



The Forgotten Griever: A Nationwide Follow-up Study of Mortality Subsequent to the Death of a Sibling

Citation

Rostila, M., J. Saarela, and I. Kawachi. 2012. "The Forgotten Griever: A Nationwide Follow-up Study of Mortality Subsequent to the Death of a Sibling." *American Journal of Epidemiology* 176 (4): 338–46. <https://doi.org/10.1093/aje/kws163>.

Permanent link

<http://nrs.harvard.edu/urn-3:HUL.InstRepos:41275475>

Terms of Use

This article was downloaded from Harvard University's DASH repository, WARNING: This file should NOT have been available for downloading from Harvard University's DASH repository.

Share Your Story

The Harvard community has made this article openly available.
Please share how this access benefits you. [Submit a story](#).

[Accessibility](#)



Original Contribution

The Forgotten Griever: A Nationwide Follow-up Study of Mortality Subsequent to the Death of a Sibling

Mikael Rostila*, Jan Saarela, and Ichiro Kawachi

* Correspondence to Dr. Mikael Rostila, Centre for Health Equity Studies, Stockholm University/Karolinska Institutet, Sveavägen 160, SE-106 91 Stockholm, Sweden (e-mail: mikael.rostila@chess.su.se).

Initially submitted December 22, 2011; accepted for publication February 29, 2012.

Previous findings have suggested that the loss of a family member is associated with mortality among bereaved family members. The least-studied familial relationship in the bereavement literature is that of siblings, although loss of a sibling may also involve health consequences. The authors conducted a follow-up study based on data from the Swedish total population register, covering the period 1981–2002. Using Cox regression, mortality risk ratios for bereaved and nonbereaved persons aged 18–69 years were estimated. All-cause mortality and cause-specific mortality (unnatural causes, natural causes, cardiovascular disease, cancer, suicide, accidents, and all other causes) were examined. In men, the mortality risk for bereaved persons versus nonbereaved persons was 1.26 (95% confidence interval: 1.22, 1.30), and in women it was 1.33 (95% confidence interval: 1.28, 1.39). An elevated mortality risk associated with a sibling's death was found in all age groups studied, but the association was generally stronger at younger ages and could be observed predominantly after more than 1 year of follow-up. There was also an increased mortality risk if the sibling had died from a discordant main cause, which may strengthen the possibility that the association observed is not due to confounding alone.

bereavement; grief; mortality; registries; siblings; stress, psychological; Sweden

Abbreviation: CI, confidence interval.

People linked through social ties have interdependent health. Illness or death in one person may consequently influence the health of another person to whom he or she is connected (1). Studies have found that the loss of a spouse, parent, or child is associated with health status and mortality among bereaved family members (2–5). The most conclusive evidence on this matter concerns the so-called widowhood effect (1), which is thought to demonstrate the health consequences of grief and isolation. In general, bereavement is suggested to adversely affect health through both acute psychophysiological mechanisms, which have been observed to follow episodes of intense psychogenic shock (2, 6–8), and longer-term mechanisms involving changes in health-related behaviors, such as smoking, increased alcohol consumption, and poor diet and exercise habits (2, 3, 8).

The least-studied familial relationship in the bereavement literature is that of adult siblings (9–11). Surviving siblings can consequently be considered “forgotten grievers,” whose

loss and pain are insufficiently acknowledged (12, 13). To the extent that siblings are also beloved and provide companionship or behavioral norms, one would expect that loss of an adult sibling, just as loss of a spouse, would be associated with mortality. In fact, the death of a sibling often represents the loss of one of the longest and most intimate relationships of a person's lifetime (14). The level of grief following sibling loss might therefore be as severe as grief associated with other types of loss, such as losing a parent (11, 15).

There is an extensive body of literature on the impact of sibling loss during childhood on behavioral problems, emotional disturbances, depression, and sleeping difficulties (16, 17), as well as on somatic symptoms such as abdominal pain, stomachaches, headaches, hysterical pain, asthma, convulsive states, and ulcerative colitis (17–19). By contrast, the health consequences of sibling loss during adulthood have been largely overlooked (20), which is surprising considering that the loss of a sibling is much more

frequent among adults. It could be that losing an adult sibling has less of an impact than the death of other family members (spouse, children), since adult siblings normally do not live together (21). The adult sibling relationship is also characterized by lower frequency of contact when compared with other familial relationships (11). Some evidence suggests that mortality risk is elevated after the loss of an adult twin (22), that bereaved adult siblings report lower overall health and life satisfaction (23), and that they have higher risks of hospitalization and disablement (23).

The potential health consequences following the death of a sibling are expected to vary across the life course. The significance of the sibling relationship presumably weakens as the siblings grow older and other relationships become relatively more significant (24). Hence, the association between the death of a sibling and the mortality risk of remaining siblings might be weaker at older ages than at younger ages. The association may depend on the nature of the death and the amount of time elapsed since the death, reflecting the intensity of bereavement (5), and maladaptive coping behaviors can take a longer time to develop compared with acute psychophysiological reactions.

An important threat to causal inference is the possibility that the death or ill health of two or more persons in the same sibling group has a common prior cause—that is, that there is confounding of the relation by an unobserved third variable. For example, if a sibling dies of a chronic disease with a strong genetic component (e.g., lung failure caused by cystic fibrosis) and another sibling dies shortly thereafter, this may be a marker of genetic or biologic similarity. Another possibility is that the deaths of both siblings originated from factors related to shared childhood environment and living conditions (e.g., material circumstances, lifestyle, parental education, etc.). One method of getting closer to causal inference is to examine deaths due to specific causes among pairs of siblings. Separating natural and unnatural deaths and dissecting these deaths further according to the main cause of death may assist us in distinguishing causation from confounding.

Our aim was to conduct a large-scale study on health consequences following the loss of a sibling in adulthood, using intergenerational linked data from nationwide Swedish registers. We postulated that the association between loss of a sibling and mortality among bereaved siblings would depend on the age at which a person experienced a sibling's death, the time interval since the sibling's death, and the nature of the death. We also aimed to get closer to causal inference by studying whether siblings died of the same specific cause or discordant causes.

MATERIALS AND METHODS

The data came from the Swedish Work and Mortality Data. The Swedish Work and Mortality Data contain multiply linked data from routinely kept national Swedish registers. The data linkage and use of the data for research purposes was approved by the regional ethical review board of the Karolinska Institutet. All persons born in Sweden during the period 1932–1962 and alive at the end of 1980 were linked to the mother, provided that she was

born in Sweden and alive at the end of 1980. Hence, sibling groups were identified through the mother. Persons born to mothers with only 1 child were excluded from the analysis. Individuals were stratified into 5 different groups consisting of people who experienced sibling loss at ages 18–29 years, 30–39 years, 40–49 years, 50–59 years, and 60–69 years. We included individual-level information about basic sociodemographic variables (age, socioeconomic status, marital status, number of children, number of siblings, region of residence, and calendar year), as well as the month and cause of death for all persons who died during the period 1981–2002. We distinguished natural deaths from unnatural deaths. The former category was further divided into deaths from cardiovascular disease, cancer, and other diseases, whereas the latter category consisted of suicide, accidents, and other external causes. The *International Classification of Diseases* codes are provided in the footnotes of Table 1.

In conformity with the death of a sibling, which was the key variable of interest, age and calendar year were time-varying. The latter two factors were used as continuous variables, but alternative categorizations did not affect the results reported here. All other variables were measured at the end of 1980, which was before any sibling's death had occurred. The socioeconomic status variable distinguished between blue-collar workers, white-collar workers, self-employed persons, and persons outside of the labor market. Marital status consisted of the categories married, previously married, and never married. Number of children and number of siblings were treated as categorical variables. Region of residence referred to each person's county of residence and consisted of 26 different categories.

All persons in the mentioned cohorts were observed over time with regard to a sibling's death and their own death. At the point in time at which a person died, the surviving sibling changed status from being a nonbereaved person to being a bereaved person. The death of a sibling referred to the first death of any person in a sibling group. Hence, in a group with 3 siblings where 1 died in August 1983, for example, the 2 surviving siblings became bereaved persons from that date onward, and they were subsequently observed with regard to their own deaths. All persons who experienced a sibling's death during the study period (1981–2002) were included in the analyses, whereas those who did not experience a sibling's death comprised a 10% random sample. In the data presentation and statistical estimations, people in each of these two groups were weighted according to their sampling proportion, and all confidence intervals were calculated from corrected *t* statistics. Using Cox regression, we estimated mortality risk ratios for bereaved and nonbereaved persons.

RESULTS

A total of 80,888 men and 79,700 women experienced the death of a sibling (Table 1). The total number of sibling deaths was 72,949. The crude mortality rate (number of deaths in relation to number of person-years) was notably higher (more than twice as high) in bereaved persons compared with nonbereaved persons. The relative difference was

Table 1. Mortality Subsequent to the Death of a Sibling in Adulthood,^a According to the Sex and Age Group of the Index Participant, Sweden, 1981–2002

Age Group, years	No. of Persons		No. of Deaths ^b		Person-Years of Follow-up		Mortality Rate (×1,000)	
	Bereaved ^c	Nonbereaved	Bereaved	Nonbereaved	Bereaved	Nonbereaved	Bereaved	Nonbereaved
<i>Men</i>								
18–29	2,796	322,011	19	1,496	11,132	1,783,397	1.7	0.8
30–39	12,589	710,085	150	5,547	82,933	5,392,925	1.8	1.0
40–49	27,637	841,368	740	13,078	225,993	6,874,318	3.3	1.9
50–59	29,128	560,953	1,679	17,581	263,506	3,790,235	6.4	4.6
60–69	9,008	176,035	1,251	7,944	88,257	718,795	14.2	11.1
All ages	81,158	810,756	3,839	45,646	671,821	18,559,670	5.7	2.5
<i>Women</i>								
18–29	2,656	305,644	8	586	10,518	1,717,522	0.8	0.3
30–39	11,932	679,375	90	2,851	80,285	5,148,960	1.1	0.6
40–49	26,565	811,994	458	8,176	219,369	6,627,697	2.1	1.2
50–59	29,061	545,396	1,159	10,941	261,508	3,740,853	4.4	2.9
60–69	9,486	177,780	751	4,794	92,255	737,441	8.1	6.5
All ages	79,700	777,328	2,466	27,348	663,935	17,972,473	3.7	1.5

^a The total number of sibling deaths was 72,949, of which 23.7% were from cardiovascular disease, 37.5% were from cancer, 19.4% were from other diseases, 8.7% were from suicide, 7.3% were from accidents, and 3.4% were from other external causes. “Cardiovascular disease” refers to *International Classification of Diseases*, Eighth, Ninth, and Tenth revisions, codes 390–458/390–459/I00–I99, “cancer” to codes 140–239/140–239/C00–D48, “other diseases” to all codes other than those explicitly mentioned here, “suicide” to codes E950–E959/E950–E959/X60–X84, “accidents” to codes E807–E949/E800–E949/V01–X59, and “other external causes” to codes E960–E999/E960–E999/X85–Y98.

^b Of all deaths among index participants, 28.7% in men and 15.9% in women were from cardiovascular disease, 28.2% and 52.9% were from cancer, 20.6% and 18.2% were from other diseases, 9.6% and 6.5% were from suicide, 9.0% and 4.0% were from accidents, and 3.8% and 2.5% were from other external causes.

^c “Number of bereaved persons” refers to those who experienced the death of a sibling at some time during the observation period. When anyone in a group of siblings died, the status of the surviving sibling(s) changed from nonbereaved to bereaved. Since the same nonbereaved persons may appear in analyses of different age intervals, the numbers of persons for the different age intervals do not sum to the total numbers of nonbereaved persons for “All ages.”

smaller at older ages than at younger ones. In absolute terms, the difference between bereaved and nonbereaved persons increased over age groups, because of an overall increase in mortality with age. Bereaved women had lower mortality rates than bereaved men. As related to nonbereaved persons, however, the mortality rate of bereaved women was slightly higher than that of bereaved men, which was confirmed by the estimation results reported below.

In younger adult men (ages 18–29 years), the relative mortality risk associated with loss of a sibling was 1.83 times that of nonbereaved persons (95% confidence interval (CI): 1.16, 2.88) when control variables were included (Table 2). The association was generally lower at older ages (i.e., 30–69 years). Bereaved women were somewhat more vulnerable than bereaved men, especially at younger ages (<40 years). The mortality risk of women aged 18–29 years who had lost a sibling was 2.19 (95% CI: 1.08, 4.41), while the risk ratios were generally lower at older ages (i.e., 30–69 years). Results of analyses in which data on both sexes were pooled (not shown) still revealed that the sex difference in the association between death of a sibling and mortality among bereaved siblings could not be considered statistically significant, except in the age group 50–59 years. Both natural and unnatural causes of death in siblings raised the mortality risk of the surviving sibling, with

the exception of unnatural deaths experienced by people in the oldest age group. At the youngest ages, unnatural sibling deaths had a stronger association with mortality among bereaved siblings than did natural sibling deaths, while the strengths of associations were relatively similar in other age groups.

The associations between the death of a sibling and mortality among bereaved siblings were substantially stronger in the longer term than in the short term (Table 3). At ages 30–39 years, for instance, the mortality risk of bereaved men during the first year after sibling loss was 1.18 (95% CI: 0.84, 1.68), whereas it was 1.69 (and statistically significant) for longer durations of follow-up (2–5 years and >5 years). A similar pattern, indicating a notable increase in the mortality risk beyond the first year of bereavement, was observed for both sexes and for both main causes of death, and in most age groups. In the oldest subjects, mortality among bereaved persons during the first year after a sibling’s death was even lower than that among nonbereaved persons, but the difference was not statistically significant.

Examining the causes of death among surviving siblings, we found excess risks of death from both natural and unnatural causes in all age groups except older males (ages ≥50 years) (Table 4). In general, unnatural sibling deaths had a stronger association with mortality among bereaved siblings

Table 2. Risk of All-Cause Mortality^a Among Persons Who Lost a Sibling in Adulthood, by Age Group, Sex, and Type of Sibling's Death, Sweden, 1981–2002^b

Type of Death	Age Group, years											
	All Ages		18–29		30–39		40–49		50–59		60–69	
	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI
<i>Men</i>												
All sibling deaths	1.26*	1.22, 1.30	1.83*	1.16, 2.88	1.55*	1.31, 1.82	1.45*	1.34, 1.56	1.19*	1.13, 1.25	1.19*	1.12, 1.26
Type of sibling's death												
Natural	1.26*	1.22, 1.31	1.49*	0.71, 3.13	1.37*	1.09, 1.72	1.40*	1.28, 1.53	1.20*	1.13, 1.27	1.22*	1.14, 1.30
Unnatural	1.25	1.17, 1.34	2.11	1.19, 3.73	1.79	1.42, 2.26	1.55	1.36, 1.76	1.14	1.02, 1.27	1.03	0.88, 1.20
<i>Women</i>												
All sibling deaths	1.33*	1.28, 1.39	2.19*	1.08, 4.41	1.83*	1.48, 2.26	1.45*	1.32, 1.60	1.36*	1.28, 1.45	1.17*	1.08, 1.26
Type of sibling's death												
Natural	1.32*	1.26, 1.39	1.76*	0.56, 5.49	1.93*	1.47, 2.53	1.44*	1.28, 1.61	1.36*	1.27, 1.46	1.16*	1.07, 1.27
Unnatural	1.37	1.26, 1.49	2.56	1.06, 6.18	1.68	1.20, 2.35	1.48	1.25, 1.75	1.36	1.19, 1.55	1.18	0.98, 1.42

Abbreviations: CI, confidence interval; RR, risk ratio.

* $P < 0.005$.

^a Risk of mortality among bereaved persons versus nonbereaved persons, adjusted for the effects of all control variables. Control variables included were age, calendar year, socioeconomic status, marital status, number of children, number of siblings, and region of residence.

^b In cases where 2 parameters were tested, the P value is for the Wald statistic of their joint significance.

than did natural sibling deaths, irrespective of whether natural or unnatural deaths in the index persons were studied. In addition, natural sibling deaths raised the risk of mortality from both natural and unnatural causes. This association between discordant causes of death among siblings makes confounding by biologic similarity and shared social conditions less likely.

A more detailed categorization, in which we pooled age groups to obtain reasonable levels of statistical power, revealed that there were associations with regard to practically all combinations of main causes of death (Table 5). A strong association was naturally found for concordant causes. Bereaved men whose siblings died of cardiovascular disease had a risk of dying from cardiovascular disease of 1.64 (95% CI: 1.49, 1.81) in comparison with nonbereaved men. The corresponding estimate for concordant causes was 1.25 (95% CI: 1.13, 1.37) for cancer, 2.08 (95% CI: 1.83, 2.36) for other diseases, 2.42 (95% CI: 1.85, 3.17) for suicide, 1.30 (95% CI: 0.87, 1.95) for accidents, and 2.33 (95% CI: 1.25, 4.35) for other external causes. The pattern for women was similar. However, there were also associations between most discordant causes, suggesting that the association was unlikely to be due to confounding alone.

DISCUSSION

This large-scale follow-up study based on the Swedish population register found that the death of a sibling was associated with overall increased mortality among surviving siblings but that the strength of the association was

dependent on the age of the bereaved person, the duration of follow-up, and partly the cause of the sibling's death.

In adulthood, the death of a sibling may have a significant impact when it involves the loss of a companion, a source of emotional support, and practical aid. It may serve as a vivid and disturbing marker of one's own mortality, with implications for health (23). Because the death of a sibling has been considered to have less impact than the death of other family members, the social support system may be unprepared to respond appropriately to the grieving sibling's needs (11, 14).

Our findings suggest increased mortality following the death of a sibling in all adult age groups studied. The associations are comparable and, in some instances, stronger than those for child and parental deaths (5, 25). The present findings are consistent with studies indicating that the level of grief following the loss of a sibling is comparable to, or even exceeds, that associated with other types of familial loss (11).

At younger ages in particular (ages 18–39 years), there was a notable elevation in mortality associated with the death of a sibling. Because there is little expectation of the death of a sibling at these ages, it may involve high immediate stress levels, strong feelings of grief, greater difficulty in accepting the death, and fewer available coping strategies (26, 27). The excess mortality risk at younger ages may also reflect grief processes occurring within the family. Parents who lose a child often become preoccupied and absorbed with their own grief and posttraumatic stress. Under such circumstances, they may be unprepared to respond to the needs of the remaining children (14). The fact that the

Table 3. Risk of All-Cause Mortality^a Among Persons Who Lost a Sibling in Adulthood, by Age Group, Sex, Type of Sibling's Death, and Time Since Sibling's Death, Sweden, 1981–2002^b

Time Since Sibling's Death, years	Age Group, years											
	All Ages		18–29		30–39		40–49		50–59		60–69	
	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI
<i>Men</i>												
All sibling deaths												
1	1.01*	0.93, 1.09	1.71*	0.85, 3.43	1.18*	0.84, 1.68	1.13*	0.95, 1.34	0.96*	0.86, 1.08	0.93*	0.81, 1.08
2–5	1.34	1.27, 1.41	2.02	1.05, 3.91	1.69	1.32, 2.18	1.64	1.46, 1.85	1.21	1.11, 1.32	1.26	1.15, 1.39
>5	1.32	1.26, 1.39	1.58	0.39, 6.34	1.69	1.29, 2.20	1.46	1.30, 1.63	1.28	1.19, 1.37	1.24	1.14, 1.34
Natural sibling deaths												
1	0.98*	0.90, 1.07	1.80*	0.67, 4.79	1.03*	0.65, 1.64	1.06*	0.87, 1.30	0.94*	0.83, 1.07	0.94*	0.81, 1.09
2–5	1.34	1.26, 1.42	1.52	0.49, 4.72	1.87	1.37, 2.54	1.60	1.39, 1.83	1.22	1.11, 1.34	1.28	1.16, 1.42
>5	1.35	1.28, 1.43	NA	NA	1.08	0.68, 1.72	1.45	1.26, 1.67	1.33	1.23, 1.44	1.29	1.18, 1.42
Unnatural sibling deaths												
1	1.17	0.97, 1.41	1.63	0.61, 4.36	1.46	0.87, 2.47	1.38	0.99, 1.93	1.09	0.80, 1.47	0.82	0.48, 1.38
2–5	1.34	1.18, 1.52	2.43	1.09, 5.43	1.43	0.93, 2.20	1.78	1.43, 2.22	1.16	0.94, 1.43	1.11	0.83, 1.49
>5	1.23	1.13, 1.35	2.62	0.65, 10.51	2.30	1.67, 3.17	1.47	1.23, 1.76	1.14	1.00, 1.31	1.03	0.85, 1.24
<i>Women</i>												
All sibling deaths												
1	1.05*	0.95, 1.16	1.21 ^c	0.30, 4.85	1.24*	0.77, 2.01	1.08*	0.86, 1.35	1.07*	0.93, 1.24	0.96*	0.80, 1.15
2–5	1.42	1.32, 1.52	3.14	1.30, 7.61	2.04	1.48, 2.81	1.76	1.52, 2.03	1.34	1.21, 1.49	1.25	1.10, 1.41
>5	1.40	1.32, 1.49	2.45	0.34, 17.51	2.06	1.47, 2.89	1.41	1.22, 1.63	1.50	1.38, 1.64	1.20	1.08, 1.34
Natural sibling deaths												
1	1.06*	0.96, 1.18	1.25 ^d	0.18, 8.90	1.02*	0.53, 1.95	1.11*	0.86, 1.42	1.09*	0.94, 1.27	0.99*	0.82, 1.19
2–5	1.41	1.31, 1.52	2.74	0.68, 11.00	2.35	1.59, 3.46	1.72	1.45, 2.04	1.35	1.21, 1.51	1.26	1.10, 1.43
>5	1.39	1.30, 1.49	NA	NA	2.34	1.50, 3.64	1.39	1.16, 1.67	1.51	1.37, 1.67	1.18	1.04, 1.33
Unnatural sibling deaths												
1	0.96	0.73, 1.26	1.17	0.16, 8.31	1.67	0.83, 3.34	0.96	0.57, 1.63	0.94	0.62, 1.45	0.68	0.34, 1.35
2–5	1.44	1.23, 1.70	3.49	1.12, 10.88	1.59	0.90, 2.80	1.86	1.41, 2.47	1.28	0.98, 1.66	1.18	0.81, 1.71
>5	1.43	1.28, 1.60	4.21	0.59, 30.15	1.78	1.07, 2.96	1.43	1.14, 1.80	1.48	1.26, 1.73	1.27	1.02, 1.59

Abbreviations: CI, confidence interval; NA, not applicable; RR, risk ratio.

* $P < 0.005$.

^a Risk of mortality among bereaved persons versus nonbereaved persons, adjusted for the effects of all control variables. Control variables included were age, calendar year, socioeconomic status, marital status, number of children, number of siblings, and region of residence.

^b The P value is for the Wald statistic of the joint significance of all parameters tested.

^c $P = 0.04$.

^d $P = 0.29$.

social support system primarily focuses on the bereaved parents may leave remaining siblings unsupported in their grief process. Such circumstances might lead to adverse health consequences for bereaved siblings at younger ages, especially in the longer term (15).

We generally found stronger associations between the death of a sibling and mortality among bereaved siblings over longer-term follow-up (>1 year) than in the short term (the first year after a sibling's death). Adult siblings normally live separate lives and have their own families. It is possible that their primary network (spouse and children) can help them

cope with grief in the immediate aftermath of a sibling's death and therefore postpone the appearance of the association for some years. Maladaptive coping behaviors may also emerge over a period of some years, leading to a time lag in the association between sibling loss and mortality among the bereaved siblings. Accordingly, some previous research has found adverse mortality consequences only after the first year subsequent to the death of a twin (22).

Sibling deaths from natural causes and from unnatural causes had fairly similar consequences for bereaved persons in the older age groups (40–69 years). At younger

Table 4. Risk of All-Cause Mortality^a Among Persons Who Lost a Sibling in Adulthood, by Age Group, Sex, Type of Sibling's Death, and Type of Index Participant's Death, Sweden, 1981–2002^b

Type of Death	Age Group, years											
	All Ages		18–29		30–39		40–49		50–59		60–69	
	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI
<i>Men</i>												
Natural death												
Natural sibling death	1.24*	1.19, 1.29	1.33 ^c	0.33, 5.34	1.57*	1.17, 2.12	1.38*	1.24, 1.54	1.21*	1.14, 1.29	1.23*	1.15, 1.32
Unnatural sibling death	1.15	1.06, 1.25	2.79	1.15, 6.76	1.71	1.23, 2.40	1.47	1.25, 1.72	1.06	0.94, 1.19	1.00	0.85, 1.17
Unnatural death												
Natural sibling death	1.22*	1.11, 1.35	1.57*	0.65, 3.79	1.17*	0.82, 1.66	1.46*	1.23, 1.73	1.14*	0.97, 1.33	1.00*	0.76, 1.32
Unnatural sibling death	1.69	1.47, 1.95	1.81	0.86, 3.80	1.87	1.35, 2.57	1.75	1.39, 2.20	1.64	1.29, 2.09	1.43	0.87, 2.36
<i>Women</i>												
Natural death												
Natural sibling death	1.30*	1.24, 1.37	2.19 ^d	0.54, 8.85	1.88*	1.36, 2.60	1.46*	1.29, 1.65	1.35*	1.26, 1.45	1.16*	1.06, 1.27
Unnatural sibling death	1.24	1.13, 1.37	2.95	0.94, 9.22	1.11	0.68, 1.81	1.32	1.08, 1.60	1.28	1.11, 1.47	1.13	0.93, 1.37
Unnatural death												
Natural sibling death	1.41*	1.20, 1.65	1.27 ^e	0.18, 9.06	2.04*	1.26, 3.32	1.35*	1.01, 1.81	1.48*	1.17, 1.87	1.27*	0.81, 1.98
Unnatural sibling death	2.41	1.96, 2.95	2.15	0.53, 8.65	3.01	1.90, 4.76	2.29	1.64, 3.20	2.28	1.60, 3.25	2.62	1.33, 5.17

Abbreviations: CI, confidence interval; RR, risk ratio.

* $P < 0.005$.

^a Risk of mortality among bereaved persons versus nonbereaved persons, adjusted for the effects of all control variables. Control variables included were age, calendar year, socioeconomic status, marital status, number of children, number of siblings, and region of residence.

^b The P value is for the Wald statistic of the joint significance of both parameters tested.

^c $P = 0.03$.

^d $P = 0.18$.

^e $P = 0.10$.

ages, unnatural causes of siblings' death had a stronger impact than natural causes. This might reflect increased exposure to posttraumatic stress disorder, which may follow the unfortunate circumstance of losing a sibling at a young age through an accident, homicide, or suicide (28, 29).

By and large, we found an increased risk of dying from both natural and unnatural causes regardless of the sibling's type of death. Additional analyses of ours also revealed associations for most siblingwise combinations of more specific causes of death, such as cardiovascular disease, cancer, accidents, and suicide. If the association were confounded by an unobserved third variable (such as genetic similarities between siblings or shared childhood environment and family effects), we would have expected to observe a relation only in cases where siblings died of the same cause. The excess mortality risk was generally weaker when siblings died of a discordant main cause. However, among men aged 50 years or more, we found no elevated mortality risk when siblings died from disparate causes (natural/unnatural), which might indicate that they are particularly vulnerable to diseases with a shared genetic predisposition or to social health determinants that originate from shared childhood conditions and experiences.

There are obvious strengths of this study, such as the use of total population register data, longitudinal follow-up, reliable information on mortality, and other included variables. However, some limitations should be noted. More detailed individual information is required to uncover the actual causal mechanisms that link siblings' mortality risks, which could minimize the possibility of omitted variable bias. Ideally, one would like to have access to biologic and genetic data, detailed information on diseases from medical records, and more information on shared childhood social environment and family characteristics—information that unfortunately is not included in the registers. Another shortcoming was the lack of indicators on the quality of the relationship and the frequency of contact between siblings, which might relate to the risk of adverse health outcomes. As a proxy measure, we included information on whether siblings were of same sex, were close in age, and lived in geographic proximity to each other. These variables, to some extent, showed associations in the expected directions (associations were somewhat stronger when siblings were of the same sex, were close in age, and lived in geographic proximity to each other) but were left out of the final results presented here, since they did not improve the fit of

Table 5. Risk of All-Cause Mortality^a Among Persons Who Lost a Sibling in Adulthood, According to the Main Cause of the Sibling's Death and the Main Cause of the Index Participant's Death, Sweden, 1981–2002^b

Main Cause of Sibling's Death	Main Cause of Index Participant's Death													
	CVD		Cancer		Other Disease		Suicide		Accident		Other External Cause		All Causes	
	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI
<i>Men</i>														
CVD	1.64*	1.49, 1.81	1.00*	0.88, 1.14	1.41*	1.23, 1.63	1.14*	0.85, 1.52	1.15*	0.86, 1.53	1.46*	0.97, 2.19	1.36*	1.28, 1.45
Cancer	0.91	0.82, 1.02	1.25	1.13, 1.37	1.15	1.01, 1.30	1.08	0.85, 1.38	1.06	0.83, 1.36	1.03	0.69, 1.53	1.11	1.05, 1.18
Other disease	1.20	1.06, 1.37	1.10	0.96, 1.27	2.08	1.83, 2.36	1.01	0.73, 1.40	1.85	1.46, 2.36	1.85	1.27, 2.67	1.42	1.32, 1.52
Suicide	1.03	0.84, 1.26	1.01	0.82, 1.25	1.50	1.22, 1.85	2.42	1.85, 3.17	1.60	1.14, 2.23	2.15	1.38, 3.35	1.31	1.18, 1.45
Accident	0.74	0.57, 0.96	1.10	0.88, 1.38	1.51	1.21, 1.90	1.19	0.78, 1.81	1.30	0.87, 1.95	1.22	0.63, 2.36	1.10	0.97, 1.24
Other external cause	1.32	1.01, 1.73	1.01	0.73, 1.40	1.81	1.37, 2.39	1.83	1.13, 2.94	1.51	0.89, 2.55	2.33	1.25, 4.35	1.42	1.22, 1.64
All causes	1.16*	1.09, 1.23	1.12*	1.05, 1.19	1.49*	1.39, 1.60	1.29*	1.13, 1.47	1.34*	1.18, 1.53	1.51*	1.25, 1.84	1.26*	1.22, 1.30
<i>Women</i>														
CVD	1.71*	1.44, 2.02	1.16*	1.03, 1.31	1.39*	1.15, 1.68	1.29*	0.83, 1.98	2.20*	1.48, 3.26	1.36*	0.70, 2.64	1.36*	1.25, 1.47
Cancer	0.99	0.83, 1.19	1.21	1.11, 1.33	1.35	1.15, 1.58	1.00	0.67, 1.49	0.84	0.50, 1.40	1.40	0.82, 2.40	1.20	1.11, 1.28
Other disease	1.34	1.08, 1.66	1.27	1.11, 1.44	2.24	1.89, 2.64	1.81	1.23, 2.65	0.95	0.51, 1.78	3.33	2.12, 5.22	1.52	1.39, 1.65
Suicide	1.30	0.95, 1.78	1.01	0.83, 1.24	1.48	1.11, 1.97	3.72	2.63, 5.27	1.17	0.55, 2.46	1.75	0.78, 3.92	1.30	1.15, 1.49
Accident	1.82	1.35, 2.44	1.15	0.93, 1.41	1.50	1.09, 2.06	1.54	0.85, 2.78	2.21	1.22, 4.01	3.20	1.65, 6.20	1.43	1.24, 1.64
Other external cause	1.67	1.07, 2.59	0.86	0.61, 1.21	2.02	1.37, 2.97	2.49	1.29, 4.80	2.55	1.14, 5.69	4.09	1.83, 9.17	1.42	1.17, 1.73
All causes	1.35*	1.22, 1.49	1.17*	1.11, 1.25	1.58*	1.44, 1.74	1.66*	1.38, 2.01	1.40*	1.10, 1.78	2.12*	1.62, 2.77	1.33*	1.28, 1.39

Abbreviations: CI, confidence interval; CVD, cardiovascular disease; RR, risk ratio.

* $P < 0.005$.^a Risk of mortality among bereaved persons versus nonbereaved persons, adjusted for the effects of all control variables. Control variables included were age, calendar year, socioeconomic status, marital status, number of children, number of siblings, and region of residence.^b In cases where 6 parameters were tested, the P value is for the Wald statistic of their joint significance.

the models and had practically no impact on the estimates. We also checked that maternal mortality during follow-up was not a plausible cause of 2 siblings' deaths. We reduced heterogeneity in the study population by restricting the analyses to people born in Sweden, with parents born in Sweden. At the same time, this delimitation excluded the possibility of drawing conclusions about the immigrant population residing in Sweden. Associations between the death of a sibling and mortality among bereaved siblings may differ among foreign-born people, due for instance to cultural differences in coping behavior. Another drawback with the data used is that sibling groups could be constructed only if the mother was alive at the beginning of the observation period. Based on official vital statistics, we estimate that approximately 80% of mothers of the relevant birth cohorts were alive at that time. If sibling groups with a deceased mother (i.e., those who could not be observed in our data set) differed greatly from those analyzed here, we would have an inference problem. We do not think that this is a major impediment with regard to the association between the death of a sibling and mortality among remaining siblings, but we still aim to overcome the problem in future studies by adopting additional data linkage to include information about deceased parents as well.

Although we found associations between the loss of a sibling and mortality among bereaved siblings from discordant main causes of death, there remains a possibility of residual confounding. For example, if a person dies of liver cirrhosis and the surviving sibling dies shortly thereafter in a car accident, the siblings are coded as having died from discordant causes; yet, it could be that the siblings shared a genetic vulnerability to alcoholism and that this (rather than bereavement *per se*) contributed to the death of both siblings.

These results indicate that the health-care system should encompass broader collateral health effects when dealing with terminally ill patients and their families (1). Most discussion has been on bereavement after the death of a spouse or a parent, while siblings could be considered "forgotten grievers." Our findings illustrate that a sibling's death can also have adverse health consequences for adult siblings. A caring and emotional attitude displayed by health-care professionals can have positive effects on recovery from grief (30) and should also be of significance for bereaved siblings. It seems important that psychological support be provided not merely for parents but also for siblings during end-of-life care, as well as after the death. Considering that their loss and pain are often insufficiently acknowledged by the parents and the informal social support system (11, 14), it is important that physicians and health-care professionals acknowledge bereaved siblings. Our findings also conform to the view that it is important for health-care workers to follow and support bereaved siblings over time and from a longer-term perspective (31). The assessment of medical interventions and medical care might be altered substantially if benefits and costs incorporated collateral health effects (1). However, more research is required on the specific types of efforts that are needed in order to support bereaved siblings. An especially important task for future research is also to determine the relative importance of underlying mechanisms linking sibling

deaths and mortality in bereaved siblings, such as deterioration of health behaviors and onset of acute psychophysiological stress mechanisms. Such information could give health-care professionals guidance in how to effectively mitigate adverse health by bereavement. Testing such mechanisms would require data with much more detailed longitudinal information than was available here.

To our knowledge, this study provides the first large-scale evidence for an increased mortality risk associated with the death of a sibling at adult ages. Considering the substantial adverse impact of sibling loss we have found here, more research on the health consequences and underlying mechanisms of this association is suggested.

ACKNOWLEDGMENTS

Author affiliations: Centre for Health Equity Studies, Stockholm University/Karolinska Institutet, Stockholm, Sweden (Mikael Rostila); Department of Social Sciences, Division for Social Sciences, Åbo Akademi University, Vasa, Finland (Jan Saarela); and Department of Society, Human Development, and Health, Harvard School of Public Health, Boston, Massachusetts (Ichiro Kawachi).

This work was supported by the Swedish Council for Working Life and Social Research (grant 2009-0547) and the Swedish Research Council (grant 2008-1677).

Conflict of interest: none declared.

REFERENCES

1. Christakis NA. Social networks and collateral health effects. *BMJ*. 2004;329(7459):184–185.
2. Li J, Precht DH, Mortensen PB, et al. Mortality in parents after death of a child in Denmark: a nationwide follow-up study. *Lancet*. 2003;361(9355):363–367.
3. Martikainen P, Valkonen T. Mortality after the death of a spouse: rates and causes of death in a large Finnish cohort. *Am J Public Health*. 1996;86(8):1087–1093.
4. Hendrickson KC. Morbidity, mortality, parental grief: a review of the literature on the relationship between the death of a child the subsequent health of parents. *Palliat Support Care*. 2009;7(1):109–119.
5. Rostila M, Saarela JM. Time does not heal all wounds: mortality following the death of a parent. *J Marriage Fam*. 2011;73(1):236–249.
6. McEwen BS. Protective and damaging effects of stress mediators. *N Engl J Med*. 1998;338(3):171–179.
7. Eshthardi P, Koestner SC, Adorjan P, et al. Transient apical ballooning syndrome—clinical characteristics, ballooning pattern, and long-term follow-up in a Swiss population. *Int J Cardiol*. 2009;135(3):370–375.
8. Cohen S, Kessler R, Gorden U. Strategies for measuring stress in studies of psychiatric physical disorders. In: Cohen S, Kessler R, Gorden U, eds. *Measuring Stress*. New York, NY: Oxford University Press; 1995:3–26.
9. Balk DE. Adolescents' grief reactions and self-concept perceptions following sibling death: a study of 33 teenagers. *J Youth Adolesc*. 1983;12(2):137–161.

10. Reed MD, Greenwald JY. Survivor-victim status, attachment, sudden death bereavement. *Suicide Life Threat Behav.* 1991;21(4):385–401.
11. Segal NL, Wilson SM, Bouchard TJ, et al. Comparative grief experiences of bereaved twins and other bereaved relatives. *Person Individ Diff.* 1995;18(4):511–524.
12. Hogan N, DeSantis L. Basic constructs of a theory of adolescent sibling bereavement. In: Klass D, Silverman PR, Nickerman SL, eds. *Continuing Bonds: New Understandings of Grief.* Washington, DC: Taylor and Francis; 1996:235–253.
13. Crehan G. The surviving sibling: the effects of sibling death in childhood. *Psychoanal Psychother.* 2004;18(2):202–219.
14. Robinson L, Mahon MM. Sibling bereavement: a concept analysis. *Death Stud.* 1997;21(5):477–499.
15. Segal NL, Bouchard TJ Jr. Grief intensity following the loss of a twin and other relatives: test of kinship genetic hypotheses. *Hum Biol.* 1993;65(1):87–105.
16. McCown DE, Pratt C. Impact of sibling death on children's behaviour. *Death Stud.* 1985;9(3-4):323–335.
17. Cain AC, Fast I, Erickson ME. Children's disturbed reactions to the death of a sibling. *Am J Orthopsychiatry.* 1964;34(4):741–752.
18. Tietz W, McSherry L, Britt B. Family sequelae after a child's death due to cancer. *Am J Psychother.* 1977;31(3):417–425.
19. Baker JE, Sedney MA, Gross E. Psychological tasks for bereaved children. *Am J Orthopsychiatry.* 1992;62(1):105–116.
20. Osterweis M, Solomon F, Green M. *Bereavement: Reactions, Consequences, Care.* Washington, DC: National Academy Press; 1984.
21. Cicirelli VG. *Sibling Relationships Across the Life Span.* New York, NY: Plenum Press; 1995.
22. Tomassini C, Rosina A, Billari FC, et al. The effect of losing the twin and losing the partner on mortality. *Twin Res.* 2002;5(3):210–217.
23. Perkins W, Harris LB. Familial bereavement and health in adult life course perspective. *J Marriage Fam.* 1990;52(1):233–241.
24. Rubin SS, Malkinson R. Parental response to child loss across the life course: clinical, research perspectives. In: Stroebe MS, Hansson RO, Stroebe W, eds. *Handbook of Bereavement Research: Consequences, Coping, and Care.* Washington, DC: American Psychological Association; 2001:219–239.
25. Rostila M, Saarela J, Kawachi I. Mortality in parents following the death of a child: a nationwide follow-up study from Sweden [published online ahead of print November 1, 2011]. *J Epidemiol Community Health.* In press. (doi:10.1136/jech-2011-200339).
26. Parkes CM. Bereavement in adult life. *BMJ.* 1998;316(7134):856–859.
27. Merlevede E, Spooren D, Henderick H, et al. Perceptions, needs and mourning reactions of bereaved relatives confronted with a sudden unexpected death. *Resuscitation.* 2004;61(3):341–348.
28. Paris MM, Carter BL, Day SX, et al. Grief and trauma in children after the death of a sibling. *J Child Adolesc Trauma.* 2009;2(2):71–80.
29. Applebaum DR, Burns GL. Unexpected childhood death: posttraumatic stress disorder in surviving siblings and parents. *J Clin Child Psychol.* 1991;20(2):114–120.
30. Meert KL, Thurston CS, Thomas R, et al. Parental coping and bereavement outcome after the death of a child in the pediatric intensive care unit. *Pediatr Crit Care Med.* 2001;2(4):324–328.
31. Milberg A, Olsson EC, Jakobsson M, et al. Family members' perceived needs for bereavement follow-up. *J Pain Symptom Manage.* 2008;35(1):58–69.