Center for Demography and Ecology

University of Wisconsin-Madison

Access or Ability: What's Behind the Relationship between Early Socioeconomic Status and Adult Mortality?

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CDE Working Paper No. 2005-05

ACCESS OR ABILITY: WHAT'S BEHIND THE RELATIONSHIP BETWEEN EARLY SOCIOECONOMIC STATUS AND ADULT MORTALITY?

by

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A thesis submitted in partial fulfillment of

The requirements for the degree of

Master of Science

(Sociology)

at the

UNIVERSITY OF WISCONSIN-MADISON

2005

ABSTRACT

There is a persistent relationship between early socioeconomic status and morbidity and mortality that is well documented in the literature. In this thesis, I explore two of the theories proposed in the literature to account for this relationship – access to resources and effects of general intelligence. I ask three main questions. First, does the inclusion of measures of early SES beyond family income add to a model of mortality? Second, do other measures of family context, such as number of siblings and intact family, which affect available resources, add to our understanding of the relationship between childhood context and adult mortality? And finally, which theoretical explanation, resources or intelligence, best explains the risk of mortality? To answer these questions, I analyze survival models of data from the Wisconsin Longitudinal Study, a cohort sample of adult, Wisconsin high school graduates that has been followed since 1957. I find that parental income is the only significant early SES variable in the model, and that the only other significant measure of family context is number of siblings. Both of these findings fit well with the resources argument, as parental income is the SES measure most closely associated with resources, and number of siblings indicates over how many individuals family resources must be spread. The effects of both indicators of general ability – IQ

and grades – are negative for women, and neither is significant. Among men, the effects of IQ and grades run in opposite directions, with higher IQ increasing the risk of mortality net of grades, and higher grades decreasing the risk of mortality net of IQ. I believe that these results lend support to the access to resources hypothesis, and they do not tend to support the intelligence hypothesis.

INTRODUCTION

The demonstrated relationship between current or childhood socioeconomic status (SES) and morbidity or mortality has been investigated thoroughly (House 2001, Feinstein 1993, Hummer et al. 1998, Kuh et al. 2002, Lantz et al. 2001, Clausen et al. 2003, Marmot et al. 1997, Preston and Taubman 1994, McGinnis and Foege 1993, van de Mheen et al. 1998). One current aspect of this research focuses on the mechanisms behind this relationship. Two proposed mechanisms are access to resources (Link and Phelan 1995, 2002, Link et al. 2003) and general intelligence (Gottfredson 2003a, 2003b). Unfortunately, most of the studies testing these mechanisms have not had adequate measures of SES, relying mainly on family income, nor do they test both theories in one model. In this paper, I ask, which mechanism explains adult mortality – resources defined as early SES and family context or intelligence, as indicated by high school test scores and grades? I propose a model of adult mortality that includes information on family context, including well-specified measures of early SES, as well as measured ability and early educational and occupational aspirations. To test these ideas, I analyze survival models of data from the Wisconsin Longitudinal Study (WLS), a cohort sample of adult, Wisconsin high school graduates who have been followed since 1957.

A REVIEW OF THE RELEVANT LITERATURE

The SES-health / SES-mortality relationship

There is an ever-increasing body of literature in the fields of sociology, public health, social epidemiology, psychology, and medicine exploring the relationship between socioeconomic factors and health outcomes. The association is well documented and widely accepted (e.g., Marmot et al. 1997, Feinstein 1993, van de Mheen et al. 1998). Many health researchers have to come to the conclusion that, "the primary determinants of disease are mainly economic and social, and therefore its remedies must also be economic and social" (Rose 1992; see Kaplan 2004, p.124). In a review of published articles on mortality, McGinnis and Foege (1993) find that low income and poorly educated populations have a higher risk of mortality than their higher status counterparts, even when controlling for risky health behaviors. Lantz et al. (2001) find that individuals of low socioeconomic status (as measured by educational attainment and income) are twice as likely to develop poor self-rated health and physical impairment than high SES individuals, net of sex, race, age, smoking status, alcohol consumption, physical activity and Body Mass Index.

The ultimate outcome of poorer health is earlier mortality, and many studies have shown that there is a strong inverse relationship between SES and mortality as well (see Hummer et al. 1998 and Preston and Taubman 1994 for an overview of the literature). A handful of longitudinal studies have also shown a relationship between childhood SES and adult mortality (Kuh et al. 2002, Claussen et al. 2003). The exact mechanism(s) through which SES affects mortality is the topic of much debate. Two of the proposed mechanisms include access to resources (Link and Phelan 1995, House 2001, Phelan et al. 2004) and intelligence (Gottfredson 2003a, 2003b).

Access to Resources

Link and Phelan (among others) assert that SES is a fundamental cause of mortality because it, "embodies an array of resources, such as money, knowledge, prestige, power, and beneficial social connections, that protect health no matter what mechanisms are relevant at any given time" (p265) (Phelan et al. 2004). A person's ability to avoid mortality is "shaped" through the resources they possess. The association between SES and health persists across time and place because the connection between SES and risk- or protective-factors is dynamic. The fluid nature of this relationship also explains why many diseases (such as cardiovascular disease) and risk factors for diseases (such as smoking) that were once most common among high-SES individuals are now most prevalent among low-SES individuals (House 2001, Link and Phelan 1995, Phelan et al. 2004, Link and Phelan 2002). Those with higher SES are in the best position to seek out and exploit new information (such as asking their doctors about the smoking-heart disease relationship posited since the 1960's but not widely publicized until 20 years later) and utilize new technologies (such as being able to pay for anti-hypertensive drugs).

Phelan et al. (2004) estimate Cox proportional hazard models on National Longitudinal Mortality Survey data, classifying deaths by preventability and education of the decedent. They find that SES, as measured by income and education, is inversely related to mortality, and that this association is stronger for preventable deaths than non-preventable deaths.

Intelligence and Self-Care

Gottfredson argues that intelligence is responsible for observed health disparities. Proponents of this theory contend that SES is related to mortality indirectly, through the relationship of each of these to intelligence. They posit that intelligence works on health through health knowledge (understanding how to avoid risks of disease) and health literacy (being able to self-manage care) (Gottfredson 2003a, Gottfredson 2003b; also, see Lantz et al. 2001). These researchers would suggest that the reason Phelan et al. (2004) found the association between SES and mortality to be stronger for preventable deaths is that more intelligent people (who tend to have higher SES) are more likely to seek out preventive care and are therefore less likely to die from preventable disease. Gottfredson (2003a) supports her hypothesis by citing a number of other studies, most of which control for SES through either income or education measures.

Lantz et al. (2001) analyze longitudinal data from the Americans' Changing Lives Study in multinomial logistic regressions that included mortality and survey non-response as competing risks to health. They expect to find that the health-risk behaviors exhibited by those with lower SES (measured as low income and educational attainment) would explain the SES-health relationship, but are forced to conclude that, "the higher prevalence of major health-risk behaviors among those in lower socioeconomic strata is not the dominant mediating mechanism that can explain socioeconomic disparities in health status among US adults" (p29). Lantz et al. conclude that, while self-management of health risks is important to the understanding of mortality, these variables do not fully explain the SES-health relationship.

Sociology and the Understanding of SES

Demographic and epidemiological studies have documented the relationship between SES and mortality, and theories of the mechanism behind the relationship have come out of the fields of epidemiology, psychology, and economics. One major contribution of sociology to the understanding of SES is the idea that SES is transferred from one generation to the next – that parental education or status influences a child's educational attainment or status, net of ability and aspirations (though these also play an important role). Many of these concepts were originally developed to explain educational attainment, and appear as part of the Wisconsin model of status attainment (see Sewell and Hauser 1992 for an overview; see also Sewell and Shah 1967). The Wisconsin status attainment models find that socioeconomic background operates independently of ability, and that ability continues to have effects on educational attainment even when SES is well-specified (Sewell and Hauser 1992, Sewell and Shah 1967).

I argue that, when applied to the study of the SES-mortality relationship, these status-transmission and status-attainment concepts will produce a richer, more fully specified model. Modeling mortality, using well-specified measures of SES *in addition to* family context variables and measures of ability and aspirations will allow an adequate test of some of the proposed mechanisms for the SES-mortality relationship.

The research questions to be answered are: (1) Does the inclusion of measures of early SES beyond family income add to a model of mortality? (2) Do other measures of family context, such as number of siblings and intact family, that affect available resources, add to our understanding of the relationship between childhood context and adult mortality? (3) Which theoretical explanation, resources or intelligence, best explains the risk of mortality?

DATA AND CONSTRUCTS

The Wisconsin Longitudinal Study

The Wisconsin Longitudinal Study (WLS) began with a random one-third sample of Wisconsin high school graduates in the spring of 1957, totaling 10,317 graduates. The survey was originally intended to assess demand in the state for higher education. Test scores from the Wisconsin State Testing Service and parental income information from Wisconsin State Tax Records, and information on deaths obtained from the Social Security Death Index and the National Death Index, were added to these student surveys. The first follow-up was conducted in 1964. It gathered information from parents about the graduate's occupation, education, military service, and marital status. The second follow-up was a telephone interview with the graduate in 1975, which asked a wide range of questions, including educational attainment, occupational status, marital history, and some retrospective questions about the graduate's family at the time they were in high school. In 1992 both a mail and phone survey were implemented. Data that are missing from earlier waves have been collected at later waves, thus limiting item non-response. Currently, data collection is underway among the graduates, the spouses of the graduates and selected siblings of the graduates. The focus of recent waves of data has shifted from educational attainment to issues of aging, health, and retirement. The WLS is one of the longest-running, prospective cohort studies, and boasts excellent retention rates.[1]

Though the WLS is specific to a (predominately white) cohort of Wisconsin high school graduates, Hauser et al. (1994) estimated that approximately 66 percent of Americans in this age range across the U.S. were white high-school graduates. Furthermore, the percentage of WLS sample members from a farm background is fairly equivalent to that found across the U.S., making this sample generalizable to approximately two-thirds of the population of Americans of the same cohort (Sewell and Hauser 1992). Despite its limitations, the richness of family background information, high school performance scores, and information on mental ability make these data especially well-suited to the proposed research.

[1] In 1964, there was an 87 percent response rate; 90 percent of living original sample members responded to the 1975 survey.

Variables of Interest

Dependent variables. The outcome is longevity, which is constructed using information on whether or not the respondent has died, and if so, when. Information on mortality comes from the 1964, 1975, 1992, and 2004 respondent tracing efforts, as well as sweeps of the Social Security Death Index (SSDI) and the National Death Index (NDI). The total number of years lived by the respondent was constructed from this information, using 1956 as the origin.[2] All living respondents in this sample were right-censored at 2003. The most recent sweep of the SSDI was performed in April of 2004. Between this external information and the 2004 survey tracing efforts, we are confident that we know about almost all deaths that occurred through 2003.

The WLS does not have an exact year of death for approximately 12 percent of the deaths to both males and females. All of these deaths took place before 1976, and we have a range of dates (either 1957-1964 or 1965-1975) for most cases. The procedure used to deal with these missing exact dates of death is discussed in the methods section. Variable names, descriptions, data sources, and percent missing for all constructs can be seen in Table 1. Means and standard deviations for the final analysis samples can be seen in Table 2.

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[2] Even though we know all sample members survived until spring of 1957, 1956 was set as the origin of time-at-risk. This was done because the unit of analysis time was years, and a death in 1957 would have produced a value of zero years lived if the origin had been set to 1957.

Socioeconomic background. The socioeconomic background variables used in these models include parental income, mother's education, father's education, and father's occupational status. Income, occupation, and education are the standard components of SES (see, e.g., Preston and Taubman 1994), and are well-measured in the WLS. Mother's education and father's education are each used as continuous variables, and ranged from 0 years to 18 years. Father's occupational status is used as a proxy for the family's status. This variable is measured on the Duncan SEI scale, which ranges from 10 to 960. Average annual family income is based on 1957-1960 tax records. The original units of this variable were hundreds of dollars. Here, income was log-transformed to normalize it, with a start value of 10 (i.e., $1,000). Family income, parental education, and father's occupational status have been shown to be the most robust components of early SES available in the WLS (Sewell and Hauser 1992).[3]

Additional family background. Measures of family context (other than SES) included in these models are number of siblings, farm background, size of place of origin, and whether or not the respondent came from an intact family. The number of siblings the respondent has is included as a measure of access to

[3] Though a large part of the work using early SES in the WLS predicts educational attainment, I believe that those constructs transfer well. Researchers have found that each of these components of SES collected in the WLS contributes largely to explaining educational attainment, net of each other and net of ability (Sewell and Hauser 1992).

family resources. Family resources are finite, and some division among family members must occur. Other things being equal, as family size increases, the available resources spent on each individual decrease. Farm origin is included in these models because earlier analysis of mortality in the WLS has found that farm background functions as a protective factor against mortality (Hauser et al. 1994). A measure of the size of the place in which the respondent grew up is also included in these models. This measure is categorical, but arranged on a log-like scale, with each category representing a population size roughly 10 times as large as the previous category. Size of place of origin is important because those living in urban areas are more likely to have access to health services than those living in rural areas. The final family context variable included in the model is an indicator of whether the respondents lived with both parents most of the time through their senior year of high school. Coming from an intact family, with the parents married to each other and living under one roof, has been shown to have positive influences on health and other outcomes later in life (Hauser and Sweeney 1997, Manski et al. 1992).

Ability and aspirations. Ability and aspirations variables include the respondent's mental ability, measured in high school, their high school grades, and their educational and occupational aspirations, as reported just before graduation. High school grades are a normalized transformation of percentile-ranked grades. Ability is measured by scores on the Henmon-Nelson Test of Mental Ability; these raw scores have been mapped onto the IQ scale. In most cases, the raw Henmon-Nelson used was based on an average over two administrations, one in the freshman year and one in the junior year. In addition to these more objective measures, variables constructed from the respondent's self-reported aspirations are also included. The occupational aspiration measure used is the 1970 occupational education code for the occupation the respondent reported that they "eventually hoped to enter" in 1957. The educational aspiration measure was based on a question that asked about the respondent's plans after high school. Those who reported they would attend public or private college or university are coded as having high aspirations, and all others are coded as having low educational aspirations.

Early adult status variables. The final set of measures included in these models was collected during the first or second follow-up survey, when the respondent was either about 25 or about 36. The first of these is a continuous measure of the respondent's educational attainment based on reports in 1975, when most respondents had completed their education.[4] Educational attainment is included in order to assess the effects of ability and parental education net of

[4] If the 1975 report was missing, I substituted the 1964 report.

own educational attainment. Marital status is known to have a protective effect on mortality (see Gardner and Oswald 2004 for a review of this literature). Marital status variables in these analyses include a dummy for unmarried in 1964 and a variable for year of first marriage for those who have been married. Year of first marriage was based on 1964 reports, or 1975 reports if the 1964 report was missing. Eighty-five percent of the sample has been married. For those who were unmarried, the mean year of marriage was used. The mean and median years of first marriage were 1962 for men and 1960 for women. Therefore, the coefficient for the unmarried dummy in the models contrasts men and women without early marriages to those who married in 1962 or 1960, respectively. A dummy variable for military service is also included; it takes a value of 1 if any military service (active or reserves) was reported in 1964 or 1975, and 0 otherwise.[5]

METHODS

Missingness in Independent Variables

Though the WLS has had excellent response rates over the years, missing data in the independent variables presented a challenge here. Several of the early status variables used in the models (marital status, year of first marriage,

[5] This question was not asked of women in 1964. All of their responses are from the 1975 interview.

military service) were collected retrospectively in 1975, after some respondents had died. Additionally, missingness on 1957 items appears to be associated with early death among WLS respondents.

There seems to be a general consensus in the methodological literature that multiple imputation is the best way to deal with missingness in large datasets (Allison 2001, King et al. 2001, Schafer and Graham 2002). In contrast to list-wise deletion, multiple imputation procedures produce unbiased estimators, retain all information available in the data, and do not negatively affect sample size. Multiple imputation results in several independent datasets, each with missing values “filled in” based on the other information available in the data. King and colleagues (2001) have developed the AMELIA program to aid in multiple imputation procedures for survey data that are missing at random. The program uses Expectation-Maximization (EM) algorithms to find the posterior means, then adds back in estimation uncertainty, then uses importance resampling to enhance sample performance, and finally imputes completely independent data sets. They refer to this process as EMis multiple imputation. King gives the advantages of this method over Monte-Carlo Markov Chains utilized by Imputation-Posterior (IP) methods of multiple imputation as greater precision in posterior draws, deterministic convergence, speed, and complete independence of imputed data sets.

The pattern of missingness in the WLS variables of interest can be seen in Table 1, referenced above. Though 21 percent of women and 35 percent of men are missing on occupational ambition, the EMis method utilized by AMELIA is valid for missingness approaching 50 percent in samples smaller than mine (see King et al. 2001, pp 63-65). Each of the variables described above in my models is included in the AMELIA estimations, as well as an additional (though flawed) measure of occupational aspirations to aid in the imputation process.[6] The imputation procedure is run separately for men and women. See Table 3 for descriptive statistics of the final analysis variables.

Missingness in the Dependent Variable

It has been confirmed from respondent tracing efforts and sweeps of the National Death Index and Social Security Death Index that 730 male and 452 female WLS graduates have died between 1957 and 2003 (the last year for which

[6] The OCST57 variable used information from the educational aspiration variable to estimate occupational aspirations, and was unsuitable for inclusion in my final models. However, this variable provided enough information to allow AMELIA to impute occupational aspirations for the missing cases. Prior to its inclusion, AMELIA could not find the mode of the posterior distribution. None of other the procedures (introducing a ridge prior, decreasing the step size, and stopping at a preset number of iterations) suggested in the AMELIA handbook to deal with this problem worked. King et al. state that it is acceptable to include any variable in the AMELIA estimations that will aid in imputation, regardless of causal ordering or the variable's suitability for inclusion in the final analysis models.

we have complete NDI search data). Of these, exact year of death is known for 636 men and 397 women. The remaining deaths are placed within an interval 1957-1964, 1964-1975, or 1957-1975.

Since all variables that will end up in the final model must be included in the AMELIA program, EMis estimates were also produced for number of years lived by people with unknown years of death. However, these estimates are unsuitable for use because they contain no information about the relatively universal survival curve, they are not constrained to be within the years specified by the bracketed responses, and they are not even constrained to be within the observed years of death.

Year of death is imputed for missing cases in two steps. First the number of deaths per year was determined, and then actual respondents were assigned to each year. The Social Security Administration has published cohort life tables for the cohort born in 1940, using historical information and predicting mortality to age 95 (Bell and Miller). The life tables use single-year intervals and are sex-specific. The proportion of those dying within the intervals described above that died each year is figured from the ${}_1d_x$ column (see Appendix 1). By applying these proportions to the totals in the WLS missing intervals, and adding across intervals, one can find the total number of deaths that *should* have taken place each year in the WLS cohort if its mortality followed that of the 1940 cohort of the same sex. Subtracting the reported deaths from the theoretical total yields the number of people with missing year of death that should be assigned to each year.[7]

I then ran the full model (which includes all of the independent variables described above) predicting mortality using Cox proportional hazards on each of the five newly imputed data sets, excluding observations with missing year of death. The outputs from this model are used to predict the hazard ratios for those with missing year of death (treating them as though they were still alive). The predicted hazard ratios are used to form a separate queue of likelihood of mortality for each range in each data set. I then assigned members of the queue sequentially to the years of death predicted from the cohort life table, giving those with the highest hazard ratios to the earliest years of death.[8]

The Models

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[7] Because I rounded deaths assigned to each year to whole numbers, the count for men was two greater than it should have been. i.e., the total number of slots assigned to years was greater than the sum of the people in the missing intervals. To correct this, I rounded the two numbers over x.5, but closest to it, *down* instead of up (the numbers were 3.54 and 3.56, which were rounded down to 3). There was no such problem with the rounded data for women. See sample calculations in Appendix 1.

[8] See Appendix 1 for sample calculations.

The models estimated below are Cox proportional hazard models, with time-constant variables, estimated on a person-years dataset.[9] These models take the form

$$\text{Log } h(t) = a(t) + b_j X_j$$

where h(t) is the hazard of mortality over time, b_j is the set of unexponentiated coefficients of the model, and X_j is the set of observed explanatory variables. Results will be presented as the exponentiated hazard ratios for ease of interpretation. Hazard ratios may be interpreted as the percent change in the hazard of death for each one-unit change in an X variable (Cleves et al. 2004).

Each of the models below was run separately on all five datasets produced by the imputation procedure. The hazard ratio reported is the arithmetic average of the hazards for the five datasets. The standard errors are calculated following the procedure outlined in King et al. (2001). They derive standard errors for multiply-imputed estimates by averaging the variance within each data set and then adding a correction factor for variance in estimates between datasets. *Z*-statistics are then calculated for the new point estimates and standard errors.[10]

RESULTS

[9] Analyses were conducted using Stata 8.2 (StataCorp 2004).
[10] See Appendix 2 for sample calculations.

Tables 3a and 3b present results from survival models on hazards of death from 1957 to 2003 respectively for women and men. Reading across, these tables give the hazard ratio, standard error, and *z*-statistic for the explanatory variables in each of the six models.

The first model included only the family background variables – family income, mother's education, father's education, father's SES, size of town of origin, an indicator for farm background, number of siblings, and an indicator for intact family. For women (Table 3a) and for men (Table 3b), the only significant predictors of mortality are family income, which reduces the hazard, and number of siblings, which increases the risk of mortality. These variables remain significant and of approximately the same size in all subsequent models. The non-significant effects of father's education, mother's education, SES, and size of town each work in opposite directions for women and men. The effect of farm background is negative and not significant for either men or women. The indicator for intact family also has no effect for either sex.

The second model adds IQ and grades to Model 1. For women, the model is essentially unchanged. The effects of both IQ and grades are insignificant. For men, higher grades significantly reduce the risk of mortality. The effect of IQ on the male hazard was small, and though it bordered on significance, it was positive, indicating that a higher IQ *increases* a man's risk of mortality net of grades.

In the third model, the measures of the respondent's educational and occupational aspirations as reported in their senior year of high school are added to the previous models. For women, high educational ambition has a negative, though not significant, effect and high occupational ambition has a significant and positive effect on mortality. For men, the effect is reversed. High educational ambition has a *positive*, though not significant effect, and high occupational ambition has a significant *negative* effect on the hazard. Because these variables operated in opposite directions, I tested for interaction effect of these by adding a term (occupational aspiration x educational aspiration) to both these models and the saturated models. For both men and women, these interactions were non-significant and therefore not included in the final models. Family income and number of siblings remain significant for both men and women, and the size of each effect is not attenuated by the addition of the ability variables.

The fourth model adds the respondent's educational attainment to the previous model. For women, the effect of education was negative but not significant, and the inclusion of this variable does not change earlier results. For men, the effect of education is negative, of moderate size, and significant. Furthermore, the addition of this variable causes the small, but previously significant, effect of occupational ambition to lose significance. Also, the small positive effect of IQ becomes significant and the relatively large positive effect of educational ambition becomes significant conditional on educational attainment. This can be interpreted to mean that within each level of attainment, the higher the IQ, the higher the risk of mortality, and those with high educational ambition have higher risk of mortality.

Model 5 includes the indicator for military service. This effect is not significant for women, only one percent of whom had served. For men, military service has a large negative effect on the hazard that is statistically significant.

The final model adds an indicator for unmarried in 1964 and year of first marriage to the previous model. For women, year of first marriage has a negative, but not significant, effect on the hazard. The coefficient of the indicator, unmarried, is positive, suggesting that unmarried women experience higher rates of mortality than women with the mean year of first marriage (1960); however, this effect is not significant. For men, year of first marriage has a moderate negative effect on the hazard, indicating that delayed marriage reduces the risk of mortality more than early marriage. Unmarried in 1964 has a positive significant effect on the hazard, indicating that unmarried men have a greater risk of death than men with the mean year of first marriage (1962).

Overall, the effects for women are consistent. Higher family income in 1957 greatly reduces mortality risks, while number of siblings increases mortality risks slightly. Additionally, reporting high occupational ambition has a significant positive effect on the hazard. However, the effect is *very* small (for the largest effect, hazard ratio = 1.0007). The effects of IQ and grades were negative but not significant in any model.

Among men, family income in 1957 greatly reduces the hazard, and number of siblings increases it slightly. IQ has a small, though significant, *positive* effect on the hazard, while grades have a small but negative effect on the hazard. Educational ambition has a large, positive effect on the hazard that becomes significant in all models that also include the respondent's educational attainment. Occupational ambition has a small negative effect on the risk of mortality that is only significant in the model without the respondent's educational attainment. Military service and marriage have significant moderate negative effects on the hazard. The effect of year of first marriage is modest but significant, though negative, indicating that later marriage is *more* protective than early marriage, contrary to findings in the literature (Gardner and Oswald 2004).

The fit statistics for each model can be seen at the bottom of Tables 3a and 3b. I took the difference between the starting and ending log likelihood for each model for each dataset, then averaged these across datasets. To get the Likelihood Ratio Chi-Square for each model, the average difference for each model was multiplied by -2. For women, Model 1 fits the data adequately (Chi-Sq=26 on 8 degrees of freedom). The fit statistics for Models 2-6 are also significant. However, since the subsequent models are nested, I calculated the difference in Chi-Square and the difference in degrees of freedom to assess the fit and found that none of the models offered a significant improvement in fit. For men, each of the overall models fits better than the models for women. Furthermore, each of the nested models offers a significant improvement in fit.

Testing model assumptions and validity

Tests of the assumptions of the proportional hazard model, as recommended by Cleves et al. (2004), have been performed. First I performed a link test to verify that the square of the linear predictor is not significant, which would indicate that the effects of the variables in the model do not vary with time in ways not already accounted for by the model. The link tests produced non-significant coefficients, suggesting that time is adequately accounted for in the model. Next I tested to make sure that the relationship between time and the residuals of the models were zero. This test produced a non-significant Chi-Square for women. For men, the raw Chi-Square was relatively large, though not significant using BIC to adjust for sample size. From this, I concluded that the proportional hazard models fit my data adequately.

As a check of the validity of my imputations of unknown years of death, I re-estimated the same models for all deaths occurring after 1976. The results can be found in Tables 4a and 4b for women and men respectively. The direction and relative size of the hazards were largely unchanged. Many of the effects are no longer significant, perhaps because the effects of early SES on mortality after age 35 are diminished by the respondent's own socioeconomic status. However, the general pattern of effects is the same, which suggests that the procedure used to apportion year of death has not dramatically altered the model outcomes.

Discussion

The purpose of this study was to explore which proposed mechanism underlying the SES-health relationship – intelligence or access to resources – better explained the relationship when early SES was well-specified. To answer this question, I ran survival models of mortality in the WLS and used Cox proportional hazards to model the relative effects of the independent variables. I asked three main questions:

(1) Does the inclusion of measures of early SES beyond family income add to a model of mortality? For both men and women, parental income is the only significant early SES variable in the model. The primary purpose for including four separate measures of SES was to assess the extent to which our understanding of the SES-health relationship is impaired by the general lack of availability of multiple measures. However, of the four measures included, parental income is the one most closely related to resources, and an argument could be made that these results support the access to resources hypothesis.

(2) Do other measures of family context, such as number of siblings and intact family, that affect available resources, add to our understanding of the relationship between childhood context and adult mortality? Yes, but only number of siblings, which raises the risk of mortality by approximately 5.5 percent for each additional sibling. This fits well with the resources argument – since family resources are spread out over more individuals, there are fewer resources available to family members of otherwise similar socioeconomic backgrounds.

(3) Which theoretical explanation, resources or intelligence, best explains the risk of mortality? The effects of both IQ and grades are negative for women, and neither is significant. For men, the effects of IQ and grades run in opposite directions, with higher IQ increasing risk of mortality net of grades, and higher grades decreasing the risk of mortality net of grades. The resource variables parental income and number of siblings each have large significant effects on mortality in the directions predicted by the resources theory. I believe that these results lend support to the access to resources hypothesis, and they do not tend to support the intelligence hypothesis.

CONCLUSION

Further research is, of course, necessary to validate these findings, and work on prospective nationally representative datasets with good early SES measures is especially needed. Papers have been published using the British Cohort Study of women and men born in 1946, which have examined the relationship between early childhood SES and adult mortality (Kuh et al. 2002), and the relationship between childhood IQ and adult mortality (Kuh et al. 2004). The more recent of these papers controlled childhood socioeconomic conditions as well as cognitive ability, measured at age 8. The study found a deleterious effect of IQ on male, but not on female mortality to age 54. The effect persisted when childhood socioeconomic conditions were controlled, but was largely explained by later socioeconomic circumstances. That is, contrary to the intelligence hypothesis, rather than explaining the association between adult success and mortality, the effect of childhood cognitive ability was mediated by adult socioeconomic success. However, in the British sample, only membership in the bottom quarter of the IQ distribution affected mortality. There was no gradient in mortality across the upper three quarters of the male ability distribution. This suggests a possible explanation of the absence of a negative IQ effect among the Wisconsin men, namely, that the least able youth in the cohort never completed their senior year in high school. One way to assess this explanation would be to look more closely at mortality differentials between low-IQ men in the Wisconsin sample and those higher in the distribution. Another valuable resource would be the National Longitudinal Survey of Youth of 1979, which administered the Armed Services Vocational Aptitude Battery to a large sample of youth aged 15 to 22 in 1980. However, that cohort has barely reached its 40s, so there is as yet little mortality experience to observe.

Acknowledgements

I would like to thank my advisor, Robert Hauser, for his support and guidance over the last three years. I would like to thank the other members of my committee, Jeremy Freese and Karen Swallen, for their attention and suggestions. I would also like to thank Tess Hauser and Linda Jordan of the Wisconsin Longitudinal Study for their help with the data. Finally, I would like to thank Erin Ruel for her encouragement throughout this process.

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Table 1. Sources and Descriptions of Variables, with Percent Missing by Sex.

Variable	Description	Source	Percent Missing Females	Percent Missing Males
Outcome variables				
Mortality	Coded 1 if deceased	1964, 1975, 1992, 2004 survey and tracing; NDI and SSDI sweeps	0.00	0.00
Years lived	Total number of years after 1957 the respondent was alive; 47 if still alive	1964, 1975, 1992, 2004 survey and tracing; NDI and SSDI sweeps	1.02	1.89
Socioeconomic background variables				
Parental income	Logged average annual family income	1957-1960 Wisconsin state tax records	7.55	5.18
Mother's education	Years of school completed by mother	1957 survey	0.00	0.00
Father's education	Years of school completed by father	1957 survey	0.00	0.00
Family SES 1957	Duncan SEI score for father's occupation	1975 survey	2.11	2.51
Additional family background variables				
Number of siblings	Total number of siblings	1975 survey	5.67	8.97
Farm background	Coded 1 if father's occupation was "farmer" in tax records	1957-1960 Wisconsin state tax records	0.00	0.00
Intact family	Coded 1 if lived with both parents most of the time until senior year of high school	1957 survey	5.35	8.59
Size of place of origin	Size of town in which attended high school	1957 survey	0.00	0.00
Ability and aspiration variables				
IQ	Measure of IQ mapped from raw Henmon-Nelson test score	Wisconsin State Testing Service records	0.00	0.00
Grades	Normalized percentile rank of high school grades	High School Records	6.36	7.08
Educational ambition	Coded 1 if planned to go to college or university	1957 survey	0.00	0.00
Occupational ambition	Duncan SEI score for intended occupation	1957 survey	20.66	35.19
Early adult status variables for graduate				
Education	years of school completed	1964, 1975 surveys	1.85	2.17
Unmarried	Coded 1 if married in 1964	1964, 1975 surveys	3.28	3.37
Year of first marriage	Year of first marriage for ever married	1964, 1975 surveys	10.24	14.49
Military service	Coded 1 if served in military	1964, 1975 surveys	5.25	3.01

Table 2. Means and Standard Deviations for Final Analysis Variables.

	Females (N=5311)		Males (N=4984)	
Variable	Mean	Standard Deviation	Mean	Standard Deviation
Mortality	0.085	0.279	0.146	0.354
Years lived	46.124	3.738	45.470	4.841
Parental income	4.107	0.596	4.122	0.581
Mother's education	10.264	2.826	10.512	2.819
Father's education	9.636	3.256	9.758	3.303
Family SES 1957	340.597	228.894	342.364	231.756
Number of siblings	3.338	2.627	3.284	2.663
Farm background	0.183	0.387	0.192	0.394
Intact family	0.892	0.310	0.896	0.305
Size of place of origin	4.730	2.705	4.531	2.633
IQ	100.281	14.557	100.646	15.284
Grades	103.709	14.523	96.780	14.637
Educational ambition	0.260	0.439	0.349	0.477
Occupational ambition	384.066	229.890	417.486	311.794
Education	13.013	1.768	13.765	2.400
Unmarried	0.849	0.358	0.678	0.467
Year of first marriage	60.285	1.925	61.735	1.847
Military service	0.010	0.100	0.580	0.494

Table 3.a. Effects of Independent Variables on Risk of Mortality, all Female deaths 1957-2003.

	Model 1			Model 2			Model 3			Model 4			Model 5			Model 6		
Variable	hazard	SE	Z	hazard	SE	Z	hazard	SE	Z	hazard	SE	Z	hazard	SE	Z	hazard	SE	Z
Parental income	0.834	0.077	-2.17	0.838	0.077	-2.10	0.836	0.077	-2.13	0.841	0.078	-2.04	0.842	0.078	-2.03	0.841	0.078	-2.04
Mother's education	0.994	0.020	-0.30	0.999	0.020	-0.07	0.996	0.020	-0.19	0.997	0.020	-0.13	0.997	0.020	-0.14	0.997	0.020	-0.14
Father's education	1.017	0.019	0.91	1.020	0.019	1.02	1.019	0.019	0.98	1.020	0.019	1.03	1.020	0.019	1.03	1.021	0.019	1.06
Family SES 1957	1.000	0.000	-0.90	1.000	0.000	-0.72	1.000	0.000	-0.83	1.000	0.000	-0.77	1.000	0.000	-0.74	1.000	0.000	-0.71
Size of place of origin	1.018	0.023	0.75	1.017	0.024	0.70	1.016	0.024	0.69	1.016	0.024	0.69	1.016	0.023	0.69	1.016	0.024	0.67
Farm background	0.761	0.126	-1.89	0.772	0.128	-1.78	0.765	0.127	-1.85	0.771	0.128	-1.78	0.771	0.128	-1.79	0.766	0.127	-1.84
Number of siblings	1.056	0.019	3.04	1.053	0.019	2.85	1.055	0.019	2.93	1.055	0.019	2.94	1.055	0.019	2.91	1.055	0.019	2.92
Intact family	1.000	0.151	0.00	1.011	0.152	0.07	1.012	0.152	0.08	1.010	0.152	0.07	1.020	0.154	0.13	1.024	0.155	0.16
IQ				0.997	0.004	-0.70	0.997	0.004	-0.79	0.997	0.004	-0.72	0.997	0.004	-0.77	0.997	0.004	-0.77
Grades				0.997	0.004	-0.81	0.995	0.004	-1.06	0.996	0.004	-0.97	0.996	0.004	-0.94	0.996	0.004	-0.89
Educational ambition							0.849	0.132	-1.15	0.907	0.153	-0.61	0.912	0.154	-0.57	0.916	0.155	-0.54
Occupational ambition							1.001	0.000	2.20	1.001	0.000	2.34	1.001	0.000	2.31	1.001	0.000	2.34
Education										0.961	0.039	-0.99	0.961	0.039	-1.01	0.956	0.040	-1.11
Military service													1.697	0.642	1.09	1.667	0.632	1.06
Unmarried																1.133	0.118	0.99
Year of first marriage																0.983	0.026	-0.66

Table 3.a, continued.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Likelihood Chi-Sq	25.68	28.74	33.69	34.73	37.37	39.06
df	8	10	12	13	14	16

N=5311, 452 deaths.
Estimates of the hazard function and associated standard errors have been adjusted for the multiple imputation process. Presented hazards are arimethic means of estimated hazards for each of five imputed data sets. Presented standard errors reflect the arithmetic mean of estimates, corrected for between-dataset variance.

Table 3.b. Effects of Independent Variables on Risk of Mortality, all Male Deaths 1957-2003.

	Model 1			Model 2			Model 3			Model 4			Model 5			Model 6		
Variable	hazard	SE	Z	hazard	SE	Z	hazard	SE	Z	hazard	SE	Z	hazard	SE	Z	hazard	SE	Z
Parental income	0.858	0.062	-2.28	0.861	0.063	-2.22	0.856	0.062	-2.30	0.863	0.063	-2.18	0.865	0.063	-2.14	0.870	0.063	-2.05
Mother's education	1.015	0.016	0.98	1.015	0.016	0.99	1.016	0.016	1.03	1.018	0.016	1.14	1.020	0.016	1.29	1.019	0.016	1.20
Father's education	0.998	0.014	-0.11	0.999	0.014	-0.04	1.000	0.014	-0.02	1.005	0.014	0.34	1.006	0.014	0.39	1.006	0.014	0.44
Family SES 1957	1.000	0.000	0.37	1.000	0.000	0.43	1.000	0.000	0.49	1.000	0.000	0.62	1.000	0.000	0.61	1.000	0.000	0.57
Size of place of origin	0.987	0.019	-0.69	0.984	0.019	-0.87	0.985	0.019	-0.77	0.989	0.019	-0.61	0.989	0.019	-0.58	0.990	0.019	-0.55
Farm background	0.882	0.110	-1.08	0.897	0.111	-0.93	0.883	0.110	-1.07	0.886	0.110	-1.03	0.877	0.109	-1.13	0.873	0.109	-1.17
Number of siblings	1.059	0.014	4.21	1.056	0.014	3.98	1.056	0.014	3.96	1.055	0.014	3.91	1.058	0.014	4.08	1.058	0.014	4.10
Intact family	0.814	0.097	-1.92	0.834	0.099	-1.67	0.833	0.099	-1.68	0.828	0.099	-1.74	0.822	0.098	-1.82	0.818	0.097	-1.87

Table 3.b, continued.

Variable	Model 1 hazard	Model 1 SE	Model 1 Z	Model 2 hazard	Model 2 SE	Model 2 Z	Model 3 hazard	Model 3 SE	Model 3 Z	Model 4 hazard	Model 4 SE	Model 4 Z	Model 5 hazard	Model 5 SE	Model 5 Z	Model 6 hazard	Model 6 SE	Model 6 Z
IQ				1.006	0.003	1.91	1.006	0.003	1.97	1.008	0.003	2.38	1.008	0.003	2.54	1.008	0.003	2.61
Grades				0.987	0.003	-4.28	0.987	0.003	-4.02	0.990	0.003	-3.09	0.989	0.003	-3.29	0.989	0.003	-3.38
Educational ambition							1.239	0.140	1.71	1.405	0.164	2.47	1.373	0.160	2.33	1.385	0.162	2.38
Occupational ambition							1.000	0.000	-2.22	1.000	0.000	-1.51	1.000	0.000	-1.48	1.000	0.000	-1.52
Education										0.914	0.022	-3.99	0.910	0.022	-4.18	0.909	0.022	-4.19
Military service													0.798	0.061	-3.33	0.798	0.063	-3.21
Unmarried																1.249	0.065	3.07
Year of first marriage																0.958	0.021	-2.00
Likelihood Chi-Sq		45.01			63.70			69.49			84.59			93.67			105.04	
df		8			10			12			13			14			16	

N=4984, 730 deaths.

Estimates of the hazard function and associated standard errors have been adjusted for the multiple imputation process. Presented hazards are arimethic means of estimated hazards for each of five imputed data sets. Presented standard errors reflect the arithmetic mean of estimates, corrected for between-dataset variance.

Table 4.a. Effects of Independent Variables on Female Mortality, 1976-2003.

	Model 1			Model 2			Model 3			Model 4			Model 5			Model 6		
Variable	hazard	SE	Z	hazard	SE	Z	hazard	SE	Z	hazard	SE	Z	hazard	SE	Z	hazard	SE	Z
Parental income	0.891	0.087	-1.24	0.896	0.088	-1.19	0.896	0.088	-1.18	0.903	0.089	-1.08	0.904	0.089	-1.08	0.905	0.089	-1.06
Mother's education	0.994	0.021	-0.29	1.000	0.021	-0.02	0.998	0.022	-0.10	0.999	0.022	-0.03	0.999	0.022	-0.03	1.000	0.022	-0.02
Father's education	1.005	0.020	0.23	1.007	0.020	0.36	1.007	0.020	0.34	1.008	0.020	0.41	1.008	0.020	0.41	1.008	0.020	0.41
Family SES 1957	1.000	0.000	-0.08	1.000	0.000	0.13	1.000	0.000	0.05	1.000	0.000	0.14	1.000	0.000	0.15	1.000	0.000	0.16
Size of place of origin	1.017	0.025	0.69	1.015	0.025	0.60	1.015	0.025	0.59	1.015	0.025	0.59	1.015	0.025	0.59	1.014	0.025	0.55
Farm background	0.830	0.148	-1.15	0.845	0.151	-1.03	0.838	0.150	-1.08	0.848	0.151	-1.00	0.848	0.151	-1.01	0.844	0.151	-1.04
Number of siblings	1.037	0.020	1.82	1.032	0.020	1.58	1.033	0.020	1.64	1.033	0.020	1.65	1.033	0.020	1.64	1.033	0.020	1.63
Intact family	0.822	0.126	-1.42	0.834	0.128	-1.30	0.835	0.128	-1.29	0.833	0.127	-1.31	0.835	0.128	-1.29	0.833	0.128	-1.30
IQ				0.998	0.005	-0.52	0.997	0.005	-0.58	0.998	0.005	-0.49	0.998	0.005	-0.51	0.998	0.005	-0.50
Grades				0.994	0.005	-1.35	0.993	0.005	-1.52	0.993	0.005	-1.40	0.994	0.005	-1.39	0.994	0.005	-1.37
Educational ambition							0.827	0.137	-1.26	0.906	0.163	-0.57	0.908	0.164	-0.56	0.911	0.164	-0.54
Occupational ambition							1.001	0.000	1.96	1.001	0.000	2.16	1.001	0.000	2.15	1.001	0.000	2.10
Education										0.947	0.041	-1.28	0.947	0.041	-1.28	0.941	0.042	-1.40
Military service													1.216	0.567	0.38	1.200	0.560	0.36

Table 4.a, continued.

Variable	Model 1 hazard	Model 1 SE	Model 1 Z	Model 2 hazard	Model 2 SE	Model 2 Z	Model 3 hazard	Model 3 SE	Model 3 Z	Model 4 hazard	Model 4 SE	Model 4 Z	Model 5 hazard	Model 5 SE	Model 5 Z	Model 6 hazard	Model 6 SE	Model 6 Z
Unmarried																1.101	0.132	-0.69
Year of first marriage																1.004	0.028	0.13

N=5256, 397 deaths

Estimates of the hazard function and associated standard errors have been adjusted for the multiple imputation process. Presented hazards are arimethic means of estimated hazards for each of five imputed data sets. Presented standard errors reflect the arithmetic mean of estimates, corrected for between-dataset variance.

Table 4.b. Effects of Independent Variables on Male Mortality, 1976-2003.

Variable	Model 1 hazard	Model 1 SE	Model 1 Z	Model 2 hazard	Model 2 SE	Model 2 Z	Model 3 hazard	Model 3 SE	Model 3 Z	Model 4 hazard	Model 4 SE	Model 4 Z	Model 5 hazard	Model 5 SE	Model 5 Z	Model 6 hazard	Model 6 SE	Model 6 Z
Parental income	0.855	0.067	-2.16	0.861	0.068	-2.06	0.861	0.068	-2.05	0.866	0.069	-1.95	0.870	0.069	-1.89	0.875	0.069	-1.81
Mother's education	1.009	0.017	0.56	1.010	0.017	0.62	1.012	0.017	0.71	1.013	0.017	0.79	1.016	0.017	0.94	1.014	0.017	0.85
Father's education	0.981	0.015	-1.30	0.982	0.015	-1.21	0.983	0.015	-1.12	0.987	0.015	-0.86	0.988	0.015	-0.81	0.988	0.015	-0.79
Family SES 1957	1.000	0.000	1.18	1.000	0.000	1.27	1.000	0.000	1.45	1.000	0.000	1.53	1.000	0.000	1.51	1.000	0.000	1.49
Size of place of origin	0.988	0.020	-0.59	0.985	0.020	-0.74	0.988	0.020	-0.59	0.990	0.020	-0.48	0.991	0.020	-0.47	0.991	0.020	-0.43

Table 4.b, continued.

	Model 1			Model 2			Model 3			Model 4			Model 5			Model 6		
Variable	hazard	SE	Z	hazard	SE	Z	hazard	SE	Z	hazard	SE	Z	hazard	SE	Z	hazard	SE	Z
Farm background	0.815	0.111	-1.66	0.831	0.114	-1.48	0.820	0.112	-1.60	0.822	0.113	-1.58	0.812	0.111	-1.69	0.807	0.111	-1.74
Number of siblings	0.997	0.016	-0.17	0.993	0.016	-0.42	0.992	0.016	-0.49	0.992	0.016	-0.51	0.994	0.016	-0.36	0.994	0.016	-0.35
Intact family	0.931	0.121	-0.57	0.954	0.124	-0.37	0.955	0.124	-0.36	0.950	0.124	-0.41	0.942	0.123	-0.47	0.939	0.122	-0.50
IQ				1.005	0.003	1.56	1.006	0.003	1.79	1.007	0.003	2.07	1.008	0.003	2.24	1.008	0.003	2.32
Grades				0.986	0.003	-4.17	0.987	0.004	-3.63	0.989	0.004	-2.98	0.989	0.004	-3.18	0.988	0.004	-3.29
Educational ambition							1.108	0.133	0.81	1.214	0.152	1.41	1.186	0.149	1.25	1.196	0.150	1.31
Occupational ambition							1.000	0.000	-2.04	1.000	0.000	-1.53	1.000	0.000	-1.51	1.000	0.000	-1.55
Education										0.937	0.023	-2.68	0.933	0.023	-2.87	0.929	0.024	-3.02
Military service													0.791	0.064	-3.26	0.778	0.065	-3.40
Unmarried																1.294	0.067	-3.40
Year of first marriage																0.970	0.023	-1.31

N=4890, 636 deaths

Estimates of the hazard function and associated standard errors have been adjusted for the multiple imputation process. Presented hazards are arimethic means of estimated hazards for each of five imputed data sets. Presented standard errors reflect the arithmetic mean of estimates, corrected for between-dataset variance.

Appendix 1. Sample calculations for assigning year of death for missing reports.

Step 1. Figuring the proportion of mortality and excess number of deaths that should have occurred each year if the WLS cohort followed the mortality of this US cohort born in 1940.

Below are the calculations made for females. Column A contains possible years of death for the population under study, and column C contains the corresponding age of that cohort. Column B shows the number of confirmed deaths (with precise years) to WLS cohort members in each year. Column D shows the number of female deaths in the SSA 1940 cohort life table to 18 year olds (l_0 = 100,000). Column E shows the proportion of the total deaths in column D to occur in each year. In column F, these proportions are applied to the known numbers of WLS deaths. If we assume that we have perfect knowledge of WLS deaths (though presumably some nonrespondents are actually decedants), and that WLS mortality follows that of the 1940 US birth cohort (though WLS respondents are predominately white Wisconsinites and all have at least a high school education, suggesting they have experienced better than average mortality), then the numbers in column F represent the number of WLS respondents who should have died in each year. These deaths are broken down into intervals (1957-1964, 1965-1975, and 1964-1975), and the proportions dying within each year of each respective interval are recorded in Columns G, H, and I. In column J, the proportions found in G, H, and I are applied to the total number of deaths in each of the three intervals 1957-1964, 1965-1975, and 1957-1975. Column K shows the results of column J (theoretical dead each year) minus column B (deaths of known year). Column L shows the rounded value of column K, which would be adjusted (if necessary) so that the sum of L equals the number of deaths to be apportioned. This is the number of people to "assign" to each year of death.

Appendix 1 Step 1, continued.

A. wls year	B. wls dead females	C. age	D. dx females	E. ndx/tot	F. wls n per yr from coh prop	G. prop dead ea yr for dead 57-64	H. prop dead ea yr 64-75	I. prop dead 57-75	J. n wls dead females based on prop	K. new wls dead females per year	L. rounded females
1957		18	56	0.0043719	1.9761105	0.1089494		0.0351097	1.8448996	1.8448996	2
1958		19	59	0.0046061	2.0819736	0.114786		0.0369906	1.9437335	1.9437335	2
1959		20	60	0.0046842	2.1172613	0.1167315		0.0376176	1.9766781	1.9766781	2
1960		21	60	0.0046842	2.1172613	0.1167315		0.0376176	1.9766781	1.9766781	2
1961		22	66	0.0051526	2.3289874	0.1284047		0.0413793	2.1743459	2.1743459	2
1962		23	69	0.0053868	2.4348505	0.1342412		0.0432602	2.2731798	2.2731798	2
1963		24	72	0.005621	2.5407136	0.1400778		0.0451411	2.3720137	2.3720137	2
1964		25	72	0.005621	2.5407136	0.1400778		0.0451411	2.3720137	2.3720137	2
1965		26	76	0.0059333	2.6818643		0.070305273	0.0476489	2.6762727	2.6762727	3
1966		27	78	0.0060895	2.7524397		0.072155412	0.0489028	2.7467009	2.7467009	3
1967		28	85	0.006636	2.9994535		0.078630897	0.0532915	2.9931997	2.9931997	3
1968		29	90	0.0070263	3.175892		0.083256244	0.0564263	3.1692703	3.1692703	3
1969	1	30	94	0.0073386	3.3170427		0.086956522	0.0589342	4.3101268	3.3101268	3
1970		31	100	0.007807	3.5287688		0.092506938	0.0626959	3.5214114	3.5214114	4
1971		32	107	0.0083535	3.7757827		0.098982424	0.0670846	3.7679102	3.7679102	4
1972		33	110	0.0085877	3.8816457		0.101757632	0.0689655	3.8735526	3.8735526	4
1973	2	34	111	0.0086658	3.9169334		0.102682701	0.0695925	5.9087667	3.9087667	4
1974		35	113	0.0088219	3.9875088		0.10453284	0.0708464	3.9791949	3.9791949	4
1975	5	36	117	0.0091342	4.1286595		0.108233117	0.0733542	9.1200514	4.1200514	4
1976	6	37	124	0.0096807	4.3756734						
1977	6	38	131	0.0102272	4.6226872						
1978	6	39	141	0.0110079	4.9755641						
1979	10	40	151	0.0117886	5.3284409						
1980	9	41	158	0.0123351	5.5754548						
1981	6	42	168	0.0131158	5.9283316						

Appendix 1 Step 1, continued.

A. wls year	**B. wls dead females**	**C. age**	**D. dx females**	**E. ndx/tot**	**F. wls n per yr from coh prop**
1982	7	43	181	0.0141307	6.3870716
1983	4	44	198	0.0154579	6.9869623
1984	9	45	214	0.016707	7.5515653
1985	5	46	230	0.0179561	8.1161683
1986	15	47	252	0.0196737	8.8924975
1987	15	48	274	0.0213912	9.6688266
1988	10	49	292	0.0227965	10.304005
1989	13	50	320	0.0249824	11.29206
1990	15	51	343	0.026778	12.103677
1991	14	52	372	0.0290421	13.12702
1992	17	53	407	0.0317745	14.362089
1993	21	54	439	0.0342728	15.491295
1994	21	55	478	0.0373175	16.867515
1995	13	56	506	0.0395035	17.85557
1996	27	57	553	0.0431728	19.514092
1997	15	58	587	0.0458272	20.713873
1998	25	59	638	0.0498087	22.513545
1999	20	60	683	0.0533219	24.101491
2000	25	61	738	0.0576157	26.042314
2001	15	62	802	0.0626122	28.300726
2002	19	63	876	0.0683894	30.912015
2003	21	64	958	0.0747912	33.805605
sum	452		12809	1	452

Appendix 1, continued.

Step 2. The full model (see Tables 3) was run using the AMELIA estimates of year of death for missing individuals. Y-hat hazards were predicted. Below is the ranking of the hazards produced by each of the five imputations for women for the range 1957-1964.

idswl	**range**	**yhat1**	**year1**	**yhat2**	**year2**	**yhat3**	**year3**	**yhat4**	**year4**	**yhat5**	**year5**
159008	57-64	0.2040059	1958	0.1093381	1958	0.3524688	1958	0.134552	1960	0.0993511	1958
237005	57-64	0.1180086	1964	0.0482783	1964	0.1006214	1964	0.09209	1964	0.0291602	1964
180011	57-64	0.1678821	1961	0.0798501	1960	0.3240554	1959	0.1597227	1959	0.1238902	1957
38030	57-64	0.2180685	1958	0.092906	1958	0.3949283	1958	0.1997246	1958	0.0905248	1958
407006	57-64	0.1856576	1959	0.0854741	1959	0.2869868	1960	0.1215395	1962	0.0533272	1959
111013	57-64	0.1507169	1962	0.0756406	1962	0.2963387	1960	0.1206714	1962	0.0335398	1964
101019	57-64	0.138044	1963	0.0604828	1963	0.2073185	1962	0.1391875	1960	0.0371173	1962
192040	57-64	0.1315169	1964	0.0597981	1964	0.2613296	1961	0.0928145	1964	0.0455522	1961
69033	57-64	0.1578857	1961	0.0791911	1961	0.2663085	1961	0.1143615	1963	0.0468012	1960
340109	57-64	0.188787	1959	0.0779266	1961	0.318096	1959	0.0956264	1963	0.0382563	1961
340118	57-64	0.1432714	1962	0.0742655	1962	0.5011653	1957	0.2045693	1958	0.0376911	1962
292017	57-64	0.1755428	1960	0.0714392	1963	0.1299657	1963	0.2427659	1957	0.0558359	1959
105001	57-64	0.1324982	1963	0.0798693	1960	0.127247	1964	0.1291848	1961	0.0370842	1963
47038	57-64	0.1744444	1960	0.0854692	1959	0.2182644	1962	0.1246684	1961	0.0355946	1963
417014	57-64	0.2433296	1957	0.1114433	1957	0.1855485	1963	0.169976	1959	0.0473222	1960
599071	57-75									0.2205715	1957
702038	57-75	0.3471001	1957	0.1527482	1957	0.4191909	1957	0.3015376	1957		

For those in the 1957-1975 range, the one with the highest hazard from each run was added to the 1957-1964 range. (The total number of deaths reported in 1957-1964 was one less than the total number of deaths in this range predicted by the cohort life table.) Once all deaths assinged to this range were re-ranked, year of death was assigned on an earliest-year-to-the-highest-hazard basis.

Appendix 1, continued.

Step 3. Showing the estimated hazards and assigned year of death for each of the five imputations for women. These are the estimates of year of death used in the models.

case	**range**	**hazard1**	**year1**	**hazard2**	**year2**	**hazard3**	**year3**	**hazard4**	**year4**	**hazard5**	**year5**
1	57-64	0.2040059	1958	0.1093381	1958	0.3524688	1958	0.134552	1960	0.0993511	1958
2	57-64	0.1180086	1964	0.0482783	1964	0.1006214	1964	0.09209	1964	0.0291602	1964
3	57-64	0.1678821	1961	0.0798501	1960	0.3240554	1959	0.1597227	1959	0.1238902	1957
4	57-64	0.2180685	1958	0.092906	1958	0.3949283	1958	0.1997246	1958	0.0905248	1958
5	57-64	0.1856576	1959	0.0854741	1959	0.2869868	1960	0.1215395	1962	0.0533272	1959
6	57-64	0.1507169	1962	0.0756406	1962	0.2963387	1960	0.1206714	1962	0.0335398	1964
7	57-64	0.138044	1963	0.0604828	1963	0.2073185	1962	0.1391875	1960	0.0371173	1962
8	57-64	0.1315169	1964	0.0597981	1964	0.2613296	1961	0.0928145	1964	0.0455522	1961
9	57-64	0.1578857	1961	0.0791911	1961	0.2663085	1961	0.1143615	1963	0.0468012	1960
10	57-64	0.188787	1959	0.0779266	1961	0.318096	1959	0.0956264	1963	0.0382563	1961
11	57-64	0.1432714	1962	0.0742655	1962	0.5011653	1957	0.2045693	1958	0.0376911	1962
12	57-64	0.1755428	1960	0.0714392	1963	0.1299657	1963	0.2427659	1957	0.0558359	1959
13	57-64	0.1324982	1963	0.0798693	1960	0.127247	1964	0.1291848	1961	0.0370842	1963
14	57-64	0.1744444	1960	0.0854692	1959	0.2182644	1962	0.1246684	1961	0.0355946	1963
15	57-64	0.2433296	1957	0.1114433	1957	0.1855485	1963	0.169976	1959	0.0473222	1960
16	57-75	0.15284	1972	0.0941616	1969	0.1931637	1972	0.1434745	1970	0.0681585	1969
17	57-75	0.2796413	1966	0.1206176	1966	0.3665923	1966	0.1415076	1970	0.0491678	1972
18	57-75	0.1604717	1970	0.0606698	1974	0.1025645	1975	0.0795563	1975	0.050333	1972
19	57-75	0.1074026	1975	0.085792	1971	0.3612777	1967	0.1548792	1970	0.2205715	1957
20	57-75	0.1572789	1971	0.0753891	1973	0.1661315	1974	0.0906083	1974	0.061199	1970
21	57-75	0.3471001	1957	0.1527482	1957	0.4191909	1957	0.3015376	1957	0.0982606	1966
22	64-75	0.2999273	1965	0.1517301	1965	0.4648283	1965	0.1192806	1972	0.1054859	1965
23	64-75	0.1796674	1967	0.0872522	1970	0.2959359	1969	0.208086	1966	0.093898	1966
24	64-75	0.1480573	1973	0.0920189	1969	0.2766143	1970	0.1679804	1969	0.0596769	1971
25	64-75	0.1743353	1969	0.0948707	1968	0.3592424	1967	0.1810193	1967	0.0449531	1973
26	64-75	0.1199054	1974	0.0591573	1975	0.2547314	1971	0.1281484	1972	0.0582248	1971

Appendix 1 Step 3, continued.

case	range	hazard1	year1	hazard2	year2	hazard3	year3	hazard4	year4	hazard5	year5
27	64-75	0.158253	1971	0.0947421	1968	0.285527	1970	0.1386581	1971	0.0623578	1970
28	64-75	0.1233002	1974	0.0540591	1975	0.2237879	1972	0.0804673	1975	0.0886775	1967
29	64-75	0.2759544	1966	0.1177416	1966	0.1923532	1973	0.1724871	1968	0.0614901	1970
30	64-75	0.1179164	1975	0.0650156	1974	0.2838336	1970	0.2129392	1966	0.0356437	1974
31	64-75	0.1692359	1969	0.1126687	1966	0.7795892	1965	0.1925019	1967	0.0728481	1968
32	64-75	0.159258	1970	0.0863101	1970	0.2424005	1971	0.0977571	1973	0.0406689	1973
33	64-75	0.1511549	1972	0.0829684	1971	0.2487665	1971	0.1733625	1968	0.0641419	1969
34	64-75	0.1783496	1968	0.0949336	1968	0.2929118	1969	0.1531866	1970	0.0606759	1970
35	64-75	0.137316	1973	0.0551832	1975	0.153074	1975	0.1286909	1971	0.033606	1975
36	64-75	0.2842472	1965	0.1756436	1965	0.2726498	1970	0.1381998	1971	0.0887935	1967
37	64-75	0.1183164	1975	0.0749581	1973	0.3203807	1968	0.0845252	1974	0.0531183	1971
38	64-75	0.1756425	1968	0.077446	1972	0.1745952	1974	0.1976733	1967	0.0358627	1974
39	64-75	0.1568514	1971	0.0731322	1973	0.1749716	1973	0.1026146	1973	0.052858	1972
40	64-75	0.167438	1969	0.0694817	1974	0.2433747	1971	0.1146801	1972	0.0348824	1974
41	64-75	0.1078137	1975	0.0826833	1971	0.1371275	1975	0.0806363	1975	0.0905869	1966
42	64-75	0.163753	1970	0.0771307	1972	0.1561425	1974	0.1732647	1968	0.0409908	1973
43	64-75	0.1662516	1970	0.0655535	1974	0.1512037	1975	0.2167275	1965	0.031706	1975
44	64-75	0.1556309	1972	0.0913606	1969	0.3275601	1968	0.1689896	1969	0.1460039	1965
45	64-75	0.1367547	1974	0.052425	1975	0.1694598	1974	0.0861209	1974	0.0240945	1975
46	64-75	0.2902091	1965	0.1309904	1965	0.2945054	1969	0.1722374	1969	0.0994432	1965
47	64-75	0.2011796	1966	0.078046	1972	0.4205666	1966	0.0906339	1973	0.0506262	1972
48	64-75	0.1379184	1973	0.0874747	1970	0.17979	1973	0.0810806	1974	0.0718036	1968
49	64-75	0.1482544	1973	0.0797513	1972	0.1931432	1972	0.0795307	1975	0.0312421	1975
50	64-75	0.1786353	1968	0.0969224	1967	0.3391507	1968	0.2581362	1965	0.0781944	1968
51	64-75	0.1221714	1974	0.097721	1967	0.2157395	1972	0.1201703	1972	0.0345534	1974
52	64-75	0.1889773	1967	0.1037636	1967	0.3567086	1967	0.1993587	1966	0.0904086	1967
53	64-75	0.1568152	1971	0.0754641	1973	0.1829114	1973	0.1072715	1973	0.0547941	1971
54	64-75	0.1789126	1967	0.0876074	1970	0.3993774	1966	0.2302203	1965	0.068307	1969
55	64-75	0.1551261	1972	0.0831822	1971	0.4590415	1965	0.1342382	1971	0.0481242	1973

Appendix 2. Sample calculations for model hazards and standard errors for women following King et al 2001.

EARLY STATUS	hazard ratio					avg hr (a)	se										
	run 1	run 2	run 3	run 4	run 5		run 1	run 2	run 3	run 4	run 5	avg se (b)	S^2 (q) (c)	S2q(1+1/m) (d)	corr var (e)	corr SE (f)	corr Z (g)
fam inc 195	0.8725977	0.8161354	0.7912333	0.8802059	0.8086573	0.833766	0.081369	0.074723	0.073391	0.0799	0.073487	0.0765741	1.42843E-05	1.71412E-05	0.005892161	0.076760	-2.17
mother's ec	0.9876519	0.9925749	0.9983864	0.9971314	0.9945747	0.994064	0.019648	0.019773	0.019935	0.019944	0.019828	0.0198255	1.50307E-08	1.80368E-08	0.000393081	0.019826	-0.30
father's ed	1.012913	1.017143	1.020962	1.017546	1.017984	1.017310	0.019041	0.019121	0.019093	0.019005	0.019046	0.01906114	2.09509E-09	2.51411E-09	0.000363331	0.019061	0.91
father's sei	0.9996213	0.9996396	0.999866	0.9998716	0.9998017	0.999760	0.000267	0.000268	0.000266	0.000265	0.000265	0.00026618	1.057E-12	1.2684E-12	7.08539E-08	0.000266	-0.90
size of tow	1.006931	1.014118	1.026647	1.020756	1.019108	1.017512	0.023244	0.023311	0.023701	0.023527	0.023456	0.02344792	3.26809E-08	3.92171E-08	0.00054987	0.023449	0.75
farm (1=Y)	0.7640067	0.7530207	0.7601997	0.7762171	0.7540434	0.761498	0.126924	0.124934	0.125983	0.128595	0.125189	0.1263249	2.21359E-06	2.65631E-06	0.015962408	0.126342	-1.89
num sibs	0.998028	1.025553	1.095898	1.098852	1.063905	1.056447	0.01898	0.018798	0.018243	0.018337	0.01845	0.0185614	9.87796E-08	1.18535E-07	0.000344723	0.018567	3.04
intact famil	0.968339	0.9808718	1.045806	0.9357342	1.069725	1.000095	0.145628	0.146862	0.158208	0.134875	0.163218	0.14975828	0.000124874	0.000149849	0.022677291	0.150590	0.00

IQ, GRADES	hazard ratio					avg hr (a)	se										
	run 1	run 2	run 3	run 4	run 5		run 1	run 2	run 3	run 4	run 5	avg se (b)	S^2 (q) (c)	S2q(1+1/m) (d)	corr var (e)	corr SE (f)	corr Z (g)
fam inc 195	0.8775895	0.820022	0.7959843	0.8836444	0.8112525	0.837699	0.08182	0.075043	0.073873	0.080182	0.073782	0.0769399	1.4326E-05	1.71912E-05	0.0059484	0.077126	-2.10
mother's ec	0.992952	0.9975299	1.002171	1.001175	0.999162	0.998598	0.019973	0.020096	0.020212	0.020233	0.020136	0.02012984	1.0724E-08	1.28688E-08	0.000405232	0.020130	-0.07
father's ed	1.015307	1.019451	1.023038	1.019648	1.020335	1.019556	0.019156	0.019232	0.019207	0.019114	0.019166	0.01917492	2.0957E-09	2.51484E-09	0.000367682	0.019175	1.02
father's sei	0.9996771	0.9996911	0.999902	0.9999128	0.9998486	0.999806	0.000268	0.000269	0.000267	0.000266	0.000266	0.00026736	1.328E-12	1.5936E-12	7.1484E-08	0.000267	-0.72
size of tow	1.005506	1.012431	1.026216	1.020168	1.018615	1.016587	0.02331	0.023377	0.02379	0.023622	0.023552	0.02352996	3.70888E-08	4.45065E-08	0.000553733	0.023532	0.70
farm (1=Y)	0.7775957	0.7647703	0.7694654	0.7851318	0.7649131	0.772375	0.129228	0.126953	0.127593	0.130122	0.127064	0.12819216	1.99166E-06	2.38999E-06	0.016437213	0.128208	-1.78
num sibs	0.994092	1.021635	1.093259	1.096005	1.060895	1.053177	0.019024	0.018847	0.018318	0.018419	0.018525	0.01862656	8.86785E-08	1.06414E-07	0.000347126	0.018631	2.85
intact famil	0.9811559	0.9934717	1.053437	0.945707	1.07898	1.010550	0.147713	0.148894	0.15952	0.136681	0.164677	0.15149692	0.00011967	0.000143604	0.023190657	0.152285	0.07
iq	0.9969703	0.997723	0.9969033	0.9967429	0.9965315	0.996974	0.004361	0.004351	0.004338	0.004328	0.004371	0.00434956	2.98743E-10	3.58492E-10	1.89193E-05	0.004350	-0.70
grades	0.9954047	0.9950191	0.9975586	0.9975257	0.9970878	0.996519	0.00427	0.004265	0.004278	0.004271	0.004283	0.00427338	5.3157E-11	6.37884E-11	1.82619E-05	0.004273	-0.81

AMBITIONS	hazard ratio					avg hr (a)	se										
	run 1	run 2	run 3	run 4	run 5		run 1	run 2	run 3	run 4	run 5	avg se (b)	S^2 (q) (c)	S2q(1+1/m) (d)	corr var (e)	corr SE (f)	corr Z (g)
fam inc 195	0.8730528	0.8190605	0.7935621	0.8822088	0.8134476	0.836266	0.08145	0.074999	0.073631	0.080218	0.073903	0.07684014	1.37444E-05	1.64932E-05	0.005931896	0.077019	-2.13
mother's ec	0.990974	0.995749	1.000016	0.99879	0.9954707	0.996200	0.019964	0.02011	0.020235	0.020269	0.020103	0.02013622	1.47108E-08	1.7653E-08	0.000405497	0.020137	-0.19
father's ed	1.015223	1.018385	1.021723	1.018994	1.019752	1.018815	0.019208	0.019299	0.019273	0.019191	0.01923	0.01924008	2.02772E-09	2.43327E-09	0.000370185	0.019240	0.98
father's sei	0.9996497	0.999667	0.9998731	0.9998842	0.9998019	0.999775	0.000271	0.000271	0.000269	0.000269	0.000269	0.00026992	1.132E-12	1.3584E-12	7.28591E-08	0.000270	-0.83
size of tow	1.00564	1.01204	1.02569	1.019773	1.01823	1.016275	0.023307	0.023378	0.023794	0.023628	0.023565	0.0235343	3.82952E-08	4.59542E-08	0.00055394	0.023536	0.69
farm (1=Y)	0.7696306	0.7588166	0.7610975	0.7785628	0.7579773	0.765217	0.12795	0.126037	0.126309	0.129093	0.125948	0.12706746	1.94305E-06	2.33165E-06	0.016150025	0.127083	-1.85
num sibs	0.9952668	1.024016	1.095246	1.097573	1.063231	1.055067	0.019156	0.018996	0.018443	0.018535	0.018663	0.01875852	9.33584E-08	1.1203E-07	0.000352069	0.018763	2.93
intact famil	0.9843901	0.993624	1.055465	0.9472446	1.080183	1.012181	0.148149	0.14891	0.159797	0.136829	0.164835	0.15170384	0.000119911	0.000143893	0.023253876	0.152492	0.08
iq	0.9966167	0.9972799	0.9964426	0.99629	0.9959899	0.996524	0.004383	0.004379	0.004364	0.004354	0.004399	0.00437558	2.96537E-10	3.55844E-10	1.91463E-05	0.004376	-0.79
grades	0.9941894	0.9940043	0.9964222	0.9965308	0.9956289	0.995355	0.004374	0.004354	0.004379	0.00437	0.004383	0.00437214	1.25293E-10	1.50352E-10	1.91159E-05	0.004372	-1.06
ed ambitio	0.7949149	0.8546981	0.9003542	0.8913161	0.8015533	0.848567	0.121883	0.132092	0.140361	0.13805	0.123152	0.13110766	7.07963E-05	8.49555E-05	0.017330811	0.131647	-1.15
occ ambitic	1.000707	1.000576	1.000479	1.000475	1.000782	1.000604	0.000272	0.000277	0.000278	0.000278	0.00027	0.00027484	1.3468E-11	1.61616E-11	7.5564E-08	0.000275	2.20

Appendix 2, continued

EDUCATION	hazard ratio					avg hr (a)	se										
	run 1	run 2	run 3	run 4	run 5		run 1	run 2	run 3	run 4	run 5	avg se (b)	S^2 (q) (c)	S2q(1+1/m) (d)	corr var (e)	corr SE (f)	corr Z (g)
fam inc 195	0.8794422	0.8241951	0.7966813	0.885313	0.8201039	0.841147	0.082354	0.075774	0.074139	0.080707	0.074829	0.07756068	1.38101E-05	1.65721E-05	0.006043279	0.077739	-2.04
mother's ec	0.992473	0.9968919	1.000875	0.9996215	0.997011	0.997374	0.020048	0.020186	0.020307	0.020338	0.020196	0.02021506	1.31749E-08	1.58099E-08	0.000408675	0.020216	-0.13
father's ed	1.016557	1.019339	1.022357	1.019642	1.021044	1.019788	0.019283	0.019357	0.019322	0.019241	0.019302	0.01930094	1.89653E-09	2.27584E-09	0.00037253	0.019301	1.03
father's sei	0.9996735	0.9996843	0.9998841	0.9998961	0.9998249	0.999793	0.000271	0.000272	0.00027	0.00027	0.00027	0.00027036	1.168E-12	1.4016E-12	7.30969E-08	0.000270	-0.77
size of tow	1.005398	1.011883	1.025565	1.019732	1.018209	1.016157	0.023275	0.023357	0.023781	0.023613	0.02354	0.02351294	4.07985E-08	4.89582E-08	0.00055294	0.023515	0.69
farm (1=Y)	0.7782546	0.7650546	0.7646745	0.7826124	0.7666488	0.771449	0.129549	0.127217	0.127008	0.129901	0.127534	0.12824204	1.88387E-06	2.26064E-06	0.016449789	0.128257	-1.78
num sibs	0.9953817	1.024001	1.09519	1.0976	1.06327	1.055089	0.019146	0.018985	0.018431	0.018526	0.018647	0.01874698	9.36374E-08	1.12365E-07	0.000351637	0.018752	2.94
intact famil	0.9813367	0.9918453	1.053848	0.9457875	1.077281	1.010020	0.147721	0.148654	0.159561	0.136628	0.164403	0.15139324	0.000118746	0.000142495	0.023157405	0.152176	0.07
iq	0.9970262	0.9975746	0.9966502	0.9964939	0.9963639	0.996822	0.004394	0.00439	0.004375	0.004365	0.004409	0.00438646	2.82203E-10	3.38644E-10	1.92416E-05	0.004387	-0.72
grades	0.9946576	0.9943814	0.9966476	0.9967744	0.9962007	0.995732	0.004392	0.004375	0.004394	0.004387	0.004409	0.00439142	1.50497E-10	1.80596E-10	1.92849E-05	0.004391	-0.97
ed ambitio	0.8670765	0.9142824	0.942002	0.9328649	0.8767227	0.906590	0.145212	0.154093	0.159988	0.158005	0.146817	0.1528227	4.34505E-05	5.21406E-05	0.023441679	0.153107	-0.61
occ ambitic	1.000772	1.000629	1.000515	1.00051	1.000849	1.000655	0.000276	0.000281	0.000283	0.000282	0.000274	0.00027938	1.5697E-11	1.88364E-11	7.80846E-08	0.000279	2.34
educationa	0.9503916	0.9609579	0.9737386	0.9738759	0.9480517	0.961403	0.038583	0.039032	0.03916	0.039336	0.038609	0.03894388	1.12702E-07	1.35242E-07	0.001516851	0.038947	-0.99

MILITARY	hazard ratio					avg hr (a)	se										
	run 1	run 2	run 3	run 4	run 5		run 1	run 2	run 3	run 4	run 5	avg se (b)	S^2 (q) (c)	S2q(1+1/m) (d)	corr var (e)	corr SE (f)	corr Z (g)
fam inc 195	0.8789667	0.826271	0.7988307	0.8870216	0.8187613	0.841970	0.082311	0.075938	0.074406	0.080869	0.074694	0.07764352	1.35711E-05	1.62853E-05	0.006055658	0.077818	-2.03
mother's ec	0.9925211	0.9964822	1.000478	0.9995165	0.9968531	0.997170	0.020044	0.020205	0.020335	0.020349	0.020239	0.02023424	1.50911E-08	1.81093E-08	0.000409455	0.020235	-0.14
father's ed	1.016516	1.019746	1.022799	1.019722	1.02089	1.019935	0.019281	0.019377	0.019284	0.019246	0.019227	0.01928314	3.34109E-09	4.00931E-09	0.000371846	0.019283	1.03
father's sei	0.9996718	0.9996886	0.9998937	0.9998957	0.9998456	0.999799	0.000271	0.000272	0.000269	0.00027	0.000269	0.00027022	1.297E-12	1.5564E-12	7.30214E-08	0.000270	-0.74
size of tow	1.005448	1.011787	1.025766	1.019666	1.01816	1.016165	0.023281	0.02335	0.02375	0.023597	0.023475	0.02349048	3.56698E-08	4.28038E-08	0.000551874	0.023492	0.69
farm (1=Y)	0.7783043	0.7651577	0.7653187	0.7826381	0.7614058	0.770565	0.129563	0.127222	0.127032	0.129876	0.1266	0.1280584	2.36158E-06	2.8339E-06	0.016403677	0.128077	-1.79
num sibs	0.9954005	1.023854	1.094022	1.097472	1.06222	1.054594	0.019147	0.01898	0.018396	0.018517	0.018601	0.01872828	1.02422E-07	1.22906E-07	0.000350953	0.018734	2.91
intact famil	0.9795181	0.9959598	1.07475	0.9488439	1.101234	1.020061	0.147561	0.149325	0.163299	0.137205	0.168486	0.15317502	0.000159578	0.000191494	0.023781744	0.154213	0.13
iq	0.9970687	0.9973969	0.9963776	0.9964188	0.9958779	0.996628	0.004397	0.00439	0.004378	0.004367	0.004411	0.0043885	2.845E-10	3.414E-10	1.92595E-05	0.004389	-0.77
grades	0.9946355	0.994493	0.9968663	0.996805	0.9966452	0.995889	0.004394	0.004371	0.004389	0.004386	0.004403	0.00438854	1.34608E-10	1.6153E-10	1.92596E-05	0.004389	-0.94
ed ambitio	0.8661929	0.9171026	0.951036	0.9354662	0.8878613	0.911532	0.14509	0.154629	0.161849	0.158564	0.149021	0.15383066	4.67175E-05	5.6061E-05	0.023757307	0.154134	-0.57
occ ambitic	1.000774	1.000627	1.000497	1.000508	1.000825	1.000646	0.000276	0.000281	0.000283	0.000283	0.000275	0.00027958	1.5417E-11	1.85004E-11	7.81958E-08	0.000280	2.31
educationa	0.9504736	0.9599304	0.9720796	0.9733306	0.9468367	0.960530	0.038592	0.039008	0.039133	0.039332	0.03859	0.03893108	1.09689E-07	1.31627E-07	0.001515848	0.038934	-1.01
military (1=	0.8694883	1.646437	2.21786	1.27668	2.475764	1.697246	0.437881	0.628863	0.714203	0.526555	0.761601	0.61382032	0.017678042	0.02121365	0.412131469	0.641975	1.09

Appendix 2, continued

MARRIAGE (SAT)	hazard ratio					avg hr (a)	se										
	run 1	run 2	run 3	run 4	run 5		run 1	run 2	run 3	run 4	run 5	avg se (b)	S^2 (q) (c)	S2q(1+1/m) (d)	corr var (e)	corr SE (f)	corr Z (g)
fam inc 19!	0.8792294	0.8272725	0.7984876	0.883967	0.8168308	0.841157	0.082549	0.076168	0.074462	0.080796	0.074577	0.07771026	1.39207E-05	1.67049E-05	0.006066726	0.077889	-2.04
mother's ec	0.9928462	0.9967655	1.000508	0.9993347	0.9967379	0.997238	0.020033	0.020209	0.02034	0.020349	0.02023	0.0202322	1.63047E-08	1.95656E-08	0.000409375	0.020233	-0.14
father's ed	1.017051	1.020246	1.023127	1.02044	1.021695	1.020512	0.019296	0.019394	0.019307	0.019275	0.019263	0.0193069	2.65788E-09	3.18946E-09	0.000372762	0.019307	1.06
father's sei	0.9996818	0.9996965	0.9998973	0.9999071	0.9998624	0.999809	0.000271	0.000272	0.000269	0.00027	0.00027	0.0002704	1.345E-12	1.614E-12	7.31189E-08	0.000270	-0.71
size of tow	1.004581	1.010954	1.025637	1.020021	1.018041	1.015847	0.023305	0.023356	0.023766	0.023618	0.023493	0.02350742	3.58292E-08	4.29951E-08	0.00055267	0.023509	0.67
farm (1=Y)	0.7726463	0.7594108	0.7621746	0.7786824	0.7571676	0.766016	0.128648	0.126316	0.126575	0.129258	0.125883	0.12733598	2.28693E-06	2.74432E-06	0.016219026	0.127354	-1.84
num sibs	0.9953905	1.023921	1.094114	1.097748	1.062408	1.054716	0.019161	0.018995	0.018407	0.018534	0.018619	0.01874326	1.02531E-07	1.23037E-07	0.000351515	0.018749	2.92
intact famil	0.9809113	0.997384	1.076183	0.9583202	1.108851	1.024330	0.148112	0.149722	0.16381	0.138955	0.169879	0.15409576	0.000156912	0.000188294	0.024059327	0.155111	0.16
iq	0.9970814	0.9974118	0.9963468	0.9963608	0.9958365	0.996607	0.004389	0.004385	0.004376	0.004364	0.004404	0.00438342	2.29037E-10	2.74844E-10	1.92148E-05	0.004383	-0.77
grades	0.9948514	0.9947248	0.9970129	0.9969697	0.9969253	0.996097	0.004392	0.00437	0.004394	0.004391	0.004404	0.00439014	1.47918E-10	1.77502E-10	1.92736E-05	0.004390	-0.89
ed ambitio	0.8725739	0.9226755	0.9532144	0.940068	0.8930751	0.916321	0.14603	0.155419	0.162164	0.159197	0.1498	0.15452206	4.38674E-05	5.26409E-05	0.023964802	0.154806	-0.54
occ ambitic	1.000773	1.000636	1.000508	1.000536	1.000844	1.000659	0.000278	0.000283	0.000286	0.000284	0.000276	0.0002812	1.6635E-11	1.9962E-11	7.91067E-08	0.000281	2.34
educationa	0.9415165	0.9526283	0.9696678	0.9725726	0.9426029	0.955798	0.039252	0.039879	0.040244	0.040461	0.039436	0.0398543	2.64377E-07	3.17253E-07	0.001588894	0.039861	-1.11
military (1=	0.8410629	1.600419	2.201461	1.258155	2.434084	1.667036	0.424034	0.61283	0.709596	0.519455	0.749292	0.60304134	0.017967339	0.021560807	0.399593535	0.632134	1.06
unmarried	0.8311202	0.8589874	0.93482	0.9203291	0.8681479	0.882681	0.10971	0.114362	0.126374	0.124519	0.114701	0.11793326	5.13572E-05	6.16287E-05	0.014010968	0.118368	-0.99
yr 1st mar (	0.9896731	0.9870269	0.9894505	0.9741624	0.9740508	0.982873	0.026127	0.026044	0.025651	0.025752	0.026067	0.02592846	4.49934E-08	5.39921E-08	0.000672375	0.025930	-0.66

(a) sum(hr)/5 (b) sum(se)/5 © sum ((qi-q-bar)^2/4) (d) S2*(1+1/5) (e) (1/5)*(sum ((qi^2)+S2)) (f) SQRT(corr var) (g) (avg hr-1)/corr se

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