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MARITAL STATUS AND MORTALITY : THE IMPORTANCE OF SELECTION

by

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Department of Sociology and Anthropology

Submitted in partial fulfilment
of the requirements for the degree of
Doctor of Philosophy

Faculty of Graduate Studies and Research
Carleton University
Ottawa, Ontario
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MARITAL STATUS AND MORTALITY: THE IMPORTANCE OF SELECTION

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in partial fulfilment of the requirements for
the degree of Doctor of Philosophy

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Abstract

It has been known for over a century that the mortality rates among the unmarried are, in general, higher than among the married. This is true for mortality from all causes and from most specific causes. It is true for both women and men, but the mortality ratio (MR = the ratio of the mortality rate among the unmarried to that among the married, expressed as a percentage) is greater for men than for women.

This marital status mortality differential (MSMD) is found in national mortality statistics and in longitudinal studies. Apart from statistical artifact, two main explanations for the MSMD have been proposed : a protective effect of marriage; or selection of the healthy into marriage or re-marriage. In this study the importance of selection is examined.

Using a multistate model of disease and marital status it is shown that in the presence of selection the MR is positively correlated with the rate of marriage or re-marriage. This is true for each of the three unmarried states (single, widowed and divorced), and for each of five main types of disease. However, the finding of a positive correlation between MR and marriage rate does not exclude the possibility of a protective effect of marriage in addition to selection.

Canadian mortality rates by marital status for women and men aged 15 to 74 were calculated for each of 9 three-year intervals centred on the census years from 1951 to 1991. The MR's were derived for death from all causes and from 42 specific causes. With a few

exceptions the MR's were greater than 100, and the MR for men was greater than that for women.

Poisson regression analysis was used to determine the correlation between the MR's and the corresponding marriage or re-marriage rates. Based on the correlation with marriage rates there was evidence of selection for mortality from all causes, and from most of the specific causes examined. The evidence was generally stronger for men than for women. Correlation with marriage rates also explained some of the gender differences in the mortality ratios.

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"Marriage is a healthy estate. The single individual is more likely to be wrecked on his voyage than the lives joined in matrimony."
(William Farr, 1858)

1 Introduction

Mortality differentials within a given population are differences in mortality rates between groups defined by some social or demographic characteristic. When expressed as the ratios of rates, mortality differentials are remarkably constant over time, despite changes in the mortality of the population as a whole. The mortality rate for a group is a measure of the average level of sickness among the individuals within the group at a given point in time, expressed as the instantaneous risk of dying. Thus, for example, the observation that the poor have a higher mortality rate than the rich implies that the poor, as a class, are sicker than the rich, as a class. However, the individuals within the two classes will, in general, differ with respect to their level of health, and the consequent risk of dying.

If it is possible for some individuals to change group status, and others not, then there are two main explanations for the existence of the mortality differential. The first explanation is that the change of status is selective with respect to the health of the individual, for example the healthier among the poor are more likely to become rich, and/or the sicker among the rich are more likely to become poor. The second explanation is that the group status of the individual modifies health, for example being poor

makes one sick and/or being rich makes one healthy. Distinguishing between these two explanations, and finding possible mechanisms through which they exert their influence, is a major challenge for social demography, with important implications for social policy. The topic of this thesis is the marital status mortality differential (MSMD). The existence of a MSMD in favour of the married has been known since the time of Hippocrates (March, 1912: 511), but the first quantitative analysis was that of Farr (1858), who studied the 1853 mortality statistics of France. Table 1.1 shows Farr's results in terms of the age-specific mortality rates for married, single (unmarried in Farr's terminology) and widowed women and men. In Table 1.2 the rates for the single and the widowed are expressed as a percentage of the corresponding rate for the married. This mortality ratio (MR) is a measure of the MSMD which is commonly used in the subsequent literature, though not by Farr himself. With the exception of women younger than 30, and men younger than 20, married people have lower rates, i.e. the MR's for the single and widowed, compared with the married are greater than 100. The MR's for the single increase to a peak in middle life and then decline, while those for the widowed decline gradually with an increase towards the end of life.

Bertillon (1874: 43-52) repeated Farr's analysis for France, and added data from Belgium and Holland. March (1912: 511-512) provided similar statistics for Prussia and Sweden. These studies confirmed Farr's findings that, for the most part, the mortality rate among married people is lower than that among those of the same age and

gender who are single or widowed. Later, as divorce became more frequent it was found that divorced people, too, have higher rates than the married.

The explanation for this constant finding is still debated. The various hypotheses which have been proposed will be discussed later, but the two most important are those mentioned above: marriage selection (the healthier being more likely to be married or re-married); and marriage protection (the beneficial effects on health of being married).

Farr favoured the protective hypothesis (see epigraph), but laid special emphasis on the high mortality rates among the married in the youngest age groups, which he attributed to the "evil consequence of marriage .. under the age of 20, before the growth of the individual man or woman is completed." (Farr, 1858: 441).

The protective hypothesis was challenged by Spencer (1896), who was the first to state the selective hypothesis. Spencer argued that the decision to marry is determined primarily by the possession of adequate means, and "(t)hough some improvidently marry without means, yet it is undeniable that in many instances marriage is delayed by the man, or forbidden by the parents, or not assented to by the woman, until there is reasonable evidence of ability to meet the responsibilities (of marriage)." Those men who are most likely to have the means to marry are "(t)he best, physically and mentally - the strong, the intellectually capable, the morally well-balanced." (Spencer, 1896: 85)

Spencer's interpretation of the MSMD as evidence of "la selection

sexuelle", rather than "la vertu propre de l'association conjugale", was disputed by Bertillon (1875: 770), chiefly on the grounds that the widowed, who have already been exposed to selection, also have higher mortality than the married. Durkheim (1897) used the MSMD for suicide as an illustration of "egoistic suicide", in which marriage is an example of the protection against suicide provided by cohesive social institutions. Durkheim appears to have been the first to express the MSMD in terms of the MR, which he called the "coefficient of preservation".

Interest in the MSMD was rekindled by the publication of detailed statistics on mortality by marital status in the United States following the 1950 census. This led to a prolonged debate between scholars in the fields of sociology, public health and demography concerning the explanation of the MSMD. An important contribution was made by Livi-Bacci (1984), who suggested that if the marriage selection hypothesis were true then the MR for the single should vary with the proportion of people who remained unmarried. Livi-Bacci used international data to illustrate his approach. Hu and Goldman (1990) and Goldman (1993) extended Livi-Bacci's analysis, and Trovato (1992) applied the method to Canadian general mortality data.

The general aim of this thesis will be to analyse the Canadian mortality data in more detail and to determine how much of the variation in the MSMD can be explained by selection, using a modification of the approach used by Livi-Bacci. The specific objectives are listed in section 3, following a review of the

literature in section 2. Section 4 describes the models used to simulate the effects of protection and selection, the empirical data used for comparison, and the methods of analysis. The results of the modelling are described in section 5, and criteria are developed for detecting the presence of selection. Section 6 gives the results of the analysis of the Canadian mortality data and relates the findings to the criteria from section 5. Finally, section 7 considers the limitations of the data, compares the results with those of other studies, discusses the implications of the findings, and suggests lines for further research.

Table 1.1 Mortality Rates by Marital Status. France, 1853

Age group	Mortality rate per 1,000					
	Women			Men		
	Single	Married	Widowed	Single	Married	Widowed
15-19	8	14	107	7	29	187
20-29	9	9	23	11	7	29
30-39	10	9	14	12	7	18
40-49	14	10	14	18	10	20
50-59	23	16	22	29	18	30
60-69	50	35	47	50	35	54
70-79	113	85	107	110	89	129
80-89	241	180	229	211	184	248
90-99	296	188	363	281	260	413
All ages	20	15	58	21	18	72

Source : Farr (1858)

Table 1.2 Mortality Ratios (Married = 100). France, 1853

Age group	Mortality ratio			
	Women		Men	
	Single	Widowed	Single	Widowed
15-19	57	782	23	637
20-29	94	248	172	440
30-39	113	150	173	259
40-49	138	137	173	195
50-59	144	133	161	161
60-69	141	132	141	153
70-79	134	126	124	145
80-89	134	127	114	135
90-99	158	193	108	159

Source : Farr (1858)

2 Literature review

In this section the extensive literature on the MSMD, both for general mortality (2.1) and for mortality from specific causes (2.2) is reviewed. Relevant data from vital statistics and from longitudinal studies are summarized. Statistics on the marital status differentials with respect to morbidity are also discussed (2.3). The theories which have been proposed to explain the MSMD are reviewed (2.4). A summary of the literature review is provided (2.5).

2.1 Marital status and mortality from all causes

Estimates of the MSMD for general mortality come from two sources: national vital statistics and the results of longitudinal studies of groups of individuals. Tables 2.1 and 2.2 summarize the results of some of the published vital statistics from European countries in the latter half of the XIX C (Farr, 1858; Bertillon, 1874; March, 1912), and from Canada, the United States and Sweden in the XX C (Statistics Canada, 1994; Klebba, 1970; Larrson, 1965). The published data were grouped by age in a variety of ways. In the tables the MR's for specific age groups have been aggregated where necessary, using geometric means. In general the pattern of the MR's by sex and age is as follows: (1) MR's are greater than 100; (2) MR's for the single increase to a maximum in middle age and then decline; (3) MR's for the widowed and divorced are highest in the youngest age group and decline continuously with age; (4) the MR's for men are greater than those for women. There are some exceptions to this general pattern: (1) in the earlier period the

MR for women in the youngest age group is less than 100 (possibly due to the high level of maternal mortality in that period); (2) in many instances the MR's for single women continue to increase at older ages; (3) in the earlier period the MR for widowed and divorced women increases in the oldest age group, and in the later period the MR for widowed and divorced men in the youngest age group is not always the highest; and (4) in the two latter categories the sex differential is reversed. Some of these discrepancies may be due to the lack of adjustment for age within broad age groups.

Apart from gender, age and marital status, the only other demographic characteristics which are frequently captured at both death registration and census enumeration are occupation and place of birth. However, deaths and populations cross-classified by marital status and either of these two variables are not routinely published. An exception is the decennial supplement on occupational mortality in England and Wales (e.g. Registrar General, 1971) which gives mortality rates for single women and married women by social class (based on the occupation of single women and the occupation of the husbands of married women). Table 2.3 shows the results for all causes of death. Within each class the mean MR for single women compared with married women is greater than 100, and, with one exception, this is true for each age group.

Trovato (1996), in a recent study of mortality by marital status and place of birth in Canada, has shown that the unmarried have higher mortality rates than the married within each nativity group.

Table 2.4 summarizes the results of a selection of the longitudinal studies which have studied the MSMD for all causes. The earliest study was that of Peller (1943) who calculated mortality rates for never married and ever married members of European ruling families between 1500 and 1899. Subsequent studies were derived from follow-up of population samples in the period since 1950. In the Canadian study by Johnston (1988), a case-control approach was used. In general the MR's from these studies are comparable with those derived from vital statistics and census records, though somewhat smaller in magnitude. As in the cross-sectional studies the MR's for men are greater than those for women.

Many of the longitudinal studies, beginning with those of Young, Benjamin and Wallis (1963) and Cox and Ford (1964) have focussed on the mortality of widows and widowers, because of the interest in the possible effect of bereavement. Mendes de Leon, Kasl and Jacobs (1993) have summarized this literature in the following way:

" While most studies have been rather consistent in finding an increase in mortality risk following widowhood, the magnitude of this risk appears to vary across age and sex groups, and may also be a function of time since onset of widowhood. Widowers experience a higher risk than widows, for whom some studies have found a higher risk, but others have failed to do so. Increased risk is inversely related to age, especially among widows, where the effect is limited to women under the age of 60 or 65, while increased risk among widowers has been observed until the age of 75 and over. The

most vulnerable period occurs after the loss of the spouse, until, at most, the first 6-12 months of widowhood, although others have observed longer periods of elevated risk."

(Mendes de Leon, Kasl and Jacobs, 1993:519)

Although many authors have concentrated on distinguishing between the effect of bereavement and that of prior illness, resulting from homogamy or from shared hazards, selection into re-marriage is also a possible explanation. One study which examined this was that of Helsing, Szklo and Comstock (1981), and the following analysis is based on Table 5 of their paper. Among widowers the age-adjusted mortality rate for those who remarried within three years was only half that of those who did not. At ages below 55, where, judging from the ratio of person-years, the remarriage rate was about 49 per cent, the mortality among the re-married was only 29 per cent of that among those who did not remarry, while at ages 55 and over, where the remarriage rate was only 11 per cent, the mortality ratio was 66 per cent. The remarriage rate among widows was much lower than among widowers, and there was only one death among the remarried.

2.2 Marital status and mortality from specific causes

The most extensive analysis of the MSMD for specific causes based on vital statistics and census records is that of Klebba (1970), based on the data for the United States in 1959-61. Although tables of deaths by age, marital status and cause have been published annually since the inception of the Canadian vital statistics system, no official analysis of the MSMD has been published. More

recent Canadian data, but for a more restricted list of causes, have been published by Boyd (1983a), Trovato and Lauris (1989) and Trovato (1992). The results of these studies are described below (pp 80-82), and compared with the findings from the present study. Longitudinal studies also provide estimates of cause-specific MSMD's, but, since the numbers of deaths involved are generally small, it is necessary to aggregate causes to obtain reasonably precise estimates. Table 2.5 compares the results of two studies which published comparable data for three broad groups of causes: cancer, cardiovascular disease, and accidents and violence. With some exceptions the two studies give concordant results. The MR's are greater for accidents and violence than for the other two cause groups, especially among men. In general, also, the MR's are consistent with those derived from vital statistics.

2.3 Marital status and morbidity

Much of the information on marital status and morbidity comes from the United States, in particular from the National Health Survey in that country. These, and other similar data, have been reviewed by Carter and Glick (1976), Verbrugge (1979) and Macintyre (1992). Table 2.6 summarizes the extensive data from health interview surveys in the United States in 1971-72, analysed by Wilder (1976). The morbidity ratios shown are for the prevalence of loss of activity, chronic and acute conditions, and for rates of consultation with physicians and admission to hospital. Wilder comments:

"Thus, these overall measures of health status indicate that

married persons had fewer health problems than formerly married persons. With the exception of limitation of activities due to chronic conditions, however, never married persons reported the lowest rates of illness in all other other health measures." (Wilder, 1976: 2; emphasis added)

The exception is important in the present context, since selection into marriage or remarriage could explain the higher prevalence of morbidity among the unmarried, and, as in the case of the mortality differential, one would expect selection to affect chronic rather than acute conditions.

The health interview surveys do not include people living in institutions. Table 2.7 shows some data on residence in chronic care hospitals from the 1960 census of the United States (Verbrugge, 1979:272). The ratios obtained from the 1970 census were almost identical. All the unmarried groups are more heavily represented in such institutions than are the married. Similar differentials were found by Pugh and MacMahon (1962) in an analysis of mental hospital data in the United States.

2.4 Explanatory theories

The theories proposed to explain the MSMD fall under three main headings : (1) statistical artifact due to mis-statement of marital status; (2) the fact of being married reduces the risk of dying, or the obverse i.e. the effect of not being married increases the risk of dying; (3) selection of the healthy into marriage or remarriage. All three explanations are plausible, and have also been proposed to explain other differentials in mortality statistics, such as

those associated with social class, occupation, and place of birth. The possibility that the MSMD might be due to a statistical artifact does not appear have been mentioned prior to the publication of the U.S. 1949-51 mortality rates. Until that time the other two explanations were prominent in the literature. The issue was raised and debated in the American Journal of Public Health by Kraus and Lilienfeld (1959), Sheps (1961) and Berkson (1962). Kraus and Lilienfeld, who studied the high mortality among young widows, considered two possible artifacts : mis-statement of marital status in the census enumeration or on the death certificate; and a higher average age within age groups for the widowed. Kraus and Lilienfeld came to the conclusion, chiefly by comparing the MR's for different diseases, that these errors could not account for the observed differences. (Kraus and Lilienfeld, 1959:211-212). Sheps came to a different conclusion, paying particular attention to the fact that the census denominators were based on a sample of the total population. Sheps also argued against the use of the MR as a measure of the MSMD, advocating the use of the difference in mortality between groups. (Sheps, 1961: 550-552) Berkson also suspected a statistical artifact, but for a different reason. Berkson did not support a causal interpretation of the association of cigarette smoking and mortality from lung cancer, one of his arguments being the fact that smoking was also associated with increased mortality from several diseases, which he found to be implausible. Berkson used the same logic in relation to the MSMD :

"For just as it is true that in the study of the statistical association of death rate with smoking, cancer of the lung is not the only disease that exhibits the association, so here cancer of the lung is not the only disease that shows the relation with marital status." (Berkson, 1962: 1231)

An opportunity to quantify the error due to mis-statement came from the "1960 Matched Records Study" (Kitagawa and Hauser, 1973). In this study a large sample of people who died soon after the 1960 U.S. census were traced back to their census schedules.

Using the combined information, it was possible to determine mis-statements of marital status, and to correct the original MSMD estimates. The changes were minimal for the single, but were more substantial, and uniformly downward, for the widowed and divorced.

The authors concluded:

" It is apparent ... that discrepancies in the reporting of marital status on the death certificates and census records do introduce substantial errors in marital status differentials...It is also true, however, that sizeable differences remain after corrections for discrepant reporting of marital status." (Kitagawa and Hauser, 1973: 111-112)

The evidence from longitudinal studies is relevant to this question. In such studies the denominators of the mortality rates are based on only one statement of marital status, that at the baseline. This may, of course, be in error, but provided that the errors are non-differential with respect to subsequent mortality it

can be shown that this will under-state the true MR. Thus if a MR greater than 100 is observed the true differential will be at least as great as that suggested by the observed MR.

Since Farr and Durkheim, most authors have favoured the protective role of marriage as an explanation of the MSMD. In a certain sense it is the most "interesting" hypothesis, both for sociologists studying the function of social institutions, and for epidemiologists and health authorities seeking the causes of morbidity and mortality and methods of reducing them. On the other hand, the selection hypothesis is more mechanistic, of interest chiefly to statisticians and methodologists, and has a more fatalistic connotation.

That marital status affects some specific causes of death is indisputable. Being married increases the likelihood of pregnancy (although being pregnant may also increase the likelihood of marriage, and therefore be a force for selection), increasing the risk of maternal mortality, and reducing the risk of death from cancer of the breast and uterus (see p.83).

However, the MSMD is seen in both sexes and for many causes of death. So it is necessary to postulate some feature of marriage that protects against death in a non-specific way. Many authors, in the Durkheimian tradition, have emphasized the the role of psychological and social support provided by marriage (e.g. Gove, 1973; Boyd, 1983a; Trovato and Lauris, 1989). This hypothesis is consistent with a more general theory of a relationship between social support and health. Broadhead and colleagues (1983) reviewed

the large body evidence that "social support (has) both a direct positive effect on health status and (serves) as a buffer or modifier of the effects of psychosocial and physical stress on the mental and physical health."

Vallin and Nizard (1977;98) identified two ways in which marital status could influence mortality: a prolonged "protective role of marriage"; and the "shock" effect of change of status - "favourable in the case of marriage, unfavourable in the case of widowhood, either favourable or unfavourable in the case of divorce, depending on the circumstances." The latter also has empirical support within the body of literature which relates "life events" to morbidity and mortality. The changes of marital status, to which Vallin and Nizard refer, feature in the list of stressful life events used in this literature, but when all such stressors are counted "the separated and divorced.. rank highest in the frequency of life events while the never married and married are the two lowest." (Goldberg and Comstock, 1980:748)

If it is plausible that marital status can influence the risk of dying, it also makes sense that the reverse relationship should hold. In general we might suppose that people who are seriously ill are likely to eschew, or at least postpone, the additional responsibility of marriage, although in some unusual cases fatal illness might precipitate marriage, for reasons of inheritance or to legitimate a child. In the past, in some jurisdictions, health examination was a legal prerequisite for marriage. In the United States such legislation began early in this century, and by 1951 39

states had such laws, primarily aimed at controlling venereal disease. (Dublin and Spiegelman, 1951: 35). Under the Catholic canon law failure to consummate nullifies a marriage, and in cases of disability the priest may require a medical certificate that the ability to consummate is not impaired. Institutionalization is also likely to reduce the chance of marriage or remarriage.

Not everyone chooses to marry. Some remain single to enter religious orders or become priests. This could induce a reverse selection if, as Deparciux (1746) claimed, the novitiates were subjected to a medical examination. Others remain single because of homosexuality. This could reduce the number of the unmarried on which selection operates.

The selection hypothesis has been more strongly emphasized by demographers and medical statisticians than by sociologists. (Newsholme, 1899:149; Spiegelman, 1968:91; Benjamin, 1968:77; Registrar General, 1971:29) This may be explained, in some part, by the fact that these disciplines are closer to the actuarial reality of the effects of selection on insurance policy holders (Benjamin and Haycocks, 1970: 174-180; Jordan, 1975: 24), and of the healthy worker effect - the "phenomenon observed initially in studies of occupational disease : Workers usually exhibit lower overall death rates than the general population, due to the fact that the severely ill and disabled are ordinarily excluded from employment." (Last, 1988:58)

Livi-Bacci (1984) cited a paper by Livi and Parenti (1938), who distinguished between temporary and permanent selection.

"Temporary selection in marriage has the same well-known role that it has in life insurance. Persons who are accepted for individual life insurance after a medical screening can be regarded as ostensibly free from major physical impairments. For some years after insurance their mortality tends to be appreciably lower than the mortality of the general population, although the advantage is gradually lost with time." (Livi-Bacci, 1984: 102)

Livi-Bacci (1984) quotes the results of an attempt by Livi and Parenti (1938) to estimate the impact of temporary selection on the mortality of married men, using the Italian 1930-32 life table and maximum and minimum estimates of the selection effect over five years, drawn from life insurance experience. Using the maximum estimates, removing selection would reduce the MR at age 25 from 172 to 121, but at age 35 only from 176 to 169. With the minimum estimates the corresponding estimates would be 172 to 137 at age 25, and 176 to 171 at age 35. (Livi-Bacci, 1984: 103)

Livi-Bacci concludes :

"We have seen that temporary selection is responsible for a large part of the excess mortality of the single population at very young ages, when most of the married have very low durations of marriage, but it cannot certainly explain the increase of excess mortality until age 35 or 40 and its persistence at high levels thereafter. The form of the excess mortality curve has to be explained in the light of one or the other of two theories, the 'protective' or the

'permanent selection'." (Livi-Bacci, 1984:104)

Livi-Bacci goes on to argue that the protection theory cannot be a satisfactory explanation, but his argument is difficult to follow, since he jumps from discussion of relative to absolute measures of the MSMD. Livi-Bacci does not define permanent selection in the same clear terms as temporary selection - presumably it is the residual effect of the selection process after the immediate effect of differential mortality has occurred. He uses the following description:

" Let us make (sic) the following example. In a population singles represent 80 per cent of the population aged 25, but 10 per cent of the population aged 40. Between these two ages, nuptiality is high and marriage operates its selection of the healthier lives. If marriage systematically excludes the impaired individuals, the frequency of the latter, in the unmarried population, will be higher at age 40 than at age 25. Accordingly, we should expect excess mortality of the single to grow. This growth should level off and stop altogether when nuptiality falls to very low levels and singles are less and less likely to marry and more and more likely candidates for permanent celibacy." (Livi-Bacci, 1984:104)

This argument is persuasive, but, as Goldman (1993) points out, it ignores the problem of the changing composition over time of the two cohorts, single (never-married) and married (ever-married). This phenomenon of "heterogeneity" within cohorts has been

described in other demographic contexts (Vaupel, Manson and Stallard, 1979; Pollard, 1993). Goldman (1993) and Goldman, Lord and Hu (1993), developed a model in which the single and married states are subdivided into "healthy" and "frail" sub-states, with multiplicative parameters modifying basic nuptiality and mortality functions. They showed that some combinations of parameters can produce a continuing increase in the mortality ratio beyond middle age.

Livi-Bacci went beyond the above qualitative analysis to suggest a quantitative empirical test of the permanent selection theory:

"Let us suppose, for a moment, that the selective efficiency of marriage acts with the same strength in different populations. By efficiency we indicate the 'screening' action made with respect to health etc. of the partner. It follows that the lower is the proportion remaining single (the proportion unsuccessfully screened) the higher must be the frequency - among the unmarried-of the less healthy and the impaired, and the higher should be the excess mortality of the singles." (Livi-Bacci, 1984: 104)

Again the argument is plausible. However, even leaving aside the question of heterogeneity raised by Goldman (1993), it is not immediately obvious what would happen to the mortality ratio as the proportion of the single who marry increases. Clearly the mortality rate of those remaining single increases, but so does that of those who marry since the proportion among them who are less healthy also increases.

Livi-Bacci used data around 1970 from 26 developed countries to examine the relationship between the MR (single vs married at ages 35-44) and the proportion single at ages 40-44. He found a negative correlation in both sexes, stronger for women ($r = -.603$) than for men ($r = -.355$).

Kisker and Goldman (1987) extended Livi-Bacci's cross-country analysis to include all age groups, and also examined correlations within selected countries at different time periods. With some exceptions they found negative correlations in both sexes in each age group, though the correlations were weak for males younger than 35. Hu and Goldman (1990), using log-linear analysis, also found negative correlations between the mortality ratio for divorced people and the proportion divorced. Trovato (1992), applying the same analysis to the 1985-87 Canadian data, found negative correlations for the single and divorced of both sexes.

Lillard and Panis (1996) discussed the possibility of adverse selection, i.e. the unhealthy have higher marriage or remarriage rates. They argued that this could happen, at least for men, if marriage was protective, so that less healthy men would have an incentive to marry to obtain this benefit. Using data from a longitudinal study (the Panel Study of Income Dynamics), they found evidence to support the existence of both positive and adverse selection into marriage.

Selection out of marriage is a possible explanation of the MSMD for the widowed and the divorced. For the widowed the high MR would be seen if there is a positive correlation between the health of

spouses. This could occur in two ways : homogamy with respect to the risk factors for disease, or shared environment leading to contagion or common risk factors.

Ciocco (1940) found significant spousal associations with respect to length of life, and for the risks of death due to tuberculosis, influenza and pneumonia, heart disease and cancer, though the validity of Ciocco's methods was questioned subsequently by Myers (1963). Spousal association in the prevalence of vascular and arthritic disease was reported by Downes (1947).

Spousal concordance has been reported with respect to diet (Lee and Kolonel, 1982; Barrett-Connor and Suarez, 1982), relative weight (Barrett-Connor and Suarez, 1982; Haynes, Eaker and Feinleib, 1983), blood pressure (Tseng, 1967; Sackett et al, 1975; Suarez, Criqui and Barrett-Connor, 1983), cigarette smoking (Barrett-Connor and Suarez, 1982; Haynes, Eaker and Feinleib, 1983; Venters et al, 1984), and alcohol consumption (Kolonel and Lee, 1981).

Whether these correlations between spouses is due to assortative mating or shared environment remains unresolved. Most of the authors favoured homogamy as the explanation.

The possibility of selection out of marriage into divorce does not appear to have been studied. An obvious explanation would be that sickness in one spouse leads to the breakdown of marriage. Boyd (1983b), in a review of the factors affecting divorce in Canada, does not identify illness as a precipitating factor.

The extensive literature on mate selection has been reviewed by Jacobsohn and Matheny (1962), Udry (1971), Matras (1975), Carter

and Glick (1976), and Baker (1990). Apart from the constraints relating to consanguinity, the marriage system in Canada is primarily "open", in the sense that there are no prescriptions concerning the choice of mate. However, "age, race, religion, ethnic origin, place of residence, educational level, social status, kinship, language, and other social, economic, and cultural factors may intervene in the process of mate selection, either singly or in combination." (Matras, 1973 : 277) Direct evidence of health as a factor in mate selection appears to be lacking (Carter and Glick, 1976 : 324). Udry (1971 : 220) cites a study by Hudson and Henze (1969) in which students were asked to rank the characteristics they would seek in a mate. Good health was ranked moderately high by both female and male respondents, but lower than dependable character, emotional stability, pleasing disposition and mutual attraction.

2.5 Summary of literature review

Mortality ratios greater than 100 for death from all causes has been evident in the vital statistics of several countries for over a century. The variations in the MR with respect to gender, age and marital status (single, widowed or divorced) are generally consistent between countries and between time periods. The findings from vital statistics are corroborated by the results from longitudinal studies, and are concordant with the evidence from morbidity statistics. The MSMD for some specific causes of death have been studied for the past 50 years, especially in the United

States and Canada. A consistent finding in all these studies is that the MR's for men are greater than those for women.

The three main explanatory hypotheses which have been proposed - statistical artifact, protection by marriage, and selection into and out of marriage - are all plausible. Livi-Bacci's approach to quantifying the effect of selection was a promising innovation. Empirical evidence of mate selection on the basis of health is lacking.

Table 2.1 Mortality Ratios (married = 100). All Causes.
Selected Countries. XIX Century

		<u>Single</u>			<u>Widowed</u>		
		<u>20-39</u>	<u>40-59</u>	<u>60+</u>	<u>20-39</u>	<u>30-59</u>	<u>60+</u>
<u>France</u>							
1853	M	172	167	121	338	177	148
	F	103	141	141	193	135	142
1856-65	M	163	165	121	336	180	132
	F	102	141	131	181	133	120
1886-95	M	134	161	136	274	192	197
	F	98	137	160	181	164	204
<u>Belgium</u>							
1856-65	M	114	118	95	312	174	140
	F	72	111	125	180	130	147
<u>Holland</u>							
1856-65	M	139	144	119	185	149	127
	F	70	126	123	104	121	130
<u>Prussia</u>							
1886-95	M	118	132	139	283	198	188
	F	75	140	147	128	135	162
<u>Sweden</u>							
1886-95	M	157	179	152	196	167	189
	F	92	125	145	148	138	192
mean	M	141	150	125	268	176	158
	F	87	131	138	156	136	154

Sources : Farr (1858), Bertillon (1877), March (1912)

Table 2.2 Mortality Ratios (married = 100). All Causes.
Selected Countries. XX Century.

		<u>Single</u>				<u>Widowed and Divorced</u>			
		<u>15-24</u>	<u>25-44</u>	<u>45-64</u>	<u>65+</u>	<u>15-24</u>	<u>25-44</u>	<u>45-64</u>	<u>65+</u>
<u>Canada</u>									
1931	M	122	154	159	133		174		
	F	65	109	119	149		162		
1941	M	130	169	144	133		183		
	F	79	109	117	143		165		
1951	M	142	194	150	139	963	335	188	181
	F	102	147	121	153	446	178	143	171
1961	M	126	184	154	137	290	347	182	179
	F	116	169	131	153	714	219	163	184
1971	M	145	217	172	133	235	292	213	200
	F	137	182	150	149	367	269	179	198
1981	M	224	278	203	151	229	424	232	198
	F	221	221	155	175	245	318	178	212
1990	M	233	334	265	173	387	338	227	192
	F	184	243	183	202	539	232	179	222
<u>United States (White)*</u>									
1949-51	M	117	219	170	142	155	352	164	132
	F	94	161	113	116	432	221	128	123
1959-61	M	133	218	159	158	415	334	184	166
	F	117	197	121	118	474	220	135	132
<u>Sweden</u>									
1921-30	M	204	193	154	121	-	196	129	114
	F	116	116	125	108	116	135	118	109
1931-40	M	170	190	147	119	-	238	137	112
	F	125	140	121	107	171	162	115	107
1941-50	M	163	203	141	120	-	196	146	111
	F	158	178	129	105	100	194	117	105
1951-60	M	175	206	145	120	-	210	178	116
	F	233	196	131	103	567	176	129	103

* Widowed only

Sources: Statistics Canada (1994), Klebba (1970, Larrison (1965)

Table 2.3 Mortality Ratios for Single Women by Social Class
England and Wales, 1959-63

Social class ¹ :	Mortality ratio (married = 100)				
	I	II	III	IV	V
Age group					
15-19	277	271	88	117	135
20-24	155	172	116	167	210
25-34	161	146	150	178	177
35-44	197	149	131	167	157
45-54	158	141	120	142	103
55-64	133	142	124	133	107
mean	175	165	120	149	143

¹ I = professional
 II = intermediate
 III = skilled
 IV = partly skilled
 V = unskilled

Source : Registrar General (1971)

Table 2.4 Mortality Ratios (married = 100). All Causes.
Longitudinal Studies.

			<u>Single</u>	<u>Widowed</u>	<u>Divorced</u>	<u>Reference</u>
European Ruling Families	M	123 ¹	-	-	-	Peller 1943
	F	116	-	-	-	
England & Wales	M	122	114	128		Fox 1982
	F	102	106	121		
Canada 25-44	M+F	-	482	293		Johnston 1988 ²
Alberta 45-64	M+F	-	307	273		
U.S. Maryland	M	-	159	-		Helsing 1981
	F	-	112	-		
U.S. California	M	207 ³	-	-		Wingard 1983
	F	110	-	-		
U.S. Connecticut	M	-	140	-		de Leon 1993
	F	-	201	-		
U.S. 25-64	M	125	169	229		Smith 1994
	F	215	114	131		
65-74	M	130	118	119		
	F	68	108	90		
U.S.	M+F	209	258	304		Rogers 1995 ²
Sweden	M	153	178	234		Rosengren 1988
Sweden	M	-	147	176		Hemstrom 1996
	F	-	127	170		
Holland	M	260	120	120		de Leon 1992

¹ never married vs ever married

² case-control study

³ unmarried vs married

Table 2.5 Mortality Ratios (married = 100). Selected Causes.
Longitudinal Studies. England & Wales, United States

	<u>Cancer</u>		<u>Cardiovascular disease</u>		<u>Accident and violence</u>	
	<u>E&W</u>	<u>US</u>	<u>E&W</u>	<u>US</u>	<u>E&W</u>	<u>US</u>
<u>Men <65</u>						
Single	111	99	121	129	158	338
Widowed	96	131	160	185	268	-
Divorced	140	281	102	212	397	265
<u>Men 65+</u>						
Single	92	97	112	118	325	369
Widowed	93	95	110	131	197	189
Divorced	136	131	92	136	199	82
<u>Women <65</u>						
Single	101	181	111	244	128	230
Widowed	106	90	126	135	113	170
Divorced	133	152	176	137	315	135
<u>Women 65+</u>						
Single	92	94	98	62	120	-
Widowed	105	87	103	110	113	70
Divorced	75	71	85	120	74	121

Source: Fox and Goldblatt (1982); Smith and Waitezman (1994)

Table 2.6 Age-adjusted Morbidity Ratios at Ages 17 and over.
United States Health Interview Survey, 1971-72.

	Morbidity ratio (married = 100)			
	Single	Widowed	Separated	Divorced
Restricted activity (days/person/year)	97	160	173	149
% limited activity chronic conditions	131	138	157	138
% limited activity acute conditions	92	94	128	124
Physician consultations (visits/person/year)	82	111	121	118
Short-stay hospital (1+ episode in last year)	61	109	125	98

Source : Wilder (1976)

Table 2.7 Institutionalization by Gender and Marital Status.
United States, 1960.

Type of institution	Age-standardized prevalence ratio (Married=1)					
	Women			Men		
	Single	Widowed	Divorced	Single	Widowed	Divorced
Chronic disease hospitals	8	4	7	18	11	19
Homes for aged	8	6	3	16	13	10
Tuberculosis hospitals	3	4	4	6	6	10
Mental hospitals	7	2	5	20	5	9
Correctional	5	23	20	4	13	9
All types	10	4	4	11	11	10

Source : Verbrugge (1979)

3 Objectives of thesis

The overall objective of the thesis is to use mortality and nuptiality data from Canada to determine how much of the variation in the MSMD can be explained by selection.

The specific objectives of the thesis are:

(1) Using multistate models of marital status, disease and death, to determine the effects of selection and protection on the MR's for the single, widowed and divorced, and the correlation of these MR's with the rates of first marriage or re-marriage.

(2) To estimate the sex-age-specific MR's (for all causes and for selected specific causes) for the single, widowed and divorced in Canada, and the corresponding first marriage and re-marriage rates, for three-year periods centred on the census years from 1951 to 1991.

(3) To assess the relative importance of selection in explaining the variation in the MR's by correlating them with the corresponding marriage rates.

(4) To compare the two sexes with respect to the importance of selection.

4 Methods

This section describes (a) the methods used to simulate the MR's for 5 types of disease with and without the presence of protection or selection, and the effect on the MR's of varying marriage rates (4.1); (b) the Canadian data used to estimate MR's for all causes and for a range of specific causes and the corresponding marriage rates (4.2); and (c) the methods used to calculate the MR's and correlate them with the marriage rates (4.3).

4.1 Models of mortality and marital status

Figure 4.1 shows a simple, two-state, deterministic model of people aged 15 and over, of a given sex, sub-divided by the presence or absence of a particular disease (or type of injury), ignoring marital status.

At time t (age in years minus 15):

$X(t)$ = the number of people without disease

$Y(t)$ = the number of people with disease

$X(t)$ and $Y(t)$ are subject to the following transition rates:

$i(t)$ = incidence of the disease

$r(t)$ = recovery from the disease

$d_1(t)$ = death from the disease

$d_0(t)$ = death from other causes.

The model has the following simplifying assumptions, common to deterministic multistate models:

(a) Continuous mixing within states (the equivalent of the Markov assumption in stochastic models), so that the transition rates apply to all individuals in a given state, irrespective of the

duration in that state, or previous sojourn in other states.

(b) $X(t)$ and $Y(t)$ are large enough to be treated as continuous functions of time.

(c) Independent competing risks, so that those with a particular disease have the same risk of death from other causes as do those without the disease.

With some diseases (e.g. coronary heart disease, stroke), and with many types of injury, death may be instantaneous. In such cases the transition to disease is assumed to have preceded death. This also makes assumption (a) more plausible, since the latter implies an exponential distribution of death in relation to duration of disease, which requires some deaths to occur at zero duration.

There is a tacit assumption in the model that the disease in question is not contagious, for otherwise the number of new cases of disease would depend on $Y(t)$ as well as $X(t)$. In the last fifty years contagious diseases with a significant risk of death have been rare over the age of fifteen. Exceptions are tuberculosis, syphilis (and more recently AIDS, which is not identified in the mortality data), and some respiratory infections such as influenza. The first two are chronic diseases in which infection occurs at younger ages and death much later, so that they can be treated as non-contagious diseases in terms of mortality. Since death from respiratory infection is rare except in those with previous impairment, these cases can be fitted into the model by defining the disease as being susceptible to death from ubiquitous respiratory infections.

Two causes of death, suicide and homicide, require special consideration. These are conceptualized as the fatal outcomes, not necessarily immediate, of self-inflicted injuries or injuries inflicted by others. Suicide may also be preceded by depressive psychosis. Maternal mortality is a similar special case. With an abuse of language it can be viewed as a fatal outcome of the "disease" pregnancy.

Many diseases occur only in later life, so that their prevalence at age 15 is zero, and their incidence increases with age. For some diseases of this type recovery, in the sense of complete cure, is possible, but for the majority this is not the case.

A small number of diseases, for example congenital anomalies and epilepsy, begin before the age of 15, are incurable, and have zero incidence at older ages, but can persist to produce mortality at older ages. Others, for example diabetes, can occur before age 15 but the incidence of new cases extends throughout life.

To encompass these differences in the simulations the following typology of disease is necessary:

Type 1 (late onset, irreversible): $Y(0)=0$, $i(t)>0$, $r(t)=0$

Type 2 (late onset, reversible): $Y(0)=0$, $i(t)>0$, $r(t)>0$

Type 3 (early onset, irreversible): $Y(0)>0$, $i(t)=0$, $r(t)=0$

Type 4 (mixed onset, irreversible): $Y(0)>0$, $i(t)>0$, $r(t)=0$

Type 5 (mixed onset, reversible): $Y(0)>0$, $i(t)>0$, $r(t)>0$

In Figure 4.2 the two-state model of the absence or presence of disease is further sub-divided by whether the individual is currently unmarried or married. There are thus four possible states

at time t : $X_1(t)$ = unmarried without disease, $Y_1(t)$ = unmarried with disease, $X_2(t)$ = married without disease, $Y_2(t)$ = married with disease. The transition rates between the marital status categories are $m_x(t)$, $m_y(t)$ = marriage or re-marriage, and $w_x(t)$, $w_y(t)$ = dissolution of marriage (through widowhood or divorce), the suffix indicating the absence or presence of disease. The suffixes 1, 2 on the incidence, recovery and disease-specific death rates specify the marital status.

If there is no selection into or out of marriage, and if marriage is not protective then, at each time t , $m_x = m_y$, $w_x = w_y$, $i_1 = i_2$, $r_1 = r_2$, $d_1 = d_2$. The following deviations can be defined:

(i) selection into marriage: the unmarried with disease are less likely to become married than the unmarried without disease, i.e.

$$m_x > m_y;$$

(ii) selection out of marriage: the marriages of those with disease are more likely to be dissolved, through death or divorce, than the marriages of those without disease, i.e. $w_x < w_y$;

(iii) preventive protection: the married without disease are less likely to develop disease than the unmarried without disease, i.e.

$$i_2 < i_1;$$

(iv) curative protection: the married with disease are more likely to be cured than the unmarried with disease, i.e. $r_2 > r_1$;

(v) palliative protection: the married with disease are less likely to die from it than the unmarried with disease, i.e. $d_2 < d_1$.

In the absence of selection and protection it is reasonable to suppose that, even though initially all the population is

unmarried, the prevalence of disease among the married will eventually equal that among the unmarried, and thus, since the death rates are equal, the MR will approach 1. Also, in the absence of protection, selection into or out of marriage will lead to a MR greater than 1, and the deviation will depend on the degree of selection. These intuitive hypotheses are proved in Appendix 1.

The model in Figure 4.2 can be extended to distinguish the single, widowed and divorced within the unmarried groups. This eight-state model is the one used for numerical simulation of the effects of selection into or out of marriage, palliative protection, and, where appropriate, preventive and curative protection on each of the five types of disease listed above.

Six age groups were used in the simulations : 15-24, 25-34, 35-44, 45-54, 55-64, and 65-74, to correspond with the age groups used in the data analysis (see below). Transition rates were assumed constant within each age interval. The method of matrix exponentials (Namboodiri and Suchindran, 1987: 137-163) was used to calculate the person-years lived in each state in each age interval, and hence the age-specific and total mortality rates by marital status, and the corresponding mortality ratios for the single, widowed and divorced.

Each set of simulations was repeated with three levels of age-specific marriage and re-marriage rates: a "medium" level in which the rates are Canadian rates for the period 1970-72, a "low" level equal to half the "medium" rates, and a "high" level equal to the "medium" rates multiplied by 1.5.

4.2 Canadian data

The numbers of deaths in Canada from all causes, and from a list of specific underlying causes for the nine three-year periods 1950-52, 1955-57, 1960-62, 1965-67, 1970-72, 1975-77, 1980-82, 1985-87, and 1990-92 were obtained on disks from Statistics Canada. The numbers of deaths were subdivided by sex, marital status (single, married, widowed, divorced, separated, not stated) and age group (15-24, 25-34, 35-44, 45-54, 55-64, 65-74). The underlying cause of death is coded to the International Classification of Diseases (ICD), which is revised at intervals. Over the period 1950-92 Revisions 6, 7, 8 and 9 were used. The causes of death chosen were those identified specifically in all four revisions of the ICD, and involved reasonable numbers of deaths in each period. The causes are listed in Appendix 2 together with the defining ICD categories in each of the four revisions. Since the titles used in the ICD are lengthy and technical, abbreviated titles are also listed, and these are used in the text and tables.

The numbers of marriages in Canada by sex, age and previous marital status for the nine three-year periods listed above were obtained from the Statistics Canada annual vital statistics reports (volume 2, catalogue 84-205).

The numbers of people enumerated in Canada by sex, age and marital status at each of the censuses corresponding to the mid-point of the nine three-year periods were extracted from the census reports, and multiplied by three to give the person-years at risk by sex, age and marital status.

4.3 Analysis

For each sex-specific cause of death the units of analysis were the groups of unmarried people (single, widowed or divorced). Each unit comprised 54 sub-units : six age-groups in each of nine time periods. For each sub-unit the following were derived from the basic data on deaths, marriages and person-years at risk:

n = the observed number of deaths

e = the number of deaths expected if the death rate among the married had applied to the unmarried

m = the marriage rate

Within each sub-unit the $MR = n/e$, but for descriptive purposes aggregation was necessary, achieved by summing the n , summing the e , and dividing the two sums. Such aggregation was done (a) by summing over time within each age group, (b) summing over age groups within each time period, and (c) summing over both age and time to give an overall estimate of the MR for the unit. The estimates of the MR are presented as percentages.

To test the hypothesis of an association between MR and marriage rate for a given unit, all 54 values of n , e , and m were incorporated in a Poisson regression analysis (Frome, 1983). This assumes that n has a Poisson distribution with mean $= e \cdot \exp(a + bm)$, a particular form of the generalized linear model (McCullagh and Nelder, 1983). Maximum likelihood estimation was used to fit two models: (1) $b = 0$; (2) b unrestricted. The difference in deviance can be compared with chi-squared on one degree of freedom to test whether the estimate of b from model 2 is significantly different

from zero, i.e. there is an association between MR and m. The ratio of the difference in deviance to the deviance from the unrestricted model, expressed as a percentage, provides a measure of the proportion of the variation in the MR which is accounted for by the regression on the marriage rate.

The hypothesis of an association between the gender ratio (GR), i.e. the ratio of the MR for men to that for women, and the marriage rate was tested in a similar fashion, combining the values of n, e, and m for women and men into a single unit. If s is a dummy variable with $s = 0$ for women and $s = 1$ for men, then n is assumed to have a Poisson distribution with mean $= e \cdot \exp(a + bm + cs)$. The two models are then (1) $b = 0$, c unrestricted; (2) b and c unrestricted.

A Basic program was written to calculate the MR's, the estimates of b and the corresponding chi-squared statistics (χ^2 .) The program was checked against manual calculation for the MR's and a statistical package Statistix II (NH Analytical Software) for the Poisson regressions.

Figure 4.1 Two State Model of Disease and Death

Figure 4.2 Four State Model of Marital Status, Disease and Death

5. Results of Modelling

Tables 5.1 to 5.5 show the age-specific MR's, and total (age-standardized) MR's, for the five types of disease, (a) with no protection or selection, (b) with preventive protection, (c) with curative protection (for types 2 and 5), (d) with palliative protection, (e) with selection into marriage, (f) selection out of marriage from widowhood, and (g) selection out of marriage from divorce. The results shown are those with low levels of marriage rates. The trends with age for medium and high levels (results not shown) were similar to those with low levels.

5.1 No protection or selection

In the absence of protection and selection the MR's approximate 100 in all types of disease. However in diseases of types 1 and 2, for which the prevalence of disease at age 15 is zero, the MR's for the single are less than 100 initially and subsequently increase, and the MR's for the widowed and divorced are greater than 100 initially and subsequently decline. In diseases of types 3, 4 and 5, where the prevalence of disease at age 15 is greater than zero, these patterns are reversed: the MR's for the single being greater than 100 initially and decrease with increasing age, while the MR's for the widowed and divorced are less than 100 initially and tend subsequently to increase.

5.2 Preventive protection

In the presence of preventive protection the MR's are elevated, and increase with age in all marital status groups, and in all types of disease (excluding type 3 where the incidence of disease after age

15 is zero and preventive protection is impossible).

5.3 Curative protection

With curative protection present (possible only in types 2 and 5, where disease is reversible), there is very little change in the MR's from those seen with no protection or selection present.

5.4 Palliative protection

In the presence of palliative protection the MR's are consistently elevated, even in the youngest age group. Among the single the MR's increase monotonically with age in types 1 and 2, decrease monotonically with age in type 3, and in types 4 and 5 show a concave pattern, decreasing initially and then increasing in the older age groups. Among the widowed the variation of the MR with age is less pronounced, the trend being generally downward in types 1, 2 and 3, and upward in types 4 and 5. Among the divorced the changes with age are also less pronounced, the changes with age resembling, to some extent, those among the single.

5.5 Selection into marriage

In the presence of selection into marriage the MR's are elevated, except for the youngest age group among the single. Two patterns of trend with increasing age are seen : a convex pattern in which the MR's increase initially and subsequently decline, and a decreasing pattern in which the MR's decrease monotonically with age. In types 1 and 2 the convex pattern is seen among the single and divorced and the decreasing pattern among the widowed. In types 3, 4 and 5 the concave pattern is seen in all three marital status groups.

5.6 Selection out of marriage

With selection out of marriage, either from widowhood or divorce, the MR's are elevated only for the corresponding category, and the trends with age are similar to those for selection into marriage.

5.7 Change in marriage rates

The effect of increasing the overall level of marriage rates is shown in Table 5.6. Only the MR's for the total age range are shown, since the trends with age shown in Tables 5.1 to 5.5 are the same. It is clear that there is little difference between type 1 and 2, or between types 4 and 5. In other words, the fact that the disease is reversible is not important.

The patterns in Table 5.6 are summarized qualitatively in Table 5.7, where a MR of 110 or more is indicated by "+", and a numerical difference greater than 5 in the MR between low and high marriage rates is denoted by "+" or "-", depending on the sign of the difference. The following general conclusions can be drawn from these results. First, selection into marriage is the only category for which the MR is increased and there is a positive relationship with the marriage rate in all three marital status groups in all types of disease. Secondly, preventive protection is the only category for which the MR is increased and there is a negative relationship with the marriage rate in all three marital status groups in all relevant types of disease. Thirdly, palliative protection in types 1 and 2 (which are the most common) can be distinguished from selection into marriage by the negative relationship between the MR and the marriage rate in the single,

and the absence of any relationship in the widowed and divorced; however in types 3, 4 and 5 the relationship of the MR with the marriage rate is positive, and palliative protection can not be distinguished from selection into marriage.

5.8 Combined protection and selection

The above results relate to "pure forms" of protection and selection, and it is clear that both protection and selection can be present. Table 5.8 shows the effect of combining each of the three different forms of protection with selection into marriage for type 2 disease. The results for other types of disease are very similar and are not shown. It is clear that the negative relationships between MR and marriage rate seen with protection alone are removed by the addition of selection, and in most cases a positive relationship is evident.

5.9 Summary

The overall conclusions can thus be drawn from the multistate modelling :

- (1) The presence of selection into marriage is indicated by elevated MR's and a positive relationship between the MR and the marriage rate in all three marital status groups. However, this pattern does not exclude the possibility of protection also being present, as the pattern for selection is dominant over those produced by the different forms of protection.
- (2) An elevated MR with a negative relationship with marriage rate among the single indicates the presence of some form of protection.

(3) With selection out of marriage from widowhood, elevation of the MR is restricted to the widowed, and the relationship with the marriage rate is, if anything, negative.

(4) With selection out of marriage from divorce, elevation of the MR is restricted to the divorced, and the relationship with the marriage rate is positive.

(5) Among the single, a convex pattern in the trend of the MR with age is an indicator of the presence of selection.

Table 5.1 Model of Type 1* Disease

Mortality Ratio (Married = 100)

	Age group:						Total
	15-24	25-34	35-44	45-54	55-64	65-74	
Single:							
(a)	74	88	98	99	100	101	100
(b)	100	120	154	176	186	185	178
(c)	na	na	na	na	na	na	na
(d)	143	169	184	185	187	187	186
(e)	99	131	132	114	107	105	108
(f)	74	88	98	100	103	109	109
(g)	74	90	101	101	102	103	102
Widowed:							
(a)	112	104	107	108	108	107	106
(b)	126	118	133	148	155	152	147
(c)	na	na	na	na	na	na	na
(d)	222	204	207	209	209	205	204
(e)	126	122	121	120	115	111	112
(f)	186	170	171	166	160	154	154
(g)	113	105	108	109	109	108	107
Divorced:							
(a)	110	105	102	99	102	102	102
(b)	126	118	133	148	155	152	147
(c)	na	na	na	na	na	na	na
(d)	218	207	199	189	195	194	194
(e)	136	138	133	125	120	115	117
(f)	110	105	103	100	105	108	110
(g)	188	185	168	140	136	131	131

* late onset, irreversible

- (a) no protection or selection
- (b) preventive protection
- (c) curative protection
- (d) palliative protection
- (e) selection into marriage
- (f) selection out of marriage (widowed)
- (g) selection out of marriage (divorced)

Table 5.2 Model of Type 2* Disease

Mortality Ratio (Married = 100)

	Age group:						Total
	15-24	25-34	35-44	45-54	55-64	65-74	
Single:							
(a)	74	88	98	99	100	101	100
(b)	100	120	155	177	187	186	179
(c)	75	90	101	102	104	105	104
(d)	139	162	181	184	186	187	184
(e)	99	131	132	114	107	105	107
(f)	74	88	98	100	103	109	109
(g)	74	91	101	101	102	103	102
Widowed:							
(a)	112	104	106	108	108	107	106
(b)	127	119	134	149	156	153	148
(c)	113	105	108	110	110	109	108
(d)	222	204	207	209	209	205	204
(e)	125	122	121	119	115	111	112
(f)	186	169	170	165	159	153	154
(g)	113	105	108	109	109	108	107
Divorced:							
(a)	110	105	102	99	102	102	102
(b)	122	115	129	148	161	161	157
(c)	111	106	104	101	104	105	105
(d)	218	207	199	190	195	194	194
(e)	136	138	133	125	120	115	116
(f)	110	105	103	100	104	108	110
(g)	188	185	167	139	135	130	130

* late onset, reversible

- (a) no protection or selection
- (b) preventive protection
- (c) curative protection
- (d) palliative protection
- (e) selection into marriage
- (f) selection out of marriage (widowed)
- (g) selection out of marriage (divorced)

Table 5.3 Model of Type 3* Disease

Mortality Ratio (Married = 100)

	Age group:						Total
	15-24	25-34	35-44	45-54	55-64	65-74	
Single:							
(a)	104	103	100	100	100	100	102
(b)	na	na	na	na	na	na	na
(c)	na	na	na	na	na	na	na
(d)	201	193	177	163	149	136	184
(e)	206	228	266	282	291	297	237
(f)	104	103	101	102	106	116	104
(g)	105	106	106	106	105	106	105
Widowed:							
(a)	98	99	98	98	98	98	98
(b)	na	na	na	na	na	na	na
(c)	na	na	na	na	na	na	na
(d)	195	196	191	189	187	184	185
(e)	100	103	109	113	110	107	108
(f)	189	191	192	193	197	207	200
(g)	99	100	99	99	99	99	99
Divorced:							
(a)	99	99	99	100	100	100	100
(b)	na	na	na	na	na	na	na
(c)	na	na	na	na	na	na	na
(d)	196	196	193	188	181	176	186
(e)	115	125	139	158	164	161	150
(f)	99	99	100	101	103	110	103
(g)	189	192	195	196	196	198	195

* early onset, irreversible

- (a) no protection or selection
- (b) preventive protection
- (c) curative protection
- (d) palliative protection
- (e) selection into marriage
- (f) selection out of marriage (widowed)
- (g) selection out of marriage (divorced)

Table 5.4 Model of Type 4* Disease

Mortality Ratio (Married = 100)

	Age group:						Total
	15-24	25-34	35-44	45-54	55-64	65-74	
Single:							
(a)	103	101	100	100	100	101	101
(b)	103	104	109	128	157	172	130
(c)	na	na	na	na	na	na	na
(d)	199	191	179	174	178	183	186
(e)	202	216	225	178	133	114	152
(f)	103	102	100	101	104	109	106
(g)	104	104	105	103	103	103	104
Widowed:							
(a)	99	100	100	103	106	106	105
(b)	99	100	104	117	136	144	140
(c)	na	na	na	na	na	na	na
(d)	196	196	195	199	204	203	202
(e)	100	106	113	117	114	110	110
(f)	188	188	185	176	164	155	155
(g)	99	100	101	104	107	107	106
Divorced:							
(a)	99	99	100	99	101	102	101
(b)	99	100	104	117	139	151	138
(c)	na	na	na	na	na	na	na
(d)	197	197	194	189	192	193	192
(e)	115	126	136	137	126	117	121
(f)	99	99	100	100	104	108	108
(g)	189	190	187	164	145	134	141

* mixed onset, irreversible

- (a) no protection or selection
- (b) preventive protection
- (c) curative protection
- (d) palliative protection
- (e) selection into marriage
- (f) selection out of marriage (widowed)
- (g) selection out of marriage (divorced)

Table 5.5 Model of Type 5* Disease

Mortality Ratio (Married = 100)

	Age group:						Total
	15-24	25-34	35-44	45-54	55-64	65-74	
Single:							
(a)	104	102	100	100	100	101	101
(b)	104	105	110	131	161	175	132
(c)	105	105	106	106	106	106	106
(d)	201	192	179	175	180	184	188
(e)	204	217	223	172	128	112	150
(f)	104	102	101	101	104	109	107
(g)	105	105	105	103	103	103	104
Widowed:							
(a)	98	99	100	104	106	106	105
(b)	98	100	104	119	139	146	142
(c)	99	100	102	106	109	108	108
(d)	195	196	194	199	204	204	202
(e)	100	105	113	117	114	110	110
(f)	187	188	184	175	163	154	155
(g)	98	100	101	104	107	107	106
Divorced:							
(a)	99	99	100	99	101	102	101
(b)	99	100	104	119	143	153	140
(c)	99	100	102	102	104	105	104
(d)	196	197	194	189	192	193	193
(e)	115	126	136	136	124	116	120
(f)	99	99	100	100	104	108	108
(g)	189	190	186	162	144	133	140

* mixed onset, reversible

- (a) no protection or selection
- (b) preventive protection
- (c) curative protection
- (d) palliative protection
- (e) selection into marriage
- (f) selection out of marriage (widowed)
- (g) selection out of marriage (divorced)

**Table 5.6 Models of Disease with Varying Marriage Rates
and Different Forms of Protection and Selection
Mortality Ratio at Ages 15-74 (Married = 100)**

	Single			Widowed			Divorced		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
(a)									
Type 1	100	99	96	106	106	106	102	102	102
Type 2	100	99	96	106	106	106	102	102	102
Type 3	102	103	104	98	98	98	100	100	100
Type 4	101	102	102	105	105	105	101	101	101
Type 5	102	102	103	105	105	105	101	101	101
(b)									
Type 1	178	175	166	147	144	141	156	146	139
Type 2	179	175	166	148	144	142	157	147	140
Type 4	130	119	110	140	135	135	138	130	125
Type 5	132	120	112	142	140	137	140	132	127
(c)									
Type 2	104	102	99	108	108	108	105	104	104
Type 5	106	106	106	108	107	107	104	104	103
(d)									
Type 1	186	184	179	204	204	205	194	196	197
Type 2	187	184	179	204	204	205	194	196	197
Type 3	184	191	196	185	186	187	186	190	193
Type 4	186	189	193	202	203	203	192	195	196
Type 5	188	191	195	202	203	203	193	195	196
(e)									
Type 1	108	112	119	110	112	115	117	125	131
Type 2	107	111	117	110	112	115	116	124	130
Type 3	237	260	267	108	115	120	150	170	177
Type 4	152	101	226	110	112	115	121	131	138
Type 5	150	188	223	110	112	115	120	130	137
(f)									
Type 1	109	106	102	154	155	156	110	109	107
Type 2	109	106	101	154	155	156	110	108	107
Type 3	104	104	104	210	207	205	103	102	101
Type 4	106	105	104	155	156	156	108	107	106
Type 5	107	105	105	155	156	156	108	107	106
(g)									
Type 1	102	100	97	107	106	106	131	140	145
Type 2	102	100	97	107	106	106	130	139	144
Type 3	105	105	105	99	99	98	195	195	194
Type 4	104	103	103	106	106	106	141	149	153
Type 5	104	104	104	106	106	106	140	148	152

Marriage rates: (1) low (2) medium (3) high

(a) no protection or selection

(b) preventive protection

(c) curative protection

(d) palliative protection

(e) selection into marriage

(f) selection out of marriage (widowed)

(g) selection out of marriage (divorced)

Table 5.7 Summary of Disease Models

	Single		Widowed		Divorced	
	MR ¹	B ²	MR	B	MR	B
Types 1&2						
(b)	+	-	+	-	+	-
(c) ³	0	-	0	0	0	0
(d)	+	-	+	0	+	0
(e)	+	+	+	+	+	+
(f)	0	-	+	0	0	-
(g)	0	-	0	0	+	+
Type 3						
(d)	+	+	+	0	+	+
(e)	+	+	+	+	+	+
(f)	0	0	+	-	0	0
(g)	0	0	0	0	+	0
Types 4&5						
(b)	+	-	+	-	+	-
(c) ⁴	0	0	0	0	0	0
(d)	+	+	+	0	+	0
(e)	+	+	+	+	+	+
(f)	0	0	+	0	0	0
(g)	0	0	0	0	+	+

¹ Mortality ratio > 109 = +, < 110 = 0

² Change with increasing marriage rates : B = MR(high) - MR(low)
 B > 4 = +
 -6 < B < 5 = 0
 B < -5 = -

³ Type 2 only

⁴ Type 5 only

- (b) preventive protection
- (c) curative protection
- (d) palliative protection
- (e) selection into marriage
- (f) selection out of marriage (widowed)
- (g) selection out of marriage (divorced)

Table 5.8 Models of Type 2 Disease with Varying Marriage Rates and Combined Protection and Selection

Mortality Ratio at Ages 15-74 (Married = 100)									
	Single			Widowed			Divorced		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
(b)	179	175	166	148	144	142	157	147	140
(b)+(e)	197	204	212	157	157	157	184	183	183
(c)	104	102	99	108	108	108	105	104	104
(c)+(e)	111	116	122	112	115	117	120	127	133
(d)	187	184	179	204	204	205	194	196	197
(d)+(e)	200	208	220	211	217	222	221	239	251

Marriage rates: (1) low (2) medium (3) high

- (b) preventive protection
- (c) curative protection
- (d) palliative protection
- (e) selection into marriage

6. Results of Mortality Analysis

This section shows the MR's for Canadian women and men, and the results of the regression of the MR's on the corresponding marriage rates (6.1); the gender ratios (GR's), i.e. the ratios of the MR's for men to those for women (6.2); and examines the evidence for selection or protection based on the criteria developed in section 5 (6.3).

6.1 Mortality ratios

Table 6.1 shows the results for mortality from all causes among women. In general the MR's are highest for divorced women, lowest for widows and intermediate for single women. The MR's decline monotonically with age for widows and divorced women; those for single women increase with age and then decline. There is an increase over time in the MR's for single women and widows, but not for divorced women.

The MR's for all cause mortality among men (Table 6.2) are uniformly higher than those for women, except for the widowed and divorced at ages 15 -24. The trends over time are similar to those for women. However, among men, the variations with age are similar in all three marital status groups, with an initial increase and a subsequent decline.

Detailed results for specific causes, similar to Tables 6.1 and 6.2, are given in Appendix 3. The overall MR's are shown in Table 6.3. The results of the regression of the MR on marriage rates are also shown in this table, and these will be discussed later.

For every cause the MR's for men exceed 100 in each marital status

group. However, among women at least one of the MR's is less than 100 with respect to four causes of death : cancer of the cervix, cancer of bone, gall bladder disease, and maternal death.

Table 6.4 shows the distributions of the MR's for specific causes of death. For both women and men the distributions are skewed to the right, as is to be expected for a ratio, which is truncated at zero. When examining groups of causes it is thus preferable to use geometric rather than arithmetic means.

Table 6.5 shows the mean MR's for women, in which the specific causes of death have been classified in two ways: first, disease "group", based on the ICD chapters; secondly, disease "type" corresponding to the typology used for modeling. Overall, the mean MR is lowest for widows (130), intermediate for the single (148), and highest for the divorced (178). The rank order is the same for all disease groups except for diabetes and circulatory diseases, for which the MR for widows is higher than that for the single. For the two diseases of type 3 (epilepsy and congenital anomalies) the MR for the single is much higher than the MR's for the widowed and divorced. In all three marital status categories the MR's are above average for infective and respiratory diseases, for mental and nervous diseases, and for violent death.

Table 6.6 shows the same breakdown of the mean MR for men. The overall ranking is the same as for women : lowest for widowers (171), intermediate for the single (211) and highest for the divorced, and this ranking is the same across all disease groups. As for women, the mean MR for diseases of type 2 is highest among

the single. Also, the disease groups with above average MR's are the same as for women.

In Tables 6.7 and 6.8 the causes with the five highest and five lowest MR's are identified. Apart from those causes for which the MR's for women are less than 100 (mentioned above), most of the causes with low MR's are types of cancer. Among the causes with high MR's the concordance between the sexes is remarkable, even at the level of individual diseases, and emphasizes the above average MR's for infective and respiratory diseases (syphilis, pneumonia), for mental and nervous diseases (psychoses, neuroses, epilepsy), and violent death (suicide, homicide). The MR's for congenital anomalies are also high among both single women and single men. The MR's for epilepsy and neuroses among men are extremely high, over 1,000 in some instances.

6.2 Gender ratios

The GR's are analysed in Tables 6.9 through 6.12 in a manner similar to the analyses of the MR's for each sex. Table 6.9 shows the analysis for all causes. The overall GR is lowest for the widowed (1.22), intermediate for the single (1.30) and highest for the divorced (1.43). The GR is consistently greater than unity, except for the widowed in the youngest age group. The trends with age, and over time, are similar to those seen in Tables 6.1 and 6.2.

Table 6.10 shows that, as for the MR's, the distribution of the GR's is skewed to the right. In consequence geometric means have been used to average them in Tables 6.11 and 6.12.

Table 6.11 shows the mean GR's by cause group and type. As in the case of the MR's the GR's are higher than average for infective and respiratory diseases, mental and nervous diseases, and violent death. The GR's are also relatively high for type 3 diseases.

Table 6.12 shows the causes with the five lowest and five highest GR's. The list of causes with high GR's is similar to that for the MR's among men. Causes with GR's less than unity (i.e. the MR for women exceeds that for men) include several types of cancer, congenital anomalies and arthritis.

It is clear from these results that, in general, the pattern of the GR's follows that of the MR's. In those categories (age group, disease) for which both the MR for women and that for men are high, the relative excess for men is greater than that for women.

6.3 Evidence for selection or protection

Table 6.13 identifies those causes for which there is evidence of selection into marriage, based on the sign of the regression coefficients of the MR's with the corresponding marriage rates, and their statistical significance ($\chi^2 > 3.84$). Those causes for which the MR (in women) is less than 100 are excluded. Some evidence of selection is judged to be present if none of the three coefficients is significantly less than zero and at least one is significantly greater than zero. The strength of the evidence is graded 1 to 3 based on the number of coefficients which are significantly greater than zero.

Among men, there is evidence of selection into marriage in 30 out of 37 causes. Among women there is such evidence in only 21 of 35

causes. Of the 33 causes common to both sexes, there is evidence of selection in 18, evidence in men but not in women in 11, and evidence in women but not in men in 3. For only one cause (cancer of the skin) is evidence of selection absent in both women and men. Table 6.14 lists the discordant causes.

Where evidence of selection into marriage was absent, evidence of protection was sought. The criterion used was a significant negative regression coefficient of MR on marriage rate for the single. Such evidence was found for 9 causes among women, and 2 causes among men. These are listed in Table 6.15, together with the remaining 9 causes for which no evidence of selection into marriage or protection was found. There was no evidence of selection out of marriage for any cause.

The results of the deviance analysis for the MR's and the GR's from all causes are shown in Table 6.16. Based on the percentage reduction in deviance, 29 per cent of the variation in the MR's is attributable to regression on the marriage rate. The proportion is lowest for the single, intermediate for the widowed and greatest for the divorced. Within each marital status the proportion is greater for men than for women. The overall measure of association between the GR's and the marriage rate is 25 per cent. As for the MR's, the proportion explained is lowest for the single, intermediate for the widowed and greatest for the divorced.

Table 6.1 Mortality from All Causes among Canadian Women
Mortality Ratio (Married =100) by Age Group and Year

	Mortality Ratio		
	Single	Widowed	Divorced
Age Group			
15 - 24	160	792	309
25 - 34	246	355	303
35 - 44	199	198	227
45 - 54	157	154	178
55 - 64	132	135	148
65 - 74	117	123	135
Year			
1950 - 52	120	116	153
1955 - 57	117	115	183
1960 - 62	123	122	159
1965 - 67	127	118	201
1970 - 72	134	128	157
1975 - 77	151	131	171
1980 - 82	164	133	161
1985 - 87	177	138	156
1990 - 92	195	143	163
Total	142	127	163

Table 6.2 Mortality from All Causes among Canadian Men
Mortality Ratio (Married =100) by Age Group and Year

	Mortality Ratio		
	Single	Widowed	Divorced
Age Group			
15 - 24	190	370	332
25 - 34	315	629	453
35 - 44	298	314	378
45 - 54	207	216	286
55 - 64	165	172	221
65 - 74	142	147	177
Year			
1950 - 52	153	141	260
1955 - 57	178	139	274
1960 - 62	145	134	233
1965 - 67	146	138	300
1970 - 72	162	158	206
1975 - 77	192	169	243
1980 - 82	210	172	221
1985 - 87	240	177	221
1990 - 92	282	190	240
Total	184	155	233

Table 6.3 Mortality Ratio (Married = 100) at Ages 15-74,
Regression on Marriage Rate (B), and Chisquare (χ^2)

Cause of Death		Women			Men		
		Single	Widowed	Divorced	Single	Widowed	Divorced
All causes	MR	142	127	163	184	155	233
	B	2.78	8.65	2.73	4.21	6.79	2.40
	χ^2	1518	850	663	7788	1638	2157
Tuberculosis	MR	198	128	187	336	225	357
	B	-1.94	6.58	-1.15	3.46	9.60	0.21
	χ^2	18.7	15.4	1.29	110	87.9	0.15
Syphilis	MR	134	168	382	244	173	552
	B	7.43	12.8	1.38	3.03	5.46	-1.93
	χ^2	7.08	2.88	0.14	2.66	1.95	0.92
Cancer:							
All	MR	127	117	135	129	136	165
	B	-0.35	4.39	0.64	1.62	4.11	1.23
	χ^2	3.50	56.8	6.65	95.9	102	54.8
Mouth and throat	MR	133	140	190	193	176	267
	B	-.634	12.0	2.13	-0.45	8.29	1.67
	χ^2	0.16	8.56	1.49	0.21	27.4	5.99
Stomach	MR	100	111	104	116	125	129
	B	2.12	-2.07	2.36	0.23	3.89	1.41
	χ^2	3.42	0.51	3.18	0.08	9.40	4.10
Intestine	MR	130	114	115	126	124	130
	B	-2.43	0.50	-0.23	1.93	0.49	1.55
	χ^2	10.0	0.07	0.06	11.2	0.16	7.62
Lung	MR	104	143	186	131	153	199
	B	1.03	7.40	1.37	1.58	6.07	2.23
	χ^2	1.04	13.7	2.98	6.69	71.3	47.4
Breast	MR	147	104	116	-	-	-
	B	-4.96	3.87	0.80	-	-	-
	χ^2	86.3	10.1	2.12	-	-	-
Cervix	MR	87	152	233	-	-	-
	B	-0.11	6.81	-0.16	-	-	-
	χ^2	0.02	16.7	0.05	-	-	-
Uterus	MR	156	113	115	-	-	-
	B	-6.07	12.5	2.37	-	-	-
	χ^2	48.9	24.6	4.37	-	-	-

Table 6.3 (continued)

		Women			Men		
		Single	Widowed	Divorced	Single	Widowed	Divorced
Prostate	MR	-	-	-	101	123	121
	B	-	-	-	2.67	4.33	2.14
	X ²	-	-	-	0.66	3.72	1.64
Skin	MR	114	103	151	112	130	147
	B	-2.76	0.21	-1.96	-2.27	1.93	1.36
	X ²	5.18	0.00	1.35	5.05	0.31	1.87
Bone	MR	174	91	94	182	123	164
	B	2.42	-13.2	-2.91	1.72	-1.86	-2.26
	X ²	4.97	2.10	0.68	3.19	0.15	1.34
Lymphoma	MR	125	113	107	117	115	115
	B	2.49	1.78	0.86	2.06	1.17	2.10
	X ²	19.3	0.41	0.65	21.1	0.43	16.0
Leukemia	MR	130	105	121	130	115	124
	B	1.90	9.16	-1.36	3.01	1.87	1.04
	X ²	11.1	12.7	1.42	37.3	0.73	2.36
Diabetes	MR	102	123	126	205	173	256
	B	9.10	8.59	3.87	6.29	9.24	3.41
	X ²	235	12.8	18.1	210	42.9	65.7
Psychoses	MR	289	154	190	389	242	357
	B	9.21	0.17	1.25	5.19	6.10	0.98
	X ²	34.8	0.00	0.14	24.6	2.57	0.51
Neuroses	MR	219	224	406	628	434	1007
	B	4.36	17.6	2.58	-0.75	9.13	1.07
	X ₂	10.9	23.2	3.88	2.08	27.0	6.07
Stroke	MR	114	124	149	152	148	195
	B	0.28	7.38	2.17	1.89	5.64	2.37
	X ²	0.44	36.0	16.7	29.1	54.4	54.4
Multiple sclerosis	MR	267	113	262	285	148	438
	B	1.81	10.3	2.61	5.96	12.7	1.75
	X ²	3.74	5.91	4.62	43.0	14.0	3.73
Epilepsy	MR	466	152	393	1446	323	986
	B	-0.94	6.05	1.91	2.70	8.74	0.93
	X ²	1.54	1.53	2.98	42.4	8.68	1.99
Rheumatic heart disease	MR	119	110	130	145	119	172
	B	-3.27	2.96	1.07	2.71	4.22	1.82
	X ²	31.4	2.03	1.33	26.2	6.03	8.95

Table 6.3 (continued)

		Women			Men		
		Single	Widowed	Divorced	Single	Widowed	Divorced
Coronary heart disease	MR	113	131	140	137	142	192
	B	5.81	10.0	3.69	1.57	4.13	2.09
	X ²	125	114	56.2	51.3	167	207
Hypertension	MR	107	125	167	173	156	251
	B	2.03	1.02	-1.89	5.92	4.47	2.04
	X ²	3.47	0.16	1.53	71.9	9.98	9.91
Arterial disease	MR	130	149	167	139	159	180
	B	-3.21	-0.21	1.05	2.10	2.29	1.90
	X ²	14.21	0.00	0.70	6.67	2.08	6.82
Pneumonia	MR	266	154	213	371	213	389
	B	2.22	11.3	1.45	5.98	10.3	3.17
	X ²	36.6	36.6	3.47	324	80.6	76.0
Bronchitis	MR	170	157	210	199	193	262
	B	7.62	12.7	-0.27	10.8	7.53	3.65
	X ²	66.5	11.6	0.03	230	21.8	28.7
Peptic ulcer	MR	158	145	246	240	193	380
	B	-0.45	5.43	2.09	2.31	4.40	1.41
	X ²	0.08	1.14	1.38	9.76	6.20	4.37
Appendicitis	MR	135	124	108	199	158	298
	B	-3.32	8.90	-6.03	3.67	6.54	-1.54
	X ²	4.17	2.08	0.91	10.1	2.95	0.69
Hernia	MR	190	137	201	311	172	329
	B	3.43	7.17	-1.52	6.07	6.54	0.10
	X ²	11.4	3.36	0.50	55.6	5.40	0.01
Cirrhosis of liver	MR	141	148	284	262	284	522
	B	11.7	24.2	5.54	3.63	10.2	2.90
	X ²	267	180	80.3	68.8	120	110
Gall bladder disease	MR	84	109	118	150	126	236
	B	-4.64	3.76	-2.02	7.03	2.05	0.34
	X ²	8.88	0.67	0.55	21.1	0.21	0.03
Chronic kidney disease	MR	140	117	135	185	150	188
	B	0.79	1.61	-1.27	2.78	3.49	15.7
	X ²	2.06	0.38	0.95	37.2	4.46	15.7
Kidney stone	MR	143	118	139	161	121	278
	B	-4.24	20.8	-5.54	1.62	5.29	2.70
	X ²	1.29	6.61	0.30	0.42	0.52	1.80

Table 6.3 (Continued)

		Women			Men		
		Single	Widowed	Divorced	Single	Widowed	Divorced
Enlarged prostate	MR	-	-	-	185	126	195
	B	-	-	-	3.22	0.80	-1.19
	X ²	-	-	-	0.20	0.02	0.04
Maternal death	MR	16	48	92	-	-	-
	B	-3.18	7.30	2.43	-	-	-
	X ²	1.90	2.21	3.35	-	-	-
Arthritis	MR	214	124	159	210	162	132
	B	3.76	17.0	2.27	7.66	11.9	-1.60
	X ²	9.64	9.19	1.12	22.7	6.20	0.23
Congenital anomalies	MR	427	123	132	424	111	110
	B	-1.14	2.08	-1.12	2.80	6.52	1.01
	X ²	3.94	0.18	0.37	27.9	2.43	0.51
Traffic accidents	MR	206	146	224	199	219	303
	B	1.66	19.1	2.27	0.18	7.09	0.67
	X ²	38.9	512	43.2	1.76	163	17.4
Non-traffic accidents	MR	214	166	327	222	251	452
	B	-0.02	15.4	2.53	-1.39	2.89	0.10
	X ²	0.01	160	41.6	69.8	19.6	0.36
Suicide	MR	215	175	426	281	282	502
	B	1.31	11.4	2.53	3.27	8.67	1.74
	X ²	12.2	60.3	52.0	346	135	101
Homicide	MR	146	229	440	279	411	892
	B	-0.19	14.6	0.90	1.27	6.76	0.66
	X ²	0.05	38.1	1.52	7.08	11.9	2.75

Table 6.4 **Distribution of Mortality Ratios (Married = 100)**
at Ages 15-74 for Specific Causes of Death

	Single	Widowed	Divorced
Women			
# causes	39	39	39
minimum	16	48	92
median	141	125	167
mean	167	134	197
maximum	466	229	440
std. deviation	86	33	99
Men			
# causes	37	37	37
minimum	101	111	110
median	199	158	256
mean	253	184	319
maximum	1446	434	1007
std. deviation	228	78	229

Table 6.5 Geometric Means of Mortality Ratios (Married = 100)
among Women at Ages 15-74 by Cause Group and Type

Cause of Death	# Causes	Single	Widowed	Divorced
Group:				
Infective & respiratory	4	186	151	238
Cancer	11	125	116	134
Mental and nervous	4	174	156	299
Diabetes & circulatory	6	114	126	146
Digestive	5	137	132	178
Violence	4	193	177	342
Other	5	124	100	129
Type:				
1 & 2	16	125	125	163
3	2	446	137	228
4 & 5	21	152	132	185
Total:	39	148	130	178

Table 6.6 Geometric Means of Mortality Ratios (Married = 100)
among Men at Ages 15-74 by Cause Group and Type

Cause of Death	# Causes	Single	Widowed	Divorced
Group:				
Infective & respiratory	4	279	200	377
Cancer	9	131	130	149
Mental and nervous	4	563	266	628
Diabetes & circulatory	6	157	149	205
Digestive	5	226	180	341
Violence	4	242	283	498
Other	5	218	133	171
Type:				
1 & 2	15	159	150	216
3	2	783	189	329
4 & 5	20	230	187	298
Total:	37	211	171	263

Table 6.7 Causes with Five Lowest and Five Highest Mortality Ratios (Married = 100) at Ages 15-74 among Women

	Lowest	Highest
Single:	Maternal death (16)	Epilepsy (466)
	Gall bladder disease (84)	Congenital anomalies (427)
	Cancer of cervix (87)	Psychoses (289)
	Cancer of stomach (100)	Multiple sclerosis (267)
	Diabetes (102)	Pneumonia (266)
Widowed:	Maternal death (48)	Homicide (229)
	Cancer of bone (91)	Neuroses (224)
	Cancer of skin (103)	Suicide (175)
	Cancer of breast (104)	Syphilis (168)
	Leukemia (105)	Non-traffic accidents (166)
Divorced:	Maternal death (92)	Homicide (440)
	Cancer of bone (94)	Suicide (426)
	Cancer of stomach (104)	Neuroses (406)
	Lymphoma (107)	Epilepsy (393)
	Appendicitis (108)	Syphilis (382)

Table 6.8 Causes with Five Lowest and Five Highest Mortality Ratios (Married = 100) at Ages 15-74 among Men

	Lowest	Highest
Single:	Cancer of prostate (10)	Epilepsy (1466)
	Cancer of skin (112)	Neuroses (628)
	Cancer of stomach (116)	Congenital anomalies (424)
	Lymphoma (115)	Psychoses (389)
	Cancer of intestine (126)	Pneumonia (371)
Widowed:	Congenital anomalies (111)	Neuroses (434)
	Leukemia (115)	Homicide (411)
	Lymphoma (115)	Epilepsy (328)
	Rheumatic heart dis.(119)	Cirrhosis of liver (284)
	Kidney stone (121)	Suicide (282)
Divorced:	Congenital anomalies (110)	Neuroses (1007)
	Leukemia (115)	Epilepsy (986)
	Cancer of prostate (121)	Homicide (892)
	Lymphoma (107)	Syphilis (552)
	Cancer of stomach (129)	Cirrhosis of liver (552)

Table 6.9 Gender Ratio* for Mortality from All Causes

	Single	Widowed	Divorced
Age group:			
15-24	1.19	0.47	1.07
25-34	1.28	1.77	1.50
35-44	1.50	1.59	1.67
45-54	1.32	1.40	1.61
55-64	1.25	1.27	1.49
65-74	1.21	1.20	1.31
Years:			
1950-52	1.28	1.22	1.70
1955-57	1.52	1.21	1.50
1960-62	1.18	1.10	1.47
1965-67	1.15	1.17	1.49
1970-72	1.21	1.23	1.31
1975-77	1.27	1.29	1.42
1980-82	1.28	1.26	1.37
1985-87	1.36	1.28	1.42
1990-92	1.45	1.33	1.47
Total	1.30	1.22	1.43

* mortality ratio for men / mortality ratio for women

Table 6.10 Distribution of Gender Ratios* at Ages 15-74
for Specific Causes of Death

	Single	Widowed	Divorced
# causes	35	35	35
minimum	0.94	0.90	0.83
median	1.31	1.26	1.41
mean	1.42	1.33	1.54
maximum	3.10	2.13	2.76
std. deviation	0.50	0.29	0.47

* mortality ratio for men / mortality ratio for women

Table 6.11 Geometric Mean of Gender Ratio* at Ages 15-74
by Cause Group and Type

Cause of death	# Causes	Single	Widowed	Divorced
Group:				
Infective & respiratory	4	1.50	1.32	1.58
Cancer	8	1.09	1.15	1.19
Mental & nervous	4	1.89	1.71	2.10
Diabetes & circulatory	6	1.38	1.17	1.41
Digestive	5	1.65	1.36	1.91
Violence	4	1.26	1.60	1.45
Other	4	1.10	1.16	1.18
Type:				
1 & 2	13	1.30	1.22	1.36
3	2	1.76	1.38	1.45
4 & 5	20	1.35	1.35	1.56
Total	35	1.35	1.30	1.48

* mortality ratio for men / mortality ratio for women

Table 6.12 Causes with the Five Lowest and Five Highest Gender Ratios* at Ages 15 - 74

	Lowest	Highest
Single:	Lymphoma (0.94)	Epilepsy (3.10)
	Traffic accidents (0.97)	Neuroses (2.87)
	Cancer of intestine (0.97)	Diabetes (2.01)
	Arthritis (0.98)	Homicide (1.91)
	Cancer of skin (0.98)	Cirrhosis of liver (1.86)
Widowed:	Congenital anomalies(0.90)	Epilepsy (2.13)
	Lymphoma (1.02)	Neuroses (1.94)
	Kidney stone (1.03)	Cirrhosis of liver (1.92)
	Syphilis (1.03)	Homicide (1.80)
	Arteriosclerosis (1.07)	Tuberculosis (1.76)
Divorced:	Arthritis (0.83)	Appendicitis (2.76)
	Congenital anomalies(0.83)	Epilepsy (2.76)
	Cancer of skin (0.97)	Neuroses (2.48)
	Leukemia (1.03)	Diabetes (2.03)
	Cancer of lung (1.07)	Homicide (2.00)

* mortality ratio for men / mortality ratio for women

Table 6.13 Evidence of Selection into Marriage

Cause of Death	Women	Men
All causes	3	3
Tuberculosis	0	2
Syphilis	1	0
Cancer:		
All	2	3
Mouth and throat	1	2
Stomach	0	2
Intestine	0	2
Lung	1	3
Breast	0	na
Cervix	*	na
Uterus	0	na
Prostate	na	0
Skin	0	0
Bone	*	0
Lymphoma	1	2
Leukemia	2	1
Diabetes	3	3
Psychoses	1	1
Neuroses	3	2
Stroke	2	3
Multiple sclerosis	2	2
Epilepsy	0	2
Rheumatic heart disease	0	3
Coronary heart disease	3	3
Hypertension	0	3
Arterial disease	0	2
Pneumonia	3	3
Bronchitis	2	3
Peptic ulcer	0	3
Appendicitis	0	2
Hernia	1	2
Cirrhosis of liver	3	3
Gall bladder disease	*	1
Chronic kidney disease	0	3
Kidney stone	1	0
Enlarged prostate	na	0
Maternal death	*	na
Arthritis	2	2
Congenital anomalies	0	1
Traffic accidents	3	2
Non-traffic accidents	2	0
Suicide	3	3
Homicide	1	2

0 = none 1 = possible 2 = probable 3 = definite
 * at least one MR less than 100

Table 6.14 Causes with Gender Discordance with respect to Evidence of Selection into Marriage

Causes with evidence for men but not for women:

- Tuberculosis
- Cancer of stomach
- Cancer of intestine
- Epilepsy
- Rheumatic heart disease
- Hypertension
- Arterial disease
- Peptic ulcer
- Appendicitis
- Chronic kidney disease
- Congenital anomalies

Causes with evidence for women but not for men:

- Syphilis
- Kidney stone
- Non-traffic accidents

Table 6.15 Evidence of Protection in the Absence of Selection

Evidence of protection present:

Tuberculosis (women)
Cancer of intestine (women)
Cancer of breast
Cancer of uterus
Cancer of skin (women and men)
Rheumatic heart disease (women)
Arterial disease (women)
Appendicitis (women)
Congenital anomalies (women)
Non-traffic accidents (men)

Evidence of protection absent:

Syphilis (men)
Cancer of stomach (women)
Cancer of prostate
Cancer of bone (men)
Epilepsy (women)
Peptic ulcer (women)
Chronic kidney disease (women)
Kidney stone (men)
Enlarged prostate

Table 6.16 Mortality from All Causes at Ages 15 - 74.
 Proportion (%) of Variation in Mortality Ratio
 and Gender Ratio* Explained by Regression on
 Marriage Rate.

	Single	Widowed	Divorced	Total
Mortality ratio:				
Women	15	25	50	24
Men	21	39	53	25
Total	19	30	52	29
Gender ratio:	19	32	52	25

* Mortality ratio for men/ mortality ratio for women

7. Discussion

7.1 Inaccuracies in data

Before discussing the substantial results it is necessary to consider possible inaccuracies in the data, in particular the way marital status is recorded on the death records and in the census reports, and the classification of the cause of death.

Table 7.1 shows the proportion of the deaths, at ages 15-74, in which marital status is not recorded. Although the percentage varies from year to year, on average marital status is missing on 0.5 per cent of deaths among women and 1 per cent of deaths among men. Since these deaths are necessarily excluded from the calculations, the calculation of rates would be biased if the marital status distribution of the missing deaths were markedly different from that of the others. It seems unlikely that this would happen, and even so the resulting error would be very small. Marital status is presumably missing on some census records, but the proportion is not known, since missing data are imputed in the census tables. In general there is an under-enumeration in the census estimates. These problems could produce inaccuracy if the errors were not distributed proportionately across marital status groups, but large discrepancies in the denominators would be necessary to skew the estimates of death rates.

After 1955 the separated are distinguished from the married in the death records. However, prior to 1986, the married category includes the separated in the published census tables. For consistency the separated have been included with the married in

all the calculations. This does not produce inaccuracy in the estimates of rates, but could result in some difficulty in interpretation. Those who are separated no longer benefit from any protective benefit of marriage. The separated are also unable to re-marry, and are thus not subject to selection.

Cohabitation is another possible source of bias in the data. Cohabiting couples, if accurately ascertained, are counted as single in both the mortality and census records. However, it is possible that the accuracy of ascertainment differs in the two data sources, which could affect the estimation of mortality rates among the single. The degree of selection into cohabitation, and the protection against mortality derived from it, is probably less than that for legal marriage, especially if the cohabitation is transient and not followed by marriage. The dilution produced by including those cohabiting with the single is likely to be small. However, the prevalence of cohabitation in Canada has increased sharply in recent years (Hobart, 1983; Beaujot, 1991: 246).

The causes of death chosen for analysis were those identifiable across the four revisions of the ICD. However, the rules for determining the underlying cause of death from the statements on the death certificate are complicated, and also change between revisions. These changes were most marked between the seventh and the eighth revisions. Nevertheless, the changes would be independent of marital status, so that the mortality ratios would not be affected unduly by them.

7.2 Mortality ratios

Table 7.2 compares the age-specific MR's for all causes in Canada in 1960-62 with those for US Whites in 1959-61. The two studies are generally concordant. Using logged variables the overall correlation coefficient is 0.78. The correlation is stronger for men (0.84) than for women (0.66), and stronger for the single (0.94) than for the widowed (0.79) or the divorced (0.68). Among the widowed the MR tends to be lower, on average, in Canada than in the US, while the reverse is true for the divorced.

Table 7.3 shows the same comparison for the specific causes used in the US study. The Canadian MR's cover the whole period, in order to achieve greater precision. Again the concordance between the two data sets is high. The overall correlation coefficient is 0.86, and the correlation is stronger for men (0.88) than for women (0.76). For these specific causes the correlation is stronger for the divorced (0.94) than for the widowed (0.88) or the single (0.81). Among the single, the MR's tend to be higher in Canada than in the US, especially for violent death.

It is not possible to make precise comparisons between the results of the present study and those of previous Canadian studies because of differences in the age ranges included, and in the methods used to estimate the MR's. Boyd (1983a) calculated age-specific MR's at ages 25-44 and 45-64, for the single and for the previously married (widowed and divorced), with respect to ten causes of death in Canada in 1970-72. Table 7.4 compares Boyd's results with those of the present study. The overall correlation between the two sets of

MR's is 0.76, which is not surprising given that the former is a small sub-set of the latter. As in the present study, Boyd found high MR's for mental disease and violent death.

Trovato and Lauris (1989) examined Canadian mortality by marital status at ages 35 and over for the census years 1951, 1961, 1971 and 1981. Multiple regression analysis was used to relate the logarithm of the death rate for all causes, for cardiovascular disease and for all cancer, to marital status, sex and age group. In Table 7.5 the regression coefficients for death from all causes have been converted to MR's, and compared with the MR's from the present study. The concordance between the two studies is good for the single and divorced, but not for the widowed. This is probably because in the age group 65 and over, used in the first study, the average age of the widowed is greater than that of the married. The MR's for the single increase over time in both studies, but the upward trend for the widowed is less marked in the second study than in the first. The results from the two studies with respect to mortality from cardiovascular disease and cancer are similar.

Trovato and Lauris discuss their findings in relation to the protective hypothesis. In the context of the present study it is relevant to ask how far the upward trends in the MR's can be explained by regression on the marriage rate. This question is examined in Table 7.6, where the nine census periods have been aggregated into groups of three. The regression coefficient increases over time in all three marital status categories, but percentage of the variation explained by the regression increases

only among the single and divorced.

In a second study, Trovato (1992) examined the Canadian mortality in the period 1985-87 for all causes and for 11 specific causes of death. Age groups 15-29, 30-49, 50-69, 70-79 and 80+ were used in a log-linear analysis. The resulting MR's (denoted by RMR in Trovato's paper) are not directly comparable with the results of the present study, but the general patterns are similar. In this paper, Trovato tested the selectivity hypothesis (a) indirectly, comparing the MR's for different causes of death, and (b) using Livi-Bacci's approach, correlating the MR's for the single and divorced with the proportion in those states at various ages. The results for mortality from all causes were consistent with the hypothesis.

The MR's, for all causes and for specific causes, found in the present study are thus concordant with those found in previous studies. The range of specific causes of death has been extended, but the general finding of MR's greater than 100 still holds, with only four exceptions, all of which are diseases in women not previously studied.

For cancer of the cervix the overall MR's are 87 for single women, 152 for widows and 233 for divorced women. This pattern is consistent with the known etiology of the disease. Early age at first sexual intercourse and multiple sexual partners are known risk factors for cancer of the cervix, which is probably caused by a sexually transmitted infectious agent such as the papilloma virus (Schiffman, Brinton, Devesa and Fraumeni, 1996). A striking finding

is the increase in the MR for single women throughout the four decades (Appendix 3, p.108), so that after 1975 the MR for single women exceeded 100. This could be explained by an increase in sexual activity among single women during this period, especially after the introduction of hormonal contraceptives. An upward trend in the MR for widowed women is also evident, which might have a similar explanation. Another factor which should be borne in mind is the increasing use of screening for cancer of the cervix after 1950. Screening reduces the risk of dying for those afflicted with the disease, but it is difficult to see how this could explain the observed trends.

The MR's for cancer of the bone were 174 for single women, 91 for widows and 94 for divorced women. The category cancer of the bone includes many different types of cancer, some with a high incidence in early life. In women cancer of the breast commonly metastasizes to the bone, and it is possible that some cases of cancer of the breast, which is more common among single women (see below), are mis-diagnosed as primary bone cancer.

The MR for gall bladder disease among single women is 84 (Table 6.3), while the MR's for widows and divorced women are 109 and 118 respectively. This is in keeping with the fact that the frequency of gallstone among women increases with parity (Langman, 1979: 116). The fact that the low MR for single women is not seen in the most recent time periods (Appendix 3, p.119) could reflect an increase in childbearing among single women.

The MR's for maternal death are 16 for single women, 48 for widows

and 92 for divorce, and are obviously related to the pregnancy rates. Again, it is noticeable that the MR for single women tends to increase with time (Appendix 3, p.121). However the risk of maternal death has decreased markedly over time and the estimates for individual time periods are imprecise.

As noted above, the general finding that, with few exceptions, the mortality rates are higher among the unmarried than among the married could be explained in three ways: (1) being at increased risk of dying reduces the chance of marrying (the selection hypothesis); (2) being married reduces the risk of dying (protection); and (3) there is some factor which increases the risk of dying and reduces the likelihood of marrying (the confounding hypothesis). Before discussing the results in the context of the first two hypotheses, the third deserves some further consideration.

Since MR's are elevated over a wide range of diseases, confounding would be possible only in relation to a factor involving general mortality, for example age, gender, social class, ethnic group. Only the first two were available within the data base used in this study, and, as in other studies, the marital status differential was shown to be present in all age groups and in both women and men. As mentioned previously, the differential has been shown to be independent of social class. Trovato (1996) has shown recently that the differential in Canada is also present in all immigrant groups. One possible confounding factor which has not received attention is cigarette smoking. Smoking increases the risk of dying from several

important causes of death. Table 7.7 shows the prevalence ratios for current smoking among women in the U.S., derived from a household survey in 1959-60 (Hammond and Garfinkel, 1961). Compared with married women the prevalence of smoking was lower among single women, slightly higher among widows and considerably higher among divorced and separated women. The pattern was consistent across age groups. It is clear that differences in smoking could not account for the all cause mortality differential for single women, and it seems unlikely that the differences for widows and divorced women could explain completely the mortality differential for those categories. However, it should be noted that the MR for lung cancer among single women is much lower than that for widowed and divorced women in both the U.S and Canada (Table 7.3). The prevalence of smoking among men was too high to permit a similar analysis for men "although the pattern of smoking in relation to marital status appeared to be about the same among men as women" (Hammond and Garfinkel, 1961: 439-40).

Similar differences in the prevalence of smoking by marital status have been described in Canadian surveys (Forbes, personal communication). However Berube, Berthelot and Woolfson (1995), in a follow-up study of the 1978 Canada Health Survey, have shown that the marital status differential persists after adjustment for smoking and socio-economic variables. In the context of smoking, it should be mentioned that epidemiological studies have shown that non-smoking spouses (usually wives) of husbands who smoke are at increased risk of lung cancer (Surgeon General, 1986). This might

also be contributing to the low MR's for lung cancer among single women.

7.3 Selection and protection

Prior to the seminal work of Livi-Bacci, discussion of the relative importance of selection and protection in explaining the marital status mortality differential was based chiefly on the differences in the magnitude of the MR's for different causes of death. The most thorough analysis along these lines was that of Gove (1973), who grouped the causes of death into four categories: "mortality due to overt social acts"; "mortality associated with the use of socially approved 'narcotics' " (i.e. alcohol and tobacco); "mortality associated with diseases requiring prolonged and methodological care"; and "mortality largely unaffected by social factors". Following Durkheim, Grove postulated that "the married of both sexes find life more satisfying than the unmarried", and hypothesized that high MR's should be found among "those types of mortality which are clearly affected by such things as one's emotional stability and willingness to take risks." Using the U.S. data, Gove found evidence to support his theory in that:

"(T)he variations in the mortality rates are particularly large where one's psychological state (1) appears to play a direct role in death, as with suicide, homicide and accidents, (2) is directly related to acts such as alcoholism that frequently lead to death, and (3) would appear to affect one's willingness and ability to undergo the drawn-out and careful treatment required for diseases

such as tuberculosis. In contrast, there is little difference between the marital statuses in mortality rates for diseases such as leukemia and aleukemia, where one's psychological state has little effect on either the etiology of the disease or treatment." (Gove, 1973: 61)

Gove, citing evidence from studies of psychological well-being, attributed the higher MR's for men than women to the fact that, "although the data .. suggest that the married are in a more advantageous position than the never married, the widowed, and the divorced (b)eing married appears to be more advantageous to males than females, while being single, widowed, and probably divorced is more disadvantageous to males." (Gove, 1973: 46-47). Grove attributed the higher MR's at younger ages to additional psychological well-being produced by the presence of children in the home. Some credence was provided for this by the subsequent study of Kobrin and Hendershot (1977) which showed lower rates for married people with children under 18 in the home compared with married people without children. This differential was evident in both men and women, but the mortality ratio declined with age. Though Gove argued strongly for the protective hypothesis, he stated the argument for selection well within the context of his postulates:

"The selective argument is essentially as follows. Marriage is a selective process, and the persons who are emotionally unstable and/or physically handicapped are much less likely to get married than those who are emotionally and physically

healthy. Furthermore, the selective processes are such that the man (who plays the dominant role in courtship) finds it more difficult get married if he is handicapped than does a women. The first part of the argument seems quite reasonable, and I would assume that handicapped persons do find it difficult to marry. The question in my view is how much of the variation in the mortality rates between the marital states can be attributed to selective processes. The second part of the argument I find less convincing, although plausible. I would think that neither a man nor a woman would want a spouse who was emotionally unstable or about to die, and that there would be little difference between the sexes in this desire." (Gove, 1973: 62)

This is a reasonable summary, but some minor qualifications could be made. First, as Wyke and Ford (1992) point out, "illness or disability could prevent someone from finding a partner simply through lack of mobility, quite apart from the impact of stigma or distaste for illness on behalf of potential mates." Secondly, the gender difference may not be simply a question of the man having the more dominant role in courtship. At least until recently, the husband has also a dominant role in providing for the family. The unmarried man who is sick, being less able to fullfil this role, is therefore at a greater disadvantage than an unmarried women who is sick.

The paper by Livi-Bacci (1984) was the first attempt to quantify the importance of selection within the cross-sectional mortality

data themselves. It was a landmark paper, but had some limitations. First, the method employed was restricted to the single, though it was subsequently used for the divorced by Hu and Goldman (1990). Secondly, the approach focused on long term selection, and assumed that short term selection is not important. Thirdly, as shown by the simulation studies of Goldman (1993), the correlations on which the method relies could be affected by the assumptions of the model.

The present study, though following the general approach of Livi-Bacci, has attempted to avoid these limitations. First, the underlying theory encompasses both short and long term selection. Secondly, the revised method is applicable to all three unmarried categories. Thirdly, the models used to develop the theory have included a variety of types of disease and disability. Fourthly, the theory was tested using a larger number of diseases than those included in previous studies.

The intuitive expectation that selection into marriage would be associated with a positive correlation between the MR and the marriage rate was shown to be correct for all the types of disease examined. Empirically such evidence of selection was found for most causes of death, the evidence being generally stronger for men than for women. The correlation with marriage rates also explained some of the gender difference in the mortality ratios.

Somewhat unexpectedly, it was found that the presence of protection, in the absence of selection, is associated in the models with a negative correlation between the MR and the marriage

especially among the single, and this was found empirically for several causes of death, mostly in women.

Some of these causes for which there is evidence of protection, in the absence of selection (Table 6.15) are consistent with known features of the etiology and natural history of the diseases concerned. For cancers of the breast and uterus the MR's for the single are elevated, but negatively correlated with the marriage rate (Table 6.3). The incidence of these cancers is known to be higher in women who have not borne children, i.e. marriage is a preventive factor (Kelsey and Hildreth, 1983). This phenomenon is thought to be due to the reduction in exposure to estrogen during pregnancy and lactation.

Most skin cancer deaths are due to malignant melanoma. The most important risk factor is exposure to sunlight, and it is possible that such exposure is greater among the unmarried than the married, though there is no evidence to substantiate this. For many types of cancer the prognosis is better if the disease is detected early, and it is possible that this is more likely if the disease occurs in a married person.

The results of the analysis of deviance in Table 6.16 must be interpreted carefully. The fact that, for example, 29 per cent of the variation in the MR's overall is explained by the regression on marriage rates does not imply that 29 per cent of the MSMD is attributable to selection. The results of disease modelling demonstrate that if selection is present a positive correlation between the MR and the marriage rate will be found, but this

correlation may not be linear. However, the results in Table 6.16 show that the regression of the MR's on the marriage rates is substantial, as well as being statistically significant.

7.4 Further research

The approach used to identify the role of selection in explaining the marital status mortality differential could be extended in several ways. Within Canada it would be of interest to disaggregate data at the provincial level, though the numbers of deaths from some specific causes would be small for a given time period. International data on mortality for all causes by marital status are readily available from the United Nations Demographic Year Books. Unfortunately marital status is not included in the data on death from specific causes maintained by the World Health Organization, so special inquiries would be needed to assemble the requisite information. Cross-sectional mortality rates were used in the present study, though the logic used in the disease models is essentially that of cohorts. Unfortunately the published Canadian data for marriages and deaths prior to 1950 are not sufficiently detailed to permit cohort analysis. In other countries, for example Sweden, this may be possible, at least for mortality from all causes.

Direct evidence of selection into marriage on the basis of health is lacking. As stated by Carter and Glick (1976 : 324-5):

"Perhaps the most beneficial further research would be large-scale longitudinal studies in which personal and family histories would be gathered and analysed on the whole

gamut of variables involved. Ideally these studies would follow subjects from childhood through middle age and would show how successive changes in marital status could be better understood through knowledge of past, current and prospective changes in health, social and economic adjustment."

As these authors acknowledge, such ambitious studies would be time-consuming and costly. However, it would be feasible to use national cross-sectional health surveys, which are frequently undertaken, as the basis of studies along these lines, if the subjects were followed up to determine changes in marital status as well as mortality. It would be essential, of course, that the initial survey include institutional as well as household samples. The recent Canadian Population Health Survey, in which a longitudinal component is planned, might be used for this purpose.

The distinction between selection and protection is not just an academic question. The prevalence of the unmarried in the Canadian population is rising sharply (Beaujot, 1991: 239-42). If marriage is protective then mortality will increase. If, on the other hand, the mortality differential is due to selection, then the decreasing prevalence of marriage will have no effect on the mortality of the population as a whole. In this context it will be important determine the extent to which cohabitation and serial marriage can substitute for monogamous marriage in terms of the protection afforded by the latter.

The approach used in this study, which identifies the presence of

selection in cross-sectional mortality data by correlating mortality ratios with transition rates, could be used for other types of mortality differential, for example social class mortality differences in terms of social mobility, and regional differences in mortality in relation to migration.

Table 7.1 Deaths from All Causes at Ages 15 - 74
Proportion (%) with Marital Status Not Stated

Year	Women	Men
1950-52	0.35	0.10
1955-57	0.20	0.62
1960-62	0.10	0.46
1965-67	0.93	1.38
1970-72	0.39	0.68
1975-77	0.13	1.84
1980-82	0.37	0.66
1985-87	0.31	0.52
1990-92	0.60	1.20
Total	0.52	0.95

Table 7.2 Mortality Ratio (married = 100). All Causes.

<u>Age group</u>		<u>U.S. Whites 1959-61¹</u>			<u>Canada 1960-62</u>		
		<u>Single</u>	<u>Widowed</u>	<u>Divorced</u>	<u>Single</u>	<u>Widowed</u>	<u>Divorced</u>
15-24	M	133	415	219	121	442	465
	F	117	474	244	111	170	480
25-34	M	215	388	401	219	377	367
	F	207	254	264	193	246	222
25-44	M	222	288	401	203	206	319
	F	187	191	213	162	146	215
45-54	M	179	220	312	162	158	278
	F	139	152	158	146	144	154
55-64	M	149	168	238	143	138	212
	F	112	127	137	119	125	140
65-74	M	170	171	222	132	131	205
	F	105	120	123	109	119	151

¹ Source Klebba (1970)

Table 7.3 Mortality Ratio (married = 100). Selected Causes.

<u>Cause</u>		<u>U.S. Whites 1959-61¹</u>			<u>Canada 1950-92</u>		
		<u>Single</u>	<u>Widowed</u>	<u>Divorced</u>	<u>Single</u>	<u>Widowed</u>	<u>Divorced</u>
Tuberculosis	M	382	217	667	336	225	357
	F	237	143	245	198	128	187
Cancer: Digestive	M	125	126	155	141	140	165 ²
	F	115	123	116	120	121	131
Respiratory	M	116	126	213	131	153	199
	F	104	118	153	104	143	186
Breast	F	146	111	114	147	104	116
Genital organs	M	95	123	137	101	123	121 ³
	F	114	118	165	116	131	164 ⁴
Leukemia	M	119	108	121	130	115	124
	F	106	110	107	130	105	121
Diabetes	M	146	141	192	205	173	256
	F	66	111	90	102	123	126
Stroke	M	137	150	181	152	148	195
	F	127	147	135	114	124	149
Coronary heart dis.	M	132	146	177	137	142	192
	F	126	148	130	113	131	140
Cirrhosis	M	257	242	622	262	284	522
	F	84	131	264	141	148	284
Motor vehicle accident	M	129	199	380	199	219	303
	F	103	110	228	206	146	224
Other accident	M	151	227	420	222	251	450
	F	172	184	237	214	166	327
Suicide	M	153	239	408	281	282	502
	F	116	166	319	215	175	426
Homicide	M	103	269	722	279	411	892
	F	51	128	451	146	229	440

¹ Source Klebba (1970)² mouth, stomach and intestine³ prostate only⁴ cervix and uterus

Table 7.4 Mortality Ratio (Married = 100) at Ages 25-64 in 1970-72
and at Ages 15-74 in 1950-92

Cause of death	Single		Widowed & Divorced	
	1970-72*	1950-92	1970-72*	1950-52
Women:				
Psychoses	166	289	232	171
Neuroses	177	219	480	302
Suicide	150	215	246	273
Homicide	141	146	328	317
Traffic accidents	258	206	145	181
Cirrhosis of liver	145	141	335	205
Tuberculosis	282	198	166	155
Diabetes	143	102	233	124
Lung cancer	97	104	211	163
Leukemia	124	130	110	113
Men:				
Psychoses	294	389	424	294
Neuroses	502	628	695	661
Suicide	291	281	372	376
Homicide	462	279	612	605
Traffic accidents	231	199	208	258
Cirrhosis of liver	246	262	573	385
Tuberculosis	465	198	650	155
Diabetes	235	205	255	210
Lung cancer	91	131	233	174
Leukemia	110	130	109	119

* Source: Boyd (1973a)

Table 7.5 Mortality Ratio (Married = 100) for Both Sexes

Trovato & Lauris (1989)				Present Study			
Year	Single	Widowed	Divorced	Year	Single	Widowed	Divorced
1951	140	135	172	1950-52	141	125	218
				1955-57	148	124	240
1961	142	142	187	1960-62	138	126	205
				1965-67	140	124	261
1971	157	165	172	1970-72	153	137	187
				1975-77	179	141	214
1981	180	189	186	1980-82	195	143	197
				1985-87	219	148	194
				1990-92	253	156	206

Table 7.6 Mortality Ratio for Both Sexes
Regression on Marriage Rate

Years	Single		Widowed		Divorced	
	B ¹	PCT ²	B	PCT	B	PCT
1950-52, 55-57, 60-62	3.06	17	5.81	82	1.40	41
1965-67, 70-72, 75-77	3.33	28	7.60	75	2.59	60
1980-82, 85-87, 90-92	7.29	49	11.88	76	5.21	77

¹ regression coefficient² percentage of variation explained by regression

**Table 7.7 Prevalence of Cigarette Smoking Among Women
in the United States, 1959-60**

Age group	Current Smokers (Married = 100)		
	Single	Widowed	Divorced & Separated
30-39	89	104	153
40-49	83	105	159
50-59	96	126	151
60-69	87	142	275
70 and over	68	120	193
Total	84	119	181

Source: Hammond and Garfinkel (1961)

Appendix 1

Consider the four-state model shown in 4.2, and let $i_1 = i_2 = i$, $r_1 = r_2 = r$, $d_1 = d_2 = d$, $m_x = m_y = m$, $w_x = w_y = w$; i.e. there is no selection and no protection. At time t , x_1 , x_2 , y_1 , y_2 satisfy the system of differential equations:

$$\dot{x}_1 = -(d_0 + i + m)x_1 + wx_2 + ry_1$$

$$\dot{x}_2 = mx_1 - (d_0 + i + w)x_2 + ry_2$$

$$\dot{y}_1 = ix_1 - (d_0 + d + r + m)y_1 + wy_2$$

$$\dot{y}_2 = ix_2 + my_1 - (d_0 + d + r + w)y_2$$

Then the death rate from the disease among the unmarried, R_1 say, is $\dot{y}_1/(x_1 + y_1)$, and the death rate from the disease among the married is $R_2 = \dot{y}_2/(x_2 + y_2)$. Note that $R_1 = R_2$ if $y_1/(x_1 + y_1) = y_2/(x_2 + y_2)$, i.e. if $x_1 y_2 = x_2 y_1$. (This is true if the prevalence of disease is the same among the unmarried as among the married).

$$\begin{aligned} \text{Then } R_1/d &= [(x_1 + y_1)\dot{y}_1 - y_1(x_1 + y_1)]/(x_1 + y_1)^2 \\ &= (x_1 \dot{y}_1 - x_1 y_1)/(x_1 + y_1)^2, \text{ and similarly} \end{aligned}$$

$$R_2/d = (x_2 \dot{y}_2 - x_2 y_2)/(x_2 + y_2)^2.$$

$$\text{But } x_1 \dot{y}_1 = ix_1^2 - (d_0 + d + r + m)x_1 y_1 + wx_1 y_2$$

$$x_1 \dot{y}_1 = -(d_0 + i + m)x_1 y_1 + wx_2 y_1 + ry_1^2, \text{ so that}$$

$$x_1 \dot{y}_1 - x_1 y_1 = ix_1^2 + (i - r - d)x_1 y_1 - ry_1^2 + w(x_1 y_2 - x_2 y_1).$$

$$\text{Also } x_2 \dot{y}_2 = ix_2^2 + mx_2 y_1 - (d_0 + d + r + w)x_2 y_2$$

$$x_2 \dot{y}_2 = mx_1 y_2 - (d_0 + i + w)x_2 y_2 + ry_2^2, \text{ so that}$$

$$x_2 \dot{y}_2 - x_2 y_2 = ix_2^2 + (i - r - d)x_2 y_2 - ry_2^2 - m(x_1 y_2 - x_2 y_1).$$

Thus if $x_1 y_2 > x_2 y_1$, i.e. $R_2 > R_1$, R_1 increases and R_2 decreases; and if $x_1 y_2 < x_2 y_1$, i.e. $R_2 < R_1$, R_1 decreases and R_2 increases. Hence $R_1/R_2 \rightarrow 1$, and $x_1 y_2 - x_2 y_1 \rightarrow 0$, with R_1 and R_2 independent of m and w .

Suppose now that there is selection into marriage, with $m_x = m$, $m_y = km$, $k < 1$.

$$\begin{aligned} \text{Then } x_1 y_1 - x_1 y_1 &= ix_1^2 + (i-r-d)x_1 y_1 - ry_1^2 + w(x_1 y_2 - x_2 y_1) \\ &\quad + (1-k)mx_1 y_1 \end{aligned}$$

and $x_2 y_2 - x_2 y_2 = ix_2^2 + (i-r-d)x_2 y_2 - ry_2^2 - m(x_1 y_2 - kx_2 y_1)$. Hence R_1 is an increasing function of m , and R_2 is a decreasing function of m , so that R_1/R_2 is an increasing function of m .

Similarly if there is selection out of marriage, with $w_x = w$, $w_y = kw$, $k > 1$.

$$\begin{aligned} \text{Then } x_1 y_1 - x_1 y_1 &= ix_1^2 + (i-r-d)x_1 y_1 - ry_1^2 + w(kx_1 y_2 - x_2 y_1) \\ x_2 y_2 - x_2 y_2 &= ix_2^2 + (i-r-d)x_2 y_2 - ry_2^2 - m(x_1 y_2 - x_2 y_1) \\ &\quad - (k-1)wx_2 y_2. \end{aligned}$$

Hence R_1 is an increasing function of w , and R_2 is a decreasing function of w , so that R_1/R_2 is an increasing function of w .

Appendix 2 Definitions

Table A2.1 Short and Full Titles of Causes of Death

Short title	Full Title (ICD 6th revision)
Tuberculosis	Tuberculosis
Syphilis	Syphilis
All cancer	All malignant neoplasms (MN)
Cancer of mouth	MN of buccal cavity and pharynx
Cancer of stomach	MN of stomach
Cancer of intestine	MN of intestine
Cancer of lung	MN of larynx, trachea and bronchus
Cancer of breast	MN of breast
Cancer of cervix	MN of cervix uteri
Cancer of uterus	MN of other and unspecified parts of uterus
Cancer of prostate	MN of prostate
Cancer of skin	MN of skin
Cancer of bone	MN of bone and connective tissue
Leukemia	Leukemia and aleukemia
Lymphoma	Other lymphatic neoplasms
Diabetes	Diabetes mellitus
Psychoses	Psychoses
Neuroses	Psychoneuroses and disorders of personality
Stroke	Vascular lesions affecting CNS
Multiple sclerosis	Multiple sclerosis
Epilepsy	Epilepsy
Rheumatic heart dis.	Chronic rheumatic heart disease
Coronary heart dis.	Arteriosclerotic and degenerative heart dis.
Hypertension	Hypertension
Arterial disease	Diseases of arteries
Pneumonia	Acute upper respiratory infections, influenza and pneumonia
Bronchitis	Bronchitis
Peptic ulcer	Ulcer of stomach and duodenum
Appendicitis	Appendicitis
Hernia	Intestinal obstruction and hernia
Cirrhosis of liver	Cirrhosis of liver
Gall bladder disease	Cholelithiasis and cholecystitis
Kidney disease	Acute and chronic nephritis
Kidney stone	Calculi of urinary system
Enlarged prostate	Hyperplasia of prostate
Maternal death	Deliveries and complications of pregnancy childbirth and the puerperium
Arthritis	Arthritis and spondylitis
Congenital anomalies	Congenital malformations
Traffic accidents	Motor vehicle and other transport accidents
Non-traffic accidents	Other accidental causes
Suicide	Suicide and self-inflicted injury
Homicide	Homicide and injury purposely inflicted by others.

Table A2.2 Causes of Death: Type, Group and ICD Categories

Short title	Type	Group	Categories in ICD Revision			
			6	7	8	9
Tuberculosis	5	1	001-019	001-019	010-019	010-018
Syphilis	5	1	020-029	020-029	090-097	090-097
All cancer	4	2	140-205	140-205	140-209	140-208
Cancer of mouth	1	2	140-150	140-150	140-150	140-150
Cancer of stomach	1	2	151	151	151	151
Cancer of intestine	1	2	152-154	152-154	152-154	153,154
Cancer of lung	1	2	161-163	161-163	161,162	160-165
Cancer of breast	1	2	170	170	174	174
Cancer of cervix	1	2	171	171	180	180
Cancer of uterus	1	2	172-174	172-174	181,182	179, 181-183
Cancer of prostate	1	2	177	177	185	185
Cancer of skin	1	2	190,191	190,191	172,173	172,173
Cancer of bone	4	2	196,197	196,197	170	170
Leukemia	4	2	204	204	204-207	204-208
Lymphoma	4	2	200-203	200-203	200-203	200-203
			205	205	208,209	
Diabetes	4	4	260	260	250	250
Psychoses	4	3	300-309	300-309	290-299	290-299
Neuroses	4	3	310-324	310-324	300-309	300-304
			326	326		
Stroke	1	4	330-334	330-334	430-438	430-438
Multiple sclerosis	4	3	345	345	340	340
Epilepsy	3	3	353	353	345	345
Rheumatic heart dis	4	4	410-416	410-416	393-398	393-398
Coronary heart dis	1	4	420-422	420-422	410-414	410-414
Hypertension	1	4	440-447	440-447	400-404	400-404
Arterial disease	1	4	450-456	450-456	440-448	440-448
Pneumonia	5	1	470-493	470-493	460-486	460-487
Bronchitis	5	1	500-502	500-502	490-493	490-493
Peptic ulcer	1	5	540,541	540,541	531-533	531-533
Appendicitis	5	5	550-553	550-533	540-543	540-543
Hernia	5	5	560,561	560,561	550-553	550-553
			570	570	560	560
Cirrhosis of liver	1	5	581	581	571	571
Gall bladder dis	2	5	584,585	584,585	574,575	574,575
Kidney disease	4	7	590-594	590-594	580-584	580-584
Kidney stone	5	7	602,604	602,604	592,594	592,594
Enlarged prostate	1	7	610	610	600	600
Maternal death	5	7	640-689	640-689	630-678	630-676
Arthritis	4	7	720-725	720-725	710-715	710-715
Congenital anomalies	3	7	750-759	750-759	740-759	740-759
Traffic accidents	5	6	E800-866	800-866	800-845	800-848
Non-traffic acc	5	6	E870-965	870-962	850-949	850-949
Suicide	5	6	E970-979	963, 970-979	950-959	950-959
Homicide	5	6	E980-985	964, 980-985	960-978	960-969

Appendix 3 Detailed Results for Specific Causes of Death

Table A3 shows the MR's for specific causes of death, comparable to the MR's for all causes of death in Tables 6.1 and 6.2.

In Table A3 the superscript ^{ns} indicates that the overall MR for all ages and time periods is not significantly different from 100.

Table A3 (continued) Mortality Ratios (Married = 100)

	Women			Men		
	Single	Widowed	Divorced	Single	Widowed	Divorced
All cancer						
Ages						
15-24	123	316	200	130	207	146
25-34	132	177	147	151	254	180
35-44	133	145	142	166	170	183
45-54	141	131	142	153	178	198
55-64	130	121	131	133	150	171
65-74	118	113	130	114	130	145
Years						
1950-52	120	110	126	116	131	221
1955-57	117	105	171	128	127	212
1960-62	122	114	132	116	118	183
1965-67	117	108	180	111	120	256
1970-72	123	118	135	113	129	143
1975-77	126	115	133	129	143	161
1980-82	133	120	126	131	142	153
1985-87	138	121	131	147	147	157
1990-92	143	125	131	162	159	172
Total	127	117	135	129	136	165
# deaths	28,587	62,052	8,864	40,292	26,232	10,739

Cancer of mouth

Ages						
15-24	64	-	-	95	-	-
25-34	264	376	250	184	-	163
35-44	171	73	154	255	286	238
45-54	154	214	221	264	316	334
55-64	150	168	207	204	199	289
65-74	114	126	154	164	162	206
Years						
1950-52	105	112	93	148	166	178
1955-57	102	91	161	166	182	301
1960-62	140	119	274	159	133	282
1965-67	134	130	224	148	172	438
1970-72	107	145	256	178	178	238
1975-77	145	153	255	184	168	269
1980-82	130	159	160	207	194	263
1985-87	170	162	155	255	184	275
1990-92	152	148	194	248	199	257
Total	133	140	190	193	176	267
# deaths	563	1,588	235	2,713	1,627	898

Table A3 (continued) Mortality Ratios (Married = 100)

	Women			Men		
	Single	Widowed	Divorced	Single	Widowed	Divorced
All cancer						
Ages						
15-24	123	316	200	130	207	146
25-34	132	177	147	151	254	180
35-44	133	145	142	166	170	183
45-54	141	131	142	153	178	198
55-64	130	121	131	133	150	171
65-74	118	113	130	114	130	145
Years						
1950-52	120	110	126	116	131	221
1955-57	117	105	171	128	127	212
1960-62	122	114	132	116	118	183
1965-67	117	108	180	111	120	256
1970-72	123	118	135	113	129	143
1975-77	126	115	133	129	143	161
1980-82	133	120	126	131	142	153
1985-87	138	121	131	147	147	157
1990-92	143	125	131	162	159	172
Total	127	117	135	129	136	165
# deaths	28,587	62,052	8,864	40,292	26,232	10,739
Cancer of mouth						
Ages						
15-24	64	-	-	95	-	-
25-34	264	376	250	184	-	163
35-44	171	73	154	255	286	238
45-54	154	214	221	264	316	334
55-64	150	168	207	204	199	289
65-74	114	126	154	164	162	206
Years						
1950-52	105	112	93	148	166	178
1955-57	102	91	161	166	182	301
1960-62	140	119	274	159	133	282
1965-67	134	130	224	148	172	438
1970-72	107	145	256	178	178	238
1975-77	145	153	255	184	168	269
1980-82	130	159	160	207	194	263
1985-87	170	162	155	255	184	275
1990-92	152	148	194	248	199	257
Total	133	140	190	193	176	267
# deaths	563	1,588	235	2,713	1,627	898

Table A3 (continued) Mortality Ratios (Married = 100)

	Women			Men		
	Single	Widowed	Divorced	Single	Widowed	Divorced
Cancer of stomach						
Ages						
15-24	75	-	-	52	-	-
25-34	140	-	172	131	616	140
35-44	120	100	120	132	175	129
45-54	119	113	132	135	144	154
55-64	99	117	92	123	139	135
65-74	92	109	90	108	121	113
Years						
1950-52	90	107	52	109	134	166
1955-57	79	101	100	115	125	127
1960-62	105	105	170	119	112	120
1965-67	103	116	90	112	119	189
1970-72	94	104	130	113	127	120
1975-77	101	108	100	127	127	149
1980-82	112	120	108	112	118	124
1985-87	116	119	100	123	124	116
1990-92	135	137	97	138	148	123
Total	100 ^{ns}	111	104 ^{ns}	116	125	129
# deaths	1,217	3,707	233	3,293	2,561	515
Cancer of intestine						
Ages						
15-24	68	-	-	85	-	-
25-34	121	118	97	150	362	229
35-44	128	127	113	188	85	154
45-54	132	123	119	141	141	145
55-64	139	114	115	127	123	129
65-74	126	114	114	117	124	120
Years						
1950-52	118	108	138	111	125	181
1955-57	129	105	146	129	120	151
1960-62	129	115	95	120	111	168
1965-67	118	108	133	126	112	215
1970-72	132	119	112	112	129	111
1975-77	121	111	109	133	133	105
1980-82	139	126	121	120	121	127
1985-87	154	117	109	131	124	115
1990-92	139	120	116	157	148	142
Total	130	114	115	126	124	130
# deaths	3,921	9,356	821	4,782	3,241	960

Table A3 (continued) Mortality Ratios (Married = 100)

	Women			Men		
	Single	Widowed	Divorced	Single	Widowed	Divorced
Cancer of lung						
Ages						
15-24	71	-	-	68	-	926
25-34	129	90	204	129	780	292
35-44	132	218	184	168	242	258
45-54	118	169	207	162	218	241
55-64	104	155	172	140	175	205
65-74	97	136	187	115	144	170
Years						
1950-52	135	113	216	116	131	404
1955-57	101	123	222	116	130	253
1960-62	94	124	205	108	129	223
1965-67	87	121	324	102	128	309
1970-72	93	140	219	109	144	179
1975-77	101	140	202	124	162	190
1980-82	100	140	202	135	163	172
1985-87	107	148	186	149	163	192
1990-92	114	149	184	177	179	214
Total	104	143	186	131	153	199
# deaths	2,266	8,776	2,016	11,478	9,092	4,683
Cancer of breast						
Ages						
15-24	39	-	-	-	-	-
25-34	95	234	134	-	-	-
35-44	131	119	115	-	-	-
45-54	157	115	126	-	-	-
55-64	152	102	113	-	-	-
65-74	152	103	107	-	-	-
Years						
1950-52	171	107	94	-	-	-
1955-57	153	97	200	-	-	-
1960-62	151	107	123	-	-	-
1965-67	136	96	163	-	-	-
1970-72	147	109	107	-	-	-
1975-77	148	107	113	-	-	-
1980-82	143	104	116	-	-	-
1985-87	142	105	118	-	-	-
1990-92	144	105	112	-	-	-
Total	147	104	116	-	-	-
# deaths	7,192	11,088	1,964	-	-	-

Table A3 (continued) Mortality Ratios (Married = 100)

	Women			Men		
	Single	Widowed	Divorced	Single	Widowed	Divorced
Cancer of cervix						
Ages						
15-24	42	1,417	724	-	-	-
25-34	106	273	207	-	-	-
35-44	103	228	236	-	-	-
45-54	88	170	246	-	-	-
55-64	84	155	222	-	-	-
65-74	77	141	225	-	-	-
Years						
1950-52	45	117	277	-	-	-
1955-57	51	124	333	-	-	-
1960-62	67	144	233	-	-	-
1965-67	62	137	206	-	-	-
1970-72	81	168	203	-	-	-
1975-77	112	165	237	-	-	-
1980-82	192	197	238	-	-	-
1985-87	177	186	207	-	-	-
1990-92	205	214	247	-	-	-
Total	87	152	233	-	-	-
# deaths	968	2,617	472	-	-	-
Cancer of uterus						
Ages						
15-24	47	-	384	-	-	-
25-34	169	501	150	-	-	-
35-44	190	140	177	-	-	-
45-54	194	143	103	-	-	-
55-64	173	118	110	-	-	-
65-74	147	109	115	-	-	-
Years						
1950-52	110	120	124	-	-	-
1955-57	127	115	164	-	-	-
1960-62	143	123	79	-	-	-
1965-67	129	108	222	-	-	-
1970-72	167	140	177	-	-	-
1975-77	190	107	163	-	-	-
1980-82	164	105	102	-	-	-
1985-87	165	114	106	-	-	-
1990-92	185	111	118	-	-	-
Total	156	113	115	-	-	-
# deaths	2,025	3,814	548	-	-	-

Table A3 (continued) Mortality Ratios (Married = 100)

	Women			Men		
	Single	Widowed	Divorced	Single	Widowed	Divorced
Cancer of prostate						
Ages						
15-24	-	-	-	-	-	-
25-34	-	-	-	31	-	745
35-44	-	-	-	137	544	107
45-54	-	-	-	120	140	101
55-64	-	-	-	115	144	122
65-74	-	-	-	96	121	121
Years						
1950-52	-	-	-	97	123	94
1955-57	-	-	-	80	109	191
1960-62	-	-	-	105	130	151
1965-67	-	-	-	93	106	291
1970-72	-	-	-	91	123	142
1975-77	-	-	-	99	127	117
1980-82	-	-	-	106	120	109
1985-87	-	-	-	106	124	106
1990-92	-	-	-	125	142	118
Total	-	-	-	101 ^{ns}	123	121
# deaths	-	-	-	1,828	2,077	464
Cancer of skin						
Ages						
15-24	73	-	-	40	-	-
25-34	130	80	130	130	291	178
35-44	115	77	138	177	143	148
45-54	168	96	155	157	116	197
55-64	133	135	156	131	140	95
65-74	99	93	167	122	128	159
Years						
1950-52	100	131	-	89	132	556
1955-57	93	140	147	173	135	111
1960-62	91	96	136	95	126	68
1965-67	126	91	214	109	110	209
1970-72	90	96	171	74	210	272
1975-77	89	104	128	120	117	144
1980-82	127	104	141	117	100	151
1985-87	125	120	126	94	140	113
1990-92	164	76	179	156	122	147
Total	114	103 ^{ns}	151	112	130	147
# deaths	349	463	128	629	236	147

Table A3 (continued) Mortality Ratios (Married = 100)

	Women			Men		
	Single	Widowed	Divorced	Single	Widowed	Divorced
Cancer of bone						
Ages						
15-24	224	-	-	207	-	414
25-34	124	-	-	201	-	70
35-44	133	77	226	131	218	66
45-54	134	94	121	186	60	235
55-64	131	80	121	160	148	191
65-74	148	96	102	121	119	144
Years						
1950-52	126	94	-	156	148	-
1955-57	175	98	123	226	139	309
1960-62	167	79	79	219	84	75
1965-67	149	56	73	171	114	67
1970-72	152	70	-	130	100	82
1975-77	197	129	-	112	87	177
1980-82	232	132	155	200	129	304
1985-87	208	131	120	324	140	143
1990-92	292	121	146	346	155	188
Total	174	91 ^{ns}	94 ^{ns}	182	123	164
# deaths	371	226	17	769	133	37
Lymphoma						
Ages						
15-24	126	-	294	110	-	187
25-34	218	146	78	162	150	216
35-44	170	125	124	158	172	165
45-54	147	120	118	123	135	112
55-64	108	116	105	110	120	111
65-74	106	111	99	95	111	99
Years						
1950-52	146	114	158	116	93	120
1955-57	110	107	101	144	108	277
1960-62	115	123	119	105	121	179
1965-67	112	108	160	82	97	246
1970-72	117	123	134	86	84	95
1975-77	106	107	121	123	126	110
1980-82	134	106	103	115	110	119
1985-87	145	108	99	156	125	97
1990-92	147	121	103	159	147	114
Total	125	113	107 ^{ns}	117	115	115
# deaths	1,535	2,946	346	2,662	1,016	427

Table A3 (continued) Mortality Ratios (Married = 100)

	Women			Men		
	Single	Widowed	Divorced	Single	Widowed	Divorced
Leukemia						
Ages						
15-24	168	662	348	156	-	-
25-34	139	120	109	141	-	152
35-44	109	142	118	142	180	177
45-54	113	119	110	124	98	112
55-64	114	116	127	108	139	116
65-74	106	100	125	98	110	122
Years						
1950-52	125	127	104	151	116	184
1955-57	100	80	36	186	130	230
1960-62	118	107	76	97	110	78
1965-67	111	93	178	111	111	216
1970-72	125	118	87	145	105	131
1975-77	122	106	89	141	108	131
1980-82	141	128	131	103	114	150
1985-87	163	91	119	146	106	106
1990-92	177	103	135	131	135	110
Total	130	105	121	130	115	124
# deaths	1,266	1,610	244	2,257	695	286
Diabetes						
Ages						
15-24	155	-	-	213	-	-
25-34	397	216	286	428	1,351	981
35-44	288	237	263	390	303	486
45-54	172	198	220	285	287	322
55-64	92	133	108	194	204	241
65-74	74	119	98	151	162	198
Years						
1950-52	80	101	94	184	151	130
1955-57	80	104	82	169	140	339
1960-62	70	105	118	183	136	233
1965-67	89	107	150	172	161	319
1970-72	83	122	100	174	166	237
1975-77	120	136	125	217	188	217
1980-82	144	153	130	211	176	266
1985-87	144	142	108	238	217	259
1990-92	179	157	149	314	223	263
Total	102 ^{ns}	123	126	205	173	256
# deaths	1,901	6,811	424	3,369	1,928	795

Table A3 (continued) Mortality Ratios (Married = 100)

	Women			Men		
	Single	Widowed	Divorced	Single	Widowed	Divorced
Psychoses						
Ages						
15-24	859	-	-	-	-	-
25-34	650	634	-	663	-	422
35-44	832	107	371	533	377	415
45-54	326	125	455	458	378	415
55-64	258	185	142	480	360	538
65-74	206	150	159	261	217	280
Years						
1950-52	312	161	-	555	183	646
1955-57	483	142	1,501	387	127	241
1960-62	457	210	589	428	327	353
1965-67	506	182	545	386	182	650
1970-72	148	124	164	283	150	390
1975-77	176	131	110	262	181	313
1980-82	146	109	185	377	340	285
1985-87	326	167	218	363	290	425
1990-92	292	185	158	417	294	326
Total	289	154	190	389	242	357
# deaths	263	428	42	505	216	96
Neuroses						
Ages						
15-24	246	-	-	542	4,661	-
25-34	355	1,488	492	534	2,150	1,053
35-44	335	530	606	832	851	1,198
45-54	193	293	398	718	646	1,011
55-64	192	255	332	614	449	1,012
65-74	114	172	283	487	376	872
Years						
1950-52	155	103	613	538	301	1,218
1955-57	169	158	310	524	384	2,171
1960-62	203	121	-	561	276	725
1965-67	196	215	887	498	418	1,058
1970-72	185	222	502	521	386	847
1975-77	211	219	375	640	416	1,119
1980-82	235	223	362	692	617	1,074
1985-87	202	226	231	758	484	1,048
1990-92	439	359	551	802	426	881
Total	219	224	406	628	434	1,007
# deaths	284	457	166	2,217	561	791

Table A3 (continued) Mortality Ratios (Married = 100)

	Women			Men		
	Single	Widowed	Divorced	Single	Widowed	Divorced
Stroke						
Ages						
15-24	88	1,154	99	109	483	261
25-34	181	230	258	203	169	286
35-44	144	164	204	237	273	334
45-54	114	148	160	194	191	254
55-64	115	133	148	160	171	197
65-74	111	121	129	139	143	164
Years						
1950-52	104	115	182	130	136	178
1955-57	100	118	130	132	137	249
1960-62	98	118	127	131	129	166
1965-67	104	115	170	139	136	243
1970-72	108	128	131	149	152	185
1975-77	121	132	136	163	157	183
1980-82	138	133	136	185	173	185
1985-87	155	134	151	207	187	193
1990-92	161	143	169	219	205	205
Total	114	124	149	152	148	195
# deaths	7,263	22,515	1,462	11,794	8,853	1,970
Multiple sclerosis						
Ages						
15-24	127	-	-	-	-	-
25-34	436	331	448	507	787	1,258
35-44	389	217	428	314	301	532
45-54	263	131	254	254	307	461
55-64	205	114	178	252	154	392
65-74	255	102	163	147	113	281
Years						
1950-52	292	75	109	244	168	144
1955-57	219	80	180	350	54	687
1960-62	263	129	61	237	128	320
1965-67	263	87	298	246	114	241
1970-72	246	114	241	293	248	410
1975-77	301	152	371	321	158	368
1980-82	291	79	178	219	166	406
1985-87	232	156	250	321	121	476
1990-92	308	143	307	341	148	480
Total	267	113	263	285	148	438
# deaths	619	376	158	459	96	128

Table A3 (continued) Mortality Ratios (Married = 100)

	Women			Men		
	Single	Widowed	Divorced	Single	Widowed	Divorced
Epilepsy						
Ages						
15-24	257	503	174	1,865	-	-
25-34	1,015	316	618	1,499	994	1,109
35-44	1,085	156	513	1,761	426	1,013
45-54	907	196	395	1,569	590	1,140
55-64	523	157	201	863	345	1,032
65-74	393	137	256	668	263	598
Years						
1950-52	711	115	191	1,454	234	-
1955-57	558	180	868	1,567	181	269
1960-62	721	121	249	1,749	258	946
1965-67	450	133	273	1,328	331	1,010
1970-72	585	155	523	2,185	585	1,356
1975-77	308	255	549	1,132	297	1,182
1980-82	231	147	430	1,237	327	861
1985-87	443	161	325	1,153	403	1,032
1990-92	676	162	361	1,896	642	1,002
Total	466	152	393	1,446	323	986
# deaths	1,076	166	87	2,118	107	174

Rheumatic heart disease

Ages						
15-24	62	289	-	127	-	-
25-34	142	75	124	212	268	270
35-44	162	131	194	181	223	261
45-54	125	131	194	158	122	198
55-64	132	117	122	136	127	171
65-74	124	105	118	118	113	119
Years						
1950-52	121	102	176	158	121	270
1955-57	116	98	157	166	99	175
1960-62	105	106	180	134	113	200
1965-67	126	106	182	123	89	278
1970-72	119	110	97	116	144	173
1975-77	128	104	131	153	138	149
1980-82	121	139	149	184	158	187
1985-87	134	131	103	179	135	80
1990-92	160	141	95	197	140	147
Total	119	110	130	145	119	172
# deaths	1,603	2,540	205	1,818	634	176

Table A3 (continued) Mortality Ratios (Married = 100)

	Women			Men		
	Single	Widowed	Divorced	Single	Widowed	Divorced
Coronary heart disease						
Ages						
15-24	116	4,419	981	55	1,136	445
25-34	214	371	185	158	274	352
35-44	193	225	212	177	215	264
45-54	139	174	183	149	175	230
55-64	113	144	143	137	151	192
65-74	107	128	122	130	137	164
Years						
1950-52	118	124	169	125	129	235
1955-57	112	122	180	121	128	235
1960-62	109	128	143	121	124	195
1965-67	105	123	176	120	128	243
1970-72	102	129	121	132	147	173
1975-77	107	131	146	149	155	185
1980-82	116	137	139	152	157	180
1985-87	125	144	131	169	164	177
1990-92	145	155	141	186	183	209
Total	113	131	140	137	142	192
# deaths	16,015	60,198	3,601	54,908	39,432	12,553
Hypertension						
Ages						
15-24	98	4,472	-	751	-	-
25-34	218	241	407	319	-	-
35-44	106	145	81	249	246	542
45-54	103	139	179	194	178	297
55-64	103	122	136	182	176	270
65-74	107	125	191	148	151	204
Years						
1950-52	94	116	139	147	150	306
1955-57	92	120	130	147	144	270
1960-62	110	116	167	181	158	274
1965-67	110	117	102	161	158	281
1970-72	130	124	77	222	161	159
1975-77	152	158	164	253	215	235
1980-82	113	139	149	259	164	212
1985-87	186	186	204	265	182	234
1990-92	248	244	300	325	220	291
Total	107	125	167	173	156	251
# deaths	1,603	5,376	191	2,822	2,062	321

Table A3 (continued) Mortality Ratios (Married = 100)

	Women			Men		
	Single	Widowed	Divorced	Single	Widowed	Divorced
Arterial disease						
Ages						
15-24	67	-	-	95	-	-
25-34	175	172	122	224	454	193
35-44	198	166	201	188	104	349
45-54	148	134	172	180	212	195
55-64	144	171	169	137	174	199
65-74	131	147	163	134	156	159
Years						
1950-52	144	155	223	132	166	93
1955-57	117	124	185	159	161	150
1960-62	109	142	325	143	131	137
1965-67	134	145	274	129	143	254
1970-72	133	156	183	116	159	167
1975-77	120	146	184	143	161	177
1980-82	154	141	159	131	155	165
1985-87	122	159	141	143	187	168
1990-92	146	169	156	170	171	206
Total	130	149	167	139	159	180
# deaths	1,180	3,845	297	2,969	2,647	727
Pneumonia						
Ages						
15-24	231	310	-	399	-	1,560
25-34	595	479	286	739	244	604
35-44	523	270	311	796	532	752
45-54	394	204	245	536	399	596
55-64	262	173	190	380	260	406
65-74	194	147	192	276	200	297
Years						
1950-52	191	116	148	280	170	387
1955-57	179	142	244	311	182	582
1960-62	247	164	227	309	201	543
1965-67	332	165	421	389	203	483
1970-72	293	150	214	352	225	393
1975-77	324	176	184	444	262	457
1980-82	334	161	209	405	235	358
1985-87	308	177	202	500	263	355
1990-92	395	154	212	576	258	334
Total	266	154	213	371	213	389
# deaths	3,354	4,523	411	7,159	2,886	997

Table A3 (continued) Mortality Ratios (Married = 100)

	Women			Men		
	Single	Widowed	Divorced	Single	Widowed	Divorced
Bronchitis						
Ages						
15-24	285	-	-	502	-	-
25-34	340	173	156	455	1,815	382
35-44	344	350	211	461	254	327
45-54	235	254	267	340	360	400
55-64	133	167	246	216	231	287
65-74	128	150	162	148	182	220
Years						
1950-52	172	109	-	206	219	345
1955-57	153	107	-	141	164	339
1960-62	195	139	-	179	157	274
1965-67	122	156	251	153	169	414
1970-72	129	137	173	167	179	262
1975-77	189	188	228	209	188	330
1980-82	167	135	207	256	228	213
1985-87	197	178	212	240	211	259
1990-92	212	174	224	278	252	222
Total	170	157	210	199	193	262
# deaths	869	2,170	306	3,111	2,243	754
Peptic ulcer						
Ages						
15-24	76	-	-	157	-	-
25-34	245	-	502	358	543	666
35-44	314	251	550	336	512	527
45-54	190	165	257	269	230	465
55-64	137	158	251	256	187	389
65-74	148	140	173	203	190	309
Years						
1950-52	104	134	124	146	165	344
1955-57	144	117	317	183	148	301
1960-62	131	144	112	216	167	220
1965-67	203	131	199	211	194	332
1970-72	136	144	245	257	180	332
1975-77	196	131	171	411	239	493
1980-82	147	161	184	403	347	371
1985-87	187	186	290	507	295	406
1990-92	206	162	335	678	396	480
Total	158	145	246	240	193	380
# deaths	373	878	105	1,923	984	296

Table A3 (continued) Mortality Ratios (Married = 100)

	Women			Men		
	Single	Widowed	Divorced	Single	Widowed	Divorced
Appendicitis						
Ages						
15-24	123	-	-	273	-	-
25-34	87	535	-	231	770	357
35-44	289	243	-	200	227	220
45-54	137	138	209	200	204	267
55-64	142	95	279	182	174	419
65-74	151	127	-	91	147	221
Years						
1950-52	117	117	-	173	96	284
1955-57	103	155	258	214	189	135
1960-62	107	97	-	121	206	339
1965-67	219	126	268	272	139	340
1970-72	191	101	170	244	224	383
1975-77	235	102	-	334	172	159
1980-82	128	155	-	391	213	244
1985-87	434	282	-	648	76	874
1990-92	485	89	237	729	220	-
Total	135	124	108 ^{ns}	199	158	298
# deaths	138	113	5	342	98	24
Hernia						
Ages						
15-24	182	-	-	392	7,765	-
25-34	392	158	146	653	1,158	-
35-44	333	220	140	610	339	305
45-54	204	178	251	362	253	456
55-64	187	134	205	293	168	347
65-74	150	135	190	244	168	291
Years						
1950-52	114	127	157	233	138	348
1955-57	153	120	114	250	180	458
1960-62	158	131	204	213	145	388
1965-67	181	121	269	233	151	475
1970-72	224	145	234	360	194	199
1975-77	243	161	198	502	262	205
1980-82	286	136	288	633	169	200
1985-87	458	202	142	828	293	505
1990-92	416	184	165	877	256	323
Total	190	137	201	311	172	329
# deaths	606	1,061	77	1,147	444	108

Table A3 (continued) Mortality Ratios (Married = 100)

	Women			Men		
	Single	Widowed	Divorced	Single	Widowed	Divorced
Cirrhosis of liver						
Ages						
15-24	375	3,078	-	119	-	-
25-34	382	634	650	353	415	959
35-44	297	420	500	418	605	735
45-54	141	252	322	315	451	622
55-64	99	174	214	237	323	475
65-74	84	117	191	189	241	366
Years						
1950-52	119	111	409	140	192	562
1955-57	88	96	430	213	200	616
1960-62	122	132	331	194	221	475
1965-67	121	138	393	232	222	643
1970-72	120	151	288	249	293	559
1975-77	148	169	329	289	330	628
1980-82	153	154	286	278	320	529
1985-87	175	148	250	327	337	461
1990-92	213	170	261	347	335	479
Total	141	148	284	262	284	522
# deaths	1,297	3,051	809	5,076	2,630	2,390
Gall bladder disease						
Ages						
15-24	26	-	-	-	-	-
25-34	129	-	103	318	-	-
35-44	114	151	64	283	-	373
45-54	117	110	130	144	142	297
55-64	93	126	214	147	143	261
65-74	82	104	64	127	122	199
Years						
1950-52	56	93	43	132	133	102
1955-57	75	111	97	107	123	324
1960-62	86	119	39	143	136	179
1965-67	74	98	124	141	89	256
1970-72	85	110	139	143	151	207
1975-77	94	109	170	133	125	150
1980-82	148	128	54	232	104	238
1985-87	265	167	190	296	103	301
1990-92	170	107	131	236	189	280
Total	84	109	118 ^{ns}	150	126	236
# deaths	310	906	37	352	224	64

Table A3 (continued) Mortality Ratios (Married = 100)

	Women			Men		
	Single	Widowed	Divorced	Single	Widowed	Divorced
Kidney disease						
Ages						
15-24	132	341	-	176	-	-
25-34	211	113	137	276	264	492
35-44	209	154	179	267	207	217
45-54	147	128	132	219	200	236
55-64	137	116	151	171	159	230
65-74	122	117	115	149	145	132
Years						
1950-52	121	101	65	135	132	189
1955-57	125	109	131	193	145	294
1960-62	132	90	153	174	151	165
1965-67	153	89	70	189	153	415
1970-72	144	138	82	210	140	124
1975-77	138	146	87	219	133	208
1980-82	213	122	134	266	175	150
1985-87	193	175	131	291	188	162
1990-92	194	163	175	277	189	196
Total	140	117	135	185	150	188
# deaths	1,381	2,316	154	2,368	1,012	235
Kidney stone						
Ages						
15-24	70	-	-	107	-	-
25-34	151	1,447	-	276	-	1,998
35-44	272	364	-	171	547	1,168
45-54	195	174	213	152	176	-
55-64	189	153	152	155	100	148
65-74	111	105	116	165	120	347
Years						
1950-52	107	103	-	84	105	-
1955-57	73	105	-	140	155	451
1960-62	73	148	-	150	121	327
1965-67	162	105	-	177	71	406
1970-72	196	141	-	216	134	272
1975-77	161	122	205	656	130	279
1980-82	437	287	864	492	110	203
1985-87	431	101	-	190	308	442
1990-92	744	37	281	607	-	-
Total	143	118 ^{ns}	139 ^{ns}	161	121 ^{ns}	139
# deaths	64	131	6	115	56	12

Table A3 (continued) Mortality Ratios (Married = 100)

	Women			Men		
	Single	Widowed	Divorced	Single	Widowed	Divorced
Enlarged prostate						
Ages						
15-24	-	-	-	-	-	-
25-34	-	-	-	-	-	-
35-44	-	-	-	-	-	-
45-54	-	-	-	425	-	449
55-64	-	-	-	214	117	174
65-74	-	-	-	175	127	197
Years						
1950-52	-	-	-	165	136	197
1955-57	-	-	-	160	111	110
1960-62	-	-	-	176	104	122
1965-67	-	-	-	192	98	597
1970-72	-	-	-	233	212	126
1975-77	-	-	-	356	164	117
1980-82	-	-	-	283	159	97
1985-87	-	-	-	620	364	255
1990-92	-	-	-	667	117	-
Total	-	-	-	185	126	195
# deaths	-	-	-	437	321	23
Maternal death						
Ages						
15-24	12	-	158	-	-	-
25-34	30	98	96	-	-	-
35-44	21	43	84	-	-	-
45-54	-	14	-	-	-	-
55-64	-	-	-	-	-	-
65-74	-	-	-	-	-	-
Years						
1950-52	12	36	47	-	-	-
1955-57	13	50	152	-	-	-
1960-62	14	63	160	-	-	-
1965-67	19	38	40	-	-	-
1970-72	27	48	67	-	-	-
1975-77	24	217	63	-	-	-
1980-82	17	-	-	-	-	-
1985-87	37	-	167	-	-	-
1990-92	60	661	129	-	-	-
Total	16	48	92 ^{ns}	-	-	-
# deaths	250	26	25	-	-	-

Table A3 (continued) Mortality Ratios (Married = 100)

	Women			Men		
	Single	Widowed	Divorced	Single	Widowed	Divorced
Arthritis						
Ages						
15-24	185	3,413	1,193	-	-	-
25-34	358	651	188	327	-	-
35-44	408	173	200	464	398	57
45-54	332	160	154	338	297	162
55-64	220	147	162	201	219	146
65-74	161	117	140	133	145	125
Years						
1950-52	214	152	-	174	134	-
1955-57	243	127	397	223	168	451
1960-62	281	130	-	182	178	-
1965-67	273	97	81	245	134	596
1970-72	194	124	93	227	209	96
1975-77	174	125	171	302	100	126
1980-82	179	137	151	183	177	86
1985-87	219	117	126	172	120	123
1990-92	194	124	205	214	255	142
Total	214	124	159	210	162	132 ^{ns}
# deaths	526	811	111	300	167	39
Congenital anomalies						
Ages						
15-24	365	429	-	419	904	-
25-34	630	66	128	533	247	132
35-44	617	158	169	441	166	152
45-54	504	127	82	435	100	91
55-64	479	114	186	377	130	111
65-74	221	126	107	206	95	77
Years						
1950-52	445	102	-	314	164	177
1955-57	273	83	126	747	183	191
1960-62	197	102	-	283	12	-
1965-67	302	122	158	329	92	232
1970-72	519	113	61	416	184	121
1975-77	511	129	101	486	114	67
1980-82	844	193	190	431	50	100
1985-87	610	117	144	549	101	117
1990-92	714	136	152	514	136	112
Total	427	123	132 ^{ns}	424	111 ^{ns}	110 ^{ns}
# deaths	1,371	269	48	1,838	61	33

Table A3 (continued) Mortality Ratios (Married = 100)

	Women			Men		
	Single	Widowed	Divorced	Single	Widowed	Divorced
Traffic accidents						
Ages						
15-24	228	1,377	312	188	400	257
25-34	240	889	318	256	715	356
35-44	170	397	280	226	373	328
45-54	119	213	190	182	262	291
55-64	93	139	151	181	207	238
65-74	100	110	107	182	185	274
Years						
1950-52	119	116	335	152	179	340
1955-57	123	107	217	339	219	407
1960-62	171	131	210	132	179	316
1965-67	156	125	221	145	214	363
1970-72	185	166	201	161	220	211
1975-77	237	160	239	213	243	293
1980-82	268	165	259	232	261	284
1985-87	298	164	216	314	259	330
1990-92	295	172	200	326	304	328
Total	206	146	224	199	219	303
# deaths	8,912	2,713	845	41,519	2,267	2,097
Non-traffic accidents						
Ages						
15-24	185	1,285	259	164	222	235
25-34	364	688	529	295	452	423
35-44	295	308	441	359	301	501
45-54	213	236	329	312	275	481
55-64	201	187	268	312	256	437
65-74	179	145	192	302	240	392
Years						
1950-52	132	162	173	160	219	442
1955-57	163	148	323	350	197	457
1960-62	193	168	529	164	218	559
1965-67	156	146	421	163	219	619
1970-72	179	180	377	190	274	349
1975-77	239	179	361	228	290	512
1980-82	294	167	323	259	349	440
1985-87	292	170	297	315	294	413
1990-92	376	169	291	414	281	466
Total	214	166	327	222	251	452
# deaths	4,058	3,297	870	24,344	2,718	2,555

Table A3 (continued) Mortality Ratios (Married = 100)

	Women			Men		
	Single	Widowed	Divorced	Single	Widowed	Divorced
Suicide						
Ages						
15-24	188	780	904	223	242	774
25-34	345	480	598	446	1,210	733
35-44	280	307	473	365	605	563
45-54	173	169	363	261	319	468
55-64	132	172	342	245	278	387
65-74	122	155	209	234	233	296
Years						
1950-52	104	158	641	198	208	581
1955-57	154	163	408	347	251	619
1960-62	115	162	484	187	244	468
1965-67	133	162	406	169	240	610
1970-72	136	173	374	225	261	388
1975-77	229	161	434	217	329	555
1980-82	245	199	401	350	336	533
1985-87	357	178	420	374	311	486
1990-92	384	206	460	416	386	494
Total	215	175	426	281	282	502
# deaths	3,704	1,620	1,235	19,351	1,790	2,804
Homicide						
Ages						
15-24	120	1,329	300	164	669	596
25-34	254	650	538	466	905	975
35-44	224	385	352	595	562	892
45-54	105	274	541	529	549	885
55-64	123	207	363	475	439	846
65-74	93	148	323	432	289	801
Years						
1950-52	43	125	373	167	333	408
1955-57	68	143	432	239	342	1,870
1960-62	62	201	292	122	311	665
1965-67	96	213	454	164	132	620
1970-72	131	188	600	198	408	689
1975-77	194	282	558	259	442	1,157
1980-82	201	228	436	447	597	807
1985-87	186	217	343	319	728	881
1990-92	178	435	430	535	510	921
Total	146	229	440	279	411	892
# deaths	955	260	248	3,022	189	482

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