

The Effect of Losing the Twin and Losing the Spouse on Mortality ¹

L'Effetto della Perdita del Gemello e del Coniuge sulla Mortalità

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Riassunto: Per gemelli danesi di età compresa fra i 50 ed i 70 anni si studia la sopravvivenza dopo la morte del coniuge e del gemello. Si evidenzia come la mortalità sia più alta nel primo anno dopo la morte del coniuge e nel secondo dopo la morte del gemello. Un'ulteriore analisi con tecniche di event-history conferma l'impatto della morte del gemello nel secondo anno, anche controllando per età, sesso, e zigosità, con un effetto simile per uomini e donne e più alto per i gemelli monozigoti. Si conferma così l'influenza di fattori genetici sulla sopravvivenza mentre la peculiare traiettoria di mortalità è consistente con l'esistenza di un effetto di lutto per la perdita del gemello.

Keywords: bereavement, twin studies.

1. Introduction and research hypotheses

Many studies have focused on the effects of losing selected members of the social network (bereavement) on an individual's mortality. Usually these studies analyse the death rates among bereaved persons and compare them with the non-bereaved, finding an increase of mortality after bereavement. The majority of the bereavement studies have focused on the loss of the spouse since it has more effects on the daily life of the survivor and it is easier to catch from both vital statistics and surveys data. The magnitude of the marital bereavement effect on mortality seems to vary with age and sex. The differences found in epidemiological studies on marital bereavement are mainly due to the differences in the research design, and to how individual characteristics are taken into account. Our approach is based on longitudinal data

¹ The full version of the paper is going to be published on *Twin Research*

focused on the transition from marriage to widowhood, and then on the analysis of subsequent mortality. It is important, for our purposes, to analyse the timing of the impact of bereavement.

Another line of research has its focus on the influence of genetic factors on longevity. Among others, Herskind (1996) found that approximately a quarter of the variation in lifespan could be attributed to non-additive genetic factors while the remaining three-quarters were due to no shared environmental factors. Several authors have proposed other theories in order to explain the similar trajectories in mortality for twins. The hypothesis is that they reflect a twin bereavement effect: Segal (1993) suggests that the grief intensity increases with increasing genetic relatedness to the deceased (kinship genetic principle). This might suggest that, in addition to a correlation between life spans due to genetic factors, there is interdependence between the deaths of the two twins (Tomassini et al. 2001). Losing a sibling has been considered to have a relative impact since adult siblings normally do not live together and often do not have regular contacts. In contrast with this view, some studies have pointed out that the sibling bond has particular characteristics, which are different from their common relationship to their parents (Krupnick 1984).

Based on this we hypothesised two possible scenarios explaining the twin correlation:

Hypothesis 1: If the correlation in lifespan between the twins is due solely to time-constant common factors (genetic or environmental) we would expect to observe correlation between the two survival times. The shorter the distance between the deaths of the twins, the higher the correlation between the two events is. We would expect to observe a higher risk of mortality for the survivor A after the death of the co-twin B.

Hypothesis 2: If there is also an effect of the co-twin's death we would expect to observe interdependence between the events. Therefore we should find a certain time lag before the event "death of a co-twin" has an impact on the risk of dying of the survivor, due to the fact that the event needs a lag of time to produce some consequences on the risk of dying of the surviving twin.

2. Materials and methods

The Danish Twin Register is a population-based register of twins born in Denmark 1870 to 1996 with more than 60,000 twin pairs. The Danish Civil Register was introduced in 1968: information on date of birth and vital status is available, and changes in the marital status of a person can be followed.

First, we selected all twins that have experienced the death of the spouse ($n=2145$) or the death of the co-twin ($n=1679$), when they were aged between 50 years and less than 70 years before January 2000. We described the survivor functions using the life-table method and estimated the hazard rates in the 36 months following the death of the spouse and of the co-twin, controlling by sex and zygosity. For each twin identified to have lost his/her co-twin a group of 2 "control-twins" were selected.

In a second approach, we performed a longitudinal analysis which considers the risk of dying of twins, from their 50th birthday to the 70th, including the death of the co-twin (when it occurs) as a time dependent covariate. We tested whether there is a significant increase in the mortality risk in the transition from the state 'co-twin alive' to the state 'co-twin dead', controlling by sex, age and zygosity. For this purpose we used event history analysis (EHA) discrete-time models, with month as the time unit. To run our

models we considered the survival of a randomly selected twin from each pair that reaches age 50 (N=8309) after 1968 and we studied his/her mortality, with censorship at age 70 or at 1/1/2000 for those younger at that date.

3. Results and discussion

The figures 2, 3 show average monthly hazard rates in the 1st, 2nd and 3rd year of bereavement. The starting point is the death of the spouse and the death of the co-twin. Figure 2 shows the two 'bereavement' effects: both have similar intensity (although the effect of losing the co-twin is consistently higher in the two groups despite similar mean age), but they have different timing. The hazard rate after the death of the spouse is higher in the first year, and then it tends to fall, as demonstrated in previous studies. The hazard rate seems to be higher in the second year after the death of the co-twin. For women, the intensity of the two effects is as expected lower than the male one, but the timing pattern is similar. We estimated also hazard rates specific for zygosity (with men and women together): the results are showed in Figure 3. The hazard rates for monozygotic twins are higher compared to same sex dizygotic twins, and the peak in the second year after the loss of the co-twin is more distinct. The trajectory for the control group (that has not lost the co-twin) shows the expected mortality trend.

The EHA results are shown in table 1 and they are in agreement with the results from the survival analyses and support the hypothesis of interdependence between the deaths of twins. The mortality risk increases significantly after the death of the co-twin, even after controlling by age. The highest point of the mortality risk is in the second year after the death of the co-twin. The interaction with sex or zygosity is not significant, so the timing effect of the loss seems not to depend on either sex or zygosity. The mortality is in general slightly lower for monozygotic twins (the principal effect is negative) and the interaction between having lost the co-twin and zygosity is strongly positive.

We have provided new evidence on the existence of the twin 'bereavement effect' and its action on the mortality of the surviving twins. While the immediate increase in death rates after bereavement is understandable in terms of stress, the consequences beyond the first year are less clear. A long and intense grieving period has related consequences in the years thereafter. Furthermore the psychological disorders and the social withdrawal that follow the loss of a close relative could lead to severe distress later in life both in health and social relations. The literature on bereavement effect of sibling loss is very sparse compared to the spouse bereavement one. However, several factors can influence the tie between siblings: shared childhood environment and experiences, critical life events and geographical proximity. Sibling relations become closer later in life, when they share the care responsibilities of their parents (especially sisters). In this perspective losing a sibling can have important consequences on mortality of the survivor, especially at older ages, since the anxiety may provoke an escalation in the fear of one's own death. All these relations could be enhanced for twins, who represent a unique sibling relationship.

Fig 1: Comparison between survival after the death of the wife (full line with squares), the husband (full line with triangles), female and male co-twin (dashed).

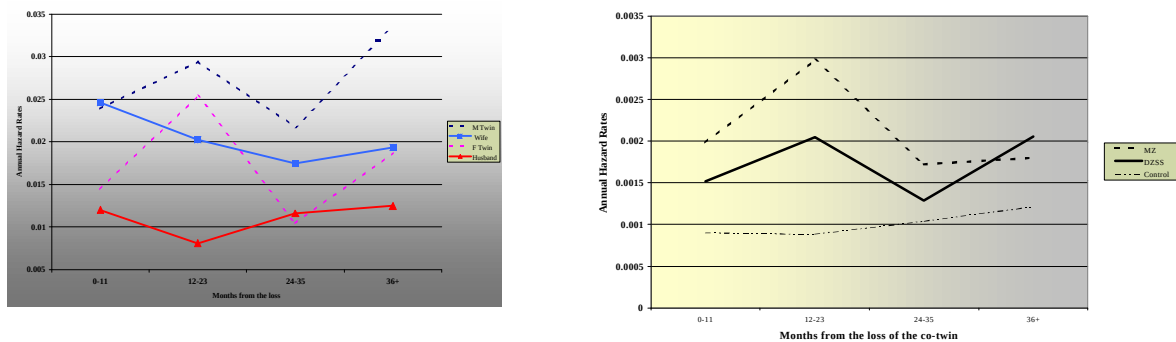


Table 2: Results from the event history model with the loss of the co-twin as a time dependent covariate

	Odds Ratios	95% Wald Confidence Limits	
Female (vs Males)	0.68**	0.59	0.77
Age (reference: 50-54)			
55-59 (vs 50-54)	1.50**	1.23	1.82
60-64 (vs 50-54)	2.78**	2.31	3.35
65-69 (vs 50-54)	3.91**	3.23	4.73
Monozygotic (vs dizygotic)	0.80	0.69	0.92
First year after co-twin's death (vs alive)	5.54**	2.56	12.03
Second year after co-twin's death	8.61**	4.12	18.03
Third year (or later) after co-twin's death	1.36**	1.10	1.68
Interactions			
Second year*Female	0.45	0.14	1.46
Second year*Monozygotic	2.56	0.82	7.97

Notes: model C. -2*LL 104943.946 with 10 df. * $p < 0.05$, ** $p < 0.01$.

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