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Mortality Differentials in Canada by Marital Status

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Abstract

The sociological and epidemiological literature suggests that married people enjoy lower death rates as a result of the social and psychological benefits that marriage affords individuals. In this study, I review the literature to delineate how marital status translates into differential mortality and the mechanisms which intervene in this process. I then proceed to investigate the hypothesis that although data are not readily available to test for all the mechanisms implied in the literature, marital status's association with the postulated intervening factors would ultimately translate into observing significant mortality differentials by marital status. The data for the analysis are from the Mortality Data Base and from the 1986 Census of Canada. Eleven causes of death are examined, classified in accordance with Gove's (1973) formulation that certain causes of death reflect etiologies associated with psychological states of mind (suicide), carelessness (motor vehicle accidents), conflict (homicide), and lifestyle (heart disease, lung cancer, cirrhosis of the liver). It is shown that the married generally display the lowest odds of death, providing support for a marriage protection effect. Further evidence indicates that health selection cannot be ruled out as an additional source of mortality discrepancies. Both marriage protection and health selection appear to be important mechanisms explaining the superior survival probabilities of married people; however, the statistical results suggest that marriage protection accounts more for this social fact.

Résumé

La littérature sociologique et épidémiologique suggère que les personne mariées bénéficient de taux de mortalité inférieurs attribuables aux avantages sociaux et psychologiques que confère le mariage. Dans la présente étude, nous examinons la littérature afin de déterminer comment le statut matrimonial se traduit par une mortalité différentielle, ainsi que les mécanismes à l'oeuvre. Nous étudions ensuite l'hypothèse selon laquelle, bien que les données permettant de tester tous les mécanismes invoqués dans la littérature ne soient pas aisément accessibles, l'association entre les facteurs intervenants postulés et le statut matrimonial se traduirait éventuellement par une mortalité différentielle significative selon le statut matrimonial. Les données de l'analyse proviennent de la base de données sur la mortalité du Recensement du Canada de 1986. Onze causes de décès ont été examinées, classées d'après la formule de Gove (1973) affirmant que certaines causes de décès sont liées à l'état psychologique (suicide), à l'imprudence (accidents de la route), à des conflits (homicides) et au mode de vie (cardiopathies, cancer du poumon, cirrhose du foie). Il est démontré que les personnes mariées courent généralement les risques de décès les plus bas, ce qui semble confirmer que le mariage aurait bien un effet protecteur. Des preuves supplémentaires indiquent qu'on ne peut éliminer totalement la sélection des sujets sains comme source supplémentaire d'écarts entre les taux de mortalité. La protection que donnent le mariage et la sélection en fonction de la santé semblent mettre en jeu des mécanismes importants, qui expliquent les chances de survie supérieures des personnes

mariées. Cependant, les résultats statistiques suggèrent que la protection que donne le mariage semble dominer.

Key Words: Marriage Protection, Health Selection, Social Support, Relative Mortality Risk, Poisson Model, Log-Rate Model, Cause of Death

Introduction

Research based on the experience of the United States and other industrialized nations has shown that the married have lower death rates than the nonmarried population (Berkman and Syme, 1979; Boyd, 1983; Gove, 1972; Hu and Goldman, 1990; Kisker and Goldman, 1987; Kitagawa and Hauser, 1973; Klinger-Vertabedian and Wispe, 1989; Kobrin and Hendershot, 1977; Litwak and Messeri, 1989; Livi-Bacci, 1984; MacMahon and Pugh, 1970; Mergenhagen *et al.*, 1985; Rosengren *et al.*, 1989; Trovato and Lauris, 1989; Umberson, 1987; Vallin and Nizard, 1977; Zick and Smith, 1991; Rogot, *et al.*, 1988). Single persons possess higher rates of mortality than married individuals of similar age, while the divorced and the widowed tend to show the highest death rates of all marital status groups. These differentials are generally wider for males than for females.

Explanations for the marital status differential are typically based on two competing theories. The protection of marriage theory (Durkheim, 1951; Gove, 1973; Kobrin and Hendershot, 1977) posits that marriage entails a protective influence for the individual due to the role obligations and responsibilities to the family members. This explanation originates from the classic work of Durkheim (1951), who argued that marriage is a significant source of social integration. The second thesis is the health selection hypothesis. Proponents of this explanation view the superior longevity of married people as a function of differential health; that is, persons who are physically and psychologically healthy get married (or remarry) while unhealthy persons tend to remain single (or unmarried) (Kisker and Goldman, 1987; Livi-Bacci, 1984; Sheps, 1961; Shurtleff, 1956).

Observed mortality differentials may be a result of data errors (Sheps, 1961). Most researchers, however, have concluded that data problems are unlikely to play a major role in explaining this phenomenon (Adams and Nagnur, 1981; Hambright, 1968; Kraus and Lilienfeld, 1959). In fact, recent sociological and epidemiological research has provided direct

evidence that marriage is indeed "protective," as the influence of being married on mortality in prospective studies remains significant even after initial health differences and a host of other relevant control variables have been taken into account (Belloc, 1980; Berkman, 1984, 1985; Berkman and Syme, 1979; Berkman, Breslow and Wingard, 1983; Cohen and Syme, 1985; Haan *et al.*, 1987; Helsing *et al.*, 1981; House, 1987; House *et al.*, 1988; Rosengren *et al.*, 1989; Schoenbach *et al.*, 1986; Wolfson *et al.*, 1989; Zick and Smith, 1991).

Purpose of the Study

This study has two objectives: (1) to review the relevant literature corresponding to how marital status affects health and mortality; and (2) to execute an empirical analysis of marital status differentials in general and cause-specific mortality in Canada for the period 1985-1987. The data analysis follows the approach developed by Gove (1973) in the context of the United States. The central hypothesis to be investigated is that the married will show relatively low death rates in comparison to single, widowed and divorced people with respect to overall and cause-specific death rates that are attributable to social psychological etiologies.

The present study represents a more recent assessment of the relationship between marital status and cause-specific mortality differences in Canada. The analysis executed by Boyd (1983) is based on the period 1970-72; and the investigation undertaken by Trovato and Lauris (1989) covers the time span 1951 through 1981. Boyd (1983) had to confine her analysis to two broad age groups (25-44 and 45-64), and to a limited classification of the marital status variable consisting of single, married and "other," making it impossible to distinguish the divorced from the widowed population. Trovato and Lauris (1989) included more age categories in their analysis, but failed to examine the population aged between 15 and 34 due to lack of data. Furthermore, their study focused on only two causes of death — cardiovascular diseases and neoplasms. The present investigation examines mortality differentials for the population aged 15 through 85, classified into five broad age intervals, and will compare death rates for the single, married, widowed and divorced populations.

into an index of social ties, predicted survivorship over the study period. People who scored low on social and community ties were more likely to die in the follow-up period than those with more extensive contacts. The association between social ties and mortality was shown to be independent of self-reported physical health status, socioeconomic status, health practices such as smoking, alcoholic beverage consumption, obesity, physical activity, and utilization of preventive health services, as well as a cumulative index of health practices. These researchers also concluded that marriage, as an intimate social bond, was a better predictor of subsequent mortality than were contacts with church and other loosely defined groups.

House and associates (1982) executed a similar investigation known as the Tecumseh Community Health Study. In 1967-69, 2754 adults were selected for a 12-year follow-up study. A composite index of social relationships and activities was found to be inversely related with the probability of mortality during the follow-up period, even after adjustments were introduced into the analysis for age, blood pressure, cholesterol level, respiratory function, electrocardiogram diagnosis, and self-reported risk factors.

Other prospective studies have confirmed the importance of social ties as a predictor of cause-specific mortality (Blazer, 1982; Haan *et al.*, 1987; Kaplan and Camacho, 1983; Kotler and Wingard, 1989; Moen *et al.*, 1989; Schoenbach *et al.*, 1986). The study of Blazer (1982) also suggests that in addition to the presence of social ties, the perception of having social support is an important predictor of mortality. Concerning marital status as a form of social ties, Rosengren and colleagues (1989) reported that married men in Gothenberg, Sweden, had an overall death rate of 9% compared with 20% for those who were divorced. After adjustments for risk factors including alcohol problems, smoking and type of occupation, the association between marital status and overall mortality was still highly significant. In virtually all risk factors analyzed, the odds ratios of divorced versus married men were well above 1.00. Alcoholism, cirrhosis of the liver, suicide and other forms of violent death were excessively high among divorced and widowed men in contrast to married men. The authors concluded that "...alcohol abuse seems to be the most important [variable] in the present study, and a substantial part of the increased mortality in the divorced men could be attributed to this factor" (Rosengren *et al.*, 1989:62). In fact, in most studies, the divorced and the widowed display very high odds of death (Helsing and Szoklo, 1981; Helsing *et al.*, 1981; Hu

and Goldman, 1990; Kitagawa and Hauser, 1973; Litwak and Messeri, 1989; Mergenhagen *et al.*, 1985; Smith and Zick, 1986; Stroebe *et al.*, 1982, 1983; Trovato and Lauris, 1989; Verbrugge, 1979; Wolfson *et al.*, 1990; Zick and Smith, 1991).

Attention has also been devoted to the effects of marital transitions on health and mortality (Trovato and Lauris, 1989; Zick and Smith, 1991; Helsing *et al.*, 1981; Perkins, 1990). The underlying premise of this area of investigation is that becoming unmarried as a consequence of divorce or widowhood precipitates emotional, psychological and physical stress, ill health and premature mortality (Benjamin, 1971). It has also been suggested that marital status transitions have different effects on the sexes. For example, Gerstel and associates (1985) show that marriage dissolution for men often leads to a loss of significant others as a source of social support; for females, divorce and separation result mostly in a loss of material well-being. Thus, the distress experienced by the sexes as a result of family dissolution occurs through different mechanisms: a loss of social support and networks for men; and reduced economic well-being for women.

Men who lose their spouses have greater levels of health problems and higher odds of mortality as compared to widowed women. In general, widowed men experience increased odds of heart disease, suicide and accidental mortality (Bowling, 1987; Helsing *et al.*, 1981, 1982; Stroebe *et al.*, 1982, 1983). In a prospective study, Helsing and associates (1981) discovered that widowers who did not remarry had a significantly higher hazard of dying when compared to never-widowed men and widowers who remarried. It was concluded that the remarried are less likely to die prematurely for two reasons: first, healthier individuals were more likely to enter remarriage; second, remarriage recreates a supportive environment that insulates the newly widowed individual from the stresses of having lost a loved one.

A change in marital status often leads to a loss of socioeconomic status. Zick and Smith (1991) hypothesized that persons who live below the poverty line will have low life expectancies because they have insufficient resources to ensure a healthy lifestyle and to afford good medical care. Moreover, they posited that married individuals would have a lower risk of mortality than the divorced, the widowed and the never-married because individuals who marry are healthier; and the marriage environment discourages unhealthy behaviours and provides a strong social support

network for individuals. Persons who have recently made the transition from being married to some other state (e.g., divorce, widowhood) were hypothesized to have elevated risks of mortality due to the higher levels of emotional stress that is generally associated with the new life-style (Zick and Smith, 1991). The results of their study indicate that while poverty is deleterious to both sexes, especially for women, current marital status and marital status transitions are only significant for men in predicting mortality — men who have been divorced or widowed for three years or more have a significantly higher probability of dying than do married males, and males who have recently divorced have a significantly higher hazard of dying than men who had no recent marital status transition.

Why should the social environment of marriage be more protective of men than of women, and why should a change in status from marriage to remarriage be more deleterious to males? The literature on sex differences in morbidity and mortality suggests a number of possible explanations. First, men generally have riskier life-styles than do women. They are more likely to drink excessively, smoke, have poorer dietary habits and are prone to experience more accidents and violence (Nathanson, 1984; Verbrugge, 1981; Waldron, 1976, 1986; Wingard, 1984). The marriage environment often serves to restrict such health-damaging behaviours (Umberson, 1987). Therefore, the man who leaves singlehood or an unmarried state (widowhood or divorce) for marriage (or remarriage) essentially improves his life expectancy due to the "protection" family life affords. Women generally have less risky life-styles, and they also live longer; thus a change in status from single to married (or from unmarried to remarried) entails less of a gain in survivorship probabilities. Therefore, marriage is less "beneficial" to women in this sense (Nathanson, 1984; Verbrugge, 1990; Wingard, 1984).

A second explanation given in the literature is that the married generally possess larger social networks than nonmarried people. According to Zick and Smith (1991), it is the wives who are usually responsible for maintaining links to the couple's social support networks. Men who are no longer living with a spouse because of either widowhood or divorce may find that their access to the support network declines considerably. Over a prolonged period of time such men will likely experience a loss of social ties and an increased risk of mortality.

What conclusions can we draw from the literature reviewed concerning social ties and mortality? The first conclusion is that marriage as a form of

meaningful and enduring social bond appears to be related to better health and longevity. Both cross-sectional and prospective data support this generalization. Secondly, it has been established by prospective studies that health selectivity cannot wholly account for the strong and significant effects of marital status on health and mortality. A third conclusion is that in general marriage entails a larger reduction in mortality risk for men than for women. Fourth, research on marital status transitions' effects on health and mortality indicates that divorce and widowhood are more devastating for men than for women, but both sexes experience elevated risks of illness and mortality from any transition away from marriage; and reentering the state of marriage after either divorce or widowhood appears to afford more "protection" than for those who remain unmarried. Fifth, the manner in which family life influences health, well-being and longevity has been postulated to be largely a function of the social support and normative regulation that the family environment provides the individual. These effects operate largely through increased intimacy and the ability to communicate feelings freely and without self-consciousness to a significant other; an increased sense of belonging to others with similar objectives and concerns; and the ready access to nurturant and supportive behaviour in times of need (Berkman, 1984; Litwak and Messeri, 1989; Moen *et al.*, 1989).[1]

A number of important mechanisms explaining marital status differences in mortality have been identified, ranging from life style factors and normative constraints to differential access to social support. A direct test of all the causes identified is not possible, as the appropriate data are unavailable. A direct evaluation would require micro-level data based on the prospective observation of individuals. The expectation in this cross-sectional study is that the marital status variable will be a significant differentiator of mortality risk since it is strongly associated with all of the relevant factors delineated in the review of the literature (see Trovato, 1991 for an expanded discussion of this).

Data and Methods of Analysis

The data for this analysis were taken from the Mortality Data Base stored at Statistics Canada in Ottawa. The file adapted for the study consists of deaths in 1985-87 by cause of death, age, sex and marital status. Corresponding population counts were taken from the 1986 Census of Canada. The variables are classified as follows: sex (male, female), age

(15-29, 30-49, 50-69, 70-79, 80+), marital status (single never married, married, widowed, divorced). Eleven causes of death plus general mortality are analyzed (see Appendix A). The causes of death are classified into various etiologies as suggested by Gove (1973): (1) mortality due to overt social acts (e.g., suicide, homicide, motor vehicle accidents, other accidents); (2) mortality associated with the use of socially approved narcotics (e.g., lung cancer, cirrhosis of the liver); (3) mortality associated with diseases requiring prolonged and methodical care (e.g., diabetes); (4) mortality largely unaffected by social factors (e.g., leukemia); (5) mortality associated with stress (e.g., heart disease, cancer of the stomach); and (6) mortality from all causes.

Statistical Methods

In order to assess the possible protective effects of marriage on mortality, Relative Mortality Ratios (RMRs) are computed (see Appendix B):

$$RMR = \frac{DR_{ijk}^{(nm)}}{DR_{ijk}^{(m)}},$$

where: RMR = relative mortality ratio,
DR = death rate,
i = gender group,
j = age group,
k = cause of death,
(m) = the married category.
(nm) = a non-married category (e.g., single, widowed, divorced).

The RMR is a measure of relative risk, denoting the odds of dying for a given unmarried class in relation to the married population. An RMR greater than 1.00 will indicate that the married have a lower mortality risk than the unmarried, while a ratio less than 1.00 will mean the opposite.

Analysis

General Mortality

Table 1 shows results from a log-linear analysis involving the overall death rate for Canada in 1985-87. The nonmarried possess relatively higher death rates than the married.[2] The relative risks (RMRs) are substantially larger for males than for females. The range of RMRs is from 1.35 (divorced males) to 1.95 (widowed males). For both sexes, the widowed appear to suffer greater odds of death than either divorced or single categories. In fact, judging from the overall main effects, the difference in RMRs between divorced and single categories is rather small, especially for males.

The RMRs based on the interaction effects of marital status with age demonstrate that in virtually all cases, each of the age-marital status groups exhibit elevated risks of death in relation to their married counterparts. Across age categories, males tend to show higher RMRs than do females, with the exception of the age classes 15-29 and 30-49, where single females display slightly higher relative risks. This does not mean that young women have higher death rates than young men, rather it demonstrates that the difference between the death rate of young women and their married counterparts is larger than is the case for young single and widowed men vis-a-vis young married men.

For men, the largest RMRs appear among the widowed and the divorced aged 15-29 and 30-49. The relative risk of widowed men 15-29 is over six times that of the married, while divorced men in the same age group have a 60% higher mortality risk than the married. The situation for women suggests that their relative mortality risk is also highest among the very young widowed, with a RMR of 4.92. Single women aged 15-29 share a 65% higher risk than their married counterparts. It would appear that while both males and females would benefit from either entering or reentering the married state, the benefit would be especially greater for widowed men and women who are 15-29 years of age. Since none of the RMRs are below 1.00, our conclusion is that overall, the married in Canadian society have a relatively lower risk of death than do single, widowed and divorced people.

TABLE 1. RELATIVE MORTALITY RISKS (RMRs) DERIVED FROM DIVIDING THE DEATH RATE OF THE NONMARRIED BY THE RATE OF THE MARRIED; CANADA, 1985-87 (GENERAL MORTALITY)

Overall Effect of Marital Status	Males				Females			
	RMR*		Z**		RMR		Z	
Single	1.37		22.52		1.45		22.30	
Widowed	1.95		21.45		1.71		16.18	
Divorced	1.35		17.24		1.31		12.03	
Interaction: Age x Marital Status (RMRs)	15-29	30-49	50-69	70-79	15-29	30-49	50-69	70-79
Single	1.42	1.32	1.52	1.35	1.65	1.47	1.42	1.22
Widowed	6.22	1.98	1.31	1.32	4.92	1.67	1.24	1.22
Divorced	1.59	1.78	1.37	1.35	1.21	1.56	1.26	1.34

* For this and subsequent table, refer to Appendix B for a description of the statistical model used in this analysis.
** In this and subsequent tables, the Z-test (one-tailed test) is used for statistical significance. Z scores below 1.64 denote insignificant effects.

NOTE: Results are net of age.

Mortality Associated With the Use of Socially Approved Substances

Lung cancer and cirrhosis of the liver can be considered as the end result of excessive smoking and alcohol consumption over one's lifetime. In Table 2, single, widowed and divorced men differ significantly in the risk of death from these two diseases in comparison to married men. Divorced men display a 51% excess mortality level, widowed men a 29% excess risk, and single men an 18% higher risk. Single women do not display any difference in their risk of lung cancer when compared to married women in Canada. However, both widowed (RMR = 1.30) and divorced (RMR = 1.67) women experience substantially higher odds of lung cancer mortality in comparison to married women.

It is generally thought that people who use narcotics like tobacco and alcohol in excess do so to drown their sorrows and difficulties in life (Gove, 1973). The evidence presented in connection with lung cancer suggests support for the view that in relation to marriage singlehood entails more sorrow and distress, culminating in more smoking and death from lung cancer for single and unmarried people.

Death from cirrhosis of the liver is more likely to occur among the divorced and the widowed. The risk is largest for divorced men. They are almost twice as likely to die from liver disease (RMR = 1.94). Widowed men are almost 50% more likely to die from cirrhosis of the liver as are married men (RMR = 1.47); single men have a 38% greater chance of perishing from this ailment.

Female risk ratios are somewhat lower than those corresponding to males, but the pattern of results is similar; that is, the risk is highest for the divorced and is lowest for the single. Single and widowed women show RMRs of 1.23 and 1.25 respectively, which is in sharp contrast to the 1.83 RMR of divorced females.

Mortality Due to Overt Social Acts

Causes of death for which etiologies are highly associated with psychological states of mind (suicide), carelessness (motor vehicle accidents, pedestrian fatalities, accidental falls), and conflict in life (homicide) are examined in Table 2. The divorced lead in relative risk of suicide, men by 92% (vis married men), women by 202% (vis married

women). Widowed men show a substantial risk of suicide (RMR = 1.67). Both single men and women have RMRs above 1.00, but the latter show a 53% excess risk, while the former display a 44% higher odds of suicide in comparison to their corresponding married counterparts.

Concerning mortality from accidental falls, divorced men suffer an 85% excess risk, followed by single (RMR = 1.60) and widowed men (RMR = 1.28). Although the risk is somewhat lower for females, their RMRs are substantially above 1.000 to indicate that both single and unmarried females share a significantly greater chance of death than do married women. Single men also show a high risk of death from these two causes, while widowed men have a modestly higher risk of death from accidental falls.

Pedestrian fatalities are more likely to occur to single women (RMR = 3.04) and single men (RMR = 2.48). Widowed men and women do not differ significantly in their odds from their corresponding married counterparts, but both sexes in the divorced state have relative risks close to 2.00.

The situation with motor vehicle accidents mortality indicates that widowed and divorced men share a particularly high risk. In comparison to married men, widowed males have a 230% greater overall risk of dying as a consequence of a motor vehicle related accident. Divorced men show a 64% greater risk than married men. Among males, the singles show the lowest relative overall risk (RMR = 1.11). For females, the situation is similar in the sense that the widowed have approximately twice the death rate as that of married women. Divorced women show a 25% excess risk, while single women have a modestly higher risk than married women (by 11%).

Since age interacts significantly with marital status, it is important to examine how groups differ in relative risk over age. Among single people, the critical ages for increased odds of motor vehicle related fatality are the very young (age 15-29) and for relatively old males (age 70-79). The male RMR in the older age group is substantially greater than that of females. For both genders, the relatively young widowed display exceptionally high relative odds of death. For example, the risk is 12.33 and 8.63 for widowed men and women respectively in the 15-29 age category. Among widowed and divorced men, the risk of death due to motor vehicle accidents remains substantial throughout all age groups, though in general, the odds

reduce as one gets older. Interestingly, single men aged 30-49 have a slightly lower chance of death than do married men (RMR = .95).

This is also true in connection with females aged 30 and above, where RMRs are below 1.00. From the results, it is clear that widowhood for women engenders a significant increase in mortality risk, though it declines with increasing age, from 8.63 for those aged 15-29, to 1.28 for women aged 70-79. Divorce is especially lethal for women in the age group 30-49, as their relative odds are over six times greater than those of the married. In the case of singlehood, the odds are below 1.00 for females aged 30 and older.

These results are indicative of the fact that in some cases, the married tend to suffer a higher incidence of motor vehicle accident related mortality than single people in certain age groups (beyond 30). For example, it has been reported that the married have more fatal car accidents in some cases than do single people (Hu and Goldman, 1990). What is unquestionably clear from our findings, however, is that in comparison to widowed (and generally divorced) persons, the overall risk of death (the main effect) as a result of motor vehicle related accidents is lower among married people, irrespective of age.

Concerning homicide, nonmarried men and women share an excess risk of death. It appears that the most vulnerable to this fate are divorced men (RMR = 2.15) and divorced women (RMR = 1.69). The lowest RMR is for single women (1.32). Widowed men and women do not differ greatly in their relative risk (46 and 43% above married men and women, respectively).

As was the case with mortality associated with socially approved substances, differences in death due to overt social acts also denote that on balance, divorced, widowed and single men and women, in that order, share considerably higher odds of mortality than do their married counterparts. This evidence is consistent with the hypothesis that marriage is a protective institution for the individual, and that the state of singlehood or being unmarried engenders less protection and hence an increased relative risk of death. This is a reasonable inference since motor vehicle accidents, pedestrian fatalities, accidental falls, homicide, and even suicide, for the most part reflect problems in the immediate circumstances of the decedent and therefore their etiologies cannot be easily attributed to health conditions prior to marriage (i.e., health selection).

TABLE 2. RELATIVE MORTALITY RISKS (RMRs) BY MARITAL STATUS AND CAUSE OF DEATH, DERIVED FROM DIVIDING THE DEATH RATE OF THE NONMARRIED BY THE RATE OF THE MARRIED, CANADA, 1985-87

Cause of Death and Marital Status	Males		Females	
	RMR*	Z	RMR*	Z
Lung Cancer				
Single	1.18	7.66	0.97	0.86
Widowed	1.29	12.64	1.30	9.54
Divorced	1.51	15.88	1.67	13.02
Cirrhosis of the Liver				
Single	1.38	8.26	1.23	2.78
Widowed	1.47	8.63	1.25	3.79
Divorced	1.94	15.00	1.83	7.83
Suicide				
Single	1.44	13.66	1.53	8.71
Widowed	1.67	5.06	1.06	0.86
Divorced	1.92	18.18	2.02	12.31
Accidental Falls				
Single	1.60	8.44	1.43	4.74
Widowed	1.28	4.51	1.21	2.88
Divorced	1.85	8.00	1.28	1.95
Pedestrian Fatalities				
Single	2.48	10.82	3.04	6.84
Widowed	0.94	0.47	1.29	1.51
Divorced	1.91	5.36	2.09	3.77
Motor Vehicle Accidents Excluding Pedestrian Fatalities				
Marital Status Main Effects				
Single	1.11	1.34	0.83	1.76
Widowed	2.30	10.25	2.03	8.47
Divorced	1.64	4.75	1.25	1.47

Age and Marital Status Interactions	Males				Females			
	15-29	30-49	50-69	70-79	15-29	30-49	50-79	70-79
Single	1.34	0.95	1.10	1.70	1.41	0.87	0.90	0.84
Widowed	12.33	2.62	1.83	1.56	8.63	3.68	1.37	1.28
Divorced	2.32	2.26	1.58	1.44	0.84	6.62	1.09	1.09

Table cont'd.

Table 2 cont'd.

Cause of Death and Marital Status	Males RMR*	Males Z	Females RMR*	Females Z
Homicide				
Single	1.65	6.62	1.32	2.58
Widowed	1.46	2.48	1.43	2.19
Divorced	2.15	7.88	1.68	3.68
Diabetes				
Single	1.46	8.44	1.17	3.01
Widowed	1.31	6.34	1.40	8.37
Divorced	1.55	7.11	0.96	0.50
Lymphoid Leukemia				
Single	1.65	3.91	9.87	0.14
Widowed	1.44	2.84	7.46	0.12
Divorced	1.11	0.49	12.94	0.16
Heart Disease				
Single	1.37	30.02	1.20	13.18
Widowed	1.30	27.60	1.25	19.08
Divorced	1.34	20.04	1.22	9.13
Stomach Cancer				
Single	1.25	3.82	1.22	2.48
Widowed	1.35	5.60	1.38	4.91
Divorced	1.27	2.89	1.16	1.31

* Net of age composition.

Mortality Associated with a Disease Requiring Prolonged and Methodical Care (Diabetes)

Diabetes is a disease which requires the individual to take methodical care and precautions in order to stay alive. Usually, persons in the constellation of the individual's significant others, such as a spouse and children, contribute to ensure that the diabetic is diligent in his/her medical regime. According to Gove (1973) this cause of death should be lowest among the married and relatively high among the single and the unmarried.

Widowed and single women show a significant overall effect on death as a consequence of diabetes, while divorced women do not. In the case of men, all three non-married groups demonstrate elevated risks. On average, single men have a 46% higher risk of death than the married,

while widowed and divorced males experience a 31 and 55% excess risk. Among women, the largest RMR is associated with widowhood (RMR = 1.40).

Mortality Largely Unaffected by Social Factors

In the preceding analyses, the assumption has been that social and emotional states of individuals are the underlying forces behind the observed marital status differentials. We have seen that by and large, there is an association between one's marital state and death probabilities, with the married generally possessing the lowest odds (with few exceptions). However, in ailments where the etiology is thought to be predominantly non-environmental, the relationship of marital status with mortality should be very weak or non-existent. Following Gove (1973) and Boyd (1983), we may consider lymphoid leukemia as one example of a disease for which social conditions are of minimal importance in its etiology.

In fact, the only statistically significant mortality differentials are for single and widowed men, who show overall relative risks that are between 44 and 65% higher than the married. None of the remaining differences are significant. In the case of females, there is no evidence to denote that differences in deaths due to leukemia occur on the basis of marital status since none of the RMRs are significant.

These findings are partly consistent with Gove's thesis. In his analysis Gove (1973) found a very small differential in leukemia by marital status. Boyd (1983) found differentials for leukemia mortality which on the whole appear larger than those analyzed by Gove (1973). The present findings are closer to Boyd's results in that overall there is little variability, while at the same time, single and widowed men show a notable risk in relation to the married. Therefore, in an overall sense, there seems to be some basis to consider Gove's claim that the social environment of marriage is only protective in the case of diseases or disorders that have a predominantly social psychological etiology to them. However, this needs qualification in that some marriage protection seems to prevail even in the case of leukemia.

Causes of Death that are Partly Associated with a Stressful Lifestyle

It is possible to go beyond the various causes of death examined thus far to include afflictions that are presumed to have a significant stress component to them. Heart disease and stomach cancer are two such examples. This is not to suggest, however, that life stress is the only cause of heart disease and stomach cancer, only that excessive stress is an important contributor to their etiology.

In Table 2, it is shown that heart disease mortality is more frequent among single and divorced men. In relation to their married counterparts, unmarried males suffer anywhere from 30% (widowed) to 37% (single) greater risk (RMR = 1.37 for singles, 1.30 for widowed, and 1.34 for divorced men). The situation for females indicates that the widowed suffer a slightly more elevated risk (RMR = 1.25) than single and divorced women. Concerning stomach cancer, widowed men and women show the largest relative risk (1.35 for men, and 1.38 for women). Divorced women demonstrate no significant difference from married women.

Health Selection Tests

While it is impossible to provide a definitive test of health selection effects on mortality discrepancies, three indirect methods are considered here. The first approach is simply to reconsider our results concerning leukemia. The selection effects hypothesis would predict that the married would show significantly lower rates of mortality than either single or unmarried populations in connection with this cause of death. The assumption is that superior health explains both selection into marriage and continued lower mortality for the married. As indicted earlier, our findings are mixed in that a few of the differentials in leukemia mortality risk turned out to be statistically significant. Therefore, this initial indirect test suggests some support for the health selection theory since, by and large, the married possess lower risks even for a cause of death that is not presumed to have a predominantly environmental etiology.

A second way in which this question can be assessed is to rely on the procedure suggested by Kisker and Goldman (1987) and Hu and Goldman (1990), who have argued that if health selection is an important cause of mortality differences across marital status groups, there should be an inverse correlation between the proportion single or divorced in a given

age-sex class and their group-specific death rates. The rationale for this prediction was given earlier. In essence, the fewer the numbers in these two categories, the greater the mortality levels for such people due to, presumably, negative health selectivity which keeps such individuals out of entering (or reentering) marriage. Thus, as the relative size of these social categories increases, their death rates should decline.

This test is given in Table 3. A log-rate regression model was fitted to the data for males and females separately, including as predictors the percentage single or divorced and age. As can be seen from the coefficients in the table, all of the effects are in the predicted direction — they are all negative and statistically significant. For example, among singles, the proportion male would multiply the overall death rate of single men by .998, which translates into a reduction in overall risk. This effect is a little stronger for the divorced (exp λ = .931 for males and .975 for females). Thus, this method seems to provide a more definitive conclusion than our first indirect test of selectivity.

TABLE 3. LOG-RATE REGRESSION COEFFICIENTS FOR THE EFFECTS OF THE PERCENTAGE OF THE POPULATION IN THE SINGLE OR DIVORCED MARITAL STATUSES ON THEIR GENERAL MORTALITY RATES

	Single			Divorced		
Sex	λ	e^{λ}	z	λ	e^{λ}	z
Males	-.01164	.998	-3.82*	-.07283	.932	-6.28*
Females	-.00295	.997	-1.70*	-.02559	.975	-1.98*

P≤ .05 (one-tailed test)

Livi-Bacci (1984) proposed another way to assess health selectivity effects which is largely based on the same assumptions as the previous method. He has argued that the interaction of age with the proportion in the population that is single or divorced should show an inverse correlation with the ratio of death rates of nonmarried to married, for the age groups 15-49 and then diminish for older ages. Presumably, such a pattern of results would denote strong health selection effects in the younger, prime marriageable ages, and not beyond. That is, the health selection effect should be strongest at ages by which the majority of persons marry (or eventually marry).

TABLE 4. OLS REGRESSION ANALYSIS OF RELATIVE MORTLITY RISK OF SINGLES TO MARRIED AND DIVORCED TO MARRIED RATES (GENERAL MORTALITY)

	$y = \frac{\text{Singles DR}}{\text{Married DR}}$			$y = \frac{\text{Divorced DR}}{\text{Married DR}}$		
Effect	ß	t	r (yxi)	ß	t	r (yxi)
x1	.0509*	3.86	.541	.0477*	2.43	.364
x2	.0781*	8.41	-.416	.0644*	4.67	-.282
x3	-.0146	-1.76	-.576	-.0105	-0.83	-.386
x4	-.0427	-4.31	-.600	-.0292*	-1.98	-.402
Sex (Male)	.1890*	2.46		.3081*	2.70	
Intercept	2.4400*	13.26		2.4100*	8.805	
R^2	.504				.230	

* P≤ .05 (one-tailed test)

NOTE: x1 = (Age 15-29 x % Single or Divorced)
x2 = (Age 30-49 x % Single or Divorced)
x3 = (Age 50-69 x % Single or Divorced)
x4 = (Age 70-79 x % Single or Divorced)
The reference age group for these interaction terms is 80+.

Table 4 displays regression equations considering the relative general mortality ratio of singles to married, and of divorced to married. The results support Livi-Bacci's thesis. The effects of percent single or divorced are positive and significant for ages 15-29 and 30-49 and then decline for subsequent age classes. The strongest effects are in the age group 30-49, as expected. Thus, our third indirect test also suggests that there may be a health selection effect on marital status differences in mortality.

Conclusions

This study examined the association between marital status and mortality in Canada, 1985-87. A number of specific causes of death were

investigated, including overall mortality. It was predicted that the married would enjoy a greater degree of "protection" from death in relation to the single and unmarried groups in society. Marriage provides the individual with social, psychological and material support, making one's environment safer and more predictable.

Since marriage bonds the individual to a significant social group in terms of obligations, expectations and support, persons in this institution would practice safety in their environment and diligence in diet, lifestyle and health matters. In general, this form of social integration is lower for single, widowed and divorced persons. Therefore, these social categories should experience relatively higher death rates than their married counterparts. This "protection" thesis was tested by examining mortality differentials for diseases or conditions that have significant social and psychological etiologies. The statistical results of this investigation appear to be consistent with the "protection" of marriage explanation. However, indirect tests for a possible health selection effect on death differences indicate that part of the apparent superior survival experience of the married may be due to health selection. That is, marriage selects healthy individuals; and the less healthy remain single or stay divorced (or widowed). The combined effects of such a process would be to heighten mortality differences in favor of the married.

It is virtually impossible to provide a definite answer as to how much "protection" accounts for the married's relative advantage in survival probabilities as opposed to "selection." A direct test of this question would require an experimental design where individuals would be observed early in life and then followed up over their life courses in order to ascertain who marries or remains single (who divorces or remarries) and for what reasons (health versus other) people enter, do not enter, or exit the various marital status categories (i.e., death, widowhood, divorce, remarriage, etc.). Judging from the relative magnitude of statistical effects obtained in this study, it would seem that "protection" accounts for more of the marital status mortality differential than "selection," since on the whole, the main effects of marital status are larger than the parameters for the health selection tests.

Many of the mortality differentials observed in this investigation denote that men have a higher risk of death than do women, both in connection with general and cause-specific mortality. As demonstrated by the RMRs in Table 5, men's relative risk is consistently above 1.00. The most

pronounced sex differences are in connection with suicide, lung cancer, cirrhosis of the liver and motor vehicle accidents — all causes which share strong social psychological etiologies. These results coincide with the literature on sex differences in mortality (Nathanson, 1984; Waldron, 1976; Wingard, 1984).

TABLE 5. SEX DIFFERENCES IN MORTALITY, CANADA, 1985-87*

Cause of Death	Male Rate / Female Rate	Z***
All Causes	1.38	214.87
Lung Cancer	1.87	99.96
Cirrhosis of the Liver	1.66	36.50
Suicide	1.97	55.86
Accidental Falls	1.31	18.63
Pedestrian Fatality	1.42	12.39
Motor Vehicle Accidents**	1.68	44.78
Homicide	1.43	12.66
Diabetes	1.15	13.53
Lymphoid Leukemia	1.51	14.12
Cancer of the Brain	1.21	10.91
Heart Disease	1.43	135.47
Stomach Cancer	1.51	30.01

* Controlling for Age and Marital Status
** Excluding Pedestrian Fatalities
*** All Z-tests are statistically significant.

It would be important to extend this analysis by including statistical controls for socioeconomic variables such as income, education and occupation, as it is likely that marital status categories differ in socioeconomic levels, and that socioeconomic position is a factor in mortality differentials. A further control of theoretical importance would be parenting status. There is some empirical evidence that within categories of marital status, parenting is linked to variability in the conditional risk of death. Finally, another important variable worth considering is duration in a given marital state. For example, among the divorced, those who had been married longer may experience more of the benefits (protection) of marriage than those who had been married for a shorter period of time. This variable has not received enough attention in the literature.

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Footnotes

1. Although we have knowledge regarding the social psychological aspects of how marriage promotes well-being and reduced mortality risk, the biomedical mechanisms through which family life affects the individual's health remain largely unexplored (House et al., 1988). House and colleagues' (1988) extensive review of the experimental and quasi-experimental literature based on humans and animals suggests that social isolation is a major risk factor for health. "These developments suggest that social relationships, or the relative lack thereof, constitute a major risk factor for health — rivalling the effects of well-established risk factors such as cigarette smoking, blood pressure, blood lipids, obesity, and physical activity" (House et al., 1988:541). There is some indication in the literature that social relationships affect our anterior hypothalamic zone in such a manner as to stimulate the release of human growth hormone, while at the same time inhibit the posterior hypothalamic zone, and hence the secretion of adrenocorthetic autonomic activity (House et al., 1988). According to Berkman and Syme (1979), social isolation leads to physiological changes in the body which increase general susceptibility to disease. In other words, stressful circumstances can have severe physiological effects in weakening host resistance to morbidity and mortality. Nervous, hormonal and immunologic control systems can be affected by prolonged stress in such a manner as to cause disease. House et al., (1988) state that more investigation is needed into the biophysical mechanisms of how social relationships act on the physiological systems of humans.

2. In this analysis, it was discovered that in all cases, the separated marital state shows a very low death rate, below all other marital statuses, including the married. Although I do not show these results, my hypothesis is that many decedents who are in actuality separated from their spouses at the time of death get classified as either single or divorced. To the best of my knowledge, no one else has ever examined this problem, thus it is difficult to give an absolute answer to this issue. More direct investigation is needed to determine whether the very low death rates of the "separated" may be a function of incorrect reporting on the death certificate, undercount in the Census, or both. From a theoretical point of view, the separated should possess relatively high death rates since they suffer a loss of social integration. Their observed low death rates are therefore anomalous in this sense. In the log-rate regressions, combining the "separated" with either the divorced or the married produced unbelievable results. For example, the single or the widowed would show a lower risk of death than the married. My overall assessment of the situation is that the "separated" class is probably undercounted in the death records. Many "separated" decedents are probably classified on the death certificate as "married" or "single," or possibly "divorced." In order to control for this possible source of error, I decided to enter a term for "separated" into the log-rate regressions, rather than to lump them with either the married or the divorced. Removing the "separated" from the multivariate analysis

proved to be problematic in that inconsistent results would emerge with respect to expected patterns of marital status differences, and also age effects.

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Appendix A

CAUSE OF DEATH:		ICD9 CODE
(a)	heart disease	391, 392.0, 393-398, 402, 404, 410-414, 415, 416, 420-429
(b)	cancer of the stomach	151
(c)	cancer of the trachea, lung and bronchus	162
(d)	lymphoid leukemia	204
(e)	diabetes mellitus	250
(f)	chronic liver disease and cirrhosis	571
(g)	pedestrian deaths	E814
(h)	accidental falls	E880-E959
(i)	motor vehicle accidents (excluding pedestrian fatalities)	E811.0, E812.0, E813.0, E815.0, E816.0, E810.0-E810.9, E811.1, E812.1, E811.2-E811.9, E812.2-E812.9, E813.1-E813.9, E815.1-E815.9, E816.1-E816.9, E817-E819
(j)	suicide	E950-E959
(k)	homicide	E960-E969

Appendix B

Statistical Model for the Relative Mortality Risk (RMR)

Given a multiway tabulation of deaths (D) by age (A), sex (S), and marital status (M), we make the assumption that the deaths in each cell of this table are independent Poisson random variables with means equal to the product of the population at risk (N) in each cell and an underlying hazard (μ). Given these assumptions, the expected number of deaths for each cell in the tabulation is:

$$E(D_{ijk}) = N_{ijk} \cdot \mu_{ijk}, \tag{1}$$

where: i = age group (1, . . . , 5),
j = (sex) (1, 2),
k = marital status group (1, . . . , 5).

This expression can be described by a log-linear model for the expected deaths (Agresti, 1990; Clogg and Eliason, 1987; Laird and Olivier, 1981),

$$\log E(D_{ijk}) = \log N_{ijk} + \log \mu_{ijk} \tag{2}$$

Given the definition of variables in this study, we can fit a log-linear model of the form:

$$\log E(D_{ijk}) = \log (N_{ijk}) + \alpha + B_i^A + B_j^S + B_k^M, \tag{3}$$

which is equivalent to:

$$\log\left(\frac{D_{ijk}}{N_{ijk}}\right) = \lambda + \lambda_i^A + \lambda_j^S + \lambda_k^M, \tag{4}$$

where: λ = a constant term (baseline hazard),

λ_i^A = parameters for age, with the constraint $\Sigma\lambda_i^A = 0$,

λ_j^S = parameter for sex, with constraint $\Sigma\lambda_j^S = 0$,

λ_k^M = parameters for marital status, with constraint $\Sigma\lambda_k^M = 0$.

Interaction terms may be added to this equation. For example,

$$\log\left(\frac{D_{ijk}}{N_{ijk}}\right) = \lambda + \lambda_i^A + \lambda_j^S + \lambda_k^M + \lambda_{ij}^{AS} + \lambda_{ik}^{AM} + \lambda_{jk}^{SM}. \tag{5}$$

Note that the married class is the reference group for the marital status variable. Therefore, the exponentiated λ_k^M parameters become measures of relative mortality risk (RMR) for each unmarried class in relation to the married. That is,

$$\text{RMR} = \exp(\lambda_k^M). \tag{6}$$

Given the presence of significant interaction effects in the statistical analysis, (6) must be computed on the basis of this information. For example, in (5) the terms λ_k^M, λ_{ik}^{AM} and λ_{jk}^{SM} would have to be added together to derive appropriate RMRs as follows:

$$\text{RMR}_{ijk}^{(nm)} = \exp\left(\sum_{k,ik,jk} \lambda^{(nm)}\right) \tag{7}$$

where $\Sigma\lambda^{(nm)}$ = parameter values for a given unmarried group summed over the k main effect and the interactions of ik and jk.

For the purposes of this study, the log-rate regression analysis is partitioned by sex, since it is known that mortality varies substantially on the basis of gender. The analysis proceeds by first fitting an equiprobability model:

$$\log\left(\frac{D_{ij}}{N_{ij}}\right) = \lambda. \tag{8}$$

In all cases, this model did not fit the data; therefore, alternative equations are fitted. The next model computed is the age effects model:

$$\log\left(\frac{D_{ij}}{N_{ij}}\right) = \lambda_i^A, \tag{9}$$

followed by a model containing only marital status:

$$\log\left(\frac{D_{ij}}{N_{ij}}\right) = \lambda_k^M. \tag{10}$$

None of these models provided an adequate fit; therefore, the main effects model was computed,

$$\log\left(\frac{D_{ij}}{N_{ij}}\right) = \lambda_i^A + \lambda_k^M. \tag{11}$$

In most cases, this model provided an excellent fit, giving R^2 levels close to 1.00. Goddness of fit is calculated by the following R^2 analog measure:

$$R^2 = 1 - \left(\frac{\text{Model Log-Likelihood Chi-Square}}{\text{Equiprobability Model Log-Likelihood Chi-Square}} \right). \qquad (12)$$

Should a main effects model fail to give an adequate fit to the data, then the saturated model is computed:

$$\log\left(\frac{D_{ij}}{N_{ij}}\right) = \lambda_i^A + \lambda_k^M + \lambda_{ik}^{AM}, \qquad (13)$$

which will always provide a perfect fit, but it is not parsimonious since it will contain many parameters.

For the purposes of this study, the parameters are expressed in their multiplicative form (the exponents of λ parameters). Thus, the interpretation of parameters is the extent to which a given term multiplies the overall death rate (general or cause specific) in relation to a given reference category. The reference class for age is 80+, while for marital status it is the married group.