Parents survive longer after stroke than childless individuals: a prospective cohort study of Swedes over the age of 65

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Background:: Parents have lower mortality than childless individuals, and one possible explanation is support provided by adult children. Since stroke often results in functional limitations, support from children may be of particular importance. Here, we examine whether the presence of children matters for survival after stroke among older Swedish men and women. **Methods:** This prospective cohort study linked data from several Swedish population registers. Individuals aged 65 years and older hospitalized for their first ischemic stroke between 1998 and 2002 (33 960 men and 36 189 women) were followed 12 years for survival. Hazard ratios for all-cause mortality were calculated by number of children using Cox proportional hazard regression stratified by sex and marital status and adjusted for education, income and comorbidities. **Results:** Childlessness and having only one child was associated with higher mortality after stroke compared with having two children among men and women. The relative survival disadvantage of childless individuals was largest among married women [HR 1.28 (1.18–1.39)] and smallest among married men [1.09 (1.03–1.15)]. The differences in predicted median survival between childless individuals and those with two children were 4 and 7 months among married and unmarried men, and 15 and 9 months among married and unmarried women, respectively. **Conclusions:** Having children is associated with a longer survival after stroke among men and women regardless of marital status. Our findings further suggest that the presence of children is especially connected to married women's survival. These results may have implications for the improvement of informal care for childless older individuals.

Introduction

Childlessness has been associated with a higher mortality compared with having one or two children in numerous studies.[1–8] Some of these studies have also demonstrated that childlessness is associated with an elevated cause-specific mortality, e.g. from cardiovascular diseases.[4,5] Suggested explanations include children's influence on their parents' health behaviors[9] or the provision of various kinds of support such as instrumental or emotional support.[1,3] In a previous study, we showed how absolute differences in death risks between parents and non-parents increase with age and are more pronounced among the unmarried.[3] Considering that a higher age is often associated with a greater need of support in daily life, this suggests that social support may be part of an explanation for the survival advantage observed among aging parents. However, this survival advantage may also be due to health-related selection, i.e. the selection of healthier individuals into parenthood[1,5] or physiological effects related to parity in women.[5] Following a more homogenous group of individuals, in which everyone has experienced a stroke, with respect to survival allows to reduce the influence of health-related selection and to examine whether the lower mortality among parents can also be found in diseased populations.

Stroke is a severe disease that often results in functional limitations and care-dependency.[10,11] While some studies linked parity to stroke incidence, albeit only among women and with inconsistent results,[12,13] little is known about whether the presence of children

affects survival once a stroke has occurred. We hypothesize that the role of children would be especially important once a disease has developed and a need of care arises. Family members, and adult children in particular, constitute a crucial part of social contacts among the European elderly,[14,15] and the relative importance of family relations may even increase for individuals with stroke. In a recent review, Northcott et al.[16] concluded that experiencing a stroke may reduce involvement in social activities and contact with friends while family networks remain stable. In Sweden, stroke treatment and rehabilitation are free of charge.[11] Nevertheless, the majority of individuals depends on help from family members or friends 1 year after experiencing a stroke.[11] Social support, such as emotional or instrumental support in daily life, for instance with housework, grocery shopping or getting to appointments,[17] may thus be one important pathway through which adult children influence their parents' survival after a stroke. The empirical evidence linking social support to favorable health outcomes is extensive.[17–21] Social support has been found to decrease psychological problems, improve coping with negative life events, facilitate the early detection and treatment of diseases,[17,19–21] and has been linked to improved health outcomes and quality of life among stroke survivors.[18,19] The presence of adult children could further promote a timely treatment or transfer to specialized stroke units, both of which have been linked to improved outcomes after ischemic stroke.[22,23]

Besides children, spouses are important sources of social support for older individuals. Being married or cohabiting is consequently associated with a longer survival after stroke compared with being

unmarried or living alone without a partner.[24,25] The importance of having children for survival after stroke may therefore be larger for individuals who cannot draw on support from a spouse. With this study, we aim to examine if the number of children is associated with survival after ischemic stroke among men and women and to investigate if and how such an association differs between married and unmarried individuals.

Methods

Study design and data sources

All Swedish men and women 65 years and older hospitalized for their first ischemic stroke between 1998 and 2002 were identified using the National Patient Register (NPR). Individuals with stroke before reaching the statutory retirement age of 65 years were excluded since patients in working age might receive special treatment and rehabilitation programs to facilitate re-entrance into employment. Furthermore, relationships toward children could change or intensify with increasing age.[9] In order to achieve a more homogenous study population, we restricted the study population to individuals with first ischemic strokes, which is by far the most common subtype of stroke. Ischemic stroke was defined as a hospital admission with an I63 diagnosis according to ICD-10. Individuals who had a previous stroke diagnosis (ICD-10: I61, I63, I64, I67–I69; ICD-9: 431, 434, 436–438) in the NPR during an 11-year period before the event in 1998–2002 were excluded. Age, sex, date of death, marital status, income and education were retrieved from administrative registers. Family members were connected using the Multi-Generation Register. The linkage between these registers was made possible through a unique personal identity number assigned to all Swedish residents.

Variables and definitions

The number of children was defined as the number of biological or adopted children alive and registered in Sweden. Marital status was defined as married or unmarried, the latter category including never married, widowed and divorced but also unmarried cohabiting individuals since it is not possible to identify these as cohabiting in the register data. Analyses were adjusted for education and income. Education was collapsed into three broad categories: basic (compulsory school), upper secondary and tertiary education. Individuals were categorized into yearly quintiles of their individual disposable income. To adjust for comorbidities, we calculated the Charlson comorbidity index as defined by Quan et al.[26] All main and contributing diagnoses in the NPR for other reasons than cerebrovascular disease at the time of and up to 1 year before the index stroke were taken into account. Individuals were divided into three groups, namely a Charlson comorbidity index score of 0, 1 and ≥2.

Additional adjustments were made for hospitalization length as a proxy for stroke severity, geographical region and country of birth. For hospitalization length, individuals were divided into four groups of approximately equal size, yielding the categories 0–3, 4–7, 8–14 and >14 days. None of these variables affected the estimates and were therefore not included in our final models.

Statistical analyses

Individuals entered the study at their first hospitalization due to stroke. Hazard ratios (HR) for mortality and corresponding 95% confidence intervals (CI) were estimated using multivariate Cox proportional hazards (PH) regression with age as the underlying time scale. Age-adjusted survival curves by number of children were estimated at the mean age of stroke (78.4 years). All variables were measured yearly and allowed to vary during the follow-up except for Charlson comorbidities, hospitalization length and income (in order to account for a potential impact of health status on income) which

were measured at baseline. Analyses were stratified by sex and marital status and the most common exposure category, i.e. having two children, served as the reference group. Three nested models were estimated in each stratum: one crude age-adjusted model (Model 1), one model additionally adjusted for parental education and income (Model 2) and one model additionally adjusted for comorbidities (Model 3). The PH assumption was tested using Schönfeld residuals. We followed all individuals until first migration, death or end-of-follow-up at 12 years after the stroke, whichever came first.

Predicted survival was estimated based on Cox regression holding covariates constant at their means, median or at the most common category depending on their level of measurement. All analyses were conducted using Stata version 14 (StataCorp LP, College Station, TX, USA).

Sensitivity analyses

The association between having children and survival after stroke may differ for short- and long-term survival, for instance since the immediate mortality after a stroke may primarily be determined by stroke severity and less influenced by support from children. Moreover, having children may be related to the time in which a stroke patient arrives in hospital and receives treatment (or the risk to die without reaching the hospital). In sensitivity analyses, we therefore stratified follow-up time and distinguished between short-term (survival up to 28 days and up to 1 year) and long-term survival (survival up to 12 years conditioning on having survived the first 28 days or 1 year, respectively). In addition, we estimated how the number of children is related to the risk of dying from the first ischemic stroke without being hospitalized.

Results

The study population included 33 960 men and 36 189 women with a mean age of 78.4 years at the time of the stroke (women slightly older than men). The characteristics of the study population at the time of the stroke are shown in table 1. The median survival was shortest among childless men (3.73 years) and women (3.56 years) and more than 1 year longer among men (4.89 years) and women (5.05 years) with two children. Childless men and women had on average slightly longer hospitalizations than parents.

Overall, women had a better survival than men (figure 1). The estimated age-adjusted median survival of fathers with two children was 0.92 years longer than for childless men (4.59 compared with 3.67 years). Among women, the difference in estimated median survival was 1.23 years (5.74 compared with 4.51 years).

Table 2 presents results from the multivariate analyses in three models, stepwise adjusted for potential confounders for men and women stratified by marital status. Among men, childlessness and having one child was associated with a higher risk of dying compared with fathers with two children, both among the married and unmarried. The adjusted HR was 1.09 (1.03–1.15) for childless married men and 1.16 (1.10–1.21) for childless unmarried men compared with fathers of two children. This translates to 9 and 16% increased hazards of dying at any time point during the follow-up. Also for unmarried and married women, there was a significantly higher mortality for the childless compared with those with one or two children. However, the relative difference was larger among childless married women than among childless unmarried women. The adjusted HR was 1.28 (1.18–1.39) for childless married women and 1.20 (1.16–1.24) for childless unmarried women compared with mothers of two children. Both among men and women, having one child was associated with a higher risk of death than having two children but a lower risk of death than being childless. There were no significant differences between individuals with three or more children compared with those with two children. A further adjustment for hospitalization

Table 1 Characteristics of the study population at the stroke by number of children (N = 70 149)

Number of children	Men (n = 33 960)				Women (n = 36 189)			
	0 (n = 6942)	1 (n = 7221)	2 (n = 10 504)	≥3 (n = 9293)	0 (n = 6722)	1 (n = 8430)	2 (n = 10 905)	≥3 (n = 10 132)
Person-years[a]	32 995	36 654	58 705	51 532	31 070	43 112	61 228	56 527
Deaths[a]	6069	6168	8603	7638	5944	7140	8891	8278
Median survival (years)[a]	3.73	4.19	4.89	4.84	3.56	4.25	5.05	4.90
Mean age (years) (SD)	77.6 (6.2)	78.0 (6.1)	77.1 (6.3)	76.8 (6.3)	80.3 (6.0)	79.7 (6.0)	79.0 (6.1)	78.8 (6.2)
Marital status								
Married (%)	35.7	65.9	72.6	70.2	21.5	31.3	37.1	33.3
Never married (%)	42.8	2.8	0.6	0.4	29.5	3.7	0.7	0.5
Divorced (%)	6.3	10.0	9.3	13.0	6.9	10.8	9.9	12.4
Widowed (%)	15.2	21.3	17.5	16.4	42.1	54.2	52.3	53.8
Education								
Basic (%)	69.7	62.2	57.3	61.6	64.8	72.9	70.5	75.0
Gymnasium (%)	24.0	28.9	30.7	26.3	25.4	22.6	24.1	20.0
Tertiary (%)	6.3	9.0	12.0	12.2	9.7	4.5	5.4	5.0
Born in Sweden (%)	96.8	97.3	97.2	96.4	95.1	95.8	96.2	95.1
Charlson comorbidity index score								
0 (%)	63.3	64.0	63.7	64.0	65.7	65.6	67.4	65.0
1 (%)	21.6	20.0	21.3	20.1	21.1	21.4	19.9	22.0
≥2 (%)	15.2	16.0	15.0	15.9	13.2	13.0	12.6	13.0
Hospitalization length								
0–3 days (%)	25.4	28.8	30.7	29.7	24.2	24.4	26.4	26.1
4–7 days (%)	25.6	26.3	26.8	27.2	23.7	25.4	26.3	26.3
8–14 days (%)	23.7	22.4	21.1	22.1	24.2	23.9	23.7	23.4
>14 days (%)	25.3	22.5	21.5	21.0	27.9	26.3	23.7	24.2

Notes: Differences between groups were statistically significant for all variables ($P \leq 0.001$ for χ^2-tests or ANOVA) except for Charlson comorbidity index score ($P = 0.06$ among men and $P = 0.007$ among women).
a: Person-years, survival and number of deaths presented for whole study period.
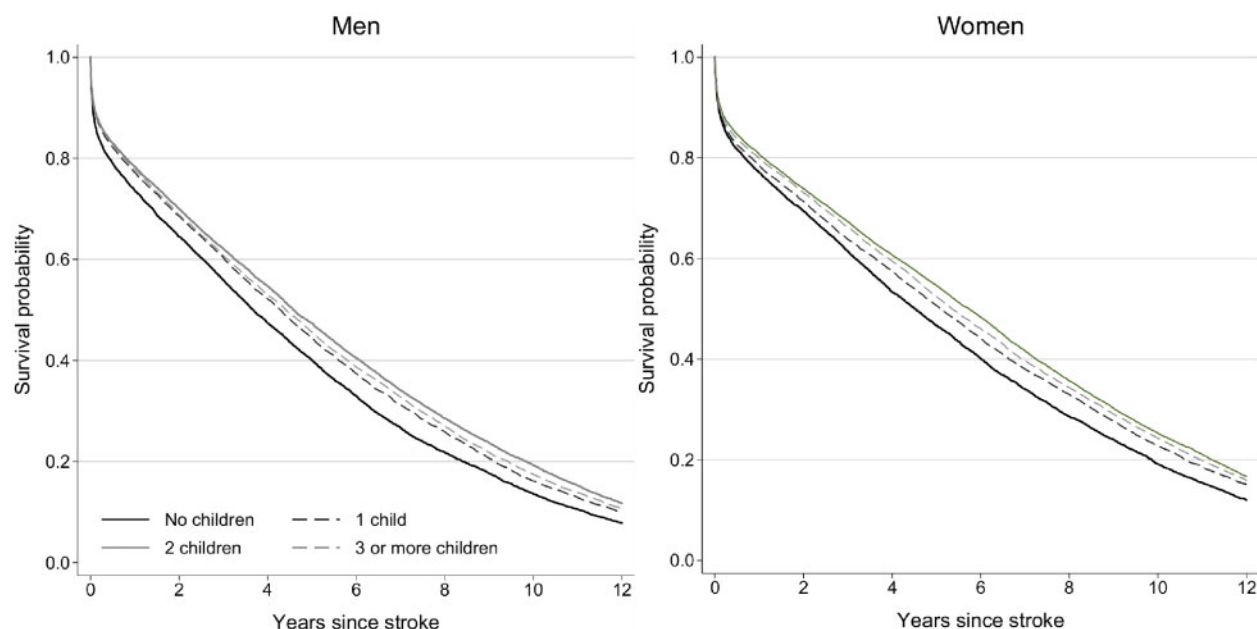
Figure 1 Age-adjusted survival curves by number of children at time of the stroke among men and women. Estimated for mean age (78.4 years) at the time of the stroke (N = 70 149)

length as a proxy variable for stroke severity did not change the results notably (data not shown).

The predicted survival is shown in table 3 for fathers and mothers with two children as well as for childless individuals. The estimated difference in median survival was largest among married women; the childless had an estimated median survival of 6.21 years compared with 7.42 years for mothers of two, a difference of 15 months. For unmarried women, married men and unmarried men, the differences in survival length were 9, 7 and 4 months, respectively.

The sensitivity analyses showed an association of number of children with both short- and long-term survival after stroke (Supplementary table S1). Mortality was higher among the childless compared with parents with two children in all strata. Among married men, however, estimates were statistically significant only for long-term survival. There was no consistent difference in effect size between short- and long-term survival. While the number of children was linked more strongly to short-term survival among unmarried men, the association was stronger for

Table 2 Hazard ratios for mortality after stroke estimated with Cox PH regression by number of children ($N = 70\,149$)

	Model 1	Model 2	Model 3
	HR (95% CI)	HR (95% CI)	HR (95% CI)
Married men			
No children	1.12 (1.06–1.18)	1.09 (1.03–1.15)	1.09 (1.03–1.15)
1 child	1.10 (1.06–1.15)	1.08 (1.04–1.13)	1.08 (1.03–1.12)
2 children	1.00	1.00	1.00
3 or more children	1.04 (1.00–1.08)	1.03 (0.99–1.07)	1.02 (0.98–1.07)
Unmarried men			
No children	1.22 (1.16–1.28)	1.16 (1.10–1.21)	1.16 (1.10–1.21)
1 child	1.10 (1.04–1.15)	1.09 (1.03–1.14)	1.08 (1.02–1.13)
2 children	1.00	1.00	1.00
3 or more children	1.04 (0.98–1.09)	1.03 (0.98–1.08)	1.02 (0.97–1.08)
Married women			
No children	1.30 (1.20–1.40)	1.32 (1.22–1.43)	1.28 (1.18–1.39)
1 child	1.16 (1.09–1.24)	1.16 (1.08–1.24)	1.11 (1.04–1.19)
2 children	1.00	1.00	1.00
3 or more children	1.05 (0.99–1.12)	1.03 (0.97–1.10)	1.02 (0.95–1.08)
Unmarried women			
No children	1.19 (1.15–1.24)	1.22 (1.17–1.26)	1.20 (1.16–1.24)
1 child	1.08 (1.04–1.12)	1.07 (1.03–1.11)	1.06 (1.02–1.10)
2 children	1.00	1.00	1.00
3 or more children	1.02 (0.99–1.06)	1.01 (0.98–1.05)	0.99 (0.96–1.03)

Notes: Model 1 adjusted for age; Model 2 adjusted for age, parental education and income; Model 3 additionally adjusted for comorbidities; likelihood ratio tests indicated improved fit ($P < 0.001$) for each stepwise inclusion of confounders.

Table 3 Estimated survival for men and women with 2 and 0 children ($N = 70\,149$)

	75% survival (years)			Median survival (years)			25% survival (years)		
	Children			Children			Children		
	0	2	diff.	0	2	diff.	0	2	diff.
Men									
Married	1.83	2.02	0.19	5.21	5.55	0.34	9.45	9.90	0.45
Unmarried	1.14	1.43	0.29	3.93	4.49	0.56	7.53	8.34	0.81
Women									
Married	2.16	2.89	0.73	6.21	7.42	1.21	11.23	n.a.	n.a.
Unmarried	1.66	2.11	0.45	5.15	5.92	0.77	9.30	10.34	1.04

Notes: 75% (25%) survival: estimated latest time point at which 75% (25%) of individuals are still alive; diff., difference; n.a., not available. Survival estimated with Cox PH regression holding covariates constant. Estimated survival is presented for individuals with mean age at stroke (78.4 years), basic education, median income and with 0 Charlson comorbidities.

long-term survival among married women. The number of children was moreover clearly associated with the probability to die from their first ischemic stroke without being hospitalized (Supplementary table S2). Childless individuals had between 23% (unmarried women) and 47% (married women) higher odds to die without being hospitalized compared with those with two children. The probability to die without being hospitalized was also elevated among parents with three or more children compared with those with two. Tests of the PH assumption detected minor violations against the proportionality assumption in some strata. However, conducting sensitivity analyses by splitting the study population into age groups in which the PH assumption was met did not change the results.

Discussion

In this study, we found that survival after ischemic stroke is longer among men and women with children than among those without, both for short- and long-term survival. The absolute difference in predicted median survival time between parents of two children compared with childless individuals was 15 months in the group

of married women. This is substantial considering the relatively short survival after stroke. Our results are in line with previous research regarding mortality in old age among parents compared with childless individuals.[1–6,8] Furthermore, having two children was associated with a longer survival than having only one child, which is also consistent with previous research.[1,2,4,5]

Unlike previous studies, we found no elevated mortality among parents with three or more compared with those with fewer children. Our sensitivity analyses, however, indicated that parents with three or more children had an increased risk of dying from stroke before reaching the hospital. Due to methodological differences we cannot draw direct comparisons to our main results, but this may indicate that factors influencing the chance to reach hospital might differ from factors affecting survival once hospitalized—a finding that should be addressed in future research.

Several causal mechanisms have been suggested that may explain the association between number of children and mortality in old age.[1,3,5,8,9] One such mechanism is a positive influence of children on parental health behaviors.[8,9] In the context of stroke survival, children may affect compliance with medication and rehabilitation programs or lifestyle factors such as smoking. Another proposed mechanism is

social support of adult children to their aging parents[1,3] which may be especially relevant for stroke survivors who live with physical or mental limitations. Considering the potential role of social support, the finding that married men experienced the smallest relative benefit of having children appears reasonable. Many studies report larger health benefits of marriage for elderly men than women.[27,28] Married men often receive support from their wives and are consequently less dependent on children acting as care-givers. Wives are often younger than their husbands and may thus be healthier once the couple reaches old age. Women also take on larger responsibility for taking care of the household and their older husbands, which may perhaps explain the large benefit of having children observed among married women. Having a stroke could aggravate the burden on married women which increases the need for support from children. It is, however, noteworthy that we observed the longest overall survival in this stratum. Married women lived longer after a stroke than unmarried women, but the difference between parents and childless was still largest among married women.

Health selection, meaning that healthier individuals are more likely to become parents, is sometimes referred to as another explanation for the longer survival of parents compared with childless individuals.[1,8] This study examines a rather homogenous group of individuals who all experienced an ischemic stroke, thereby ruling out health selection to a large degree. Still, it is possible that parents experience less severe strokes, have fewer comorbidities, or a healthier lifestyle than childless individuals—all of which could be reasons for a longer survival after stroke. Even though we cannot rule out selection effects completely, we found little evidence for confounding by comorbidities or stroke severity.

In an era of increasing childlessness in many countries, it is important to consider potential care deficits arising among older individuals, especially after a severe disease. Childless individuals seem to carry a double burden—previous studies have observed a higher stroke risk among childless women[12,13] and our results show that these are coincidentally at a higher risk of death. Moreover, our sensitivity analyses indicated that childless individuals are at higher risk to die from their stroke before reaching the hospital. Further research is needed to facilitate a better understanding of which type of support could potentially reduce differences in survival chances.

In Sweden, family members play a smaller role in elder care compared with other, for instance southern European, countries[14,15,29] in which having adult children could consequently matter even more for survival after stroke and other diseases. Therefore, it is possible that the difference in mortality between parents and childless individuals is even larger in other countries. Moreover, there is some evidence that children's characteristics, such as sex or socioeconomic position, may affect their parents' mortality.[30] The impact of children's attributes on their parents' survival after stroke could be investigated further.

This study has several strengths. One is the register-based design which resulted in a large study population without selection bias. It has been shown that the Swedish population registers exhibit a good validity and completeness in the context of stroke.[31,32] Furthermore, loss-to-follow-up (less than 0.4% of the study population) and outcome misclassification are virtually non-existent. The restricted possibilities to adjust for additional confounders, especially clinical characteristics, are one limitation of this study. It is possible that parents experience less severe strokes which are associated with a longer survival. Still, our findings were not attenuated considerably when controlling for Charlson comorbidity index score and length of hospitalization, which strengthens the validity of our results. Some misclassification regarding confounding variables may have occurred. It was, for instance, not possible to identify unmarried cohabiting couples in the registers. To assess to which extent this potential bias could have affected our results, the population and housing census from 1990 was used to estimate the proportion of unmarried couples that were cohabiting in the birth cohorts included in this study. These data showed that about 10% of

unmarried individuals were cohabiting with a partner in 1990 and it is thus unlikely that this misclassification has affected the results considerably.

Conclusions

This large population-based study suggests that having children matters for survival after stroke. Among men, the relative survival advantage of having children is largest among the unmarried whereas the opposite is true among women. Potential explanations include a larger health-benefit of marriage for men than for women, and a larger burden of caring for spouse and household among women. In an era of increasing childlessness as well as rising life expectancy, these results may have implications for how to personalize and improve formal and informal care for older individuals, and to identify vulnerable segments of the population.

Ethical approval

This study was approved by the regional ethics committee in Stockholm (permit numbers Dnr 2011/136-31/5 and Dnr 2015/1917-32). The board waived the need for patient consent.

Supplementary data

Supplementary data are available at *EURPUB* online.

Funding

Key points

- Older parents have a longer survival after stroke and this survival advantage was found among both married and unmarried individuals.
- No evidence was found for confounding through socioeconomic status, stroke severity or comorbidities.
- The results suggest that childless individuals may require additional support after experiencing a stroke.

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