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ABSTRACT

The aging of the U.S. population coupled with heightened consumerism among those using the health care system have increased public and research interest in menopause. Despite these trends, we know little about the process of menstrual cessation. This paper reviews previous claims regarding secular trends in menopausal age by considering how menstrual cessations differ by type: (1) that due to surgical intervention such as hysterectomy, and (2) that due to "natural" (non-surgical) menopause.

Kaufert recommends that the experience of surgically-induced menopause (through the removal of the uterus and/or ovaries) be excluded from analyses of naturally-occurring menopause. However, analyses of menopause that exclude hysterectomized women are flawed, because such women constitute a high proportion of American women at mid-life. In 1992, 580,000 women had their uteri surgically removed, and cumulatively more than one-third of U.S. women will undergo this procedure by age sixty.

Competing risk survival analysis techniques are applied to model the shape of the underlying hazards for reproductive organ surgery versus "natural" menopause among 3506 mid-life women from the Wisconsin Longitudinal Study. Actuarial life table estimates and non-parametric Kaplan-Meier estimates are used as exploratory techniques. Weibull models are used to evaluate effects of a variety of possible correlates (including education, mental ability, occupation, family background, fertility experience, smoking behavior and hormone therapy). While socioeconomic parameters do contribute to observed differences in age at menstrual cessation, these factors operate through more proximate health-related behaviors (such as smoking in the case of natural menopause and fertility for surgical menopause).

Introduction

Of late, the subject of menopause has enjoyed a great deal of popular media attention in the United States. As the population ages, due to the aging of post World War II baby boomers and to life expectancy gains, more women are in the phase of their lives when menopause is likely to occur. Despite this increasing attention, what is really known about the menopausal transition is limited.

Menopause is an important topic of study in demography for a number of reasons. Its role as a marker of the finality of fecundity in a woman's life cycle is applicable under natural fertility regimes. In societies with controlled fertility, however, women complete the reproductive phases of their lives well before menopause. Menopause might also be a marker for biological aging in women. An early menopause has been found to be associated with an elevated mortality rate (Snowdon et al., 1989).

Assumptions about the final close of a woman's fertility are often made in demographic research. For the most part, fertility studies consider the childbearing phase of women's lives as lasting until 45 or 50. Fertility rates decline precipitously before these ages. And without exception, studies of populations from industrialized nations have centered menopausal age estimates at around fifty years of age. (See Khaw, 1992.) One recent study of mid-life Massachusetts women found a median age at menopause of 51.3 years (McKinlay et al., 1992: 107).

Research on the timing of menopause has tended to focus on the "natural" (nonsurgical, and sometimes also non-exogenous-hormonal) menopause only. Yet restricting data to a "natural" menopausal experience precludes samples from being representative of a large proportion of midlife female experience. The prevalence of hormone use and reproductive organ surgery are high in the United States. For some women, menopause is a life phase associated with illness. Many seek medical assistance for unpleasant symptoms, such as hot flashes, associated with menopause.[1] American physicians have prescribed numerous drugs, particularly estrogens, to ameliorate these symptoms. The sometimes heavy bleeding associated with the menopausal transition for some has contributed to surgical intervention. American women in particular are at risk for a high prevalence of hysterectomy; by age sixty more than one-third of U.S. women have had their uteri removed (U.S. Congress OTA, 1992: 20). All in all, the menopause may indeed mark a period in women's lives when they utilize medical care and treatment extensively.[2]

This paper represents an attempt to synthesize questions regarding what social and behavioral factors are related to menstrual cessation via menopause and hysterectomy. Event history analytical techniques are used to evaluate the process of menstrual cessation and its correlates.

Long Term Trends in Age at Menopause

Secular trends in age at menarche led to the hypothesis that menopause may be affected by environmental conditions, such as diet and disease, and by genetic factors. Improved health might manifest itself in an extension of the reproductive life-span at both endpoints (i.e. earlier menarche and later menopause). But the evidence, as assessed in the 1960s, supports the conclusion that age at menopause remained relatively stable -- centered at about 50 years of age -- for over one hundred years (Burch and Gunz, 1967: 8). One study of Finnish women reports a steady increase in the estimated age at menopause from 47.9 years in 1897 to 51 years at present (Luoto et al.,

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[1] The meaning and interpretation of menopause and hot flashes appear to vary cross-culturally. (See especially Kroenberg (1990) for a review of hot flashes.)

[2] American women generally have higher health care utilization rates compared to American men in terms of annual physician visits, hospitalization, and prescription drug use (Pol and Thomas, 1992: 330 (Table 11.2), 334).

1994: 72-73). While there appears to have been a slight rise in the *mean* age of menopause in the United States and in the developed world generally (Pearl, 1938:51-2, 319; Khaw, 1992: 252-3), those differences have been attributed to differences in age structure of the sampled populations and to methodological inconsistencies (MacMahon and Worchester, 1966: 7-8). For example, changes in the mortality schedule of a population might have contributed to changes in the observed distribution of menopausal age over time. Another difficulty in evaluating trends in menopausal age centers on the choice of estimates. Means are very sensitive to missing cases and outliers, and medians will be distorted if right-censored cases are excluded. None of the secondary sources claiming a trend in menopausal age explicitly address these issues of measurement.

Given the dearth of long term data on menopausal age, competing scenarios regarding the selection effects of increased survivorship on menopausal age (or any midlife event) seem difficult to support or refute. However, there is recent evidence to support a proportional association between menopause and mortality. The Snowdon team (1989: 710) found that among Seventh-day Adventist women, the odds of death decreased as natural menopausal age increased, up to age 55. In a later analysis, Snowdon (1990: 405) found that an early age at natural menopause was associated with both a longer post-menopausal life and an earlier age at death, for these women. While Snowdon's analyses can not provide a direct answer to the question of how improvements in population life expectancies have influenced observed menopausal age, his findings do support the rejection of the claim that improved survivorship benefitted early menopausal women more and thus decreased observed menopausal age. Women with an early natural menopause tend to die earlier than women with later natural menopause.

Another piece of evidence that supports the assertion that early menopause is indicative of ill-health comes from the comparison of healthy versus malnourished groups in Third-World populations. For example, one study of Melanesian women in Papua New Guinea found the difference in median age between nourished and malnourished women to be 3.7 years (Khaw, 1992: 253-4).

Previous Research

Much of the diverse literature on menopause is replete with methodological concerns. A primary concern focuses upon the use of clinical populations to evaluate the menopausal transition. Convenience samples of women who have sought medical care are common and have been used mistakenly to evaluate the level of menopausal distress among women in the general population (see McKinlay and McKinlay, 1973: 535-41).

While the social scientific literature emphasizes the use of population or community based representative samples in order to reduce selection biases, there have remained questions about what kinds of study design are most suitable. For example, McKinlay and McKinlay (1973) are skeptical of the value of retrospective data. Observed age heaping and difficulties in recall, especially for respondents who experienced an event well before a study, are viewed as riddling any analysis. Some correction of digit preference has been utilized in other retrospective studies (Bolden and Jeune, 1990: 295; Luoto et. al, 1994: 67). However, all data are subject to error, and the task of statistical analysis is to minimize the effects of error. Although there is evidence of age heaping in the data used for this paper, the consequences of such heaping have been minimized.

Much of the contemporary literature endeavors to avoid retrospective designs altogether (Kaufert et al., 1986: 1285-6). Alternative designs can introduce other issues when considering the relationship between menopausal aetiology and age. The sorts of data sets generated for menopausal research tend to be highly specialized and prospective.

Analytical techniques vary widely. Often, investigators purposefully exclude those for whom the event of menopause has yet to occur (e.g., MacMahon and Worchester, 1966: 6-7; Leidy, 1990a, 1990b). Excluding right censored cases may introduce bias in the statistical estimates, and thus yield improper inferences.[3] Yet including all right censored cases in direct estimates of median menopausal age is also problematic, because it is necessary to assume that all right censored cases will eventually experience menstrual cessation. This would be an incorrect assumption, because long term hormone therapy can permanently forestall menstrual cessation by mimicking ovarian function. Women with experience taking hormones are less likely to undergo menopause "naturally" due to the delaying effect of hormone therapy. Yet use of hormone therapy is not limited to women with intact uteri who continue to menstruate "artificially". Surgically menopausal women have a high rate of hormone use. Women whose ovaries have been removed often go on hormone "replacement" therapy following their operation.

Most troubling is the omission of women who experience menstrual period cessation as a result of surgical intervention. The case that should have been made in the literature is that the process of menstrual cessation and its consequences are different for women who experience it naturally from those who experience it surgically. However, these researchers claimed that the best way to learn about the natural menopausal phenomenon was to purge one's data of the surgical menopause experience.

> Women whose menses are stopped surgically should *not* be included with those undergoing natural menopause, particularly when health related outcomes are under investigation (Kaufert et. al., 1986: 1286).

> Methodologically speaking, the naturally and the artificially menopausal should neither be combined in the same study population, nor should generalizations be made from one set of women to the other (Kaufert, 1990: 116-7).

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[3] See Smith (1992:chapters 4 through 6, especially Appendix 4A-1) and Tuma and Hannan, 1984: chapter 5) for detailed discussions of bias and censored events in life table analyses.

However, these claims should not be universally applied to menopause research. While aetiological and symptomological questions might be better explored by such a data restriction, where timing is concerned, the menstrual and ovulatory exposure of surgically menopausal women should be included in analyses. The crux of the problem is found in the notion of the risk set, and in the assumption of "prior" knowledge of the manner of menstrual cessation and its distribution.

While it is certainly important to investigate the natural menopausal transition, the context in which United States women experience menopause is one where the risk of natural menopause competes with surgically induced menopause. In 1992, 580,000 women had their uteri surgically removed (NCHS, 1994). Cumulatively, about 37 percent of American women undergo hysterectomy by age 60 (U.S. Congress OTA, 1992: 20).

Given that socioeconomic differences are frequently identified in studies of health outcomes, a number of measures of socioeconomic status are included in the analyses for this paper. Social class has been consistently found to be positively associated with health and negatively associated with morbidity and mortality (Alder et. al., 1993; Marmot et. al., 1987). Socioeconomic status has been posited to be related to health through a variety of mechanisms. Social class may be correlated with health through access to resources, especially access to health and medical care. The association between socioeconomic status and health could be spurious, such that common factors affect both outcomes. A selection effect has been hypothesized as well, such that poor health depresses upward social mobility.[4]

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[4] This paper can not distinguish between these hypotheses. Although the analytical models do take advantage of the temporal ordering of independent versus dependent variables, the precise mechanisms of observed correlations should not be interpreted as direct or causal.

Associations between education attainment and age at menopause have been inconsistent across samples. McKinlay et. al. (1992: 108) did not find education effects among their sample of Massachusetts women when they controlled other variables, while Luoto et. al. (1994: 73) did find persistent educational differences in their sample of Finnish women, where women with higher levels of education experienced later menopause. Kjerulff et. al. (1993) identified education as a major correlate of hysterectomy among American women; those in the 1988 Behavioral Risk Factor Surveillance System study with lower levels of educational attainment had higher prevalences of hysterectomy than those with more schooling.

Santow and Bracher (1992: 936) found educational attainment to be significant in their model of the risk of hysterectomy for Australian women; a dummy variable indicating university attendance reduced the risk of hysterectomy in their model. In a later study, Santow (1995) explored in depth the relationship between educational attainment and hysterectomy and found that within the medical encounter college-educated women were offered hysterectomy less often than less-educated women, and that once offered, better-educated women were more likely to resist the suggestion of surgery.

The number of children ever born to a woman has been posited to affect her age at natural menopause, and also the age and likelihood of surgery. For at least part of the lifecourse of the women included in the sample for this paper, American physicians considered both age and parity in decisions regarding sterilization including hysterectomy. For example, the 1965 professional standards for voluntary contraceptive sterilization defined as permissible sterilizations for women age 25 with at least five children, age 30 with 4 or more, and age 35 with at least three living children (American College of Obstetrics and Gynecology, 1965: 49, 57). Such recommendations for contraceptive sterilization are summarized in these analyses of hysterectomy as whether or not a woman's age multiplied by her parity exceeds 120. (See below.) Santow and Bracher's (1990:

932, 936) analysis of hysterectomy demonstrates that parity indeed has significant positive effects on risk of hysterectomy both by itself and combined with age. In their final model including time-varying dummies for the number of children ever born, the greatest effect on the risk of hysterectomy was for a dummy for parity of three or more at ages 20 to 24. A dummy variable for children ever born was included in the MWHS study on non-surgical menopause (McKinlay et. al., 1992: 108-109) but was not found to be associated with menopausal age.

Given that hysterectomy has ramifications for a woman's fecundity, it is unlikely that decisions to undergo hysterectomy are made without regard to past fertility and conception behavior, especially at younger ages. For example, women with tubal sterilizations are slightly more likely to undergo hysterectomy than other women, at least during the years immediately following their sterilizations (Althaus, 1994).

Smoking has been consistently identified in numerous studies as associated with reduced menopausal age (Baron and Greenberg, 1987: 151-2; McKinlay et. al., 1992; Luoto et. al., 1994). The MWHS study found a significant difference in age at natural menopause for current smokers versus non-smokers. Smokers had a median age at natural menopause at least 1.73 years lower than non-smokers (ibid). Smoking exhibits negative consequences for the reproductive system, in addition to its consequences for the cardiovascular system (Snowdon et al., 1989: 709), and thus may be expected to be associated with an earlier menopause. Cigarette smoking has been theorized to have an antiestrogenic effect, and is an ovarian toxin in rodents (Baron and Greenberg, 1987: 156). There is suggestive evidence that cigarette smoking is related to an elevated risk of cervical cancer (Swan, 1987: 182), however, smoking's antiestrogenic effect is implicated in a *reduced* risk of endometrial cancer among smokers (Rosenberg and Lesko, 1987: 164). Therefore, cigarette smoking might be associated with some cancers related to hysterectomy (cervical cancer) but not to others (endometrial cancer).

A sizeable proportion of women in the United States and in this study experience their menopause as a medically mediated event. In particular, the use of midlife hormone therapy should be considered in the examination of menstrual cessation.[5] The timing of hormone therapy can vary relative to the onset of women's menstrual irregularities accompanying menopause; among women who use hormone therapy, some begin after their menstrual periods have ceased, while others begin before any menstrual changes become apparent. For women with intact uteri, some varieties and dosages of hormone therapy may induce uterine bleeding or menstruation. Therefore, hormone therapy may be associated with a delayed last menstrual period. Women who have had both ovaries removed, especially at younger ages, may be more likely to have hormones prescribed for them to replace their natural estrogen production, but women who had surgery due to cancers may actively avoid any exogenous hormone ingestion. The relationship between hormone therapy and menopause—both surgical and non-surgical—is complicated, and cannot receive a complete treatment in this paper. (See below.) However, a flag for whether a woman ever had hormone therapy is included in the parametric model. Hormone therapy has been observed to vary by social class, therefore it is important to control effects of hormones when examining any relationship between socioeconomic factors and menstrual cessation.

The Data

The data used in analyses for this paper are from the Wisconsin Longitudinal Study (WLS), a one-third simple random sample of the Wisconsin high school class of 1957 (N = 10,317). The goal of the original study was to determine what the future demand for higher education in the state would be. It later evolved into a study of social mobility. Additional data

[5] There is no single consensus within the medical community on hormone therapy for mid-life women. Thus decisions on hormonal treatment tend to be idiosyncratic and reflect individual women's health risks and family histories. Heightened susceptibility to cancers may be outweighed by the protective cardiac effects of estrogen, for example.

were collected from parents in 1964, from respondents in 1975, and from randomly selected siblings in 1977. In 1992-93, a follow-up round took place in two parts: a telephone interview (lasting about 1 hour) and a mailed questionnaire (about 20 pages) which contained the items on menopause and health.

Overall, the one-third WLS sample included 5325 women. By 1992, the telephone interview response rate for women was 84.8 percent (4514 / 5325). Of the 3684 women who returned the mail questionnaire, 92 failed to complete any of the questions on women's health, and 68 had to be excluded because of missing data on the type and/or age of menstrual cessation. Another eighteen were excluded because of excessively early reported menstrual cessation, under age 25, due to offsetting the start time of the processes (see below). The final analyses of 3506 women represents 65.8 percent of the original female WLS sample, and 77.7 percent of those women found and interviewed in 1992-93.

The WLS sample, as representative of 1957 Wisconsin high school graduates, is predominately white, and, by definition, does not represent those who attained less than twelve years of education. Other surveys used for menopausal analyses of women at mid-life also tend to be similarly selective, though not purposefully. An advantage to using sociological data, such as the WLS, to study health characteristics, such as menopause, is the inclusion of good measures of socioeconomic status.[6] In a recent U.S. Office of Technology Assessment Report on menopause,

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[6] The long duration of the WLS is useful in identifying selectivity in the sample over time Recognition of how this sample evolved over a period of thirty-six years is necessary to situate the results of this study. For example, 229 women in the original sample of 5325 women died by 1992, and nearly equal numbers of these women had education beyond high school (115) as those who did not (114), and they were fairly evenly distributed across parental socioeconomic status. Of those 582 women who did not respond to the 1992 phone interview (but were not identified as deceased), equal numbers (289 versus 293) had no education beyond high school versus those with more schooling. Among those who did participate in the 1992 telephone interview, equal proportions responded to the mail questionnaire as those who did not, by education (high school versus more than high school).

the absence of adequate measures of socioeconomic status in health studies was cited as problematic in analyses of the relationship between health and class (1992: 83).

Although all WLS respondents attained at least a high school diploma, and thus the sample does not represent those on the very low end of educational attainment, this should not preclude the WLS from analyses of health outcomes and social standing. Health differentials exist over the entire range of social class in addition to the pronounced health differentials between the most affluent and impoverished (Alder et. al., 1993; Feinstein, 1993).

The majority of women in the WLS sample were born in 1939 or 1940, and were approximately aged 53 when they were last interviewed and surveyed. Because the maximum age in the sample is close to the median age at menopause cited in the literature, this sample contains heavy censoring. About thirty percent of women were still menstruating at last report (Figure 1A). For these analyses, women who experienced a menstrual period in the twelve months prior to the survey were categorized as still menstruating, and thus are considered censored at the time of interview. About two-fifths experienced period cessation via menopause, and more than a quarter (28.2%) of women faced a surgical end to menstruation. In the United States, rates of hysterectomy have been particularly high compared to other nations, and those high rates are reflected in the experience of this sample (Table 1).

Both risks of surgical and non-surgical menopause are confounded by menstrual cessation delayed or otherwise mediated by artificial hormone therapy. Nearly half (47.9%) of the women in the WLS sample indicated that they had ever used hormone therapy (e.g., exogenous hormones such as estrogen) to alleviate menopausal symptoms (Table 1). Most of the women with experience using hormone therapy (41.3%) underwent a surgical end to their menstrual lives. This reflects the medical practice of prescribing hormone "replacement" therapy for women who had their ovaries removed (typically accompanying the excision of their uteri). The majority

(70.2%) of women experiencing surgical menopause used hormone therapy in their life-times. While proportionately more women in the sample who reported continued menstrual cycling took hormones than women who reported non-surgical menopause, over two-fifths (42.8%) of the women in the still menstruating group have experience taking hormones. Many women who start hormone therapy do not take hormones indefinitely, even though many—though not all—physicians recommend life-time use of hormone therapy. In this sample, nearly half of those who ever used hormone therapy did not do so at the time of the study. A quarter (24.4%) of the sample were currently taking hormones. Because the data collection on hormones varied due to an expansion of question items, a flag for whether a woman ever had hormone therapy is the only indicator of hormone therapy in the analyses for this paper.[7] While hormone use is endogenous to the process of menstrual cessation as modelled here, hormone therapy has been observed to vary by social class, therefore it is important to control effects of hormones when examining any relationship between socioeconomic factors and menstrual cessation.

Given that other researchers have emphasized that the surgical and non-surgical processes are so divergent that they should not appear in the same model, the baseline estimates for each process are expected to yield different shapes. Similarly, I expected that some covariates will have different effects on surgical and non-surgical cessation.

The non-parametric modelling tested a variety of measures of socioeconomic status, such as educational attainment, occupation, social background (e.g., parents' occupation and socioeconomic index score, size of family of origin) and income for effects on menstrual

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[7] Hormone intake could be indicated in a quantitative model as an independent time varying covariate or as a competing destination state such that women who experience protracted menstrual cycling due to exogenous hormone are treated as a separate group distinguished from women with a naturally late menopause (i.e. "natural" censoring). However such parameterizations require full information on the timing of hormone therapy. Fewer than half of the WLS sample of women were asked to report a complete history of hormone intake.

cessation. Only those variables that had independent main effects were included in the parametric Weibull models.

As mentioned above, the original WLS sample was selected based upon educational attainment of at least grade twelve. Just over two-fifths of the sample continued their education past the high school diploma (Table 1). In order to produce a variable with a reasonable amount of variation, four levels of an education variable were constructed: high school only; high school plus some vocational or technical training; high school plus some college; and bachelor's degree or higher. Educational attainment may be related to health via health behaviors, such as smoking and nutrition. Also, educational attainment tends to be negatively associated with lifetime fertility for women.

A measure of high school performance and mental ability was included as a quartiled "best" measure composite of high school grades/rank and Henmon-Nelson intelligence score (measured during respondent's junior year of high school). By including an ability measure, this analysis goes farther than others in teasing out the components of educational effects. Ability and educational attainment are positively associated, with a Pearson correlation of 0.38 (Appendix 2).

Related to educational attainment, a measure of ability could operate in a number of ways on a health outcome such as menstrual cessation. For example, high school performance provides an indication of how well an individual can navigate complex social webs of interaction, expectation, and reward. This crude evaluative composite measure, as an indicator of one's capacity (and willingness) to conform to performance standards in high school, might predict an individual's conformity across a wide variety of situations and circumstances from the job setting to the medical setting. In addition, individuals who have experiences that foster the belief that their actions influence their rewards may carry their internal locus of control (or perceived competence) into other arenas such as their health (Wallston, 1992: 193-4).[8] Mental ability might also operate as an indicator or proxy for one's capacity to adopt and implement practices beneficial to one's health—from a predilection to seek out materials on health and maintain a healthful diet to avoiding specific behaviors which compromise health and resisting negative coping behaviors such as high stress, smoking and alcohol/drug abuse. Furthermore, mental ability is likely associated to the articulateness of female patients which Santow (1995: 15) points to as part of the relationship between education and hysterectomy.

Social class may also be associated with unmeasured health-related behaviors and practices, such as diet or stress. Due to correlations between education, ability and occupational status, the effects of these variables on menstrual cessation may be similar. However, employment status for women is more complicated than for men (see Baxter, 1994), largely because men remain the dominant earners in families.

The WLS's history as a social mobility study gave easy access to variables on 1975 occupational status. Based on most recent occupation as of 1975, indicator variables are included for the entire 1975 female sample for: unemployed or not in the work force; all blue collar jobs and farm jobs; lower white collar jobs (mainly retail sales and clerical positions); and upper white-collar jobs. Unskilled, semi-skilled, and skilled blue collar jobs are collapsed with farm jobs because so few women were employed in any of these categories. Due to correlations among education, ability and occupational status, the effects of these variables on menstrual cessation may be similar. However, employment status for women is more complicated than for men, largely because men remain the dominant earners in families.

[8] Although there is a great deal of literature on the psychology of health behaviors which explores the cognitive processes involved in the adoption of health-promoting behaviors and health-related practices (Noack, 1988), much of this research focuses on specific aspects of cognition but not on generalized ability or academic performance.

In this paper, three kinds of variables were included to represent the effects of children on natural and surgical menstrual cessation. Indicators were included for none, one child, two children, three children, and four or more children as time-varying measures of number of biological children. Another set of dummy variables were included for the woman's age at her first birth (no children, age 20 through 21, age 22 though 23, age 24 through 29, and age thirty or more). Finally, a time-varying indicator variable is included to represent an interaction between a woman's age and her number of biological children. If age times number children was greater than or equal to 120, then this variable gets "turned on".

Half of the women in the sample smoked cigarettes regularly during their lifetime, and about two-fifths of women who smoked did so for more than twenty-five years, about half their lifetime. Dummy variables on ever smoking, current smoking, and number of years smoked were tested in these models.

A number of additional control variables were included in the modeling: a social background indicator of farm origin (whether or not a woman's father was a farmer); a dummy variable for never marrying; and a dummy variable for never having held a job for pay. These indicators were found to have significant effects in the non-parametric modeling (see above), and may have substantive interpretations in terms of differentiating among groups with different backgrounds and lifestyles.

The Methods

The techniques employed to analyze the data for this paper varied, but all fall under the heading "event history". There are two necessary components to event history: (1) failure (whether or not a particular event took place) and (2) duration (when the event occurred, if it did take place). In studying menopause, the lack of a menstrual period constitutes failure. In competing risk scenarios, failure occurs on different dimensions or by types. Duration is merely the waiting time to failure or the interview (censor).

In the WLS, menopause is operationalized retrospectively as a woman's very last menstrual period. This is an epidemiological definition where after twelve months of having no periods whatsoever a woman in considered post-menopausal. For the most part, other studies also have defined menopause as having occurred if there was an absence of menstrual periods for twelve consecutive months. Kaufert et. al. made this recommendation explicit (1986: 1286). Some analysts use different lengths of time to demarcate menopause, such as nine or six months (Kaufert et. al., 1991) or even stretches of amenorrhea lasting three to eleven months to define the peri-menopausal period (McKinlay et. al., 1992). Other methods of locating a woman in the process of menopause are by self-definition, by associated symptoms such as hot flashes, or by hormone levels in the blood (Kaufert, 1986: 67-71). A concern in any operationalization is that menopause is not merely a fixed point in time, but final menstrual cessation may be preceded by extended spells of menstrual irregularity. In this sense, menopause is not a single event *per se*, but a process or transition. An alternative operationalization of menopause considers the duration of the transition of menstrual change. The duration between the median start of mid-life menstrual change (peri-menopause) and the median age of the final menstrual period was estimated to be 3.8 years (McKinlay et. al., 1992: 107).

Although the WLS captures information on symptoms associated with the menopause as well as menopause as explicitly self-defined, for this paper, failure, i.e. menstrual cessation, is defined as having no menstrual period in the twelve months prior to the survey[9]. Menstruating women were treated as censored at the time of the survey.[10]

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[9] See Appendix 1 (A and B) for the actual items from the WLS 1992-93 mail questionnaire.

[10] Duration for censored women equals age. Most women in the sample were aged 53-54 at the time of the 1992-93 study. Because this age is fairly close to reported median ages at menopause,

Type of failure was defined as surgical or non-surgical. Duration for women who failed due to surgical intervention has been complicated by the administration of two alternate questionnaire forms. (See Appendix 1.) One asked whether menopause was due to hysterectomy; the other asked whether and what type of reproductive organ surgery occurred, and respondents identified the organs removed. Age at surgery was also asked for women who had surgery. It is, of course, possible for a woman to undergo more than one surgery to have her uterus and her ovaries removed. Data on age at surgery from the revised questionnaire do not indicate that multiple surgeries were experienced by WLS respondents.

Therefore, for women who ceased menstruation due to surgery, age at surgery, if available, was the failure time. Otherwise, age at last menstrual period was used for duration. Women who stopped menstruating but did not have surgery were assigned durations of age at last period. All analyses for this paper were offset by 25 years.[11] Although the individual items on age at period cessation and age at surgery show slight evidence of final digit preference, the composite nature of the duration variable reduces some of this preferencing, and the summary nature of the analyses reduces the effects of preference bias.

My analytic strategy was threefold and my models evaluate surgical and natural (non-surgical) menopause as competing risks. (See Figure 1B.) First, I used an actuarial lifetable technique to evaluate the overall consequences of different failure, censor, and exclusion specifications. The lifetable method was also useful in comparing the general shapes of the survival functions for surgical and menopausal menstrual cessation. Second, I employed non-

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these data are heavily censored.

[11] There were extremely low numbers of failures in both categories at ages less than 25. The selection of a start time for this process is somewhat arbitrary, given that the WLS contains no data on menarche of primary respondents. However, the few early teenage responses for age at last menstrual period were viewed skeptically by this researcher, and are excluded from these analyses.

parametric Kaplan-Meier estimates in order to decide upon a functional form for the underlying hazard and to identify main effects of independent variables of interest. The third and final strategy was to employ a fully parametric technique to model the hazard and the effects of independent variables.

The Results

In this paper, various censoring and exclusion methods are examined in order to judge whether or not analyses are biased by such data manipulation. I analyzed the data using alternative specifications for censor, using simple actuarial techniques to estimate cumulative probabilities of dying (q_x) and survival ($S(x)$), probability density ($f(x)$) and hazard ($\mu(x)$) functions (using the Lifetest Procedure in SAS).

The result of this exercise was not entirely in accordance with this researcher's expectation, because whether or not the surgically menopausal are treated as censored or excluded tends to make little difference in the estimates of the survival curve for naturally menopausal women (Figure 2). The top curve is the correct specification (natural cessations are failed and all others are censored). The next highest survival curve represents $S(x)$ when women who underwent surgery are dropped entirely, and is nearly equal to $S(x)$ when these women are treated as censored. This by no means should be interpreted as an all-out rejection of the methodological concerns I have raised thus far. Excluding cases unnecessarily reduces the power of any analyses, because standard errors will rise, making a finding of significant differences more difficult.[12] The survival curves for women who cease menstruating due to surgery (Figure 3) are more sensitive to censoring and exclusion, largely because of differences in the overall

[12] It does not follow that such an inclusion of cases, properly specified, will produce misleading results due to an inflation of N and reduction of standard errors.

distributions of surgery, natural menopause and delayed menopause. Estimates of the corresponding hazard rates for each of the alternative censoring and exclusion specifications are given in Figures 4 and 5. For the non-surgical specifications (Figure 4) the hazards are nearly equivalent except for the top curve which approaches 1.0 due to the exclusion of all those who did not experience menstrual cessation. As with the survival curves for surgery, the corresponding hazard rates for surgery (Figure 5) are more sensitive to exclusion and censoring specifications.

The characteristics of the sampled population need to be considered in any serious engagement of this problem of censoring and exclusion. Surgical rates vary considerably across countries, and even within the United States by region. If my sample originated in the southern U.S., I would expect the results of these censoring and exclusion alternatives to differ more, because hysterectomy and oophorectomy rates in the South are higher than in the rest of the U.S. (NCHS, 1994). On the other hand, were my sample from northern Europe or even the Northeastern U.S., I would expect even less difference than in my Wisconsin sample, because surgical rates in those areas tend to be lower (Bachmann, 1990; Fisher, 1988: 39; NCHS, 1994; Payer, 1988). In addition to region, the educational selection of the WLS sample may also have constrained the level of surgery in the sample insofar as other researchers have found relationships between educational attainment and hysterectomy (Kjerulff et. al., 1993; Santow, 1995). Rates of surgery by age do not dominate the overall menstrual survival curve because relative to the natural menopausal component, rates of surgery tend to be smaller and are more invariant by age.

The correctly specified survival functions for surgical cessation, natural cessation, and all menstrual cessations are graphed for comparative purposes in Figure 6. The curve for surgery steadily decreases to about .65 by the mid-fifties. The profile of natural menopause is different. The survival curve for natural menopause steepens over the mid- to late-forties, and drops to about .40 by the mid-fifties. The combined survival curve indicates that menstrual cessation takes places throughout mid-life. Figure 7 provides the related hazard rates for these specifications.

In the second phase of event history analyses, the data were evaluated via non-parametric techniques. Kaplan-Meier estimators were generated, using SAS, in order to determine the possible shapes for the underlying hazards. I approached the data with no preconceptions regarding the shape of the underlying hazard, for I found no explicit examples in the literature. Kaplan-Meier estimators aid in choosing a parametric specification, and in these analyses the indicators, $S(x)$, $\ln(S(x))$, and $\ln(-\ln(S(x)))$, pointed toward a Weibull or a Gompertz model. A Weibull specification was used in subsequent analyses. The general form of the hazard in the Weibull model is:

$$\mu(\underline{x},t) = \exp(\gamma_0 + \gamma_1 \ln t) * \exp(\underline{\beta x}) \quad (1)$$

where μ is the hazard function; $\underline{x}$ is the covariate vector; t is duration; γ_0 is the intercept; γ_1 is similar to a slope parameter; and $\underline{\beta}$ is the vector of covariate effects.

Kaplan-Meier techniques were also useful in narrowing the selection of possible correlates, by using the log-rank (Cox-Mantel) test to distinguish survival curve differences between levels or strata of independent variables. Exogenous variables that had no independent main effects on S(t) with the log-rank test were not considered for evaluation with the fully parametric models.[13]

The results of the third phase of analysis show that the baseline underlying hazard with no covariates using the Weibull model are comparable to the hazards generated via actuarial

[13] Measures that had no significance in log-rank tests for menstrual cessation specifications (surgical, natural or combined) were father's nationality, parents' socioeconomic status, religion, height, 1974 income, and number of children.

techniques (Figures 7 and 8).[14] The hazards differ by failure type, as predicted. For surgical menstrual cessation the Weibull hazard is represented by:

$$\mu(t) = \exp(-6.376 + 0.769 * \ln t) \qquad (2)$$
$$(0.159) \quad (0.057)$$

while for natural cessation the steeper hazard function is:

$$\mu(t) = \exp(-13.755 + 3.383 * \ln t) \qquad (3)$$
$$(0.267) \quad (0.084)$$

Combined failures represent a blending of the other two functions:

$$\mu(t) = \exp(-8.381 + 1.791 * \ln t) \qquad (4)$$
$$(0.126) \quad (0.042)$$

As predicted, the "best" models vary by transition type; both the baseline hazards and the effects of covariates differ in Weibull models for surgical versus natural menopause. Many comparative models were run. Those presented here summarize the more interesting findings (Tables 2 and 3).[15] All of the models presented are significantly different from the previous model (except for model H; see below). The log likelihood ratio test for these model transitions are summarized in Table 4.

The results for surgical cessations (Table 2) for the first model (A) in which only education is included replicates other findings of a differential rate of hysterectomy by educational level. Women with at least a college degree have a hazard of hysterectomy 32 percent lower than women who just completed high school. Adding the ability measure to the model (B) does not

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[14] Except for the drop for 53-54 year olds—due to heavy censoring—the actuarial hazards are generally increasing. The Weibull hazards capture this overall rise.

[15] Although the Weibull models were run for destination states (surgical and non-surgical menstrual cessation) simultaneously, I present the parameters separately for each cessation type.

alter the effect of education much. Neither does the effect of education change drastically when parameters for farm background, never marriage, and never held a job are included (C). When these additional controls are included in the Weibull hazard models, there is hardly any change in the parameters for the surgical transition. Only education appears to have any significant relation to the hazard of surgery in this model.

The effects of education persist in model D which includes 1975 occupation. In this model two additional parameters are significant: the parameter for never having held a job and the parameter for not holding a job in 1975. Women who never held a job by definition did not hold a job in 1975, therefore the effects of both of these significant parameters must be incorporated to evaluate the effect of never working on the hazard of surgery. Never working women have a seven percent higher risk of surgery than other women, because the product of the relative risks for these two parameters is greater than one (1.62 * 0.66 = 1.069). The indicator for no job in 1975 represents some of the women who had intermittent or discontinuous work histories (most likely due to childbearing and childrearing). These women have a much lower risk of surgery (34% lower) than women who held a blue collar or farm job in 1975. This reduced risk of surgery for these intermittently working women may have at least two sources. First, women who were not working in 1975 (but ever held a job) might experience a lower risk of surgery than other women due to a correlation with higher or later fertility. (See below.) Second, the non-working women in 1975 are likely to be able to afford not to work, compared to other women, and thus might have better, more consistent health care access.

Smoking history is added to the model for surgery (E), and again the effects of education remain consistent. An association between smoking and risk of surgery is unclear. Just one of the smoking indicators (13 through 25 years) is significant, and barely that (t = 2.07).

Indicators of fertility history are included in model F. The number of biological children appears to have no effect on the risk of surgery.[16] However, there is a significant interaction between number of children and age. The flag, for whether age multiplied by number of biological children is at least 120, is associated with a significant reduction in the risk of surgery in this model. If physicians were discriminating among women based on their achieved fertility, the effect of this parameter would be to increase the risk of surgery rather than decrease it.

In model F, birth age is significant for the surgical transition. First births at older ages are significantly less likely for women who undergo surgery. Here, the direction of causation is important, because it is unlikely that delayed childbearing, *per se*, reduces the risk of surgery, as suggested by the parameters estimates. Women who give birth at older ages can do so in part because they have *not* had surgery. Notably, the parameter for higher education is no longer significant once these childbearing measures are included. This suggests a framework for the pathways from education to surgery. Childbearing appears to mediate the relationship between education and risk of surgery. Additionally, once indicators of childbearing are included, the parameter for never marrying appears to significantly reduce the risk of surgery. Among this sample of women, remaining single is probably also associated with remaining childless. However, having no biological children does not have significant effects in this model.

Hormone therapy is added in model G. Although the effects of ever hormone therapy are significantly and positively associated with surgery, there is little change in the effects of other correlates on the risk of hysterectomy when hormone therapy is included. The exceptions are that the flag for never married is longer significant, as it was in model F when fertility history was included. The parameter for the second quartile of ability (versus the lowest quartile) also

[16] Number of children had no significant effects in the non-parametric Kaplan-Meier models. And even though number of children had no main effects in the Weibull models, these parameters are kept in the model due to the presence of an interaction term for number of children with age.

appears to significantly reduce the risk of surgery. Perhaps there is some unmeasured indication of health behaviors operating.

Turning to the models for natural menopause (Table 3), a different story emerges. The first model (A) for menopause resembles model A for surgery, because women with at least a college degree have a 25 percent lower risk of menstrual cessation than women who just completed high school. When ability is added in model B, the effects of education are more eroded for the natural transition compared to the surgical one. Also, higher levels of ability appear to be related to a lower risk of early menopause.

When marriage, work and farm background controls are added to the model (C), both the education and ability effects persist. A farm background—having a father who was a farmer—is also associated with a reduced risk of menopause. Farm background might be indicative of health-related lifestyle factors including nutrition. Inclusion of a categorical measure of the 1975 job (model D) reveals that job (as characterized here) has no significant effect on the risk of natural menopause.

Moving to model E, in which indicators for years of smoking are added, there are significant changes in parameters for the natural menopausal transition. The effects of ability again persist. However, the effects education and farm background are reduced and no longer significant. Long-term cigarette smoking (over twenty-five years) significantly increases the risk of menopause, indicating earlier ages at menopause for women who smoke. This finding is consistent with other studies (Baron and Greenberg, 1987; McKinlay et. al., 1992; Luoto et. al., 1994). That the effects of education wash out when smoking is added to the model suggests that smoking is more proximate to the risk of menopause than education, and that at least part of the effect of education on menopausal age is indirect and operates though the effect of smoking. Also, the coefficients for the smoking parameters indicate that the length of smoking spells is associated with a higher risk of menopause, in a grade-like fashion.

In model F indicators for age at first birth, number of children, and a flag for number of children by age are added. None of these new parameters have significant effects on the natural transition, and the other parameters do not change considerably in magnitude or significance.

In model G in which hormone therapy is added, no changes in the effects of ability or smoking are registered. The parameter for farm background does become significant again, though. Hormone therapy in the model for non-surgical menopause reduces the risk of menstrual cessation. This is consistent with the delaying effect of exogenous hormones.

The final model (H) for both surgical and natural menopause (Tables 2 and 3) depicts which parameters can be constrained to be equal across destination states without jeopardizing the significance of the model (Table 4). Although there were differences in the effects of unconstrained parameters from model to model (A through G) between types of menstrual cessation, many of the apparent differences are not significant. Parameters were individually tested using log likelihood ratio tests to determine whether the effects differed across destination states. Model H represents the "best" model including the most constraints; model H is the most parsimonious model.

According to model H, none of the socioeconomic indicators are different in their effects on hysterectomy versus menopause. In addition, the effects of the number of children and the interaction between number of children and age do not differ across destination states. The only free parameters in model H are years of smoking, age at first birth and hormone therapy. The effects of smoking are stronger for the natural transition, while age at first birth impacts surgery more. Hormone therapy is associated with a lower risk of natural menopause, but a higher risk of surgical menopause.

Conclusion

This study is an important step in the understanding of the relationship between sociological factors and physical health. Social background, socioeconomic status, and social behavior appear to contribute to observed differences in age at menopause. The identification of ability as influencing age at menopause is new, and needs to be further explored. The significant predictors of menopausal age identified here should be compared with other indicators of health. The direct and indirect pathways to health, in general, are still being identified in the literature.

The health of mid-life women is of particular import when taken in context. American women as a group have higher rates of reproductive organ surgery and high rates of hormone therapy. By directly comparing surgically menopausal women to naturally menopausal women, this research has answered some methodological questions, and provides additional bases for understanding the distinct processes of menstrual cessation. That none of the socioeconomic indicators differed by type of menstrual cessation supports an approach to modelling menstrual cessation that includes both surgical and non-surgical cessations. However, the behavioral variables for hormone use, smoking and fertility did differ across destination state.

Even though this paper goes farther than others in the application of analytic techniques to the problem of menstrual cessation, it may not provide the definitive answer. The competing risk framework used in these analyses assumes that the surgical and non-surgical outcomes are independent of each other. However, this assumption is arguable. An alternative way to conceptualize menstrual cessation would be to consider the observed results as a manifestation of an unobserved underlying process in which individuals move from a state of healthy menstruation to some latent state. From this latent state the risks of natural and surgical menopause would be independent. The current analyses could be considered a reduced form model of the model including the latent process.

Furthermore, the specification of hormone therapy was not ideal. As discussed above, the relative timing of hormone use and menstrual cessation differs between surgical and non-surgical menopause. Hormone therapy tends to follow surgery rather than precede it. Hormone use would be better represented as a competing risk of natural (non-hormonal and non-surgical) menopause.

Even though the majority of the WLS sample reside in Wisconsin, there may be some regional or geographic variation in level of and access to health care and in exposure to health hazards. In addition to the geographic and birth cohort specificity of this sample, the WLS was selected on educational attainment, and thus these findings might not be generalizable to the United States female population at large. However, the strengths of this research lie in a sample that provides richness unavailable from clinical populations, the data set's breadth of measures, and the application of demographic techniques for analyses.

Further research should exploit the richness of the WLS by including other measures of sources of stress, such as characteristics of jobs. Both physical environmental stresses and social environmental stresses are believed to contribute to physical health outcomes. One interpretation of the finding that women with higher ability and achievement levels have a later menstrual cessation is that such women have more resilient coping strategies. Perhaps they are more socially integrated and/or engage better health-related practices.

In addition, WLS data now includes health measures for selected siblings of the original sample members, and the health data collected from sisters is more extensive than the original sample. This new data could be used in a variety of ways: similar analyses of sisters' menstrual cessation and health; resemblance models for sister-sister pairs (including twins); or as proxies for missing data in the original sample of women. Unfortunately, data on birth control use and other fertility related practices, such as breastfeeding, are not available from the original sample of women, but the sister sample does contain more developed women's health information.

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Figure 1A
Final Distribution Model

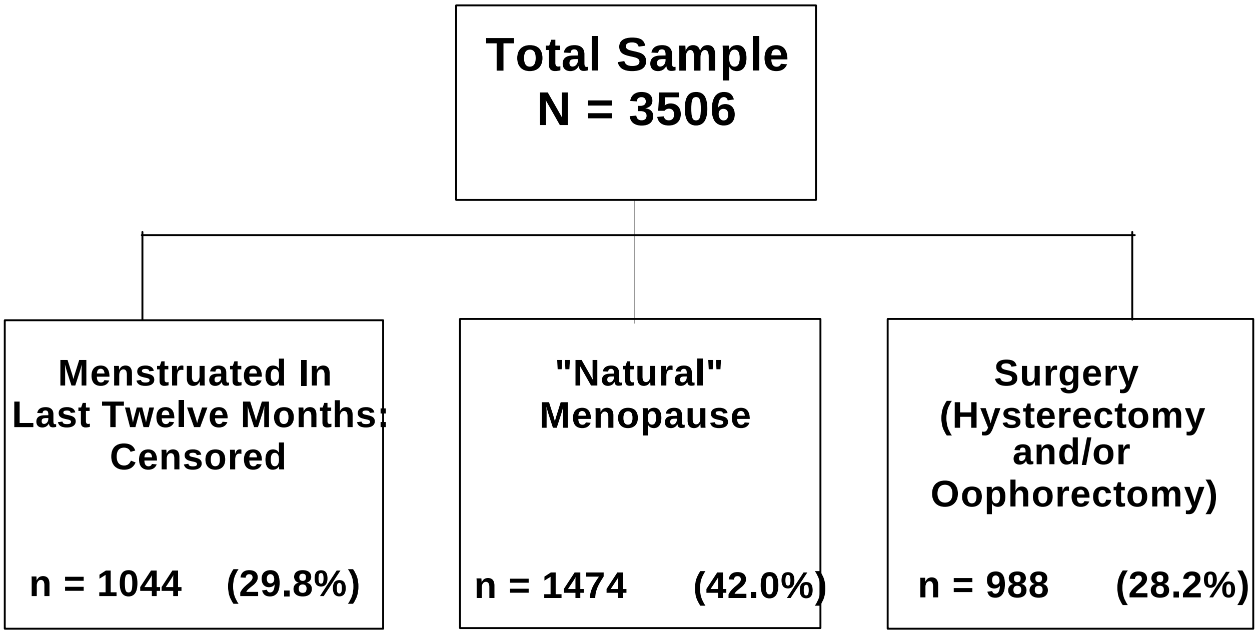


Figure 1B
Theoretical Model

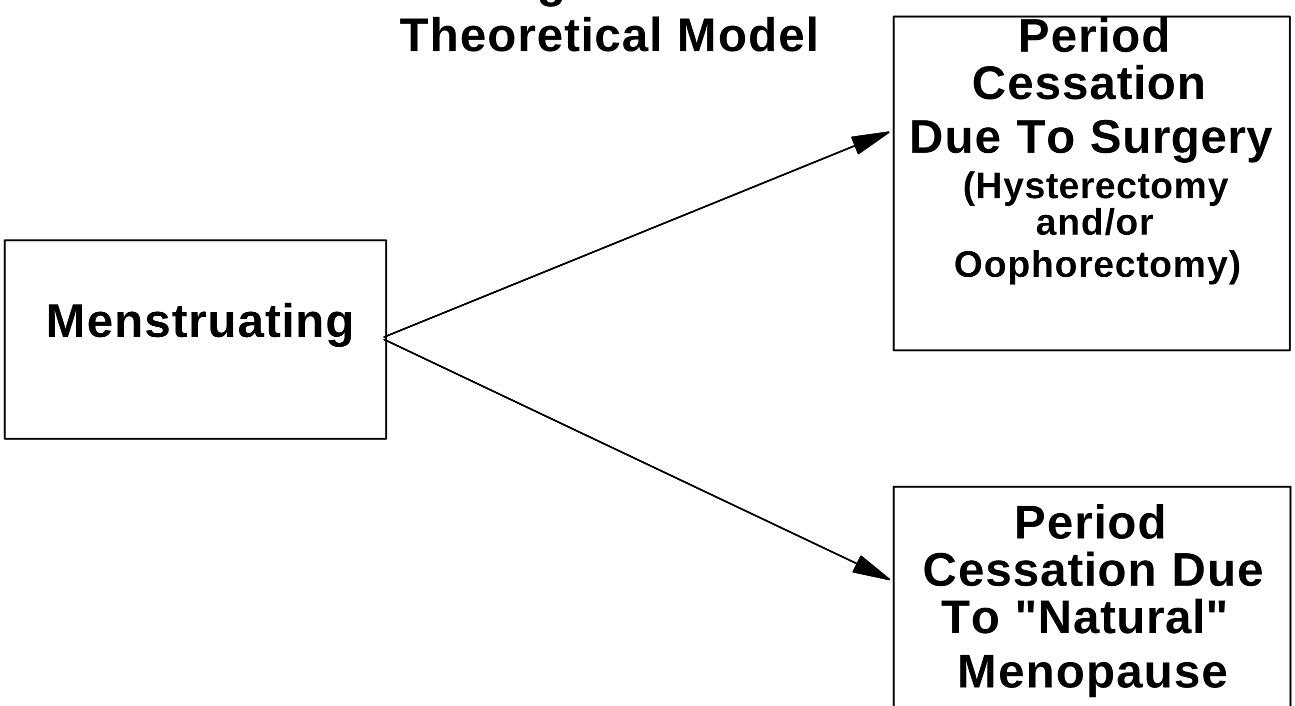
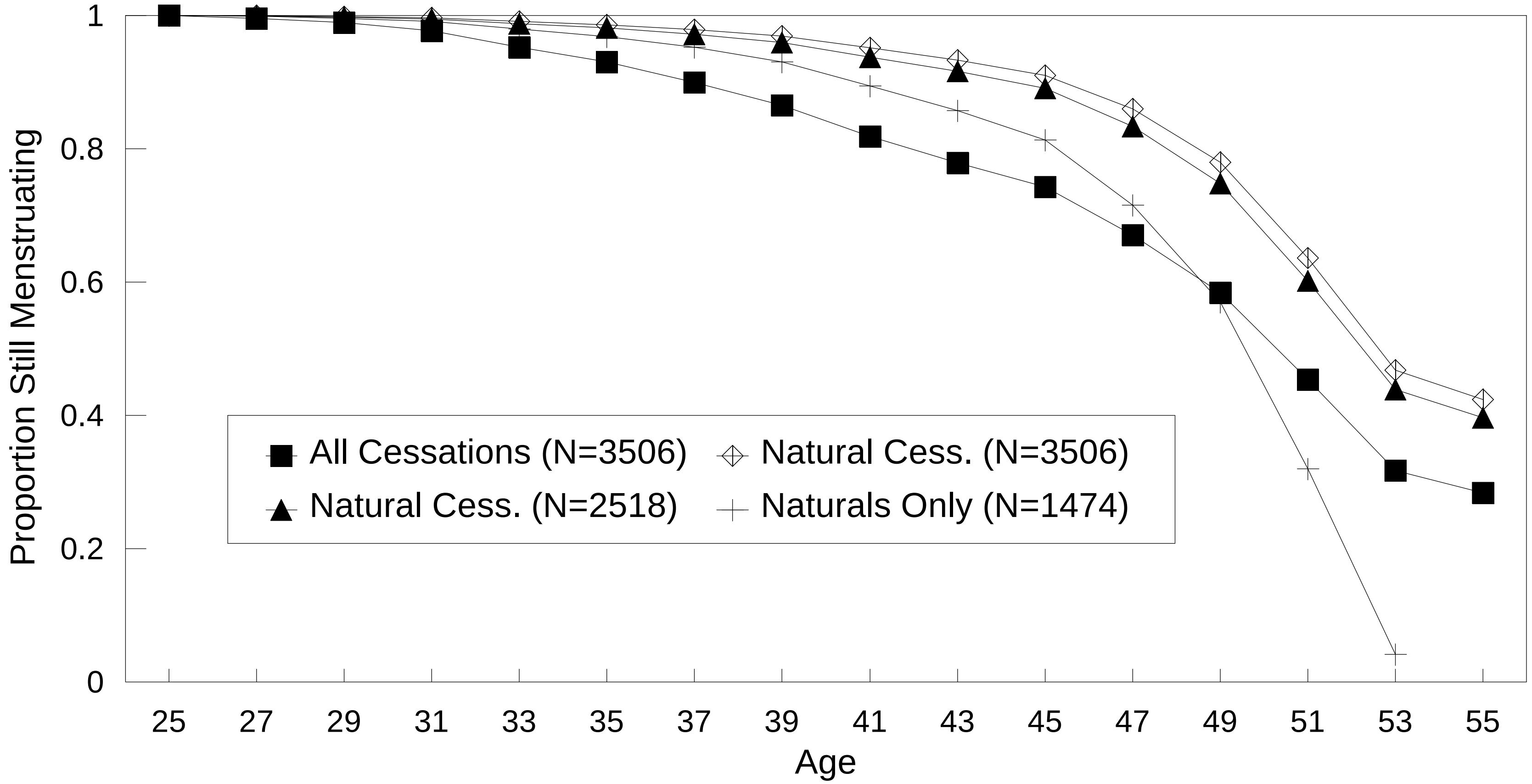


Figure 2: Survival Estimates for Natural Menstrual Cessation

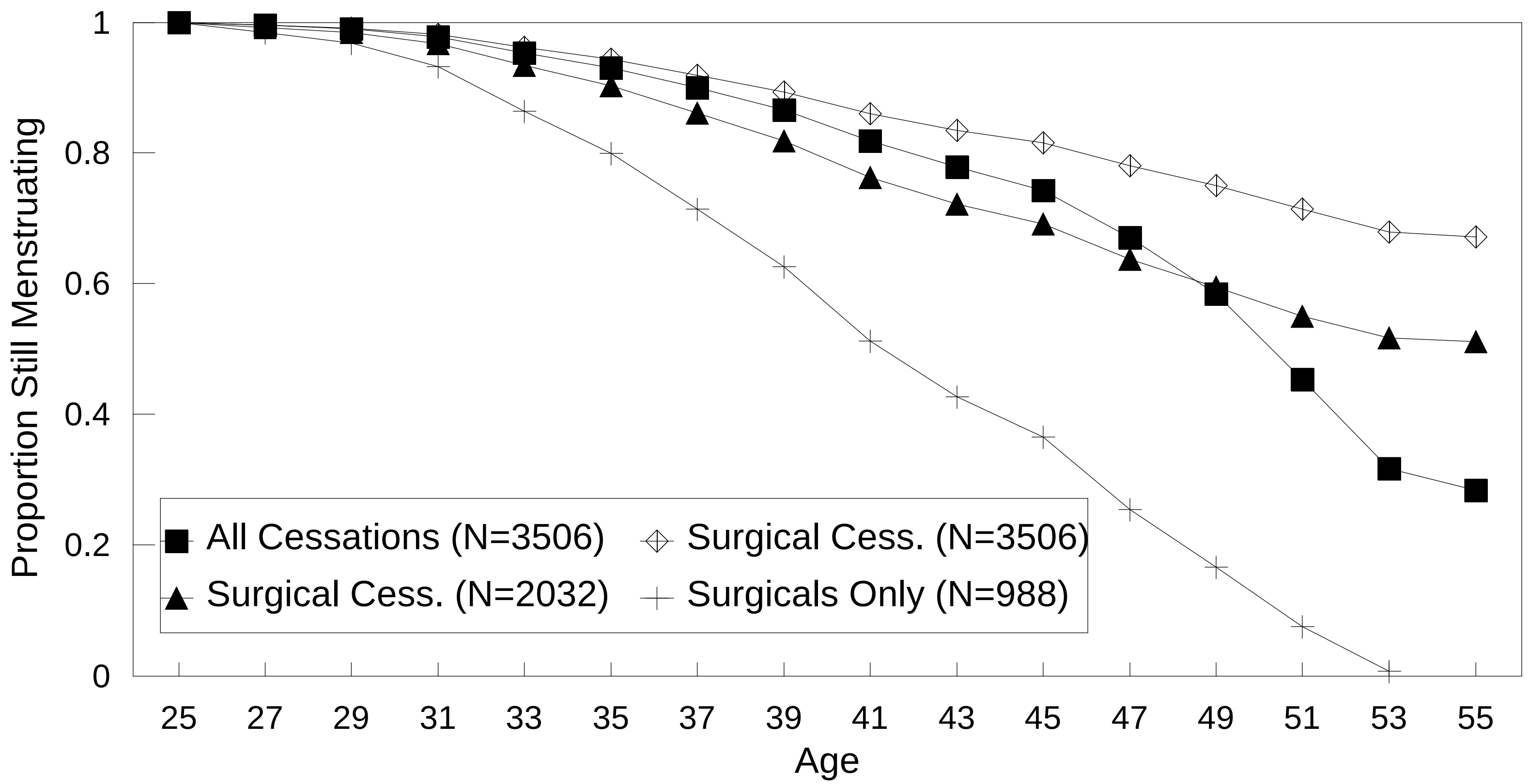
Comparison of Censoring and Exclusion Alternatives



Actuarial Estimates of S(x) using SAS

Figure 3: Survival Estimates for Surgical Menstrual Cessation

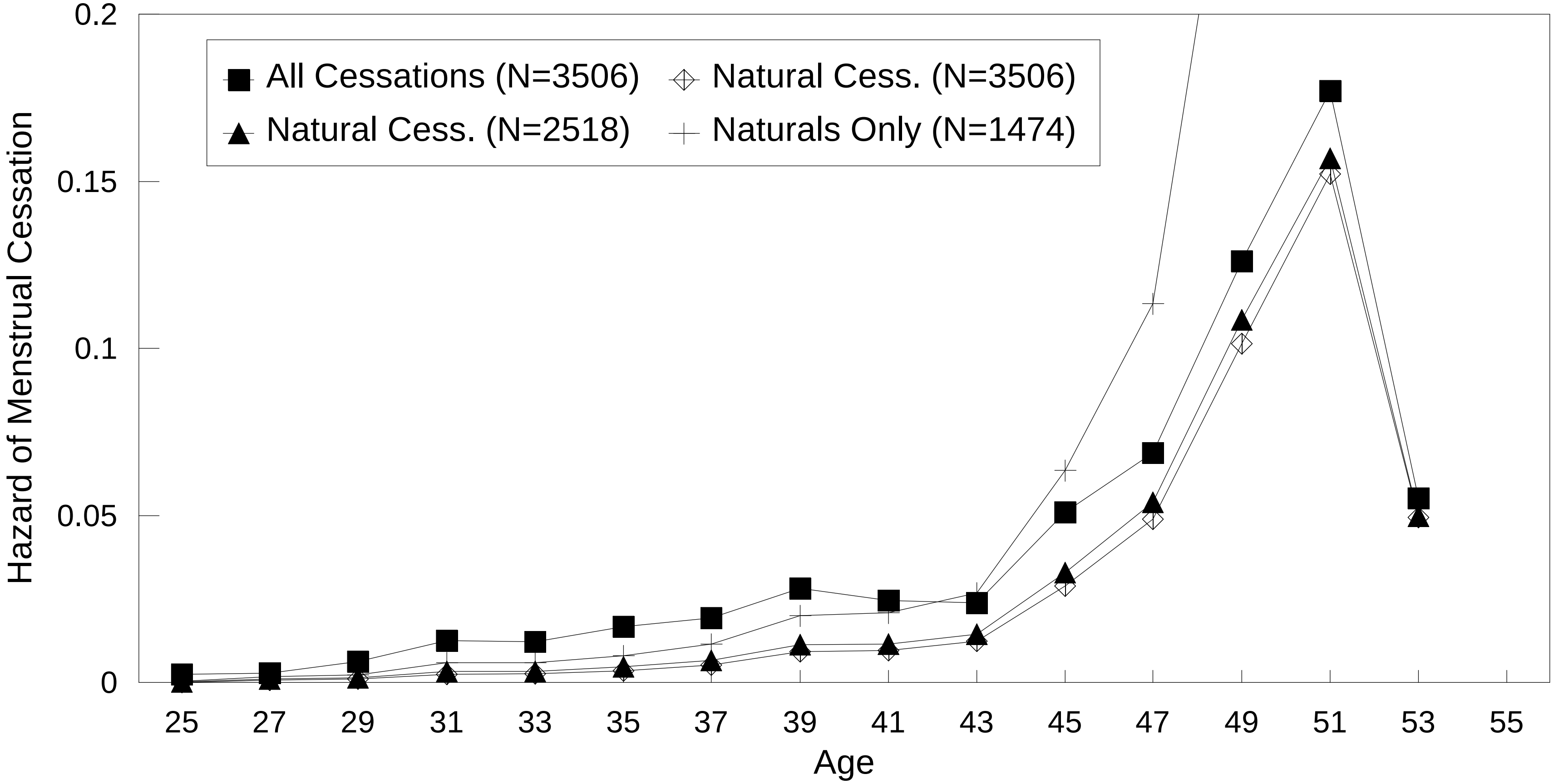
Comparison of Censoring and Exclusion Alternatives



Actuarial Estimates of S(x) using SAS

Figure 4: Hazard Estimates for Natural Menstrual Cessation

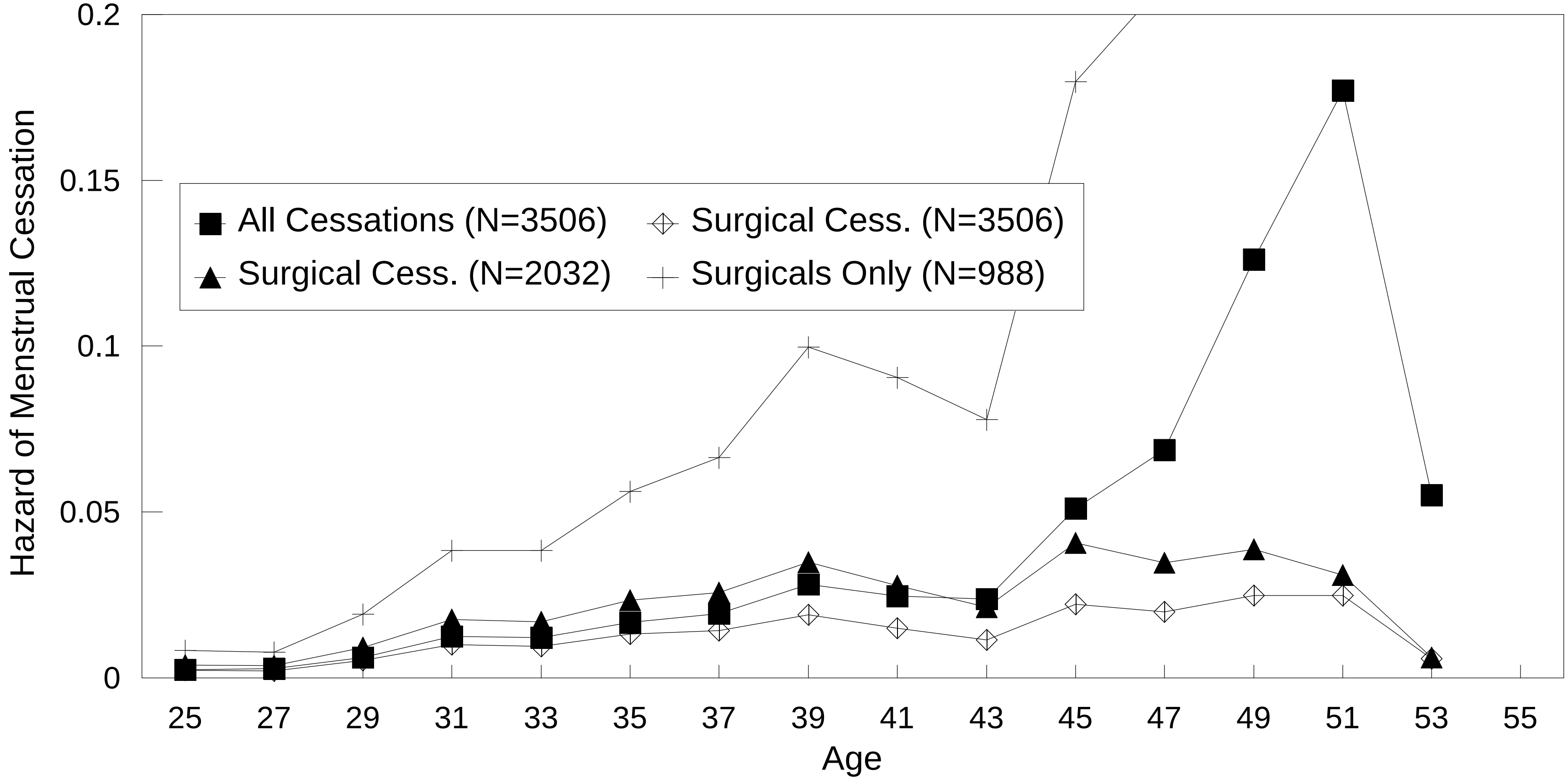
Comparison of Censoring and Exclusion Alternatives



Actuarial Estimates using SAS

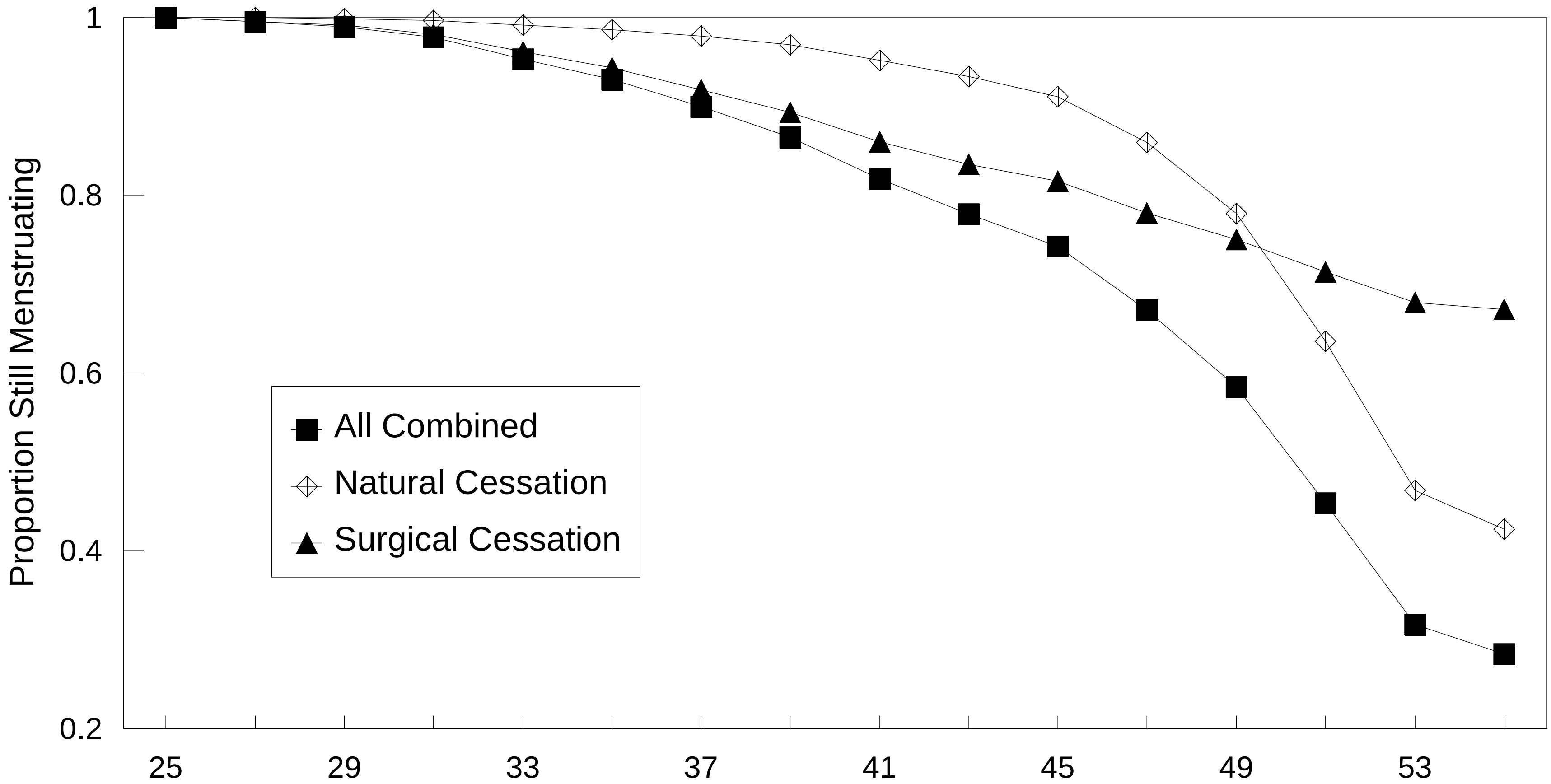
Figure 5: Hazard Estimates for Surgical Menstrual Cessation

Comparison of Censoring and Exclusion Alternatives



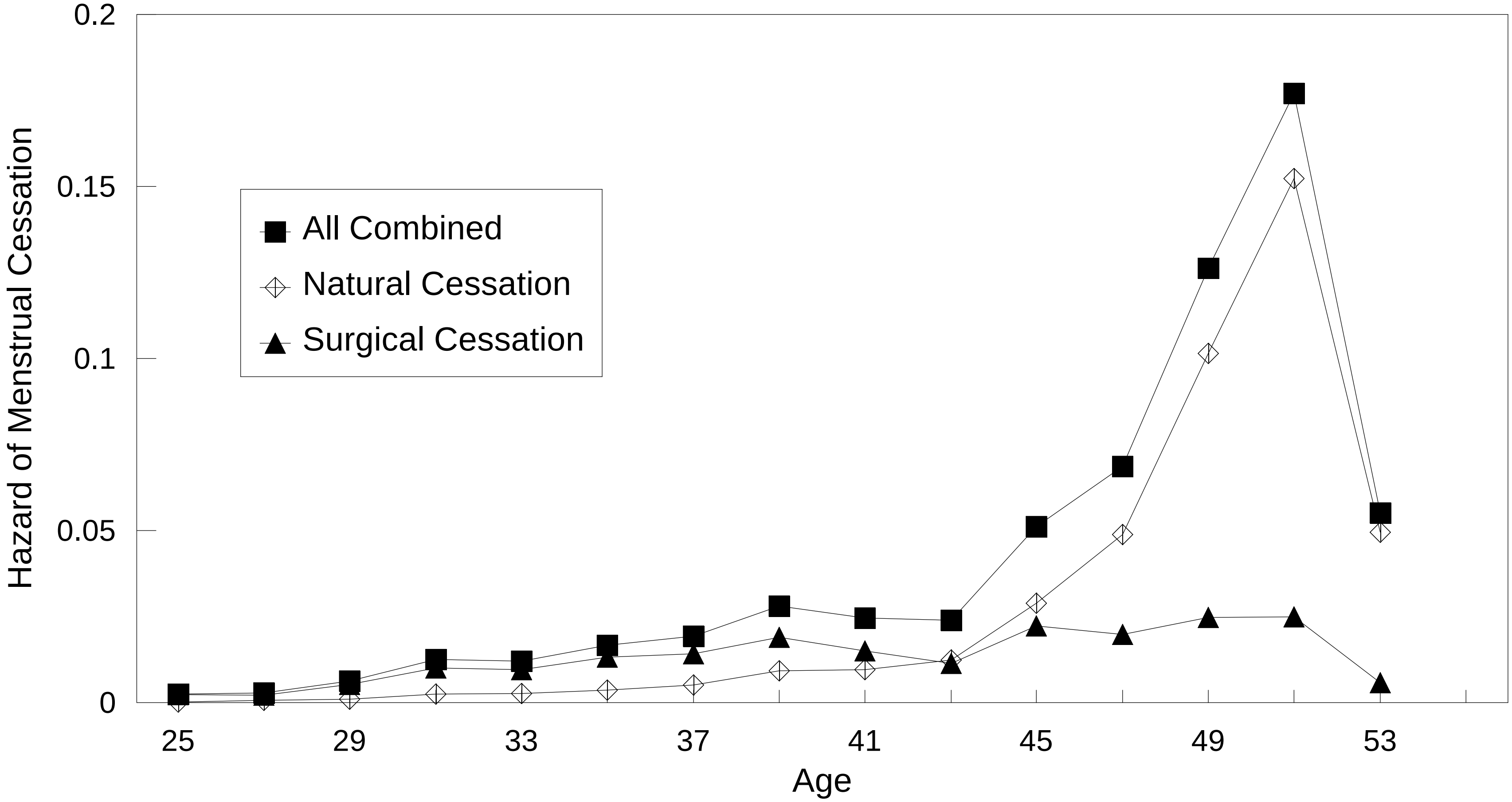
Actuarial Estimates using SAS

Figure 6: Survival Curves for Menstrual Cessation By Type



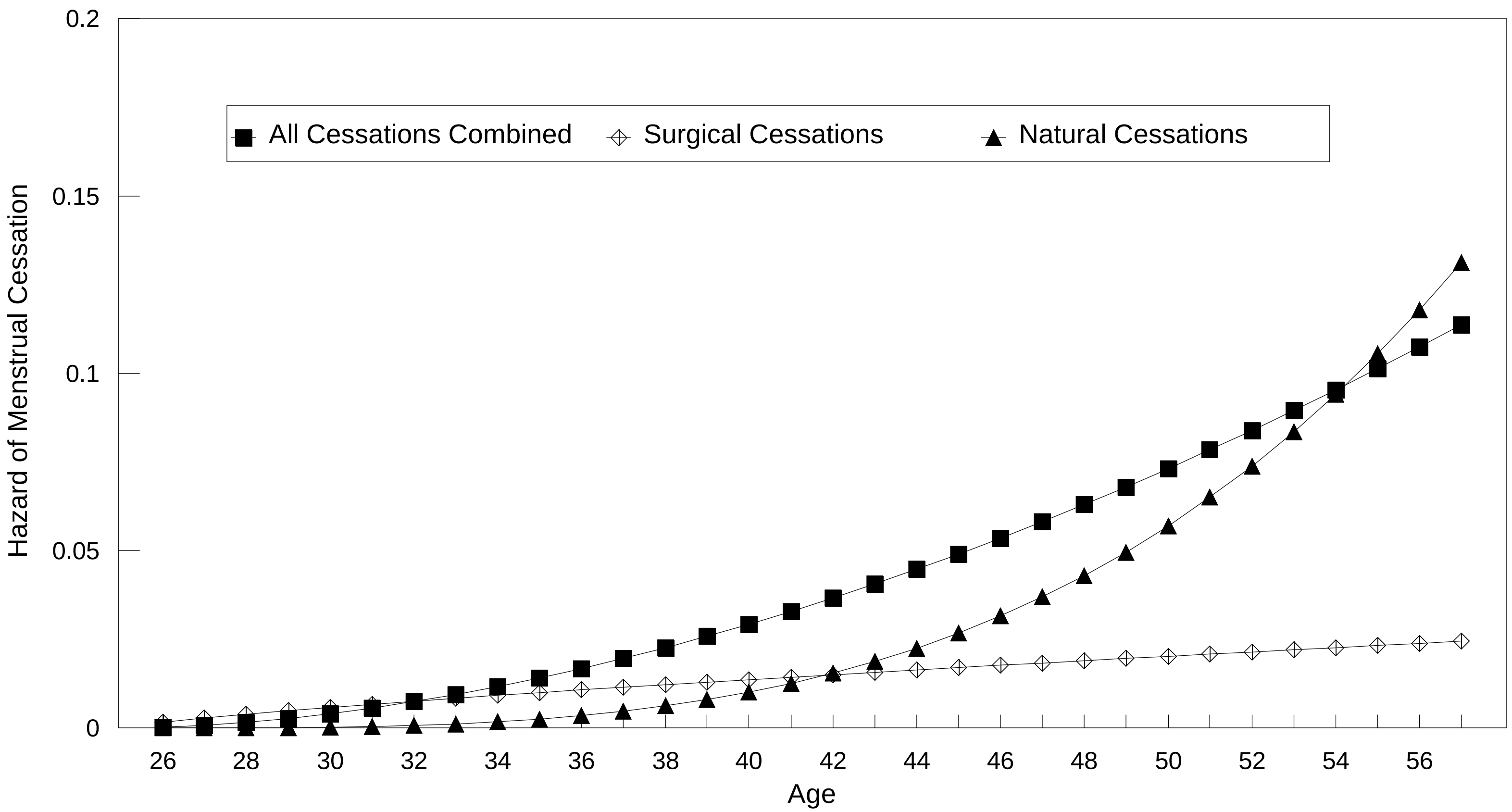
Actuarial Estimates of S(x) using SAS

Figure 7: Hazards of Menstrual Cessation By Type



Acutarial Estimates of the Hazard using SAS

Figure 8: Weibull Estimates of the Hazard Rates of Menstrual Cessation By Typ



Note: Weibull Baseline Hazard Estimates (no covariates) using CTM (N=3506)

TABLE 1: Characteristics of Surgical, Menopausal, and Censored Women

	Surgical		Menopausal		Censored		All Women	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Totals:	988	28.18 %	1474	42.04 %	1044	29.78 %	3506	100.00 %
Education:								
High School Only	566	29.00	859	44.01	527	27.00	1952	55.68
Some Vo-Tech	145	31.45	179	38.83	137	29.72	461	13.15
Some College	129	29.66	174	40.00	132	30.34	435	12.41
BS/BA or higher	148	22.49	262	39.82	248	37.69	658	18.77
Father a Farmer	176	26.79	259	39.42	222	33.79	657	18.74
Ability (HS Rank & IQ):								
Lowest Quartile	265	30.46	399	45.86	206	23.68	870	24.81
Second Quartile	204	26.84	345	45.39	211	27.76	760	21.68
Third Quartile	267	29.08	361	39.32	290	31.59	918	26.18
Highest Quartile	252	26.30	369	38.52	337	35.18	958	27.32
Never Married	37	21.89	81	47.93	51	30.18	169	4.82
Never Worked	79	35.75	90	40.72	52	23.53	221	6.30
First FT Civilian Job:								
None	126	31.11	166	40.99	113	27.90	405	11.55
Blue Collar/Farm	193	29.69	287	44.15	170	26.15	650	18.54
Lower White Collar	476	27.77	728	42.47	510	29.75	1714	48.89
Upper White Collar	193	26.19	293	39.76	251	34.06	737	21.02
Job Held in 1975								
None	277	25.65	461	42.69	342	31.67	1080	30.80
Blue Collar/Farm	214	31.56	282	41.59	182	26.84	678	19.34
Lower White Collar	291	29.94	417	42.90	264	27.16	972	27.72
Upper White Collar	206	26.55	314	40.46	256	32.99	776	22.13
Biological Children:								
None	117	28.40	186	45.15	109	26.46	412	11.75
One	77	29.17	107	40.53	80	30.30	264	7.53
Two	248	27.99	375	42.33	263	29.68	886	25.27
Three	410	28.31	602	41.57	436	30.11	1448	41.30
Four or more	136	27.42	204	41.13	156	31.45	496	14.15
Age at First Birth:								
None	117	28.40	186	45.15	109	26.46	412	11.75
< 20	151	32.75	181	39.26	129	27.98	461	13.15
20-21	302	33.86	366	41.03	224	25.11	892	25.44
22-23	203	26.92	319	42.31	232	30.77	754	21.51
24-29	185	22.59	345	42.12	289	35.29	819	23.36
30+	30	17.86	77	45.83	61	36.31	168	4.79
Smoking:								
Never Smoked	472	26.59	704	39.66	599	33.75	1775	50.63
Years Smoked:								
<1	497	26.85	734	39.65	620	33.50	1851	52.80
1-12	133	29.82	173	38.79	140	31.39	446	12.72
13-25	157	31.59	199	40.04	141	28.37	497	14.18
26-30	88	28.76	147	48.04	71	23.20	306	8.73
31+	113	27.83	221	54.43	72	17.73	406	11.58
Hormone Therapy:								
Ever Used	694	41.28	540	32.12	447	26.59	1681	47.95
Missing	14	42.42	11	33.33	8	24.24	33	0.94

TABLE 2: Weibull Model Summaries for Surgery

Model:	A		B		C		D		E		F		G		H*	
	R.R.*	B/s.e.	R.R.	B/s.e.	R.R.	B/s.e.	R.R.	B/s.e.	R.R.	B/s.e.	R.R.	B/s.e.	R.R.	B/s.e.	R.R.	B/s.e.
Education (vs. high school only):																
Some Vo-Tech	1.06	0.66	1.07	0.76	1.10	1.02	1.10	1.01	1.10	0.93	1.18	1.66	1.13	1.23	*0.98*	*-0.26*
Some College	1.00	-0.03	1.02	0.24	1.03	0.30	1.04	0.44	1.04	0.37	1.10	0.99	1.09	0.86	*0.99*	*-0.22*
BS/BA or higher	**0.68**	**-4.13**	**0.71**	**-3.46**	**0.73**	**-3.07**	**0.76**	**-2.53**	**0.76**	**-2.44**	0.90	-0.91	0.88	-1.12	*0.87*	*-1.89*
Father A Farmer (vs. father not a farmer)					0.90	-1.26	0.88	-1.46	0.90	-1.19	0.91	-1.08	0.98	-0.22	*0.91*	*-1.72*
Ability (HS Rank & IQ; vs. lowest quartile)																
Second Quartile			0.84	-1.92	0.84	-1.92	0.83	-1.94	0.84	-1.85	0.84	-1.81	**0.79**	**-2.46**	***0.87***	***-2.35***
Third Quartile			0.93	-0.88	0.92	-0.90	0.92	-0.90	0.93	-0.85	0.94	-0.64	0.85	-1.83	***0.83***	***-3.38***
Highest Quartile			0.86	-1.57	0.86	-1.66	0.86	-1.56	0.87	-1.46	0.88	-1.37	0.84	-1.81	***0.79***	***-3.99***
Never Married (vs. ever)					0.80	-1.30	0.74	-1.72	0.74	-1.75	**0.61**	**-2.52**	0.68	-1.89	*0.87*	*-1.14*
Never Held A Job (vs. ever)					1.26	1.93	**1.62**	**3.60**	**1.62**	**3.59**	**1.52**	**3.09**	**1.44**	**2.66**	*1.17*	*1.77*
Job Held in 1975 (vs. blue collar/farm)																
No Job							**0.66**	**-4.08**	**0.67**	**-4.05**	**0.73**	**-3.11**	**0.75**	**-2.83**	***0.86***	***-2.43***
Lower White Collar							0.93	-0.84	0.93	-0.82	0.91	-1.07	0.91	-1.00	*0.96*	*-0.63*
Upper White Collar							0.88	-1.15	0.88	-1.17	0.89	-1.07	0.86	-1.31	*0.94*	*-0.85*
Smoking, in years (vs. <1 year):																
1-12									1.13	1.29	1.14	1.35	1.06	0.62	1.06	0.60
13-25									**1.21**	**2.07**	**1.21**	**2.03**	1.09	0.90	1.08	0.87
26-30									1.11	0.86	1.11	0.90	1.06	0.50	1.06	0.49
31+									1.08	0.72	1.02	0.23	1.03	0.28	1.04	0.38
Fertility History:																
Number of Biological Children (vs. two):																
None											0.87	-0.99	0.95	-0.35	*1.04*	*0.46*
One Child											1.07	0.53	1.12	0.85	*1.02*	*0.20*
Three Children											1.05	0.53	1.09	0.90	*1.12*	*1.39*
Four Or More Children											1.12	0.72	1.25	1.42	*1.13*	*1.13*
Age at First Birth (vs. <20):																
20-21											0.99	-0.11	1.04	0.37	1.10	1.10
22-23											**0.76**	**-2.55**	**0.79**	**-2.19**	0.85	-1.66
24-29											**0.60**	**-4.34**	**0.62**	**-4.03**	**0.67**	**-3.81**
30+											**0.41**	**-4.29**	**0.45**	**-3.79**	**0.50**	**-3.39**
Interaction of Kids and Age																
Kid*Age >= 120 (vs. <120)											**0.71**	**-3.10**	**0.72**	**-2.85**	***0.77***	***-3.08***
Hormone Therapy:																
Ever (vs. never)													**2.96**	**15.13**	**2.97**	**15.31**
Missing													**3.46**	**4.77**	**3.68**	**5.00**

* NOTES: R.R. stands for relative risk. Bolded parameters are significant at 0.05 level. In model H, parameters in italics are constrained across destination states.

TABLE 3: Weibull Model Summaries for Menopause

Model:	A		B		C		D		E		F		G		H*	
	R.R.*	B/s.e.	R.R.	B/s.e.	R.R.	B/s.e.	R.R.	B/s.e.	R.R.	B/s.e.	R.R.	B/s.e.	R.R.	B/s.e.	R.R.	B/s.e.
Education (vs. high school only):																
Some Vo-Tech	0.86	-1.85	0.87	-1.70	0.87	-1.81	0.86	-1.84	0.88	-1.54	0.88	-1.57	0.89	-1.47	*0.98*	*-0.26*
Some College	0.87	-1.67	0.92	-1.00	0.90	-1.20	0.90	-1.25	0.92	-0.97	0.91	-1.04	0.91	-1.11	*0.99*	*-0.22*
BS/BA or higher	**0.75**	**-4.15**	**0.84**	**-2.32**	**0.82**	**-2.60**	**0.81**	**-2.44**	0.87	-1.65	0.86	-1.66	0.86	-1.61	*0.87*	*-1.89*
Father A Farmer (vs. father not a farmer)					**0.83**	**-2.69**	**0.83**	**-2.68**	0.88	-1.86	0.88	-1.83	**0.87**	**-2.10**	*0.91*	*-1.72*
Ability (HS Rank & IQ; vs. lowest quartile):																
Second Quartile			0.92	-1.18	0.92	-1.16	0.91	-1.30	0.92	-1.09	0.92	-1.15	0.93	-1.01	*0.87*	*-2.35*
Third Quartile			**0.78**	**-3.44**	**0.78**	**-3.36**	**0.77**	**-3.47**	**0.80**	**-3.08**	**0.79**	**-3.14**	**0.81**	**-2.83**	***0.83***	***-3.38***
Highest Quartile			**0.75**	**-3.77**	**0.74**	**-3.87**	**0.73**	**-3.89**	**0.75**	**-3.57**	**0.75**	**-3.61**	**0.76**	**-3.53**	***0.79***	***-3.99***
Never Married (vs. ever)					1.16	1.20	1.13	0.96	1.17	1.27	1.02	0.11	0.98	-0.12	*0.87*	*-1.14*
Never Held A Job (vs. ever)					0.98	-0.15	1.04	0.34	1.02	0.14	1.00	0.01	1.01	0.11	*1.17*	*1.77*
Job Held in 1975 (vs. blue collar/farm):																
None							0.94	-0.77	0.95	-0.65	0.95	-0.71	0.94	-0.73	***0.86***	***-2.43***
Lower White Collar							1.04	0.52	1.03	0.34	1.01	0.09	1.01	0.07	*0.96*	*-0.63*
Upper White Collar							1.04	0.43	1.01	0.13	0.99	-0.09	1.00	-0.00	*0.94*	*-0.85*
Smoking, in years (vs. <1 year):																
1-12									1.05	0.62	1.05	0.58	1.07	0.75	1.06	0.72
13-25									1.10	1.18	1.10	1.19	1.13	1.52	1.13	1.55
26-30									**1.50**	**4.69**	**1.51**	**4.68**	**1.53**	**4.82**	**1.52**	**4.80**
31+									**1.72**	**6.97**	**1.72**	**6.96**	**1.71**	**6.89**	**1.70**	**6.85**
Fertility History:																
Number of Biological Children (vs. two):																
None											1.18	1.27	1.15	1.04	*1.04*	*0.46*
One Child											0.97	-0.27	0.96	-0.35	*1.02*	*0.20*
Three Children											1.17	1.02	1.15	0.93	*1.12*	*1.39*
Four Or More Children											1.14	0.72	1.10	0.51	*1.13*	*1.13*
Age At First Birth (vs. <20)																
20-21											1.10	1.03	1.07	0.81	1.02	0.19
22-23											1.08	0.80	1.06	0.60	0.99	-0.09
24-29											1.04	0.38	1.02	0.21	0.95	-0.57
30+											0.96	-0.25	0.92	-0.54	0.84	-1.28
Interaction of Kids and Age																
Kid*Age >= 120 (vs. <120)											0.78	-1.57	0.78	-1.61	***0.77***	***-3.08***
Hormone Therapy:																
Ever (vs. never)													**0.76**	**-5.16**	**0.75**	**-5.26**
Missing													0.88	-0.38	0.85	-0.50

* NOTES: R.R. stands for relative risk. Bolded parameters are significant at 0.05 level. In model H, parameters in italics are constrained across destination states.

TABLE 4: Likelihood Ratio Tests for Weibull Models

Model		-ln Likelihood
	Baseline	11384.97
A	Education	11364.59
B	A + Ability	11353.24
C	B + Farm, Never Married, Never Worked	11345.08
D	C + 1975 Job	11333.71
E	D + Smoking History	11303.50
F	E + Fertility History	11273.36
G	F + Hormone Therapy	11130.11
H	Constrained Model	11141.94
	(Education, Ability, Farm, Marriage, Work, Job, *Number Children, and Kids*Age are constrained across destinations.)*	

Reduced	Full	Chi-square	df	p-value	
A	B	22.86	6	0.0008	
B	C	16.32	6	0.0121	
C	D	22.74	6	0.0009	
D	E	60.42	8	3.855E-10	
E	F	60.29	18	1.837E-06	
F	G	286.50	4	<1.000E-10	
H	G	23.66	17	0.1290	*not significant*

APPENDIX 1A

Wisconsin Longitudinal Study
Mail Questionnaire, 1992-93, Page 6, Version 1

1. The ORIGINAL version of page six of the 1992 WLS Mail Questionnaire.

MEN - GO TO QUESTION 17, PAGE 7

The following questions 13-16 are being asked of WOMEN ONLY :

13a. Have you had a menstrual period in the last 12 months? *(Circle your answer.)*

1 Yes 2 No →

13b. What age were you when you had your last period?

Age________

13c. Have you gone (or are you currently going) through menopause? *(Circle your answer.)*

1 Yes →

2 No

13d. Was menopause induced or hastened by a hysterectomy (surgical removal of your uterus and/or ovaries)? *(Circle your answer.)*

1 Yes 2 No

14a. Have you ever taken hormones or birth control pills for menopausal or aging symptoms? *(Circle your answer.)*

1 Yes →

2 No

14b. At what age did you first start taking them for these symptoms?

Age___________

14c. Are you currently taking them? *(Circle your answer.)*

1 Yes 2 No

15a. To what extent do or did you experience the following menopausal symptoms?	*Circle one number for each symptom.*			
	Not at all	A little	Somewhat	A lot
a. hot flushes/flashes	0	1	2	3
b. depression	0	1	2	3
c. sleep disturbance	0	1	2	3
d. bone pains	0	1	2	3
e. night sweats	0	1	2	3
15b. To what extent are you currently experiencing any menopausal symptoms?	0	1	2	3

16. Please respond to the following set of questions which relate to feelings you may have had (or continue to have) about menopause. *(Circle one number for each row.)*

Going through menopause has affected or is likely to affect my:	In a positive way	Both positive and negative	In a negative way	No effect
a. Family life	1	2	3	4
b. Work life	1	2	3	4
c. Feelings about myself as a woman	1	2	3	4

APPENDIX 1B

Wisconsin Longitudinal Study
Mail Questionnaire, 1992-93, Page 6, Version 2

2. The REVISED page six of the 1992 WLS Mail Questionnaire:
MEN - GO TO QUESTION 17, PAGE 7

The following questions 13-16 are being asked of WOMEN ONLY :

13a. Have you had a menstrual period in the last 12 months? *(Circle your answer.)*

1 Yes 2 No → 13b. What age were you when you had your last period?

Age________

13c. Have you gone (or are you currently going) through menopause? *(Circle your answer.)*

1 Yes 2 No

13d. Have you ever had surgery to remove your uterus and/or ovaries? *(Circle all that apply.)*

2 No, I did NOT have surgery 3 Yes, One Ovary 4 Yes, Both Ovaries 5 Yes, Uterus

13e. How old were you when you had surgery? Age________

14a. Have you ever taken hormones or birth control pills for menopausal or aging symptoms? *(Circle your answer.)*

1 Yes → 14bu. What medications do or did you take? *(Circle all that apply)* When did you take them?

2 No

Medication(s)	**Age Started**	**Age Stopped**	**Reason Stopped**
a. Estrogen	________	________	________________________________
b. Estrogen and Progesteron	________	________	________________________________
c. Not sure, but drug name(s) are:			
____________________________	________	________	________________________________
d.__________________________	________	________	________________________________

15a. To what extent do or did you experience the following menopausal symptoms?	*Circle one number for each symptom.*			
	Not at all	A little	Somewhat	A lot
a. hot flushes/flashes	0	1	2	3
b. depression	0	1	2	3
c. sleep disturbance	0	1	2	3
d. bone pains	0	1	2	3
e. night sweats	0	1	2	3
15b. To what extent are you currently experiencing any menopausal symptoms?	0	1	2	3

16aa. Please indicate any other treatment(s) or method(s) you are using or have used to control your menopausal symptoms (such as herbal remedies, change of diet, exercise, lifestyle change).

____

____

16bb. During menopause, did you have enough information about the changes you were experiencing? *(Circle your answer.)*

1 Yes 2 No

16cc. Who and what were your sources of information (such as magazines, sister, friend, physician)?

____

____

____

APPENDIX 2

Correlation Matrix

APPENDIX 2

Pearson Correlation Coefficients Among Exogenous Variables

	Education	Father A Farmer	Ability	Never Married	Never Worked	First FT Civ. Job	1975 Job	Number of Children	Age at First Birth	Ever Smoked
Father a Farmer	-0.067									
Ability	0.382	-0.059								
Never Married	0.16	0.0045 ns	0.056							
Never Worked	-0.094	-0.107	-0.027 ns	-0.058						
First FT Civilian Job	0.309	0.038	0.189	0.051	-0.515					
1975 Job	0.323	0.0015 ns	0.218	0.197	-0.321	0.263				
Number of Children	-0.206	0.028 ns	-0.085	-0.398	0.014 ns	-0.097	-0.243			
Age 1st Birth	0.158	-0.001 ns	0.062	-0.372	-0.021 ns	0.158	-0.11	0.206		
Smoked Ever	0.044	0.134	0.071	0.033	-0.026 ns	0.056	0.002 ns	0.021 ns	0.019 ns	
Years Smoked	-0.0997	-0.125	-0.08	-0.04	0.036	-0.071	0.006 ns	-0.017 ns	-0.058	-0.805

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