survival analyses over the period from 1960 to 2007 to analyze the risk of mortality before age 65. I run separate analyses for males and females, using cohorts born in 1941 and 1942.

RESULTS
For males, the results generally show that for both males and females a higher proportion of males was associated with a lower relative risk of mortality before age 65. The results were not statistically significant.

CONCLUSIONS
The lack of a consistent statistically significant association for either males or females, and the trend for males being in the opposite direction of what was hypothesized, suggests that support for the hypothesis in Sweden is very weak.

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1. Introduction

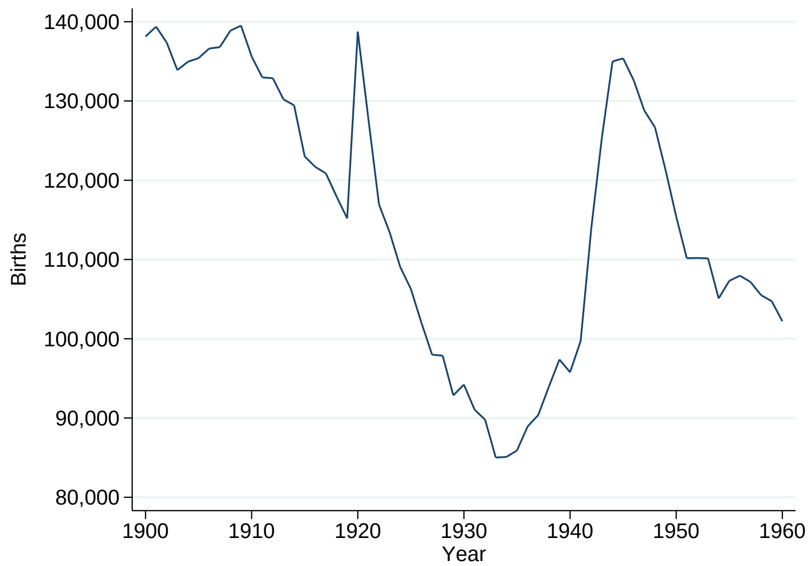
While previous research has indicated that imbalances in the human sex ratio can influence patterns of marriage and divorce, fertility behaviour, and labour supply (Svarer 2007; Lloyd and South 1996; Angrist 2002), very little research has addressed the relationship between sex ratios and health. A small handful of studies have examined whether gender imbalances in the workplace are associated with morbidity and differences in sickness absenteeism rates for males and females, but the evidence is mixed (Bryngelson, Hertzman, and Fritzell 2011; Mastekaasa 2005; Hensing and Alexanderson 2004; Svedberg et al. 2009). Even less research has been conducted on the relationship between sex ratios and mortality risk. A study published recently by Jin et al. (2010) was the first to propose the hypothesis that imbalances in the contextual sex ratio at sexual maturity may be related to longevity. They found that a higher proportion of males in the local context, defined as schools and U.S. states, was associated with an increased risk of mortality for males, though not for females, both before and after the age of 65. The current study will attempt to replicate these analyses as closely as possible using Swedish administrative register data, investigating mortality before age 65. Jin et al. (2010) proposed three potential mechanisms by which such a relationship might operate. The first was that imbalances in the sex ratio may lead to delays in marriage, and that individuals would thus be less likely to gain from the cumulative health benefits associated with marriage. Secondly, imbalances in the sex ratio might mean that individuals have to settle for a partner of a lower quality, meaning that even conditional upon entry into a long-term partnership, the cumulative benefits would be lower for members of the supernumerary sex. Finally, imbalances in the sex ratio should be related to higher levels of competition for sexual partners, and the psychosocial stress associated with this elevated level of competition at a relatively sensitive age might have a long-term impact upon health.

The study performed by Jin et al. (2010) used two different datasets. The first was the Wisconsin Longitudinal Study (WLS), which collected data on one-third of all high school graduates in Wisconsin in 1957. Jin et al. (2010) were able to compute the sex ratio for the graduating class of each high school that the individuals within their sample attended. They subsequently estimated a Cox proportional hazards model, specifying shared frailty for schools, and followed the members of their sample until 2004. The sex ratio was operationalized as a linear term for the proportion of males in the graduating class of each high school. The results indicated that a 1% increase in the proportion of males was significantly associated with a 1% increase in the hazard of dying before 65 for males, but not for females. The second dataset used allowed the authors to examine whether sex ratios at sexual maturity might be related to an increased risk of mortality in old age. The data used came from a register containing all elderly men in the United States who were registered in 1993 for Medicare, America's old-age health insurance programme, and the final sample used for analysis totalled approximately 7.7 million males. All these men were aged over 65, and the average age was 71. The sex ratios at sexual maturity for these males were calculated at the U.S. state level, using census data from 1930, 1940 and 1950, and exponential interpolation to estimate the sex ratios for when each male in the sample was aged 20. A 10-year age range was used to calculate the sex ratio, using males aged 18 to 27 and females aged 15 to 24. The staggered age bands were used to reflect the average age difference between husbands and wives at that time. A Cox proportional hazards model was used to examine whether the sex ratio at sexual maturity was associated with mortality risk, and the follow-up period was from 1993 to 2002. The results were consistent with the first analysis using the WLS. The relative risk of mortality was approximately 1.6% higher for males who were sexually mature in states where the mean proportion of males in the aforementioned age ranges was 52% relative to states where the mean proportion of males was 47%.

When sex ratios at birth follow the naturally occurring ratio of between 103 to 105 boys born per 100 girls, adult sex ratios can only vary for three reasons. The first is migration, and particularly internal migration, leading to different proportions of males and females in different regions (Edlund 2005). It is also possible for a measure of the sex ratio to fluctuate due to changes in fertility rates over time, if it is calculated to reflect common patterns of age-differences in partnering and marriage observed in a society (Bergstrom and Lam 1994). It has been argued that using staggered age bands, such as a sex ratio calculated using males aged 18 to 27 and females aged 15 to 24, more accurately reflects the effective partner market for individuals in this context (Fossett and Kiecolt 1991). If the total fertility rate is increasing from year to year, for example, then using a staggered age band to calculate the sex ratio means that there will be, on average, a higher proportion of females per geographical unit. Finally, sex ratio imbalances can result from sex-differentials in mortality, although the importance of this factor is greater at older ages. To address potential confounding between the sex ratio and mortality, I will attempt to control for factors that should affect internal migration to the extent that the data permit (Morgan and Winship 2007).

The potential importance of changes in fertility rates for sex ratio variation is highlighted in Figure 1. The two birth cohorts that will be used for the analysis in this study were born in 1941 and 1942. These cohorts were born midway between the trough of live births seen in 1934, and the peak in 1946. Knowing that men tend to partner women younger than them, and vice versa, this creates different conditions for the males and females in this study. While men may, on average, marry women two years younger than themselves, if there is a shortage of women in this age category it is also possible to marry younger women. The rising number of live births after 1941/1942 would mean that the cohorts of males in this study would have a large supply of women younger than them as potential partners. This is somewhat reflected in the wider calculation of the sex ratio (males 18-27 and females 15-24), and it should be pointed out that in 1960 most males lived in regions with a relatively large supply of females. The females in the 1941/1942 cohorts on the other hand have a smaller supply of potential partners because the cohorts preceding them, from which they would be most likely to source a potential partner, were considerably smaller. Nevertheless, the hypothesis being tested would still predict that men and women with fewer potential partners should have worse outcomes relative to those with more potential partners according to the mechanisms posited; there need not be an absolute shortage of potential partners.

Figure 1: Live births in Sweden, 1900-1960



A key component of the study by Jin et al. (2010) is the focus on the 'age of sexual maturity', because this is the point at which the sex ratio is measured and found to be associated with mortality risk in that study. While Jin et al. (2010) do not explicitly discuss how they decide what constitutes the age of sexual maturity in either of the analyses they conduct, the implication is that it is a point in time at which an individual has a heightened level of sensitivity to marriage-market conditions. Subsequently it is important to consider carefully what age lays the most valid claim to being the 'age of sexual maturity'. Previous research suggests that this should vary between males and females, and it is likely to vary over time because of changes in nutrition. For females, the onset of sexual maturity is usually defined as the onset of menarche (Ljung, Bergsten-Brucefors, and Lindgren 1974). It is estimated that the average age for the onset of menarche for females in Sweden in 1960 was between 13 and 14. However, females aged 13 or 14 are not in the marriage market, and thus it is probably more reasonable to analyze females who are in their late teenage years and who could be said to be open to, and legally able to, enter relationships with members of the opposite sex. In males one way of defining the onset of sexual maturity is to look at cohort-specific mortality curves and identify the point at which the 'accident hump' amongst males is at its peak (Goldstein 2011). The 'accident hump' in early adult mortality amongst males reflects an increase in deaths attributable to accidents, violence, and disease, and there is evidence that this coincides with the peak of male hormone production (Parkes 1976). In Sweden in 1960 the peak of this 'accident hump' occurred at approximately the age of 18 (Goldstein 2011). Subsequently this study will focus upon males and females aged 18 and 19 in 1960.

2. Data and methods

As the purpose of this study is to examine whether any further support exists for this new hypothesis using Swedish register data, I follow the same analytical strategy that was used by Jin et al. (2010) to the extent that it is possible. The data that I use for the empirical analyses is Swedish administrative register data. The earliest point in time for which I have data is the 1960 census. I have used this dataset to calculate the sex ratio at two geographical levels, municipalities and parishes, discussed below. The dataset also allows me to control for the socioeconomic status of the ego in 1960, parental socioeconomic status in 1960, place of birth within Sweden by county (Län), and region of residence by county (Län) in 1960. In these analyses I only include individuals who were born in Sweden. The parental socioeconomic status is identified by using the multigenerational Swedish register data to identify biological fathers and mothers, and then extracting the parental socioeconomic status measure from the 1960 census. I take the father's socioeconomic status where it is available, and if that is missing, I take the mother's socioeconomic status. All these variables are non-time-varying, as in the study by Jin et al. (2010). The second dataset I have used is individual-level mortality data over the period 1960-2007. I have used piece-wise constant survival models to estimate the impact of the contextual sex ratio upon all-cause mortality risk. The piece-wise model splits the total period over which the subjects are under observation into several pieces, in this case one-year units. The baseline hazard is age. These models have been estimated using cluster-adjusted standard errors to account for any potential intragroup correlation (Primo, Jacobsmeier, and Milyo 2007). The clusters in this study are the geographical units of residence. I run separate analyses for males and females. Table 1 shows how the study size for analysis changes as I include additional variables. The difference between the sample size for those aged 18 and 19 in 1960 is attributable to the difference in the size of the live birth cohorts born in 1941 and 1942 (SCB 1999), which can also be seen in Figure 1. The early 20th century baby boom in Sweden began in the early 1940s (Dahlberg and Nahum 2003). It can be seen that the study size decreases slightly for the bivariate analyses where only age, as the baseline hazard, and the sex ratio are included. However, there are some missing values even in the Swedish register data, and thus the study size decreases slightly more in the full multivariate analyses. As discussed earlier, the onset of female sexual maturity in Sweden in 1960 was estimated to be between the ages of 13 and 14 (Ljung, Bergsten-Brucefors, and Lindgren 1974). However, only those aged 18 in 1960 will have reached the age of 65 by the latest point in time for which I have data on mortality, which is 2007, and thus those aged 18 are the youngest group, in 1960, for whom I can reasonably conduct this analysis. I only analyze individuals who were unmarried at the age of exposure, as it seems likely that the proposed mechanisms in terms of competition for a partner would be most relevant to this group. This is also the strategy followed by Jin et al. (2010).

Table 1: Study size

	Men		**Women**	
	Cohort		**Cohort**	
Variables	**1941**	**1942**	**1941**	**1942**
Birth cohort	51,152	58,606	48,575	55,355
Cohort size 1960	47,975	55,496	45,967	52,955
Combined n in 1960	103,471		98,922	
Bivariate analysis	101,401		89,978	
Multivariate analysis	96,410		86,276	

Source: Swedish administrative register data, compiled by the author.

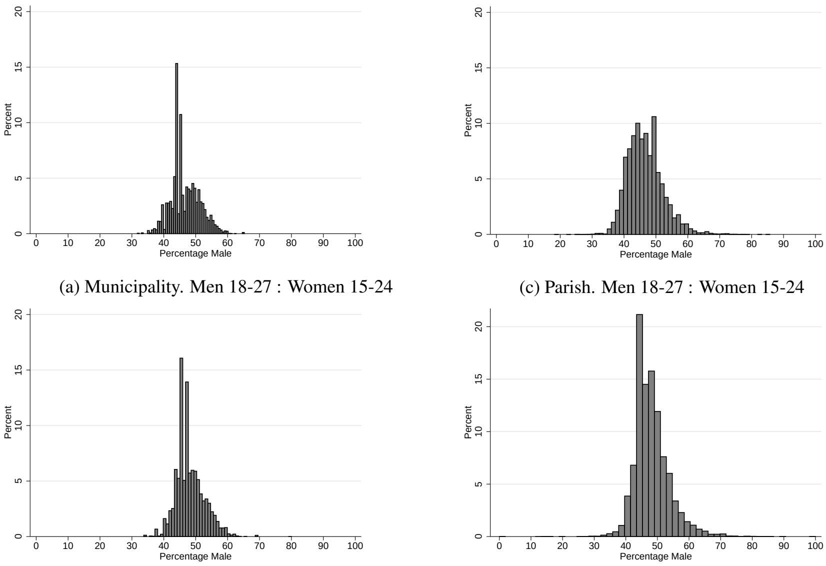
2.1 Sex ratio calculations

In the study by Jin et al. (2010), when the contextual sex ratio was calculated within geographical units, in this case at the state level, the authors used the age band of males aged 18 to 27, and females aged 15 to 24. The three year difference was used to reflect the average age difference between married partners in the United States in the 1920s, 1930s, and 1940s. Past research suggests that it is also appropriate to use a three year age difference for calculating sex ratios in Sweden in 1960 (Bergstrom and Lam 1994;

Kolk 2012). I will also test the hypothesis using a second, narrower definition of the sex ratio, specifying the ratio of males aged 18 to 22 and females aged 16 to 20. This may represent a more realistic partner market for males and females aged 18 and 19. The sex ratio is operationalized as the proportion of males, and divided into sextiles. I calculate these sex ratios at two different geographical levels: municipalities (*kommun*) and parishes (*forsamling*). The population of Sweden in 1960 was 7,497,967. In 1960 there were 1,029 municipalities, with an average population of 7,286, while there were also 2,658 parishes, with an average population of 2,820. The calculated sex ratio for any given individual reflects the sex ratio of the municipality or parish in which their residence is registered. In my models I also include variables for the absolute number of males and females in each of these geographical units. The sex ratio is essentially an interaction term derived from these two variables, and it is standard practice to include the variables from which an interaction term is derived (Kronmal 1993).

A factor that should be considered is the extent to which it is reasonable to test this hypothesis in the Swedish context. After all, Sweden is one of the most progressive and secular countries in the world and scores at the top of most development indices, alongside the other Nordic nations. The key point is whether there is sufficient variance in the adult sex ratio in Sweden for one to expect any impact of sex ratios on adult behaviour. As mentioned in the introduction, there are three potential sources of variance in the adult sex ratio in Sweden: gendered patterns of migration, changes in the fertility rate when there tend to be age differences in male-female partnering, and sex-differentials in mortality. As shown in Figure 1, changes in fertility rates coupled with age heterogamy in heterosexual partner formation would result in sex ratio imbalances in the effective marriage market. Furthermore, there has been substantial female migration from rural to urban areas in Sweden, with men more likely to stay behind (Edlund 2005). A a result there are higher proportions of females in urban areas, and higher proportions of males in rural areas. Figure 2 shows the distribution of men and women from birth cohorts 1941 and 1942 by the sex ratio in municipalities and parishes in Sweden in 1960 for the two age ranges used to calculate the sex ratio for this study. As would be expected, there is more variance in the proportion of males in parishes than municipalities, as parishes are smaller geographical units. There is also more variance in the proportion of males for the narrower age band of men aged 18 to 22 and women aged 16 to 20 than in the larger age band of men aged 18 to 27 and women aged 15 to 24. In the original paper by Jin et al. (2010), they do not describe the range of the sex ratio for the sex ratios calculated within schools. However, they do describe it for the sex ratios calculated within states, and the full range was 44% to 66% males (Jin et al. 2010, page 583). In Figure 2 it can be seen that the range for the percentage of males in Swedish municipalities and parishes was wider than that, suggesting that the Swedish context in 1960 is a reasonable test case for the hypothesis proposed by Jin et al. (2010).

Figure 2: Sex ratio distribution by municipality and parish in Sweden, 1960



(a) Municipality. Men 18-27 : Women 15-24

(c) Parish. Men 18-27 : Women 15-24

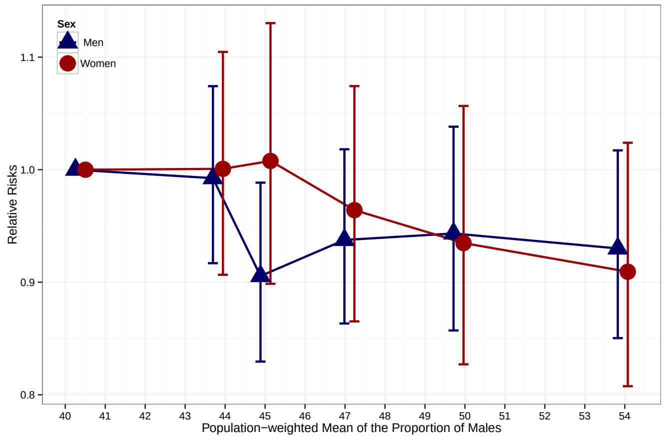
(b) Municipality. Men 18-22 : Women 16-20

(d) Parish. Men 18-22 : Women 16-20

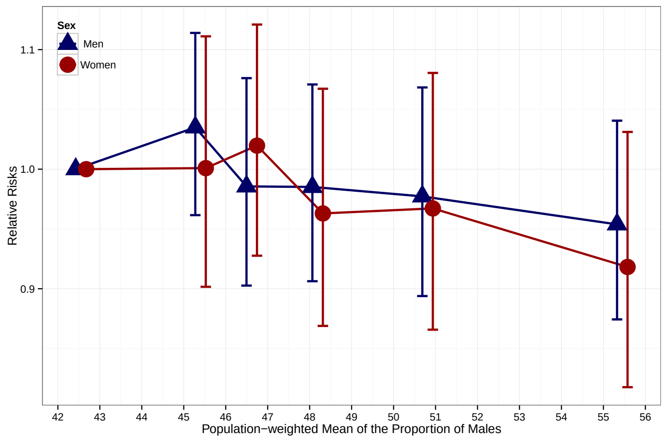
3. Results and analysis

The results from the multivariate analyses can be seen in Figures 3 and 4. The results from the bivariate analyses are available in the appendices, in Figures A-1 and A-2. The results from the multivariate analyses can also be viewed in greater detail in the appendices, in Tables A-1, A-2, A-3 and A-4. Figures 3 and A-1 show the results for the relative risk of mortality based upon sextiles of the same age ranges used to calculate the sex ratio in the study by Jin et al. (2010), which was males aged 18 to 27, and females aged 15 to 24. According to the main hypothesis, the relative risk of mortality for males should be higher in regions with a higher proportion of males. Although the study by Jin et al. (2010) did not focus on females, the hypothesis would also predict that the relative risk of mortality for females should be lower in regions with a higher proportion of males.

Figure 3: Multivariate analyses for males and females: Mortality risk by sex ratio calculated at municipality and parish levels. Sex ratio: Males aged 18-27, females aged 15-24



(a) Municipality

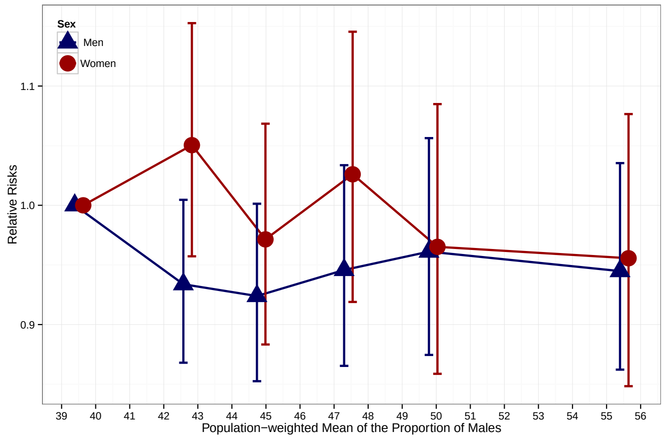


(b) Parish

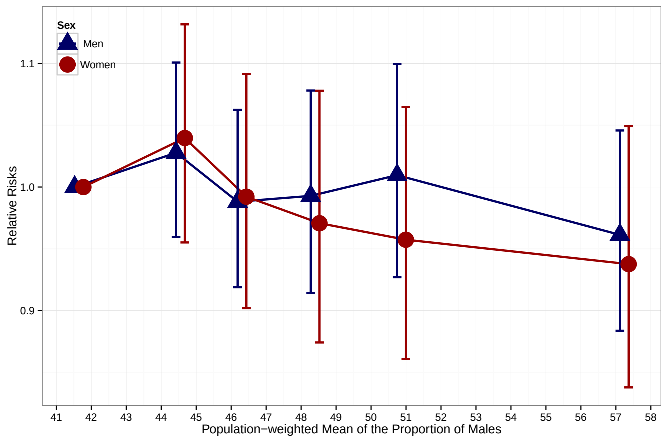
Overall, it is clear that the support for this hypothesis in this data using this specification of the sex ratio is weak. Neither the bivariate nor the multivariate analyses at the municipality or parish level consistently show that a higher proportion of males at the age of sexual maturity is associated with higher mortality. Indeed, the more common pattern is that the parameter estimates for males show the relative risk of mortality is lower in regions with a higher proportion of males, though this is not statistically significant more often than could be expected according to chance. Figures 3(a) and 3(b) generally show that for females the relative risk does not change or is slightly elevated for sextiles 2 and 3, but there is a lower relative risk associated with a higher proportion of males for the upper three sextiles. This pattern is partially consistent with the hypothesis, but the lack of statistical significance despite relatively high statistical power suggests that the support is weak at best. Overall, the inconsistency of the results for males, and the weak support for females, suggests that the hypothesized mechanisms are not the predominant factors influencing the patterns observed.

Figures 4(a) and 4(b) show the multivariate results from the second specification of the sex ratio, calculated using males aged 18 to 22 and females aged 16 to 20. The study by Jin et al. (2010) did not test the hypothesis using this calculation of the sex ratio, but it seems more plausible that both males and females aged 18 or 19 in 1960 would be seeking partners within this age range. Subsequently one might expect that a potentially more valid measure in terms of reflecting the pool of potential partners might yield support for the hypothesis even when the wider calculation of the sex ratio using males aged 18 to 27 and females aged 15 to 24 had not. However, the overall pattern is rather similar to that seen from the analyses using the wider calculation of the sex ratio. None of the models, either bivariate or multivariate, show a clearly increased relative risk of mortality for males at higher sex ratios. In Figure 4(a) there is a negative relationship between the proportion of males and the relative risk of mortality, which runs in the opposite direction of what was hypothesized, while in 4(b) the relative risk fluctuates without a clear pattern. The results for females in Figure 4(a) show that the associated relative risk fluctuates up and down for sextiles 2 to 4, but is lower for the upper two sextiles, while in figure 4(b) the relative risk is slightly elevated for sextile 2 and lower in parishes where the proportion of males falls into the upper quantiles. Again, the results for females are partially consistent with the original hypothesis, but were not statistically significant. I have also run separate analyses for men and women by birth cohort; these analyses do not show any substantial differences from those presented here, and are available upon request.

Figure 4: **Multivariate analyses for males and females: Mortality risk by sex ratio calculated at municipality and parish levels. Sex ratio: Males aged 18-22, females aged 16-20**



(a) Municipality



(b) Parish

4. Discussion and conclusion

In summary, this study found very limited support for the hypothesis that the contextual sex ratio at sexual maturity is linked to mortality risk for either males or females in Sweden. The results generally showed that there was no statistically significant relationship between the contextual sex ratio at sexual maturity and the mortality risk for either males or females. While the direction of the pattern in the results for females often ran in the hypothesized direction, the results for males ran in quite the opposite direction of that predicted by the hypothesis. Nevertheless, it should be added that the parameter estimates are rather imprecise, and that the confidence intervals for the male analyses overlap with almost all of the confidence intervals from the original study presented by Jin et al. (2010). In this study I was not able to control extensively for variables that could influence the propensity of individuals to migrate from one region to another. Thus, there may still be confounding factors that are related both to the sex ratio to which the units in my analysis were exposed to at the age of sexual maturity and mortality risk. However, in light of the results of the analyses above, I suspect that the failure to fully account for these potential confounders is of secondary concern.

One of the inherent problems in conducting a study investigating the relative influence of marriage markets on a given outcome is the challenge inherent in attempting to accurately define the appropriate marriage market for the individuals under analysis. When using geographical units to calculate sex ratios, it is difficult to know the extent to which the marriage market for any given individual is being overbound or underbound. Individuals may work or study in a different geographical unit from that in which they live, and this is particularly likely to be true in the case of parishes, which are rather small. It is likely that the sex ratio in the context in which an individual spends most of his or her day would be the most relevant unit for which to calculate the sex ratio, but of course it is not possible to know this. Municipalities in Sweden are larger, and thus it is more likely that the individuals in this study worked or studied in those unit areas in addition to living there. However, larger units lead to a decrease in the precision of the measurement of the sex ratio that an individual actually encounters on a day-to-day basis. It is impossible to assess the exact extent of the measurement error, so any interpretation of the municipality-level results should be accompanied with caution.

In this sense, the original study by Jin et al. (2010) had an advantage in terms of being able to calculate sex ratios within the graduating classes of high schools. Unfortunately I do not have access to any variables that could serve as a school identifier for 1960 in Sweden. However, they also found statistically significant results using a geographical unit, which was states in the United States. These geographical units are much larger than either Swedish municipalities or parishes, and this necessarily leads to a substantial loss of precision in the measurement of the relevant local sex ratio for any given individual.

A further important point is that the validity of the sex ratio measure as an index of mate availability is problematic in the sense that the relevant sex ratio for any given individual is likely to be stratified by factors such as education, intelligence, and physical attractiveness, which is evidenced by the strongly persistent pattern of homophilic partnering in humans (Fossett and Kiecolt 1991; McPherson, Smith-Lovin, and Cook 2001). The sex ratios calculated in this study do not reflect this stratification, and any attempt to capture this stratification would have to be somewhat speculative.

An additional limitation of this study was that the earliest point in time for which I could access data was 1960. This meant that it was not possible to examine the relationship between the contextual sex ratio at sexual maturity and mortality risk amongst those over the age of 65 as Jin et al. (2010) did in their study. Future research may corroborate the original findings for this older age group. Another limitation of this study was that for females the sex ratio was not calculated at what is defined as the onset of female sexual maturity, which is usually defined as the onset of menarche. However, given that the proposed mechanisms concern competition for partners in a marriage market, it can be argued that examining females exposed at ages 18 and 19 is still a reasonable approach. Indeed, it would have been more problematic had I calculated the contextual sex ratio at the age of 13 for females, as these individuals would not be seeking sexual partners.

Although the results of this analysis were not consistent with the results observed in the original study by Jin et al. (2010), this may be because of different patterns of marriage, cohabitation, and childbearing in Sweden and the United States in these cohorts. It could be that the sex ratio at sexual maturity, defined here as being 18 or 19 years old, was less salient a factor for individuals living in Sweden than the United States because the average age of marriage and childbearing in Sweden was higher. However, the age difference at which these events occurred for cohorts born around 1940 in the United States and Sweden was not dramatically different. For the 1938-1942 cohorts in the United States, the mean age at first marriage was 23.3 for males, and 21.1 for females (Schoen et al. 1985). For the 1940 cohort in Sweden, the highest rate of first marriage formation amongst women occurred at the age of 22 (Coale 1971), and by the age of 27 over 80% of females in that cohort had married (Ohlsson-Wijk 2011). The mean age at first childbirth for women in Sweden born in cohorts 1940 to 1943 was approximately 23.8 (Hoem 1990). The mean age at first childbirth for women in the United States for the same cohorts was similar, at 22.2 (Bloom 1982). It seems unlikely that these relatively small age differences should dramatically alter the relative salience of competition for partners at what has been defined as the age of sexual maturity in this study.

More speculatively, the differences observed between the United States and Sweden could be attributable to differences in relationship patterns after the first marriage. Sweden has been at the forefront of the second demographic transition, one of the central characteristics of which has been less committed relationships between men and women

(Lesthaeghe 2010). Less committed relationships, and a lower prevalence of marriages, would have meant that those who entered partnerships would have been less likely to have been permanently removed from the marriage market. While disadvantages would still have remained for members of the supernumerary sex, this tendency towards relationship turnover could have meant that the supply of potential partners would not have fallen so drastically and permanently as could otherwise have been the case. Thus the degree to which the potential mechanisms by which it has been posited that the sex ratio at sexual maturity might affect mortality risk may not have been so salient as they were for individuals in the United States at this same point in time.

Although it is difficult to find directly comparable figures for the two countries for specific cohorts, 37% of first marriages in the 1938-1942 cohort in the United States ended in divorce for females (Schoen et al. 1985). In Sweden, the rate of dissolution of the first union by the age of 45 for females was substantially lower - 27.8% for the 1936-1940 cohort, and 26.4% for the 1941-1945 cohort (Blanc 1987). In terms of remarriage, 80.8% of males from the 1938-1942 cohorts in the United States who had dissolved the first union remarried, with the average age of remarriage 39.7; 73.4% of females from the same cohort remarried following dissolution of the first union, with the average age of remarriage being 37.3 (Schoen et al. 1985). In Sweden the cumulative proportion of females who entered a second union was approximately 50%, although the vast majority of these second unions were non-marital cohabitations (Blanc 1987). Of course, these figures do not tell the whole story because of the much higher rate of non-marital cohabitation in Sweden in comparison with the United States (Popenoe 1987). However, neither do they universally indicate that the marriage market in the United States had a considerably lower level of turnover relative to Sweden. An obvious explanation for the difference in the results testing the hypothesis for the relationship between sex ratios at sexual maturity and longevity between the United States and Sweden is not immediately clear. Given that it is difficult to find cohort specific mortality data where information is also available to calculate the contextual sex ratio at the time of sexual maturity for those individuals, it remains to be seen the extent to which it will be possible to test this hypothesis further.

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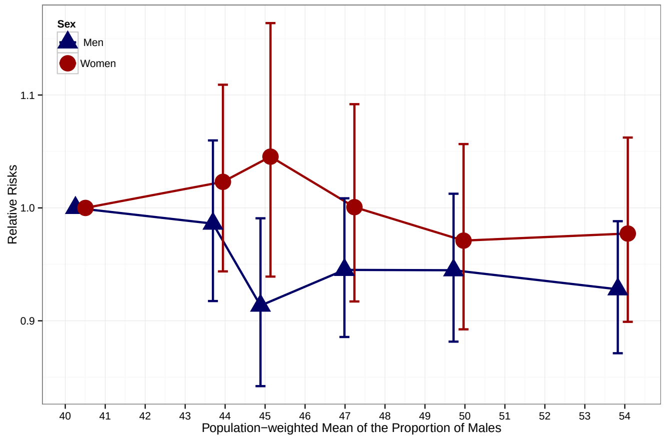
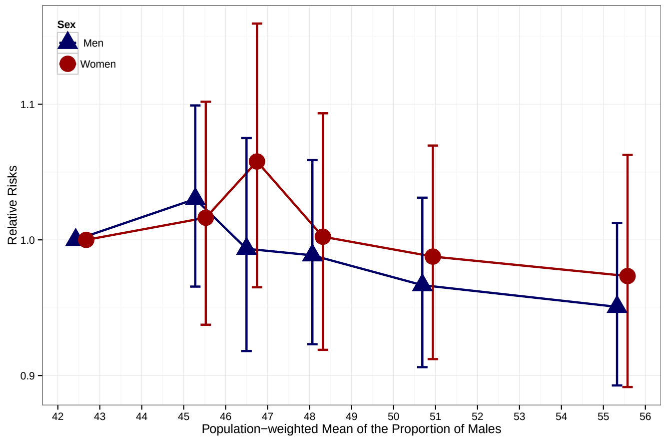
Appendices

Figure A-1: Bivariate analyses for males and females: Mortality risk by sex ratio calculated at municipality and parish levels. Sex ratio: Males aged 18-27, females aged 15-24

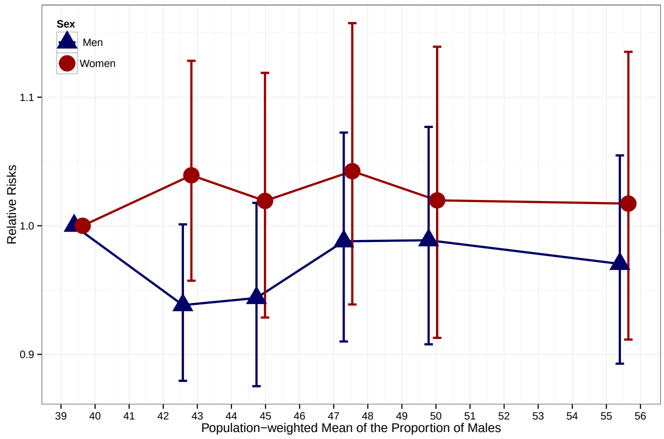


(a) Municipality

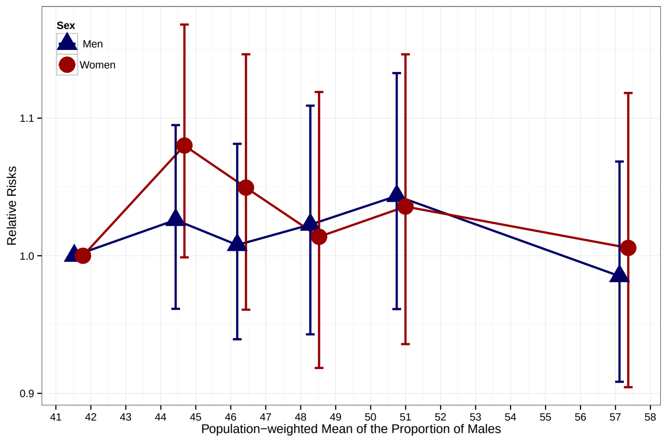


(b) Parish

Figure A-2: Bivariate analyses for males and females: Mortality risk by sex ratio calculated at municipality and parish levels. Sex ratio: Males aged 18-22, females aged 16-20



(a) Municipality



(b) Parish

Table A-1: All-cause mortality results: Males and females, aged 18 and 19 in 1960, sex ratio (males: 18-27, females: 15-24) calculated within municipalities

				Males	
Covariates		**RR**	**S.E.**	**P-value**	**95% CI**
Age	18-25	0.01	0.00	0.000	0.00 - 0.01
	26-30	0.20	0.02	0.000	0.17 - 0.23
	31-35	0.26	0.02	0.000	0.22 - 0.30
	36-40	0.44	0.03	0.000	0.39 - 0.51
	41-45	0.64	0.03	0.000	0.58 - 0.71
	46-50	1.00			
	51-55	2.26	0.09	0.000	2.09 - 2.45
	56-60	3.28	0.12	0.000	3.06 - 3.51
	61-65	4.99	0.17	0.000	4.66 - 5.33
Socioeconomic Index	Self-employed in Agriculture, Forestry	1.00			
	Semi-skilled Workers in Agriculture, Forestry	1.13	0.08	0.076	0.99 - 1.30
	Self-employed in Industry, Trade, Service sectors	1.20	0.12	0.055	1.00 - 1.45
	Professionals	1.01	0.32	0.985	0.54 - 1.87
	Routine Non-manual Occupations	0.99	0.07	0.905	0.87 - 1.13
	Semi-skilled Workers	1.08	0.07	0.210	0.96 - 1.22
	Service Occupations	1.51	0.16	0.000	1.22 - 1.87
	Military	0.91	0.14	0.526	0.66 - 1.23
	No Identifiable Occupation	1.50	0.32	0.059	0.98 - 2.30
	Students	0.80	0.05	0.001	0.71 - 0.91
	Other	1.11	0.07	0.099	0.98 - 1.25
Parent	Self-employed in Agriculture, Forestry	1.00			
Socioeconomic Index	Semi-skilled Workers in Agriculture, Forestry	1.35	0.07	0.000	1.22 - 1.50
	Self-employed in Industry, Trade, Service sectors	1.15	0.05	0.002	1.05 - 1.26
	Professionals	1.01	0.10	0.907	0.83 - 1.23
	Executives/Managers	1.13	0.08	0.095	0.98 - 1.30
	Routine Non-manual Occupations	1.17	0.05	0.000	1.08 - 1.27
	Semi-skilled Workers	1.26	0.05	0.000	1.17 - 1.35
	Service Occupations	1.66	0.09	0.000	1.49 - 1.85
	Military	1.03	0.15	0.846	0.77 - 1.37
	No Identifiable Occupation	2.70	0.68	0.000	1.64 - 4.43
	Students	0.99	0.34	0.971	0.51 - 1.93
	Other	1.43	0.07	0.000	1.30 - 1.57
Sextiles of Sex Ratio	1	1.00			
	2	0.99	0.04	0.852	0.92 - 1.07
	3	0.91	0.04	0.026	0.83 - 0.99
	4	0.94	0.04	0.125	0.86 - 1.02
	5	0.94	0.05	0.233	0.86 - 1.04
	6	0.93	0.04	0.112	0.85 - 1.02
N				96,410	
Deaths				11,631	

Source: Swedish administrative register data, compiled by the author. Estimates for sum of males, sum of females, county of residence in 1960 and county of birth omitted.

Table A-1: (Continued)

				Females	
Covariates		**RR**	**S.E.**	**P-value**	**95% CI**
Age	18-25	0.01	0.00	0.000	0.00 - 0.02
	26-30	0.11	0.01	0.000	0.09 - 0.14
	31-35	0.20	0.02	0.000	0.16 - 0.24
	36-40	0.26	0.02	0.000	0.23 - 0.31
	41-45	0.54	0.03	0.000	0.48 - 0.60
	46-50	1.00			
	51-55	1.93	0.11	0.000	1.73 - 2.15
	56-60	2.98	0.14	0.000	2.71 - 3.27
	61-65	4.37	0.19	0.000	4.02 - 4.75
Socioeconomic Index	Self-employed in Agriculture, Forestry	1.00			
	Semi-skilled Workers in Agriculture, Forestry	1.10	0.26	0.685	0.69 - 1.75
	Self-employed in Industry, Trade, Service sectors	0.90	0.19	0.616	0.60 - 1.35
	Professionals	2.10	1.58	0.322	0.48 - 9.14
	Routine Non-manual Occupations	0.93	0.13	0.607	0.71 - 1.22
	Semi-skilled Workers	1.26	0.18	0.102	0.96 - 1.65
	Service Occupations	1.14	0.16	0.358	0.86 - 1.50
	Military				-
	No Identifiable Occupation	1.00	0.35	0.989	0.50 - 2.01
	Students	0.87	0.12	0.326	0.66 - 1.15
	Other	1.64	0.23	0.000	1.25 - 2.15
Parent Socioeconomic Index	Self-employed in Agriculture, Forestry	1.00			
	Semi-skilled Workers in Agriculture, Forestry	1.16	0.08	0.024	1.02 - 1.33
	Self-employed in Industry, Trade, Service sectors	1.13	0.07	0.040	1.01 - 1.27
	Professionals	1.05	0.16	0.771	0.78 - 1.41
	Executives/Managers	1.03	0.10	0.788	0.85 - 1.23
	Routine Non-manual Occupations	1.20	0.06	0.000	1.09 - 1.33
	Semi-skilled Workers	1.22	0.05	0.000	1.13 - 1.33
	Service Occupations	1.46	0.10	0.000	1.28 - 1.68
	Military	0.93	0.16	0.667	0.66 - 1.30
	No Identifiable Occupation	0.89	0.46	0.818	0.32 - 2.47
	Students	2.52	0.78	0.003	1.38 - 4.62
	Other	1.33	0.07	0.000	1.19 - 1.48
Sextiles of Sex Ratio	1	1.00			
	2	1.00	0.05	0.988	0.91 - 1.10
	3	1.01	0.06	0.894	0.90 - 1.13
	4	0.96	0.05	0.508	0.87 - 1.07
	5	0.93	0.06	0.281	0.83 - 1.06
	6	0.91	0.06	0.117	0.81 - 1.02
N				86,276	
Deaths				6,726	

Source: Swedish administrative register data, compiled by the author. Estimates for sum of males, sum of females, county of residence in 1960 and county of birth omitted.

Table A-2: All-cause mortality results: Males and females, aged 18 and 19 in 1960, sex ratio (males: 18-27, females: 15-24) calculated within parishes

				Males	
Covariates		**RR**	**S.E.**	**P-value**	**95% CI**
Age	18-25	0.01	0.00	0.000	0.00 - 0.01
	26-30	0.20	0.02	0.000	0.17 - 0.23
	31-35	0.26	0.02	0.000	0.22 - 0.30
	36-40	0.44	0.03	0.000	0.40 - 0.50
	41-45	0.64	0.03	0.000	0.58 - 0.71
	46-50	1.00			
	51-55	2.26	0.09	0.000	2.10 - 2.44
	56-60	3.28	0.13	0.000	3.04 - 3.53
	61-65	4.99	0.19	0.000	4.63 - 5.37
Socieconomic Index	Self-employed in Agriculture, Forestry	1.00			
	Semi-skilled Workers in Agriculture, Forestry	1.14	0.08	0.078	0.99 - 1.31
	Self-employed in Industry, Trade, Service sectors	1.20	0.12	0.056	0.99 - 1.45
	Professionals	1.00	0.32	0.994	0.53 - 1.88
	Routine Non-manual Occupations	0.99	0.07	0.937	0.87 - 1.13
	Semi-skilled Workers	1.08	0.07	0.212	0.96 - 1.22
	Service Occupations	1.52	0.16	0.000	1.23 - 1.87
	Military	0.91	0.14	0.523	0.67 - 1.23
	No Identifiable Occupation	1.51	0.34	0.063	0.98 - 2.34
	Students	0.81	0.05	0.001	0.71 - 0.91
	Other	1.11	0.07	0.094	0.98 - 1.25
Parent	Self-employed in Agriculture, Forestry	1.00			
Socioeconomic Index	Semi-skilled Workers in Agriculture, Forestry	1.36	0.07	0.000	1.23 - 1.50
	Self-employed in Industry, Trade, Service sectors	1.16	0.05	0.002	1.06 - 1.27
	Professionals	1.02	0.11	0.829	0.83 - 1.25
	Executives/Managers	1.14	0.09	0.076	0.99 - 1.33
	Routine Non-manual Occupations	1.18	0.05	0.000	1.09 - 1.28
	Semi-skilled Workers	1.26	0.05	0.000	1.18 - 1.36
	Service Occupations	1.67	0.09	0.000	1.50 - 1.86
	Military	1.04	0.15	0.779	0.79 - 1.37
	No Identifiable Occupation	2.71	0.70	0.000	1.64 - 4.49
	Students	0.99	0.37	0.989	0.48 - 2.05
	Other	1.43	0.07	0.000	1.31 - 1.57
Sextiles of Sex Ratio	1	1.00			
	2	0.93	0.03	0.066	0.87 - 1.00
	3	0.92	0.04	0.054	0.85 - 1.00
	4	0.95	0.04	0.219	0.87 - 1.03
	5	0.96	0.05	0.411	0.87 - 1.06
	6	0.94	0.04	0.224	0.86 - 1.04
N				96,410	
Deaths				11,631	

Source: Swedish administrative register data, compiled by the author. Estimates for sum of males, sum of females, county of residence in 1960 and county of birth omitted.

Table A-2: (Continued)

Covariates		RR	S.E.	Females P-value	95% CI
Age	18-25	0.01	0.00	0.000	0.00 - 0.02
	26-30	0.11	0.01	0.000	0.09 - 0.14
	31-35	0.20	0.02	0.000	0.16 - 0.24
	36-40	0.26	0.02	0.000	0.22 - 0.31
	41-45	0.54	0.03	0.000	0.47 - 0.61
	46-50	1.00			
	51-55	1.93	0.09	0.000	1.75 - 2.12
	56-60	2.98	0.14	0.000	2.72 - 3.26
	61-65	4.37	0.19	0.000	4.02 - 4.76
Socieconomic Index	Self-employed in Agriculture, Forestry	1.00			
	Semi-skilled Workers in Agriculture, Forestry	1.09	0.26	0.708	0.68 - 1.75
	Self-employed in Industry, Trade, Service sectors	0.90	0.19	0.599	0.60 - 1.35
	Professionals	2.06	1.51	0.322	0.49 - 8.66
	Routine Non-manual Occupations	0.93	0.13	0.588	0.71 - 1.21
	Semi-skilled Workers	1.25	0.17	0.099	0.96 - 1.64
	Service Occupations	1.14	0.16	0.355	0.87 - 1.49
	Military				-
	No Identifiable Occupation	1.00	0.35	0.995	0.50 - 2.00
	Students	0.87	0.12	0.304	0.67 - 1.13
	Other	1.64	0.22	0.000	1.26 - 2.14
Parent	Self-employed in Agriculture, Forestry	1.00			
Socioeconomic Index	Semi-skilled Workers in Agriculture, Forestry	1.17	0.08	0.023	1.02 - 1.33
	Self-employed in Industry, Trade, Service sectors	1.13	0.06	0.030	1.01 - 1.26
	Professionals	1.05	0.14	0.734	0.80 - 1.37
	Executives/Managers	1.03	0.10	0.759	0.86 - 1.24
	Routine Non-manual Occupations	1.20	0.06	0.000	1.09 - 1.32
	Semi-skilled Workers	1.22	0.05	0.000	1.13 - 1.33
	Service Occupations	1.47	0.11	0.000	1.26 - 1.70
	Military	0.92	0.17	0.662	0.65 - 1.32
	No Identifiable Occupation	0.89	0.48	0.825	0.31 - 2.57
	Students	2.56	0.77	0.002	1.41 - 4.63
	Other	1.33	0.07	0.000	1.19 - 1.48
Sextiles of Sex Ratio	1	1.00			
	2	1.05	0.05	0.299	0.96 - 1.15
	3	0.97	0.05	0.551	0.88 - 1.07
	4	1.03	0.06	0.648	0.92 - 1.15
	5	0.97	0.06	0.552	0.86 - 1.08
	6	0.96	0.06	0.455	0.85 - 1.08
N				86,276	
Deaths				6,726	

Source: Swedish administrative register data, compiled by the author. Estimates for sum of males, sum of females, county of residence in 1960 and county of birth omitted.

Table A-3: All-cause mortality results: Males and females, aged 18 and 19 in 1960, sex ratio (males: 18-22, females: 16-20) calculated within municipalities

				Males	
Covariates		**RR**	**S.E.**	**P-value**	**95% CI**
Age	18-25	0.01	0.00	0.000	0.00 - 0.01
	26-30	0.20	0.02	0.000	0.17 - 0.23
	31-35	0.26	0.02	0.000	0.22 - 0.30
	36-40	0.44	0.03	0.000	0.39 - 0.51
	41-45	0.64	0.03	0.000	0.58 - 0.71
	46-50	1.00			
	51-55	2.26	0.09	0.000	2.09 - 2.45
	56-60	3.28	0.12	0.000	3.06 - 3.51
	61-65	4.99	0.17	0.000	4.66 - 5.33
Socieconomic Index	Self-employed in Agriculture, Forestry	1.00			
	Semi-skilled Workers in Agriculture, Forestry	1.13	0.08	0.078	0.99 - 1.30
	Self-employed in Industry, Trade, Service sectors	1.20	0.12	0.056	1.00 - 1.45
	Professionals	1.01	0.32	0.983	0.54 - 1.86
	Routine Non-manual Occupations	0.99	0.07	0.912	0.87 - 1.13
	Semi-skilled Workers	1.08	0.07	0.209	0.96 - 1.22
	Service Occupations	1.51	0.16	0.000	1.22 - 1.87
	Military	0.92	0.14	0.582	0.67 - 1.25
	No Identifiable Occupation	1.50	0.32	0.060	0.98 - 2.29
	Students	0.80	0.05	0.001	0.71 - 0.91
	Other	1.11	0.07	0.099	0.98 - 1.25
Parent	Self-employed in Agriculture, Forestry	1.00			
Socioeconomic Index	Semi-skilled Workers in Agriculture, Forestry	1.35	0.07	0.000	1.22 - 1.50
	Self-employed in Industry, Trade, Service sectors	1.15	0.05	0.002	1.05 - 1.26
	Professionals	1.02	0.10	0.873	0.84 - 1.23
	Executives/Managers	1.13	0.08	0.082	0.98 - 1.30
	Routine Non-manual Occupations	1.18	0.05	0.000	1.09 - 1.27
	Semi-skilled Workers	1.26	0.05	0.000	1.18 - 1.35
	Service Occupations	1.66	0.09	0.000	1.50 - 1.85
	Military	1.03	0.15	0.822	0.78 - 1.38
	No Identifiable Occupation	2.71	0.68	0.000	1.66 - 4.44
	Students	0.99	0.34	0.988	0.51 - 1.94
	Other	1.43	0.07	0.000	1.30 - 1.57
Sextiles of Sex Ratio	1	1.00			
	2	1.03	0.04	0.360	0.96 - 1.11
	3	0.99	0.04	0.746	0.90 - 1.08
	4	0.99	0.04	0.725	0.91 - 1.07
	5	0.98	0.04	0.613	0.89 - 1.07
	6	0.95	0.04	0.287	0.87 - 1.04
N				96,410	
Deaths				11,631	

Source: Swedish administrative register data, compiled by the author. Estimates for sum of males, sum of females, county of residence in 1960 and county of birth omitted.

Table A-3: (Continued)

				Females	
Covariates		**RR**	**S.E.**	**P-value**	**95% CI**
Age	18-25	0.01	0.00	0.000	0.00 - 0.02
	26-30	0.11	0.01	0.000	0.09 - 0.14
	31-35	0.20	0.02	0.000	0.16 - 0.24
	36-40	0.26	0.02	0.000	0.23 - 0.31
	41-45	0.54	0.03	0.000	0.48 - 0.60
	46-50	1.00			
	51-55	1.93	0.11	0.000	1.73 - 2.15
	56-60	2.98	0.14	0.000	2.71 - 3.27
	61-65	4.37	0.19	0.000	4.02 - 4.75
Socieconomic Index	Self-employed in Agriculture, Forestry	1.00			
	Semi-skilled Workers in Agriculture, Forestry	1.10	0.26	0.684	0.69 - 1.75
	Self-employed in Industry, Trade, Service sectors	0.90	0.19	0.628	0.60 - 1.36
	Professionals	2.11	1.58	0.318	0.49 - 9.17
	Routine Non-manual Occupations	0.93	0.13	0.621	0.71 - 1.22
	Semi-skilled Workers	1.26	0.18	0.097	0.96 - 1.65
	Service Occupations	1.14	0.16	0.349	0.87 - 1.50
	Military				
	No Identifiable Occupation	1.00	0.35	0.992	0.50 - 2.00
	Students	0.87	0.12	0.334	0.66 - 1.15
	Other	1.64	0.23	0.000	1.25 - 2.16
Parent	Self-employed in Agriculture, Forestry	1.00			
Socioeconomic Index	Semi-skilled Workers in Agriculture, Forestry	1.16	0.08	0.022	1.02 - 1.33
	Self-employed in Industry, Trade, Service sectors	1.13	0.07	0.038	1.01 - 1.27
	Professionals	1.05	0.16	0.765	0.78 - 1.41
	Executives/Managers	1.03	0.10	0.773	0.85 - 1.23
	Routine Non-manual Occupations	1.20	0.06	0.000	1.09 - 1.33
	Semi-skilled Workers	1.23	0.05	0.000	1.13 - 1.33
	Service Occupations	1.47	0.10	0.000	1.28 - 1.68
	Military	0.93	0.16	0.682	0.66 - 1.31
	No Identifiable Occupation	0.89	0.46	0.822	0.32 - 2.48
	Students	2.52	0.78	0.003	1.38 - 4.62
	Other	1.33	0.07	0.000	1.20 - 1.48
Sextiles of Sex Ratio	1	1.00			
	2	1.00	0.05	0.987	0.90 - 1.11
	3	1.02	0.05	0.686	0.93 - 1.12
	4	0.96	0.05	0.472	0.87 - 1.07
	5	0.97	0.05	0.555	0.87 - 1.08
	6	0.92	0.05	0.149	0.82 - 1.03
N				86,276	
Deaths				6,726	

Source: Swedish administrative register data, compiled by the author. Estimates for sum of males, sum of females, county of residence in 1960 and county of birth omitted.

Table A-4: All-cause mortality results: Males and females, aged 18 and 19 in 1960, sex ratio (males: 18-22, females: 16-20) calculated within parishes

				Males	
Covariates		**RR**	**S.E.**	**P-value**	**95% CI**
Age	18-25	0.01	0.00	0.000	0.00 - 0.01
	26-30	0.20	0.02	0.000	0.17 - 0.23
	31-35	0.26	0.02	0.000	0.22 - 0.30
	36-40	0.44	0.03	0.000	0.40 - 0.50
	41-45	0.64	0.03	0.000	0.58 - 0.71
	46-50	1.00			
	51-55	2.26	0.09	0.000	2.10 - 2.44
	56-60	3.28	0.13	0.000	3.04 - 3.53
	61-65	4.98	0.19	0.000	4.63 - 5.37
Socieconomic Index	Self-employed in Agriculture, Forestry	1.00			
	Semi-skilled Workers in Agriculture, Forestry	1.13	0.08	0.079	0.99 - 1.31
	Self-employed in Industry, Trade, Service sectors	1.20	0.12	0.056	0.99 - 1.45
	Professionals	1.00	0.32	0.996	0.53 - 1.89
	Routine Non-manual Occupations	0.99	0.07	0.917	0.87 - 1.13
	Semi-skilled Workers	1.08	0.07	0.222	0.96 - 1.22
	Service Occupations	1.51	0.16	0.000	1.23 - 1.87
	Military	0.90	0.14	0.514	0.67 - 1.22
	No Identifiable Occupation	1.51	0.34	0.064	0.98 - 2.33
	Students	0.80	0.05	0.001	0.71 - 0.91
	Other	1.11	0.07	0.099	0.98 - 1.25
Parent Socioeconomic Index	Self-employed in Agriculture, Forestry	1.00			
	Semi-skilled Workers in Agriculture, Forestry	1.36	0.07	0.000	1.23 - 1.50
	Self-employed in Industry, Trade, Service sectors	1.15	0.05	0.002	1.05 - 1.27
	Professionals	1.02	0.11	0.869	0.83 - 1.25
	Executives/Managers	1.14	0.09	0.087	0.98 - 1.32
	Routine Non-manual Occupations	1.18	0.05	0.000	1.09 - 1.27
	Semi-skilled Workers	1.26	0.05	0.000	1.17 - 1.35
	Service Occupations	1.67	0.09	0.000	1.50 - 1.86
	Military	1.04	0.15	0.796	0.79 - 1.36
	No Identifiable Occupation	2.72	0.70	0.000	1.65 - 4.49
	Students	0.99	0.37	0.983	0.48 - 2.05
	Other	1.43	0.07	0.000	1.31 - 1.56
Sextiles of Sex Ratio	1	1.00			
	2	1.03	0.04	0.435	0.96 - 1.10
	3	0.99	0.04	0.746	0.92 - 1.06
	4	0.99	0.04	0.864	0.91 - 1.08
	5	1.01	0.04	0.826	0.93 - 1.10
	6	0.96	0.04	0.358	0.88 - 1.05
N				96,410	
Deaths				11,631	

Source: Swedish administrative register data, compiled by the author. Estimates for sum of males, sum of females, county of residence in 1960 and county of birth omitted.

Table A-4: (Continued)

				Females	
Covariates		**RR**	**S.E.**	**P-value**	**95% CI**
Age	18-25	0.01	0.00	0.000	0.00 - 0.02
	26-30	0.11	0.01	0.000	0.09 - 0.14
	31-35	0.20	0.02	0.000	0.16 - 0.24
	36-40	0.26	0.02	0.000	0.22 - 0.31
	41-45	0.54	0.03	0.000	0.47 - 0.61
	46-50	1.00			
	51-55	1.93	0.09	0.000	1.75 - 2.12
	56-60	2.98	0.14	0.000	2.72 - 3.26
	61-65	4.37	0.19	0.000	4.02 - 4.76
Socieconomic Index	Self-employed in Agriculture, Forestry	1.00			
	Semi-skilled Workers in Agriculture, Forestry	1.09	0.26	0.705	0.69 - 1.75
	Self-employed in Industry, Trade, Service sectors	0.90	0.19	0.601	0.60 - 1.35
	Professionals	2.11	1.54	0.306	0.50 - 8.82
	Routine Non-manual Occupations	0.93	0.13	0.590	0.71 - 1.21
	Semi-skilled Workers	1.25	0.17	0.099	0.96 - 1.64
	Service Occupations	1.14	0.16	0.353	0.87 - 1.49
	Military				
	No Identifiable Occupation	1.00	0.35	0.989	0.50 - 2.00
	Students	0.87	0.12	0.308	0.67 - 1.14
	Other	1.64	0.22	0.000	1.26 - 2.14
Parent	Self-employed in Agriculture, Forestry	1.00			
Socioeconomic Index	Semi-skilled Workers in Agriculture, Forestry	1.17	0.08	0.022	1.02 - 1.33
	Self-employed in Industry, Trade, Service sectors	1.13	0.06	0.029	1.01 - 1.26
	Professionals	1.05	0.14	0.722	0.80 - 1.37
	Executives/Managers	1.03	0.10	0.741	0.86 - 1.24
	Routine Non-manual Occupations	1.20	0.06	0.000	1.09 - 1.32
	Semi-skilled Workers	1.23	0.05	0.000	1.13 - 1.33
	Service Occupations	1.47	0.11	0.000	1.26 - 1.70
	Military	0.93	0.17	0.687	0.65 - 1.32
	No Identifiable Occupation	0.89	0.48	0.826	0.31 - 2.58
	Students	2.56	0.78	0.002	1.41 - 4.63
	Other	1.33	0.07	0.000	1.20 - 1.48
Sextiles of Sex Ratio	1	1.00			
	2	1.04	0.04	0.368	0.96 - 1.13
	3	0.99	0.05	0.872	0.90 - 1.09
	4	0.97	0.05	0.578	0.87 - 1.08
	5	0.96	0.05	0.422	0.86 - 1.06
	6	0.94	0.05	0.262	0.84 - 1.05
N				86,276	
Deaths				6,726	

Source: Swedish administrative register data, compiled by the author. Estimates for sum of males, sum of females, county of residence in 1960 and county of birth omitted.