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The contribution of specific causes of death to mortality differences by marital status in the Netherlands

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The purpose of this study was to describe the differences in mortality by marital status in the Netherlands in the period 1986–1990 for specific causes of death and to estimate the contribution of each specific cause to the differences in total mortality. We have used mortality and population data from Statistics Netherlands. Poisson regression was used to calculate relative risks of dying from the specific causes of death. The relative risks and the overall mortality rates were used to estimate the contribution of the specific causes of death to the differences in total mortality by marital status. For men the general pattern was that the divorced had the highest risks, followed by the never-married and that the widowed had risks closest to married men. For women the general pattern was that the divorced had the highest risks, while widowed and never-married women alternately had risks closest to married women. Important exceptions to these risk patterns were found for, among others, infectious and parasitic diseases among men and breast cancer among women. External causes of death in particular, contributed more to the excess mortality of the 3 unmarried groups of men and women than expected, while the contributions of malignant neoplasms and diseases of the circulatory system were lower than expected on the basis of the percentages of these causes of death in mortality in the married population. Since the causes of death that contributed disproportionately to the excess mortality of the unmarried almost all have unhealthy lifestyles as important risk factors, we argue that the majority of the mortality differences by marital status can be explained by social causation (marital status affects health through lifestyle differences). However, longitudinal data are necessary to rule out selection effects (effect of health on marital status), preferably controlling for sociodemographic confounders such as socioeconomic status and taking into account living arrangements.

Key words: marital status, cause-specific mortality

Mortality differences between marital status groups have already been described in the previous century.[1,2] Since then many researchers have looked into this subject and have reported very consistently that married persons have the most favourable death rates, that the never-married and widowed have intermediate rates and that the divorced have the most unfavourable rates.[3–8]

Some studies have focused on the differences in mortality from specific causes of death by marital status.[6,9–14] Knowledge about the causes of death that are responsible for the mortality differences by marital status can give an indication as to the explanations for these differences. Gove,[9] for instance, described large mortality differences by marital status from causes which are due to 'overt social acts' (e.g. suicide and homicide), causes which are associated with the use of socially approved 'narcotics' (e.g. cirrhosis of the liver and cancer of the lung) and from causes which require prolonged and methodical care (e.g. diabetes and tuberculosis), but only small mortality differences from causes which are largely unaffected by these 'social factors' (e.g. leukaemia and aleukemia). From these results Gove[9] concluded that mortality differences by marital status can largely be attributed to the psychological states and lifestyles associated with the different marital roles (emotional stability, willingness to take risks) and not to selective processes. Koskenvuo et al.[10] found the greatest variation in mortality rates by marital status in the main categories of mental disorders, disorders of the nervous system, respiratory diseases, infectious diseases and external causes of death.

The purpose of this study is to describe the differences in mortality by marital status in the Netherlands in the period 1986–1990 for a number of specific causes of death and to estimate the contribution of each specific cause to the differences in total mortality by marital status.

MATERIAL AND METHODS

In this study we have used the mortality statistics and the population statistics of Statistics Netherlands (formerly

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the Central Bureau of Statistics, CBS). Both sets of statistics are based on the *de jure* resident population of the Netherlands: all persons who are registered in the population registers of the Dutch municipalities.

In the Netherlands the system of population registration is organized municipally. Births, deaths, marriages and marriage-dissolutions are registered by the local registrar. At Statistics Netherlands the information from the municipal population registers is brought together, resulting in annual statistics of the population by sex, year of birth and marital status for the Netherlands as a whole.[15]

With regard to the mortality statistics, for each death occurring in the Netherlands the underlying cause of death is recorded by a physician on a death certificate, which is sent in a closed envelope to the local registrar of the municipality in which the death occurred. After receiving the death certificate, the registrar removes the personal card of the deceased from the population files and sends the personal card together with the unopened envelope containing the death certificate to Statistics Netherlands. The personal card contains information about, among other things, date of birth, sex, marital status and date of death of the deceased. At Statistics Netherlands the demographical information on the personal card of the deceased person is, anonymously, combined with the information on the death certificate.[16]

The mortality data used in this study consist of information about the underlying cause of death, marital status, age and sex of all deceased persons in the Netherlands in the period 1986–1990. The underlying causes of death are divided into 29 categories and a category containing all other causes of death (information on the ICD codes of the causes of death and number of deaths by marital status and sex is available on request). In the analyses we have aggregated the numbers of deaths for several years. The analyses have been confined to the Dutch population of 25 years and older and men and women have been analysed separately.

In order to describe the mortality differences by marital status we have used Poisson regression models.[17] Separate models have been fitted for total mortality and specific causes of death. In the models we have controlled for age, coded as 13 5-year categories and a 'rest' category for the oldest age group (25–29, 30–34, ≥90 years of age). The regression coefficients of marital status and their standard errors have been used to calculate relative risks (RR) with 95% confidence intervals. The married group was the reference category. The statistical package used was EGRET.[18,19]

In order to estimate the contribution of each specific cause of death to the differences in total mortality by marital status, we have used the RR of the unmarried groups (the term 'unmarried' is used throughout this article to refer to the never-married, the widowed and the divorced) to calculate risk differences (RD) for dying from the specific causes of death between each of the unmarried groups and the married. Dividing the RD for each cause of death by the RD for total mortality results in the relative contribution of the causes of death to the differences in total mortality (C_{ix}). Details of these calculations are given in the Appendix. Contrary to the RR_{ix}s the C_{ix}s also take into account the importance of a specific cause for overall mortality.

RESULTS

The RRs for total mortality and for mortality from the specific causes of death of the unmarried groups, controlled for age, are shown in *table 1*. The figures represent the mortality risks of the unmarried relative to married persons.

For both men and women, all the unmarried groups have higher total mortality risks than the married. The divorced have the highest risks (RR=1.62 for men; RR=1.49 for women). Never-married men have higher risks than widowed men, while never-married and widowed women have equal risks for total mortality.

The pattern for differences in total mortality among men is not followed by each specific cause. We found no differences in the risks of mortality from colon cancer or pancreas cancer between the marital status groups. The RRs for mortality from cirrhosis of the liver (with and without mention of alcoholism), suicide, homicide and injury purposely inflicted by other persons and other external causes of injury and poisoning are twice those for total mortality for all 3 unmarried groups. Furthermore, the very high RR of never-married men for mortality from infective and parasitic diseases (RR with 95% confidence interval: 6.08: 5.50–8.71) and the fact that never-married men have a lower risk for mortality from cancer of the trachea, bronchus and lung (0.92: 0.88–0.97) than married men is striking.

Likewise, among women the pattern for differences in total mortality is not followed by each specific cause. We found no differences in the risks of mortality from pancreas cancer. Again the RRs for mortality from cirrhosis of the liver with mention of alcoholism, suicide, homicide and injury purposely inflicted by other persons and other external causes of injury and poisoning were twice those for total mortality. Never-married women were found to have highest RRs of all marital status groups for mortality from breast cancer (1.28: 1.21–1.35), cancer of the body of the uterus (1.57: 1.35–1.83) and ovary cancer (1.48: 1.34–1.62), and the lowest RRs for mortality from diabetes mellitus (0.83: 0.77–0.90) and complications of pregnancy, childbirth and the puerperium (0.22: 0.08–0.61). Widowed women had a higher RR for mortality from ischaemic heart disease than divorced women (1.32 versus 1.18). The very high RR for cervical cancer mortality among divorced women (3.76: 3.25–4.37) was striking.

Finally it is noteworthy that the mortality differences between the marital status groups are larger for men than for women for all specific causes of death, except for cancer of the trachea, bronchus and lung and chronic obstructive lung diseases (COLD).

The contributions of each specific cause of death to the excess total mortality by marital status are shown in *table 2*. If the total mortality risks of the never-married, widowed or divorced men had applied to the married male

Table 1 Relative mortality risks (RR_{ix}) by marital status (95% confidence intervals), controlled for age, with the married as reference category, 1986–1990[a]

	Men			Women		
	Never-married RR (95% CI)	Widowed RR (95% CI)	Divorced RR (95% CI)	Never-married RR (95% CI)	Widowed RR (95% CI)	Divorced RR (95% CI)
Total mortality	1.47 (1.45–1.49)	1.28 (1.27–1.30)	1.62 (1.60–1.65)	1.24 (1.22–1.25)	1.23 (1.21–1.24)	1.49 (1.46–1.52)
Infective and parasitic diseases	6.08 (5.50–8.71)	1.75 (1.52–2.01)	2.20 (1.84–2.63)	1.82 (1.55–2.14)	1.36 (1.19–1.55)	2.08 (1.69–2.56)
Malignant neoplasms	1.05 (1.02–1.07)	1.13 (1.11–1.15)	1.23 (1.19–1.27)	1.16 (1.13–1.19)	1.12 (1.10–1.14)	1.26 (1.22–1.30)
Stomach	1.15 (1.04–1.26)	1.08 (1.01–1.16)	1.06 (0.94–1.20)	0.90 (0.80–1.01)	1.10 (1.02–1.19)	1.01 (0.86–1.18)
Colon	1.03 (0.93–1.13)	1.07 (1.00–1.14)	1.02 (0.90–1.16)	1.17 (1.08–1.26)	1.08 (1.02–1.14)	1.01 (0.90–1.13)
Pancreas[c]	1.07 (0.94–1.21)	1.06 (0.97–1.17)	1.10 (0.95–1.28)	0.94 (0.84–1.06)	1.05 (0.97–1.14)	1.12 (0.96–1.31)
Trachea, bronchus and lung	0.92 (0.88–0.97)	1.19 (1.16–1.23)	1.28 (1.22–1.34)	1.09 (0.99–1.21)	1.34 (1.25–1.43)	2.09 (1.91–2.29)
Breast[b]	2.34 (1.29–4.47)	2.18 (1.27–3.74)	1.67 (0.67–4.18)	1.28 (1.21–1.35)	1.01 (0.96–1.05)	1.02 (0.95–1.05)
Prostate	0.92 (0.84–1.01)	1.09 (1.04–1.15)	1.13 (1.01–1.26)	–	–	–
Cervix	–	–	–	0.95 (0.77–1.18)	1.52 (1.33–1.74)	3.76 (3.25–4.37)
Corpus uteri	–	–	–	1.57 (1.35–1.83)	1.22 (1.08–1.36)	1.17 (0.93–1.47)
Ovary	–	–	–	1.48 (1.34–1.62)	1.09 (1.02–1.18)	1.10 (0.96–1.25)
Other malignant neoplasms	1.18 (1.13–1.23)	1.11 (1.08–1.15)	1.29 (1.22–1.35)	1.11 (1.06–1.16)	1.13 (1.09–1.16)	1.27 (1.20–1.34)
Diabetes mellitus	1.92 (1.77–2.08)	1.51 (1.42–1.62)	2.17 (1.96–2.39)	0.83 (0.77–0.90)	1.35 (1.29–1.42)	1.40 (1.28–1.54)
Diseases of the circulatory system	1.33 (1.31–1.36)	1.26 (1.24–1.28)	1.47 (1.44–1.51)	1.09 (1.06–1.11)	1.17 (1.16–1.19)	1.36 (1.32–1.40)
Ischaemic heart disease	1.23 (1.19–1.26)	1.25 (1.22–1.27)	1.38 (1.34–1.43)	1.02 (0.98–1.05)	1.32 (1.27–1.38)	1.18 (1.15–1.20)
Other heart diseases	1.90 (1.81–1.99)	1.45 (1.40–1.51)	1.89 (1.77–2.01)	1.26 (1.20–1.32)	1.27 (1.22–1.32)	1.52 (1.42–1.63)
Arteriosclerosis	0.95 (0.87–1.05)	1.16 (1.10–1.23)	1.38 (1.24–1.54)	1.10 (0.99–1.22)	1.19 (1.10–1.29)	1.15 (0.98–1.36)
Cerebrovascular accident	1.39 (1.32–1.45)	1.20 (1.16–1.23)	1.52 (1.43–1.62)	1.09 (1.04–1.13)	1.12 (1.08–1.15)	1.34 (1.26–1.41)
Diseases of the respiratory system	1.54 (1.47–1.61)	1.38 (1.34–1.42)	1.77 (1.68–1.88)	1.44 (1.36–1.52)	1.38 (1.32–1.44)	2.09 (1.95–2.25)
Chronic obstructive lung diseases	1.38 (1.31–1.46)	1.39 (1.34–1.44)	1.73 (1.62–1.85)	1.33 (1.22–1.46)	1.46 (1.38–1.56)	2.41 (2.18–2.65)
Pneumonia[b,c]	1.92 (1.76–2.09)	1.41 (1.33–1.49)	2.02 (1.78–2.29)	1.47 (1.34–1.60)	1.32 (1.23–1.42)	1.75 (1.55–1.98)
Other diseases of the respiratory system	1.80 (1.57–2.08)	1.29 (1.16–1.43)	1.60 (1.30–1.97)	1.43 (1.21–1.68)	1.15 (1.01–1.31)	1.90 (1.53–2.36)
Cirrhosis of the liver with mention of alcohol	4.80 (4.15–5.56)	4.59 (3.81–5.54)	9.14 (3.81–5.54)	2.32 (1.73–3.12)	3.05 (2.38–3.91)	6.02 (4.89–7.41)
Cirrhosis of the liver without mention of alcohol	2.65 (2.20–3.18)	1.59 (1.29–1.95)	3.19 (2.60–3.91)	1.20 (0.94–1.54)	1.42 (1.20–1.68)	2.31 (1.82–2.94)
Nephritis and nephrosis[b,c]	1.67 (1.43–1.94)	1.29 (1.17–1.43)	1.51 (1.19–1.91)	1.32 (1.15–1.52)	1.35 (1.22–1.51)	1.62 (1.33–1.96)
Complications of pregnancy, childbirth and the puerperium[d]	–	–	–	0.22 (0.08–0.61)	–	1.08 (0.39–3.00)
External causes of injury and poisoning	2.92 (2.78–3.07)	2.09 (1.96–2.22)	3.82 (3.61–4.05)	2.32 (2.17–2.48)	1.90 (1.79–2.01)	2.99 (2.77–3.22)
Traffic/transport accidents	1.78 (1.62–1.95)	1.58 (1.38–1.81)	2.24 (1.98–2.53)	1.67 (1.43–1.96)	1.28 (1.11–1.49)	1.69 (1.40–2.05)
Accidental falls[b,c]	2.02 (1.76–2.32)	1.64 (1.49–1.80)	2.77 (2.33–3.28)	1.42 (1.26–1.60)	1.37 (1.25–1.51)	1.87 (1.59–2.20)
Suicide	4.25 (3.94–4.60)	3.70 (3.27–4.18)	5.00 (4.57–5.47)	3.42 (3.08–3.81)	2.63 (2.33–2.97)	3.94 (3.52–4.41)
Homicide and injury purposely inflicted by other persons[e]	3.89 (2.96–5.12)	3.50 (1.78–6.88)	10.58 (8.11–13.79)	2.44 (1.49–3.97)	2.47 (1.01–6.00)	8.69 (5.86–12.87)
Other external causes	3.96 (3.50–4.47)	2.08 (1.74–2.47)	5.26 (4.58–6.03)	3.39 (2.78–4.11)	2.27 (1.88–2.73)	4.22 (3.40–5.24)
All other causes	2.21 (2.14–2.28)	1.45 (1.41–1.49)	2.21 (2.11–2.30)	1.65 (1.59–1.70)	1.38 (1.34–1.41)	1.78 (1.70–1.86)

a: Seperate models have been fitted for men and women
b: Model for men could only be fitted for age ≥45 years
c: Model for women could only be fitted for age ≥45 years
d: Model for women could only be fitted for age 25–44 years
e: Model could only be fitted for age 25–89 years for men and age 25–64 years for women

population, 517, 356 and 720 more men per 100,000 person years would have died respectively (the mortality rate of married men is 1,207 per 100,000 person years). If we compare the contributions of larger categories of causes of death to the excess total mortality with the contributions of these categories to overall mortality in the married population, it appears that, in particular, external causes contribute disproportionately to the excess mortality of unmarried men (external causes constitute 3.0% of the total mortality of married men against

Table 2 Risk difference in mortality (RD_{tx}) per 100,000 person years (contribution to excess mortality in percentage, C_{tx}) by marital status and sex, 1986–1990

	Men						Women					
	Never-married		Widowed		Divorced		Never-married		Widowed		Divorced	
	RD	%	RD	%	RD	%	RD	%	RD	%	RD	%
Total mortality	516.8	100.0	355.7	100.0	720.3	100.0	121.7	100.0	123.7	100.0	225.2	100.0
Infective and parasitic diseases	30.2	5.9	4.5	1.3	7.1	1.0	2.3	1.9	1.0	0.8	3.0	1.3
Malignant neoplasms	16.3	3.2	56.4	15.9	97.1	13.5	32.6	26.8	21.3	17.2	50.2	22.3
Stomach	4.4	0.8	2.3	0.7	1.7	0.2	–0.9	–0.7	0.9	0.7	0.1	0.0
Colon	0.9	0.2	2.0	0.6	0.6	0.1	3.0	2.5	1.4	1.2	0.2	0.1
Pancreas	1.3	0.2	1.1	0.3	1.8	0.3	–0.6	–0.5	0.5	0.4	1.2	0.5
Trachea, bronchus and lung	–13.2	–2.6	31.4	8.8	46.3	6.4	1.5	1.2	5.6	4.5	17.9	7.9
Breast	0.5	0.1	0.4	0.1	0.2	0.0	13.7	11.2	0.5	0.4	1.0	0.4
Prostate	–3.1	–0.6	3.5	1.0	5.0	0.7	–		–		–	
Cervix	–		–		–		–0.2	–0.2	2.0	1.6	10.7	4.7
Corpus uteri	–		–		–		2.3	1.9	0.9	0.7	0.7	0.3
Ovary	–		–		–		6.8	5.6	1.3	1.0	1.4	0.6
Other malignant neoplasms	25.7	5.0	15.7	4.4	41.4	5.7	7.0	5.7	8.2	6.6	17.1	7.6
Diabetes mellitus	21.0	4.1	11.6	3.3	26.7	3.7	–3.2	–2.6	6.6	5.3	7.5	3.3
Diseases of the circulatory system	161.0	31.2	127.8	35.9	231.2	32.1	14.5	12.0	43.2	34.9	48.9	21.7
Ischaemic heart disease	69.3	13.4	75.3	21.2	114.5	15.9	1.8	1.4	28.1	22.7	15.8	7.0
Other heart diseases	59.2	11.4	29.6	8.3	58.5	8.1	7.8	6.4	8.1	6.6	15.6	6.9
Arteriosclerosis	–1.7	–0.3	5.3	1.5	12.6	1.7	0.6	0.5	1.2	0.9	0.9	0.4
Cerebrovascular accident	34.3	6.6	17.6	4.9	45.7	6.3	4.4	3.6	5.8	4.7	16.5	7.3
Diseases of the respiratory system	49.6	9.6	37.2	10.5	74.6	10.4	7.8	6.4	7.6	6.1	22.7	10.1
Chronic obstructive lung diseases	26.9	5.2	27.6	7.8	51.7	7.2	3.6	3.0	5.1	4.1	15.5	6.9
Pneumonia	16.5	3.2	7.4	2.1	18.3	2.5	3.1	2.6	2.1	1.7	5.0	2.2
Other respiratory diseases	6.2	1.2	2.2	0.6	4.6	0.6	1.0	0.9	0.4	0.3	2.2	1.0
Cirrhosis of the liver with mention of alcohol	12.7	2.5	12.0	3.4	27.3	3.8	1.9	1.6	2.9	2.4	7.2	3.2
Cirrhosis of the liver without mention of alcohol	5.7	1.1	2.1	0.6	7.6	1.1	0.4	0.4	0.9	0.7	2.9	1.3
Nephritis and nephrosis	4.5	0.9	1.9	0.5	3.4	0.5	1.0	0.8	1.1	0.9	1.9	0.9
Complications of pregnancy, childbirth and the puerperium	–		–		–		–0.2	–0.2	–		–0.3	–0.1
External causes of injury and poisoning	66.8	12.9	46.9	13.2	96.4	13.4	25.0	20.6	16.0	13.0	33.8	15.0
Traffic/transport accidents	9.3	1.8	6.9	1.9	14.7	2.0	3.0	2.5	1.3	1.0	3.1	1.4
Accidental falls	7.4	1.4	4.6	1.3	12.9	1.8	1.6	1.3	1.4	1.1	3.2	1.4
Suicide	34.4	6.6	28.5	8.0	42.3	5.9	16.1	13.2	10.8	8.8	19.6	8.7
Homicide and injury purposely inflicted by others	2.1	0.4	1.8	0.5	6.9	1.0	0.5	0.4	0.5	0.4	2.7	1.2
Other external causes	13.7	2.6	5.0	1.4	19.7	2.7	3.8	3.1	2.0	1.6	5.2	2.3
All other causes	148.8	28.8	55.4	15.6	148.8	20.7	39.5	32.5	23.1	18.7	47.4	21.1

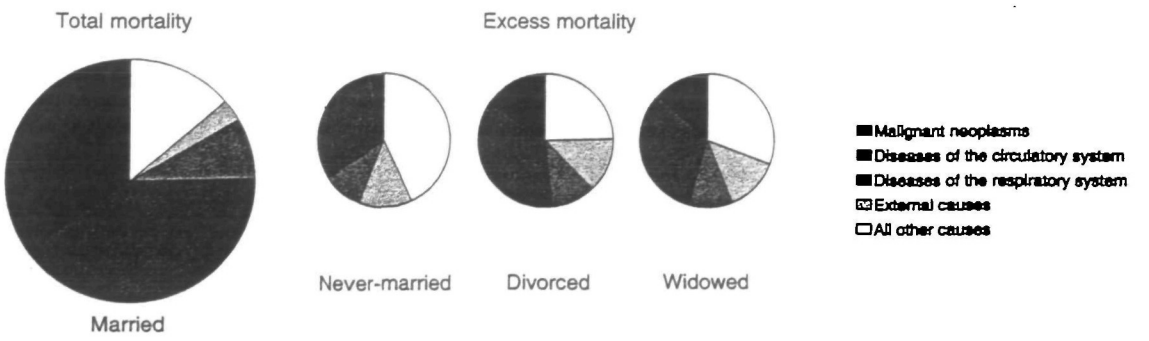

Figure 1 Contributions of broad causes of death (in %) to mortality by marital status for men

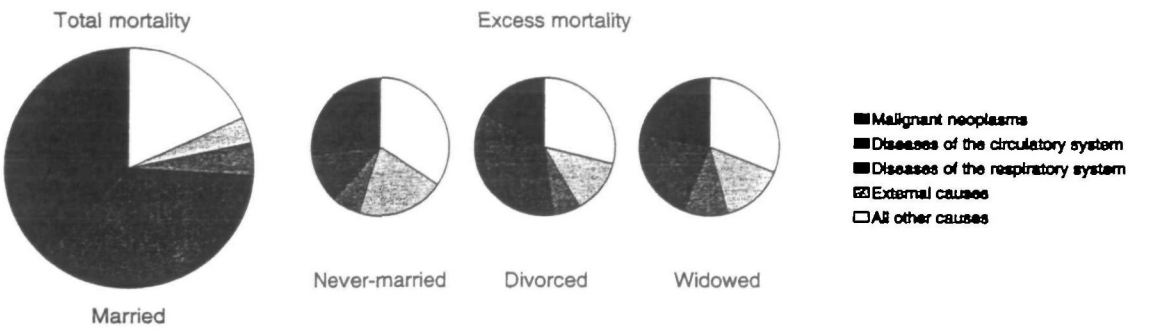

Figure 2 Contributions of broad causes of death (in %) to mortality by marital status for women

more than 13% of the excess mortality of the separate groups of unmarried men) (*figure 1*). Malignant neoplasms and diseases of the circulatory system, which constitute 35.0 and 40.3% respectively of the total mortality of married men, contribute far less to the excess mortality of the unmarried groups (*figure 1*). If we finally look at the contributions of the specific causes of death, diabetes mellitus, other heart diseases, pneumonia, cirrhosis of the liver with mention of alcoholism and 'all other causes' prove to contribute more than expected to the excess mortality of all 3 groups of unmarried men (*table 2*). Infective and parasitic diseases are over-represented as an underlying cause of death among never-married men and COLD are over-represented among widowed and divorced men.

If the mortality risks of the never-married, widowed or divorced women had applied to the married female population, 122, 124 and 225 more women per 100,000 person years would have died respectively (the mortality rate of married women is 486 per 100,000 person years) (*table 2*). In addition, among women we find that, in particular, external causes contribute more than expected to the excess mortality (external causes constitute 3.5% of the total mortality of married women against 13–20% of the excess mortality of unmarried women) (*figure 2*). The overall excess mortality from malignant neoplasms is lower than expected (38.5% of the total mortality of married women versus ≤27% of the excess mortality for unmarried women). This also applies for the mortality from diseases of the circulatory system among never-married and divorced women (35.6% of the total mortality of married women versus 12 and 22% among never-married and divorced women respectively) (*figure 2*). Specific causes of death which contribute more than expected to the excess mortality of all 3 groups of unmarried women are pneumonia, cirrhosis of the liver with mention of alcoholism and 'all other causes'. Among never-married women the contribution of breast cancer and ovary cancer is also higher than expected. Cancer of the trachea, bronchus and lung, diabetes mellitus, ischaemic heart disease and COLD contribute disproportionately to the excess mortality of widowed women. Cancer of the trachea, bronchus and lung, cervical cancer and COLD contribute disproportionately to the excess mortality of divorced women.

DISCUSSION

We found that unmarried persons, among both men and women, had higher mortality risks than married persons for almost all specific causes of death investigated in this study. For men the general pattern was that the divorced had the highest risks, followed by the never-married and that the widowed had risks closest to married men. For women the general pattern was that the divorced had the highest risks, while widowed and never-married women alternately had risks closest to married women. Important exceptions to these risk patterns were found for, among others, infectious and parasitic diseases among men and for breast cancer among women. In particular, external causes of death contributed more to the excess mortality of the 3 unmarried groups of men and women than expected, while the contributions of malignant neo-

plasms and diseases of the circulatory system were lower than expected on the basis of the percentages of these causes of death in mortality in the married population.

Since the mortality statistics and the population statistics both have the same municipal population registration system as a basis, numerator denominator bias will hardly be a problem in our analyses of mortality differences, unlike many analyses based on population size estimates from census data.

Misclassification of the causes of death could be a problem if there is differential misclassification by marital status. Given the fact that the coding of the cause of death precedes the linkage of mortality data with demographic data, we assume that it is unlikely that differential misclassification occurs during the coding procedure. Differential misclassification could occur, however, if the cause of death is more often unknown among the unmarried than married or vice versa. Never-married persons have lower health care utilization and divorced and widowed persons have higher utilization of health services than married persons.[4,20,21] However, the fact that never-married persons use health services less, does not necessarily imply that their diseases are not diagnosed, but could also mean that given a certain disease, never-married persons consult physicians less often. This might especially be the case for the Netherlands, where financial constraints do not explain the lower use of health services among never-married persons, since approximately 99.5% of the population has health insurance.[22] Thus, it is unlikely that differential misclassification can account for our results.

In this study we do not have information about possible confounders of the relationship between marital status and mortality, such as socioeconomic status, degree of urbanization of residence or religious affiliation. Each of these variables is associated with mortality. The distribution of these variables probably also differs among the marital status groups. The higher mortality risks of unmarried persons compared to married persons could partly be due to these variables and not to marital status itself. Thus, not controlling for these variables might lead to an overestimation of mortality differences by marital status. However, other studies concerning health differences by marital status, in which information about such factors was available, showed that health differences still existed after controlling for one or more of these factors.[4,6,20,23]

In addition, we did not have information about the living arrangements of the deceased. One of the explanations mentioned in the literature for the health differences by marital status is that marital status affects health through social support or control.[20,24–27] Since social support and control can also be provided by a partner in a consensual union, analyses by a combination of marital status and living arrangements are preferable. However, it has been shown that, besides having a common effect, marital status and living arrangements both have a separate effect on health.[23] Thus, marital status is still important as an independent determinant of health. Furthermore, only a relatively small percentage of unmarried persons are cohabiting in the older age groups (where most deaths occur) and the importance of cohabitation in our analysis should therefore not be overestimated.

For both men and women, we found that the category 'all other causes' contributed disproportionately to the excess mortality of the widowed and divorced and in particular, to the excess mortality of the never-married (29 and 33% for never-married men and women respectively versus 10 and 13% respectively of the total mortality among married men and women). This category consists of, among others, mental disorders and disorders of the nervous system, for which Koskenvuo et al.[10] reported very large mortality differences by marital status. Unfortunately we do not have information about the specific causes of death within the category 'all other causes' by marital status.

Our results are, in general, similar to those reported for other countries.[6,9–14] Some results differed, however. For example, never-married men in our study had an extremely high RR for mortality from infective and parasitic diseases (RR=6.08). The RR of never-married men showed a clear interaction with age: the RR declines from 32.9 for the 25–44 year olds, via 11.7 for the 45–64 year olds, to 1.4 for the never-married men of 65 years and older. Tuberculosis, which has been mentioned as an explanation for the mortality differences for infective diseases found in other decades,[10] hardly plays a role in the differences found in our study. Mortality from AIDS, which in our data set could not be distinguished from the other infective and parasitic diseases, could possibly explain some of the differences among men younger than 65 years. Of all men between 25 and 64 years of age in the Netherlands between 1986 and 1990, 972 died from infective and parasitic diseases; 705 of them died from AIDS.[28]

In our study never-married men had lower risks for mortality from cancer of the trachea, bronchus and lung than married men. This is contrary to the results which have been reported for the United States and the United Kingdom, where never-married men had higher RRs than married men.[9,11,29] From studies of smoking behaviour in the Netherlands it appears that there have been higher percentages of never smokers among never-married men than among the married men, although these differences have been declining.[30–34] This could explain some of the differences in mortality from cancer of the trachea, bronchus and lung among never-married and married men in our study.

The specific causes of death which we found contributed disproportionately to the excess mortality of the unmarried have almost all unhealthy lifestyles as important risk factors. Alcohol is an important cause of cirrhosis of the liver, traffic/transport accidents and poisoning. Smoking is an important cause of cancer of the trachea, bronchus and lung and COLD. Obesity is an important risk factor for diabetes mellitus. Unprotected sexual activity, having several partners or a partner with several other partners is associated with cervical cancer, cirrhosis of the liver without mention of alcoholism and certain infectious diseases. This seems to point to an effect of marital status on health (social causation), either through

marriage promoting healthy lifestyles, marriage buffering the effects of stress by providing social support and so reducing the 'need' for smoking and alcohol (palliative coping responses) or the stressful event of divorce or bereavement itself increasing the 'need' for these drugs.[20,24–27]

However, it cannot be ruled out that selection effects cause the different distributions of lifestyles among the marital status groups. Drinking, obesity and emotional (in)stability could influence one's chances of becoming married (or divorced) as well as one's chances of contracting chronic diseases. It is also possible and likely that some of the mortality differences by marital status are caused by health selection: unhealthy persons are probably less attractive marriage candidates and disease of one of the partners could increase the likelihood of divorce.[8,12,35,36] Thus, although our results point more to an effect of marital status on health as the explanation for health differences by marital status, longitudinal data are necessary to disentangle the selection effects from the social causation effects[37], preferably controlling for sociodemographic confounders such as socioeconomic status and taking into account differences in living arrangements.

Intervention strategies to decrease the mortality differences between the marital status groups should first of all be aimed at lowering the mortality from those causes of death that contribute disproportionately to the excess mortality of the unmarried, such as diabetes mellitus, cancer of the trachea, bronchus and lung, COLD, cirrhosis of the liver with mention of alcoholism and external causes of death. However, although the contribution of diseases of the circulatory system to the excess mortality of the unmarried was lower than expected, they still contributed 30–35% of the excess mortality of widowed women and all groups of unmarried men. Thus, intervention strategies could also be directed at lowering the excess mortality from diseases of the circulatory system. The diseases mentioned in both strategies have several risk factors in common such as smoking, obesity and alcohol consumption. Thus, strategies directed at these risk factors could prove to be very fruitful.

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Appendix

Let RR_{ix} be the relative risk of dying from cause x for the unmarried index population i, and let R_{mx} be the mortality rate for dying from cause x in the married population. Then the risk difference for dying from cause of death x between the unmarried index population i and the married population is estimated by

$$RD_{ix} = (RR_{ix} \times R_{mx}) - R_{mx} = (RR_{ix} - 1) \times R_{mx}$$

The outcome of this formula represents the number of extra deaths per 100,000 person years that would have occurred in the married population if the married population had had the death rates of the unmarried index populations.

Dividing the RD for cause of death x (RD_{ix}) by the RD for total mortality (RD_i) results in the relative contribution of this cause of death to the difference in total mortality between the unmarried index population i and the married population:

$$C_{ix} = RD_{ix}/RD_i$$