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“The psychological skeleton in the closet”: mortality after a sibling’s suicide

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Abstract

Purpose To study the association between loss of an adult sibling due to suicide and mortality from various causes up to 18 years after bereavement.

Methods We conducted a follow-up study between 1981 and 2002, based on register data representing the total population of Swedes aged 25–64 years ($n = 1,748,069$).

Results An elevated mortality rate from all causes was found among men (RR 1.26; 95 % CI: 1.14–1.40) and women (1.27; 1.11–1.45) who had experienced a sibling’s suicide. The standardized rate ratio of suicide of bereaved to non-bereaved persons was 2.46 (1.86–3.24) among men and 3.25 (2.28–4.65) among women. We also found some indications of an interrelation between sibling suicide and subsequent deaths from external causes other than suicide in men (1.77; 1.34–2.34) and deaths from cardiovascular disease in women (1.37; 0.99–1.91). An elevated all-cause mortality rate was found after the first year of bereavement in men, while bereaved women experienced higher

mortality rates during the first 2 years and after 5 years of bereavement.

Conclusions Our study provides support for adverse health effects among survivors associated with sibling loss due to suicide. Sibling suicides were primarily associated with suicide in bereaved survivors, although there was an increased mortality rate from discordant causes, which strengthens the possibility that the observed associations might not be entirely due to shared genetic causes.

Keywords Bereavement · Sibling · Mortality · Sweden · Suicide

Introduction

‘The person who commits suicide puts his psychological skeleton in the survivor’s emotional closet’ [1] expresses the fact that every case of suicide leaves surviving kins to deal with grief that may have lingering adverse effects for several years following the loss [2]. Several scholars suggest that the bereavement process after suicide is different and more difficult to cope with as compared to other types of losses [3–5]. Suicide survivors often experience more severe and prolonged grief reactions as compared to other survivors [6]. Studies have also documented a higher prevalence of mental disorders, such as post-traumatic stress disorder, complicated grief disorder, and depression among family members who have experienced suicide when compared to natural deaths [7–10]. This indicates that more severe health consequences could follow family deaths due to suicide when compared to deaths from other causes. However, the empirical evidence documenting the adverse health impacts among suicide survivors remains sparse, due to the comparatively rare occurrence in the

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general population, as well as the lack of linked data [11, 12].

Previous studies have examined the influence of spousal suicide on health and mortality among surviving spouses [13], while studies on bereavement following suicide among siblings have been largely overlooked. It could be that the suicide of 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 [14]. The adult sibling relationship is characterized by lower frequency of contact when compared with other familial relationships [15]. Nevertheless, to the extent that siblings are also beloved and provide companionship, one would still expect that suicide of an adult sibling, just as suicide of a spouse, would be associated with adverse health effects. In fact, the death of a sibling often represents the loss of the most intimate and durable relationships of a person's lifetime [16].

There are specific qualitative aspects of the mourning process that are intensified and frequently more problematic for survivors of suicide than for other types of bereaved [17, 18], which could contribute to adverse health effects. Most of these relate to the fact that suicide survivors are viewed more negatively by others as well as by themselves ("survivor guilt") [18]. These negative consequences become additional stressors over and above the 'normal' grief process for the suicide survivor and may lead to an unsatisfactory bereavement outcome, which may be manifested as deterioration in physical or mental health, as well as put the survivor him/herself at risk of suicide. During the acute stage of grief following loss of a loved one, survivors are at risk of intense psychogenic shock, also known as the "broken heart syndrome" [19–21]. Chronic stress following suicide bereavement could additionally lead to pathophysiological changes in the sympathetic nervous system, the hypothalamic–pituitary–adrenal (HPA) axis, and the immune system [22, 23]. Deleterious coping responses such as smoking, increased alcohol consumption, and poor diet and exercise habits may also follow the complicated bereavement process after suicide [24]. Such behaviors are likely to contribute to increased risk of both suicide and physical health over the longer term.

The association between sibling suicide and mortality among bereaved siblings could additionally depend on the time since the death. One study found that suicide survivors took much longer for symptoms to abate and remained higher on some dimensions such as anxiety when compared to natural death survivors [25], while other studies have found that any initial differences disappeared 2–4 years after the death [6, 12]. Whether the mortality risk remains over longer periods after the loss of a sibling remains unclear.

Siblings share a biological predisposition to death and disease, which makes confounding by genetic inheritance likely. For instance, there is evidence that genetic factors can predispose people towards the development of psychiatric disorders that are associated with suicide, particularly depression and bipolar disorders [26]. Siblings also share many environmental exposures during childhood and adolescence, such as disorganization and breakup, parental loss, substance abuse, intrafamily violence, and sexual abuse that could be considered confounders [18]. An increased risk of suicide after a sibling's suicide might, therefore, be a partial marker of shared genetic predisposition or shared environmental determinants of suicide. One method of getting closer to causal inference is to examine deaths due to specific causes [27]. By studying whether pairs of siblings died of the same specific cause (both died of suicide) or a discordant cause may assist in teasing out causation from confounding.

We sought to conduct a large-scale longitudinal study of mortality following the loss of an adult sibling due to suicide, using intergenerational linked longitudinal data from nationwide Swedish registers. We postulated that the association between sibling's death due to suicide and mortality will vary according to time since the sibling's suicide, gender of the bereaved sibling, and specific cause of the bereaved sibling's death.

Methods

The data come from the Swedish Work and Mortality Data (HSIA). HSIA is a multiple-linked data of national Swedish routine registers, maintained at the Centre for Health Equity Studies (CHESS) in Stockholm. The data material was approved by the Regional Ethical Review board of Karolinska Institutet in 2002-11-11 (decision no. 02-481) and the Central Ethical Review Board 2012-09-13 (application no. 2012/1260-31). These decisions approve that the data can be used for several purposes, including this study. Written consent was not needed since all information is anonymous and researchers did not have access to any personal information that could identify study participants (e.g., personal identity number, home address, etc.). Consequently, it was not possible to trace specific individuals included in the data material. We have also followed all other ethical principles and guidelines in handling the data.

In the study, 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 same time. Hence, sibling groups were identified through the mother. Siblings could not be linked unless the mother was alive at the end of 1980. Singletons (persons from one-child families) were excluded from analysis.

To get a reasonable age balance and in order to use adequate control variables, we focused on people aged 25–64 years. The study persons were observed from the beginning of 1981 until 2002 (the last observation point in time in the dataset used) unless they died before that.

We included individual-level information about basic socio-demographic variables (age, socioeconomic status, marital status, number of children, number of siblings, region of residence, and calendar year) to proxy social and regional mortality differences, and the month and specific cause of death for all persons who died during the study period. Socioeconomic status distinguished blue-collar workers, white-collar workers, self-employed, and individuals who were not active in 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 refers to each person's county of residence and consisted of 26 different categories. All covariates except age and calendar year (which are time-varying) were measured at the end of 1980, which antedated any death. Deaths due to suicide were distinguished by the ICD8 and ICD9 codes E950–E959, and ICD10 codes X60–X84. In persons who experienced a sibling's suicide we additionally separated between deaths from external causes other than suicide (ICD8 codes E807–E949 and E960–E999, ICD9 codes E800–E949 and E960–E999, and ICD10 codes V01–X59 and X85–Y98), cardiovascular diseases (ICD8 codes 410–438 and 795, ICD9 codes 410–438 and 798, and ICD10 codes I21–I52 and I60–I69), cancer (ICD8 and ICD 9 codes 140–239, and ICD10 codes C00–D48), and all other causes (all other codes).

All people who experienced a sibling's death (from any cause) during the study period were included in the dataset used, whereas those who did not experience a sibling's death (from any cause) comprised a 10 % random sample. In the statistical analyses, people from each group were weighted according to their sampling proportion. Normalized weights were used to correct for inflated *t*-statistics. The suicide of a sibling was treated as a time-varying exposure, which means that when a sibling died due to suicide, the surviving sibling changed status from being a non-bereaved to being a bereaved person. If no sibling died, or if a sibling died from any other cause than suicide, the index person was categorized as 'non-bereaved'. We estimated standardized mortality rates in the index persons using Poisson regressions, and focused on the rate ratio of bereaved and non-bereaved persons. Separate analyses were conducted for men and women. Covariates included in the regressions were age, calendar year, region of residence, socioeconomic status, marital status, number of children, and number of siblings. Each control variable

Table 1 Descriptive statistics by sex of the index persons

	Men	Women
Number of sibling suicides	4,339	4,323
Number of (ever) bereaved persons	6,833	6,810
Number of non-bereaved persons	884,370	850,056
Number of person-years in bereaved persons	74,967	75,002
Number of person-years in non-bereaved persons	18,439,093	17,844,752
Number of deaths in bereaved persons from		
Suicide	53	32
Other external cause than suicide	52	13
Cardiovascular disease	76	36
Cancer	82	89
Any other cause	94	47
Number of deaths in non-bereaved persons from		
Suicide	4,565	1,854
Other external cause than suicide	6,018	1,847
Cardiovascular disease	12,023	3,916
Cancer	12,892	14,907
Any other cause	10,750	5,464

'Bereaved' refers to having experienced the suicide of a sibling

provided good statistical fit. Throughout the paper the level of statistical significance referred to is 0.05.

Results

In total, 6,833 men and 6,810 women experienced a sibling's suicide, and 357 and 217 of them subsequently died (Table 1). The corresponding numbers in non-bereaved persons (persons who did not experience a sibling's suicide) were 46,248 deaths among 884,370 men, and 27,988 deaths among 850,056 women. Almost 15 % of all deaths in bereaved men and bereaved women, respectively, were due to own suicide, as compared to about 10 % in non-bereaved men and less than 7 % in non-bereaved women. The unstandardized mortality rate of bereaved persons was roughly twice that of non-bereaved persons (4.8/2.5 for men and 2.9/1.6 for women in Table 2).

Bereaved persons were slightly older than non-bereaved persons, somewhat more of them had a lower socioeconomic position and were not married, and they had more siblings, which is expected considering that the likelihood of observing a sibling's death must be higher in larger sibling groups (Table 2). We accounted for distributional differences between bereaved and non-bereaved persons using the control variables. Hence, throughout the analyses we estimated standardized mortality rate ratios, i.e., the ratio of the death rate of persons who experienced the

Table 2 Characteristics of persons who experienced and of those who did not experience the suicide of a sibling, by sex

	Men						Women					
	Bereaved			Non-bereaved			Bereaved			Non-bereaved		
	%	Deaths	Rate	%	Deaths	Rate	%	Deaths	Rate	%	Deaths	Rate
Age in years												
25–29	2.5	3	1.6	6.8	1,071	0.9	2.3	0	0.0	6.7	432	0.4
30–34	6.7	1	0.2	12.0	1,980	0.9	6.4	4	0.8	11.8	974	0.5
35–39	13.1	26	2.6	17.5	3,690	1.1	12.9	9	0.9	17.4	1,954	0.6
40–44	18.7	42	3.0	19.9	5,755	1.6	18.4	19	1.4	19.8	3,377	1.0
45–49	20.7	67	4.3	18.4	7,954	2.3	20.5	51	3.3	18.4	5,187	1.6
50–54	19.1	83	5.8	13.7	9,747	3.9	19.1	60	4.2	13.9	6,058	2.4
55–59	12.9	77	8.0	8.1	9,353	6.3	13.5	47	4.6	8.3	5,935	4.0
60–64	6.3	58	12.2	3.5	6,698	10.4	6.9	27	5.3	3.7	4,071	6.2
Socioeconomic status												
Blue-collar worker	48.7	165	4.5	44.1	20,081	2.5	35.0	70	2.7	30.5	8,704	1.6
White-collar worker	28.0	70	3.3	35.5	12,517	1.9	31.7	62	2.6	38.1	8,948	1.3
Self-employed	8.7	27	4.1	9.1	4,392	2.6	3.2	10	4.2	3.5	1,038	1.7
Outside labor market	14.5	95	8.8	11.3	9,258	4.4	30.1	75	3.3	27.9	9,298	1.9
Marital status												
Married	43.8	116	3.5	49.4	21,103	2.3	55.9	111	2.6	58.4	16,271	1.6
Previously married	6.7	69	13.7	5.7	6,080	5.8	9.4	35	5.0	8.4	4,329	2.9
Never married	49.5	172	4.6	44.9	19,065	2.3	34.7	71	2.7	33.2	7,388	1.2
Number of children												
0	42.3	151	4.8	41.1	17,087	2.3	27.7	60	2.9	28.6	6,811	1.3
1	18.3	76	5.5	18.2	8,530	2.5	19.8	52	3.5	19.7	5,782	1.6
2	26.0	71	3.6	28.1	12,643	2.4	33.7	72	2.9	34.9	9,460	1.5
>2	13.4	59	5.9	12.6	7,988	3.4	18.9	33	2.3	16.7	5,935	2.0
Number of siblings												
1	17.2	60	4.6	41.8	18,047	2.3	16.8	39	3.1	42.2	11,066	1.5
2	27.0	91	4.5	29.3	13,011	2.4	26.0	54	2.8	28.9	7,935	1.5
>2	55.8	206	4.9	28.8	15,190	2.9	57.2	124	2.9	28.9	8,987	1.7
Total	100.0	357	4.8	100.0	46,248	2.5	100.0	217	2.9	100.0	27,988	1.6

'Deaths' refer to deaths from any cause

Descriptive statistics for region of residence and calendar year are not displayed

Number of person-years (total risk time) in bereaved men is 74,976, in non-bereaved men 18,439,093, in bereaved women 75,002, and in non-bereaved women 17,844,752. % refers to percentage of total risk time. *Rate* is number of deaths per person-years multiplied by 1,000

suicide of a sibling and the death rate of persons who did not experience the suicide of a sibling.

In addition, the standardized mortality rate was notably higher in bereaved persons than in non-bereaved persons (Table 3). Among men, the mortality rate ratio of bereaved to non-bereaved persons was 1.26 (95 % CI: 1.14–1.40), whereas in women it was 1.27 (1.11–1.45). In most sub-categories of the control variables, there was an association between having experienced a sibling's suicide and own mortality, but the statistical power was generally too small to facilitate any detailed conclusions on this point ("Appendix").

The strongest association was for deaths due to suicide (Table 3). Bereaved men had a standardized suicide rate that was 2.38 times higher (1.81–3.14) than that of non-bereaved men, while the association was even stronger in women (3.25; 2.28–4.65). We also found associations of sibling suicide with other external causes of death (primarily accidents and other violent deaths) in men (1.77; 1.34–2.34). The broad category of deaths from any other cause (than external, cardiovascular disease, or cancer) was also associated with sibling suicide among men (1.25; 1.02–1.53). In women, the relatively small number of deaths implied broader confidence intervals. Results were

Table 3 Association between sibling's suicide and mortality from different main causes in index persons

Cause of death in index persons	Men	Women
All causes	1.26 (1.14–1.40)	1.27 (1.11–1.45)
Suicide	2.38 (1.81–3.14)	3.25 (2.28–4.65)
Other external than suicide	1.77 (1.34–2.34)	1.31 (0.76–2.27)
Cardiovascular disease	0.95 (0.76–1.19)	1.37 (0.99–1.91)
Cancer	1.07 (0.86–1.33)	1.01 (0.82–1.24)
Any other	1.25 (1.02–1.53)	1.30 (0.97–1.73)

Numbers are standardized mortality rate ratios (with 95 % confidence intervals), i.e., the ratio of the death rate of bereaved persons and the death rate of non-bereaved persons, adjusted for effects of all control variables

Control variables included in the estimations are age, calendar year, socioeconomic status, marital status, number of children, number of siblings, and region of residence

similar as those for men in terms of no association with cancer mortality and an equally strong association with deaths from any other cause (than external, cardiovascular disease, or cancer), whereas the association with external causes other than suicide was smaller. In contrast with men, deaths from cardiovascular diseases in women seemed related to a sibling's suicide (RR 1.37), albeit the estimate was only close to statistically significant (95 % CI: 0.99–1.91).

Men did not experience an immediate elevation in all-cause mortality rate after a sibling's suicide (Fig. 1). The standardized mortality rate was highest during the second year, when it was over twice that of non-bereaved men. Thereafter it was fairly stable at around 1.5 that of non-bereaved men. Women displayed a somewhat different pattern. During the first 2 years after a sibling's suicide, they had a mortality rate that was approximately 1.5 that of non-bereaved women. During the third to fifth year, the two groups were more or less in parity, whereas thereafter bereaved women generally experienced an elevation in the mortality rate.

Discussion

This large-scale follow-up study based on the Swedish population register examined bereavement following a sibling's suicide. We found elevated risks of all-cause mortality among both bereaved women and bereaved men. Sibling suicide primarily increased the risk of own suicide, and stronger associations were found in women than in men. However, there were also some indications of associations with deaths from cardiovascular disease in women and external causes other than suicide in men. An elevated

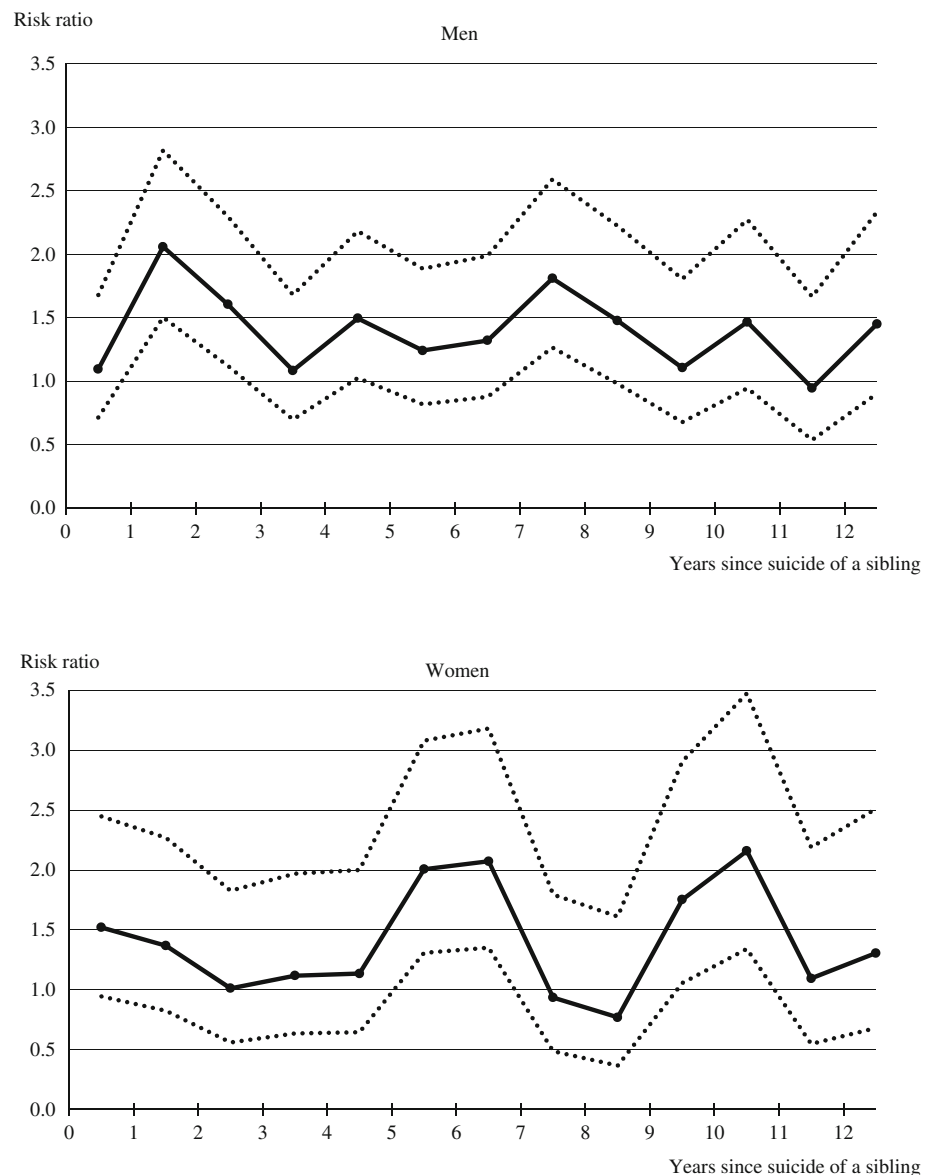
risk starting in the second year after bereavement was found among men, while some support was found for both a short-term and a longer-term elevation in mortality following sibling suicide among women.

There are reasons to believe that suicide among siblings have particularly severe consequences for the health of surviving siblings. Since 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 after suicide [15, 16]. Grief processes occurring within the family may also leave the remaining sibling(s) more vulnerable. Parents who lose a child often become preoccupied and absorbed with their own grief and post-traumatic stress. Under such circumstances, they may be unprepared to respond to the needs of the remaining children [16]. The fact that the social support system primarily focuses on the bereaved parents may leave remaining siblings unsupported in their grief process. Given the fact that bereavement after suicide is more difficult than grief following other types of losses it could have particularly severe consequences for the health of surviving siblings in circumstances where siblings lack support from their immediate social networks.

The strongest association was found with respect to concordant causes of death, i.e., when both persons in a sibling pair committing suicide. This might be an indication of a more difficult bereavement process as compared to other types of losses [17, 18]. The prevalence of mental disorders, such as post-traumatic stress disorder, complicated grief, and depression among those who have experienced suicides and violent deaths are comparatively higher in individuals bereaved by suicide [7–10] and could contribute to their higher risk of completed suicide. Qualitative aspects of the mourning process could all contribute to a higher suicide risk in bereaved siblings. Survivors of suicide seem to struggle more with making sense of the sudden and unexpected loss [28]. Since suicide violates fundamental notions of self-preservation, survivors often struggle to make sense of the motives and frame of the mind of the deceased. They often exhibit higher levels of guilt, blame, and responsibility for the death than other mourners [29] and experience feelings of rejection and abandonment by the loved one, along with anger toward the deceased [6]. Death by suicide is also stigmatizing to surviving family members and triggers a chain reaction of negative consequences [18]. Stigma is in turn linked to the lack of social support, and suicide survivors seem to receive less emotional support than natural death survivors [30].

We also found some evidence suggesting that sibling suicide might be associated with elevated cardiovascular mortality among women, albeit the association was only

Fig. 1 Standardized all-cause mortality rate after a sibling's suicide as compared with non-bereaved persons (with 95 % confidence interval)



close to statistically significant due to the relatively few deaths. Extreme stress levels following the suicide of a sibling could lead to cardiovascular disease through psycho-physiological stress mechanisms [19–21]. Women have been suggested especially vulnerable to acute stress levels following grief (i.e., ‘the broken heart syndrome’) [20]. Chronic stress following suicide bereavement could also lead to pathophysiological changes in the sympathetic nervous system, the HPA axis, and the immune system [22, 23]. In addition, deleterious coping responses such as smoking, increased alcohol consumption, and poor diet and exercise habits could also follow the complicated bereavement process after suicide [24]. Such behaviors could both contribute to increased suicide rates among bereaved and the excess risk of cardiovascular disease among women. Men’s higher mortality rate from external

causes (other than suicide) might reflect adverse coping behaviors such as violent and high-risk behavior that could lead to an increased risk of accidents and crime-related deaths.

As compared to men, women were found to be more vulnerable to a sibling’s suicide in terms of own risk of suicide and they also seemed to exhibit an excess rate of cardiovascular mortality following a sibling’s suicide. These findings may reflect that women place more emphasis on social relationships than men do, particularly when it comes to family members [31]. The loss of a sibling could hence have stronger emotional consequences for women, and this could, in turn, account for poorer mental health and higher risk of suicide. The longer-term association between sibling suicide and mortality from all causes among bereaved women may also suggest that longer-term

mechanism such as an extended and complicated grief process and severe depression underlie the association. We have previously reported that women's health is more influenced by bereavement than men's [27].

We found that the associations between concordant causes of death (both siblings died of suicide) were stronger than associations between discordant causes. This could, to some extent, indicate confounding by genetic resemblance or shared environmental risk factors. Genetic factors can predispose people towards the development of psychiatric disorders that are associated with suicide [26]. Siblings also share many environmental exposures during childhood and adolescence such as disorganization and breakup, parental loss, substance abuse, intrafamily violence, and sexual abuse [18]. On the other hand, we also found associations between sibling's suicide and mortality from discordant causes such as cardiovascular disease and other external causes (than suicide), which strengthen the possibility that the association may be causal. Confounding by genetic similarities or shared environmental conditions would seem more likely if we had found associations only when both siblings died of suicide. It could also be that many deaths from the same cause still reflect effects of bereavement. Suicide and poor mental health is strongly linked to the bereavement process. Even though siblings died of the same cause we cannot exclude the possibility that the association partially reflects bereavement rather than genetic confounding, i.e., one sibling dies of suicide and the remaining sibling takes his/her own life due to bereavement, rather than because of genetic vulnerability or shared environmental exposures.

Despite the obvious strengths of this study such as the use of total population register data, large sample size, longitudinal follow-up, reliable information on mortality and other included variables, some limitations should be noted. Data in Swedish registers are collected systematically without the purpose of being used for specific research. Use of such data may reduce the risk of differential misclassification bias [32]. Nevertheless, suicides might be prone to misclassification during death ascertainment procedures [33]. It is possible that Swedish suicide rates may be influenced by death certification and registration procedures as well as substantive factors. For instance, it has been found that autopsy rates may spatially and temporally affect the validity of suicide statistics. One study found that Swedish suicide data are of inferior quality relative to the suicide data of some other countries [33]. Accordingly, it could be that many sibling suicides go underreported and that our analyses are biased to some extent while there is far less reason for concern about the validity of the other causes of death included in this study. Underreported suicide rates could also vary by socio-demographic variables such as gender, age, and

socioeconomic position. However, non-reported suicides would then be classified as deaths from other causes in our study which would primarily lead to an underestimation the "true" association between sibling suicide and suicide risk among remaining siblings. Furthermore, more detailed individual information is required to uncover the actual causal mechanisms that link sibling suicide and mortality. Such information could also minimize the possibility of omitted variable bias. Ideally, one would like to have access to biological and genetic data, detailed information on diseases from medical records (including diagnosis of post-bereavement depression), more information on shared childhood social environment and family characteristics, and detailed data on personal and relational characteristics, which are unfortunately not included in the registers. On the other hand, our results likely underestimate the true bereavement effect, since we could study only deaths, and we know that all suicide attempts do not lead to death [34]. Examining attempted suicide, depression, variation in health and risk taking behaviors, etc., would presumably provide more precision and even greater statistical power to the analyses. Our way of treating deaths from concordant causes as an indication of confounding might further underestimate the true effect of bereavement, since many deaths from the same cause in a sibling pair could be related to bereavement processes.

Our findings illustrate that a person's suicide can have adverse health consequences for their adult siblings. The health care system should incorporate broader collateral health effects when dealing with individuals and families exposed to suicide [35]. Considering that their loss and pain are often insufficiently acknowledged by the parents and the informal social support system [15, 16], it is important that physicians and health care professionals recognize the needs of siblings bereaved due to suicide. Some possible clinical interventions have previously been suggested for suicide survivors [18] and these could also be relevant for individuals exposed to sibling suicide. For instance, bereaved should be offered the opportunity to interact with other suicide survivors in support groups, not just other mourners. With the elevated risk of suicidality associated with survivorship, management of survivors in the health care system should include not only support for their grief but also proactive monitoring of their risk of psychiatric disorders and suicidality. Furthermore, support services should target the interface between the survivors and their social network. Since many survivors feel stigmatized they need help in dealing with the social aftermath of suicide. Moreover, bereavement services, such as support groups and support services provided by the health care system, should be directed toward family systems given the risk of additional suicides within the family. This may be the most important multigenerational prevention

available to mental health professionals. A unique Swedish example of such a service is “Bartraumateamet” at Vrinnevi hospital in Norrköping that supports families after the loss of a family member both immediately after the death as well as in a longer-term perspective. Similar support services for bereaved children and adults should be provided also in other parts of Sweden. Finally, our findings also conform to the view that it is important for mental health professionals to support surviving siblings due to suicide over time and in a longer-term perspective.

In summary, our study provided the first large-scale evidence for mortality associated with sibling suicide at adult age. Bereavement related deaths may be prevented by targeted support for people who lost a sibling due to suicide.

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

Appendix

See Table 4.

Table 4 Association between sibling’s suicide and all-cause mortality in index persons stratified by age category, socioeconomic status, marital status, number of children, and number of siblings

	Men	Women
Age in years		
25–29	1.64 (0.53–5.09)	n.a.
30–34	0.18 (0.03–1.26)	1.47 (0.55–3.91)
35–39	1.83 (1.24–2.69)	1.20 (0.62–2.30)
40–44	1.55 (1.14–2.10)	1.20 (0.77–1.89)
45–49	1.53 (1.20–1.94)	1.83 (1.39–2.42)
50–54	1.29 (1.04–1.60)	1.57 (1.22–2.02)
55–59	1.11 (0.88–1.38)	1.08 (0.81–1.44)
60–64	1.04 (0.80–1.34)	0.78 (0.54–1.15)
Socioeconomic status		
Blue-collar worker	1.26 (1.08–1.47)	1.16 (0.92–1.47)
White-collar worker	1.20 (0.95–1.51)	1.36 (1.06–1.75)
Self-employed	1.14 (0.78–1.66)	1.76 (0.94–3.28)
Outside labor market	1.37 (1.12–1.67)	1.27 (1.01–1.59)
Marital status		
Married	1.02 (0.85–1.23)	1.16 (0.96–1.39)
Previously married	1.63 (1.29–2.07)	1.21 (0.87–1.69)
Never married	1.36 (1.17–1.58)	1.56 (1.23–1.97)
Number of children		
0	1.45 (1.23–1.70)	1.55 (1.20–2.00)
1	1.38 (1.10–1.73)	1.46 (1.11–1.92)
2	0.99 (0.78–1.25)	1.28 (1.02–1.62)
>2	1.14 (0.88–1.48)	0.82 (0.58–1.15)

Table 4 continued

	Men	Women
Number of siblings		
1	1.35 (1.05–1.74)	1.49 (1.09–2.05)
2	1.32 (1.07–1.62)	1.35 (1.04–1.77)
>2	1.22 (1.06–1.40)	1.18 (0.99–1.41)

Numbers are standardized mortality rate ratios (with 95 % confidence intervals), i.e., the ratio of the death rate of bereaved persons and the death rate of non-bereaved persons, adjusted for effects of all control variables

Control variables included in the estimations are age, calendar year, socioeconomic status, marital status, number of children, number of siblings, and region of residence

The results are based on five different specifications for each sex, where we in each model with all main effects have included also the joint effect of sibling’s death and the control variable of interest

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