



Original Contribution

Birth Order and Suicide in Adulthood: Evidence From Swedish Population Data

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Each year, almost 1 million people die from suicide, which is among the leading causes of death in young people. We studied how birth order was associated with suicide and other main causes of death. A follow-up study based on the Swedish population register was conducted for sibling groups born from 1932 to 1980 who were observed during the period 1981–2002. Focus was on the within-family variation in suicide risk, meaning that we studied sibling groups that consisted of 2 or more children in which at least 1 died from suicide. These family-fixed effects analyses revealed that each increase in birth order was related to an 18% higher suicide risk (95% confidence interval (CI): 1.14, 1.23, $P = 0.000$). The association was slightly lower among sibling groups born in 1932–1955 (hazard ratio = 1.13, 95% CI: 1.06, 1.21, $P = 0.000$) than among those born in 1967–1980 (hazard ratio = 1.24, 95% CI: 0.97, 1.57, $P = 0.080$). Further analyses suggested that the association between birth order and suicide was only modestly influenced by sex, birth spacing, size of the sibling group, own socioeconomic position, own marital status, and socioeconomic rank within the sibling group. Causes of death other than suicide and other external causes were not associated with birth order.

birth order; family; fixed effect models; registry data; siblings; suicide; Sweden

Abbreviations: CI, confidence interval; HR, hazard ratio.

Higher birth order within the sibling group has been linked to heightened risk of depression and anxiety, as well as to lower self-esteem (1, 2). Some studies have also documented a relationship between birth order and suicide (3–6) and suicide attempts (7). Bullying and aggression among siblings has accordingly been found to be associated with mental distress comparable to victimization from peer aggression (8). Some researchers also argue that children of high birth order are born into conditions characterized by restricted access to parental attention and supervision (9, 10), which may result in less attention paid to the health and safety of these children during their first years of life, including lower awareness of children's psychological health and signs of psychiatric deviations. Children who enjoy greater parental attention early in life may develop greater resilience to maladaptive responses to stressful events in adulthood (11). It has further been argued that later-born siblings tend to identify less with their parents and are often subject to domination or bullying by older siblings (8, 12), which could lead to mental

and psychiatric health problems. There is also a possibility of weaker attachment between later-born children and their parents because of parents' limited time and emotional resources (13–15). Even if parents subdivide their resources equally among their offspring at any given point in time, the cumulative distribution of investment will be unequal among the offspring, favoring first-born children and last-born children at the expense of middle-born children (16).

A recent study from Norway provides new insights into the etiology of mental health by analyzing birth order and suicide risk (6). The authors found that each increase in birth order (i.e., from first-born to second-born to third-born) was associated with an approximately 46% higher suicide risk in people up to age 41 years. In contrast with previous research, that study used family-fixed effects models, which controlled for factors that siblings share within the family, such as the influence of genetic factors, rearing environment, and other observed, as well as unobserved, time-invariant environmental characteristics.

Here, we replicate and extend the Norwegian results by using a similar approach and data from Sweden, which is a country with low overall mortality and birth rates comparable to those of Norway (17) and a similar welfare society (18). Additional contributions of our study are that we examine whether birth order effects also manifest in earlier-born sibling groups, whether they can be attributed to adult-age socio-demographic factors, and whether birth order effects can be observed for causes of death other than suicide.

In theory, birth order effects might become progressively weaker with age as other life circumstances and social conditions become increasingly salient for suicide risk. For instance, relationships with intimate partners or one's own offspring might become more relevant over the life course. On the other hand, theories of the developmental origins of disease argue that early-life circumstances, such as birth order, can alter the risk of disease throughout the life course (19). This could happen either because birth order exerts an effect on mental health during a sensitive period of human development (i.e., the latency model), or because birth order sets in motion a trajectory of mental health that affects the risk of depression/suicide through the subsequent life course (i.e., the trajectory or pathways model).

The Swedish data used here also include sibling groups who are in midlife and beyond. We can therefore account for each person's own marital status, socioeconomic position, and socioeconomic rank within the sibling group to see if these factors mediate the birth order effect. Suicide rates are known to be correlated with socioeconomic and marital status, albeit the causality is disputed (20), and whether this association underlies the birth order effect is not known. It might be mediated if the relative ordering of siblings influences prospects in adulthood, such as the likelihood of being married or attaining a specific socioeconomic position. A related issue is the potential importance of an individual's socioeconomic rank within the sibling group as observed at adult age. If children of higher birth order receive less support during childhood in the form of parental investment, this might result in lower socioeconomic attainment at adulthood, which in turn might affect the suicide risk compared with that of first-born children.

Hence, by using family-fixed effects models, we sought to study the association between birth order and suicide in Sweden by conducting a large-scale longitudinal study with inter-generational linked data from nationwide Swedish registers. In particular, we studied whether the association between birth order and suicide also manifests in earlier-born sibling groups, and whether it depends on sex, birth spacing, size of the sibling group, own socioeconomic position, own marital status, and each person's socioeconomic rank within the sibling group in adulthood. Corresponding models were also estimated for main causes of death other than suicide.

METHODS

We used data from the Swedish Work and Mortality Data which was approved by the regional ethical review board of Karolinska Institutet in 2002 (decision 02-481). The data contain information from several national Swedish registers, maintained at the Centre for Health Equity Studies in Stockholm, Sweden.

Data from all persons born in Sweden during the period 1932–1980 and alive at the end of 1980 were linked to data from the mothers, provided the mothers were born in Sweden and alive at the end of 1980. Hence, sibling groups were identified through the mother. Included in the analyses were sibling groups with 2 or more children, in which at least 1 died from suicide. Hence, like the Norwegian study (6), our study was concerned only with the within-family variation in suicide risks and not with variation among families. All subjects were observed from 1981 until the end of 2002 unless they died prior to baseline. Deaths from suicide were distinguished by the *International Classification of Diseases, Eighth Revision*, and *International Classification of Diseases, Ninth Revision*, codes E950–E959 and the *International Classification of Diseases, Tenth Revision*, codes X60–X84. Corresponding analyses were also performed for other main causes of death.

Using Cox regressions stratified by the mother, we estimated suicide risks according to each person's birth order. Because all subjects entered the observation window at the same point in time, at the beginning of 1981, age at entry reflects each person's birth year and is, together with sex and mother's age at delivery, used as a control variable. Duration is time since the beginning of 1981 until censoring at the end of 2002 or death prior to this point in time. The baseline hazard of the Cox model captures variation in suicide risk over calendar time. In analyses concerned with earlier-born sibling groups (born in 1932–1955), we additionally controlled for each person's own marital status, socioeconomic position, and socioeconomic rank within the sibling group at adult age, which were all measured at the end of 1980.

RESULTS

Characteristics of the sibling groups are presented in Table 1 for all cohorts born in 1932–1980. They are also broken out by earlier-born cohorts that consist of sibling groups in which all persons were born in 1932–1955, as well as later-born cohorts that consist of sibling groups in which all persons were born in 1967–1980. For all cohorts, there were 10,656 suicides. There were 4,422 suicides in the earlier-born sibling group and only 872 suicides in the later-born sibling groups because of the age balance of the data.

The family-fixed effects analyses revealed that birth order was associated with a higher suicide risk (Table 2). Each increase in birth order was related to a 1.18 times higher suicide risk (95% confidence interval (CI): 1.14, 1.23, $P = 0.000$). In the earlier-born group, the association was slightly lower at 1.13, but still statistically significant (95% CI: 1.06, 1.21, $P = 0.000$). In the later-born group, the corresponding estimate was higher, or 1.24, but not statistically significant because of a small number of observations (95% CI: 0.97, 1.57, $P = 0.080$). In the total population, birth order effects were not much different from the family-fixed effects estimates (Table 2), which agrees with the results from the Norwegian study (6).

Birth order was associated primarily with suicide, whereas few associations were found for other causes of death (Table 3). Only for external causes of death other than suicide, which consist primarily of accidents, did we find some indications

Table 1. Characteristics of Sibling Groups, Swedish Work and Mortality Data, 1981–2002

Variable	Born 1932–1980				Born 1932–1955				Born 1967–1980			
	Persons With Suicidal Deaths		Persons Without Suicidal Deaths		Persons With Suicidal Deaths		Persons Without Suicidal Deaths		Persons With Suicidal Deaths		Persons Without Suicidal Deaths	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Birth order												
First	3,887	36.5	6,643	28.0	1,522	34.4	2,840	30.7	435	49.9	434	35.1
Second	3,828	35.9	6,702	28.2	1,650	37.3	2,712	29.3	354	40.6	515	41.6
Third	1,711	16.1	4,893	20.6	749	16.9	1,746	18.9	71	8.1	219	17.7
Fourth or higher	1,230	11.5	5,519	23.2	501	11.3	1,957	21.1	12	1.3	69	5.6
Maternal age at child's birth, years												
<20	876	8.2	1,417	6.0	157	3.6	309	3.3	111	12.7	84	6.8
20–24	2,955	27.7	6,225	26.2	898	20.3	1,935	20.9	309	35.4	435	35.2
25–29	3,187	29.9	6,960	29.3	1,391	31.5	2,777	30.0	303	34.7	450	36.4
30–34	2,130	20.0	5,302	22.3	1,096	24.8	2,409	26.0	128	14.7	222	17.9
>34	1,508	14.2	3,853	16.2	880	19.9	1,825	19.7	21	2.4	46	3.7
Sex												
Male	7,707	72.3	12,038	50.7	3,113	70.4	4,614	49.9	639	73.3	653	52.8
Female	2,949	27.7	11,719	49.3	1,309	29.6	4,641	50.1	233	26.7	584	47.2
Birth year												
1932–1938	829	7.8	2,171	9.1	801	18.1	2,033	22.0				
1939–1945	1,924	18.1	4,382	18.4	1,708	38.6	3,574	38.6				
1946–1952	2,394	22.5	5,311	22.4	1,539	34.8	2,916	31.5				
1953–1959	2,141	20.1	4,786	20.1	374	8.5	732	7.9				
1960–1966	1,914	18.0	3,953	16.6								
1967–1973	1,055	9.9	2,165	9.1					527	60.4	662	53.5
1974–1980	399	3.7	989	4.2					345	39.6	575	46.5
Marital status												
Never married					1,681	38.0	2,561	27.7				
Married but living alone					112	2.5	133	1.4				
Married and living with partner					2,022	45.7	5,585	60.3				
Divorced					584	13.2	902	9.7				
Widowed					23	0.5	74	0.8				

Table continues

of a birth order effect similar to that for suicide. This suggests that the birth order effect may not be specific to suicide, per se, but perhaps mediated by a higher tendency toward risk taking or impulsivity. For external causes of death other than suicide, the effect sizes were nevertheless smaller, and in the birth cohorts from 1967–1980 and 1932–1955, the estimates were not statistically significant. Further analyses were therefore concerned with suicide only.

Also consistent with the findings from Norway (6), the birth order effect on suicide was similar for men and women (Table 4), and it was not dependent on the length of the birth interval or the size of the sibling group (data not shown). Our preliminary analyses were concerned with how sensitive the birth order effect was to the particular sex composition of the sibling group, but we found no consistent patterns on this account.

In sibling cohorts born in 1932–1955, for whom we could observe adult-age sociodemographic variables, there was no association between socioeconomic rank within the sibling group and suicide after we accounted for socioeconomic status (Table 5). The association between birth order and suicide was only modestly influenced by own marital status, socioeconomic position, and socioeconomic rank within the sibling group. None of these variables attenuated the birth order effect to any noteworthy degree, despite being correlated with the suicide risk. After adjustment for all control variables, second-born offspring in these cohorts were found to have a suicide risk that was 1.17 times (95% CI: 1.05, 1.30, $P = 0.004$) that of first-born offspring. The suicide risks for third-born and fourth- or higher-born offspring were 1.43 (95% CI: 1.20, 1.69, $P = 0.000$) and 1.63 (95% CI: 1.27, 2.08, $P = 0.000$) times that of first-born offspring, respectively.

Table 1. Continued

Variable	Born 1932–1980				Born 1932–1955				Born 1967–1980			
	Persons With Suicidal Deaths		Persons Without Suicidal Deaths		Persons With Suicidal Deaths		Persons Without Suicidal Deaths		Persons With Suicidal Deaths		Persons Without Suicidal Deaths	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Socioeconomic status												
Unskilled employee					1,019	23.1	2,349	25.4				
Skilled employee					744	16.8	1,289	13.9				
Assistant nonmanual employee (lower level)					207	4.7	536	5.8				
Assistant nonmanual employee (higher level)					267	6.0	645	7.0				
Intermediate nonmanual employee					583	13.2	1,257	13.6				
Professional or other higher nonmanual employee					331	7.5	635	6.9				
Self-employed (excluding farmers)					250	5.7	468	5.1				
Farmer					109	2.5	216	2.3				
Unclassified employee or part-time worker					67	1.5	189	2.0				
Outside labor market					479	10.9	1,157	12.4				
No information					366	8.3	514	5.6				
Socioeconomic order within the sibling group ^a												
First					2,050	46.4	3,879	41.9				
Second					1,744	39.4	3,394	36.7				
Third					533	12.1	1,518	16.4				
Fourth or higher					95	2.1	464	5.0				
Total	10,656	100.0	23,757	100.0	4,422	100.0	9,255	100.0	872	100.0	1,237	100.0

^a Persons are ranked by socioeconomic status, from highest to lowest, as follows: 1) professional or other higher nonmanual employee; 2) intermediate nonmanual employee; 3) assistant nonmanual employee (higher level); 4) assistant nonmanual employee (lower level); 5) skilled employee or self-employed (excluding farmers); 6) unskilled employee or farmer; and 7) unclassified employee or part-time worker, outside labor market, or no information. Sequential ranks are given to unique values.

Table 2. Risk of Suicide by Birth Order, Swedish Work and Mortality Data, 1981–2002^a

Birth Order ^b	Born 1932–1980			Born 1932–1955			Born 1967–1980		
	No. of Suicides ^c	HR	95% CI	No. of Suicides	HR	95% CI	No. of Suicides	HR	95% CI
First	3,887	1.00	Referent	1,522	1.00	Referent	435	1.00	Referent
Second	3,828	1.25	1.17, 1.34	1,650	1.18	1.07, 1.31	354	1.31	1.00, 1.71
Third	1,711	1.43	1.28, 1.58	749	1.44	1.22, 1.70	71	1.62	0.95, 2.75
Fourth or higher	1,230	1.79	1.54, 2.08	501	1.61	1.27, 2.04	12	1.68	0.68, 4.16
Birth order trend ^d	10,656	1.18	1.14, 1.23	4,422	1.13	1.06, 1.21	872	1.24	0.97, 1.57

Abbreviations: CI, confidence interval; HR, hazard ratio.

^a The hazard ratios are adjusted for age, period, sex, and maternal age at child's birth.

^b For the total population, which included sibling groups with 1 child and those without any suicidal deaths, hazard ratios corresponding to those shown in this table were as follows: for the group born in 1932–1980, 1.26 (95% CI: 1.21, 1.32), 1.50 (95% CI: 1.41, 1.59), 1.89 (95% CI: 1.77, 2.03), and 1.18 (95% CI: 1.16, 1.19) for the first-, second-, third-, and fourth- or higher-born, respectively; for the group born in 1932–1955, 1.16 (95% CI: 1.08, 1.23), 1.35 (95% CI: 1.23, 1.47), 1.48 (95% CI: 1.33, 1.64), and 1.11 (95% CI: 1.08, 1.14) for the first-, second-, third-, and fourth- or higher-born, respectively; and for the group born in 1967–1980, 1.16 (95% CI: 1.01, 1.34), 1.37 (95% CI: 1.06, 1.78), 1.97 (95% CI: 1.10, 3.53), and 1.18 (95% CI: 1.07, 1.31) for the first-, second-, third-, and fourth- or higher-born, respectively.

^c In the sibling group born in 1932–1980, 98.8% of the mothers experienced the suicide of 1 child only.

^d Refers to the use of a continuous variable for birth order (instead of a categorical one with the categories of first, second, third, and fourth or higher). Hence, it refers to an estimate of the linear effect of birth order.

Table 3. Risk of Main Cause of Death^a by Birth Order, Swedish Work and Mortality Data, 1981–2002^b

Cause of Death by Birth Order	Born 1932–1980		Born 1967–1980		Born 1932–1955		Born 1932–1955 ^c	
	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI
All causes								
First	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent
Second	1.00	0.98, 1.02	1.07	0.96, 1.19	0.98	0.95, 1.01	0.97	0.95, 1.00
Third	1.04	1.00, 1.07	1.12	0.91, 1.38	1.02	0.98, 1.07	1.01	0.96, 1.06
Fourth or higher	1.03	0.98, 1.08	1.17	0.81, 1.71	1.02	0.96, 1.09	1.00	0.94, 1.07
Myocardial infarction								
First	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent
Second	0.99	0.91, 1.07	2.72	0.50, 15.17	0.97	0.88, 1.06	0.96	0.87, 1.06
Third	0.99	0.87, 1.14	7.39	0.39, 140.8	0.98	0.84, 1.14	0.96	0.82, 1.12
Fourth or higher	0.88	0.72, 1.07	Merged ^d		0.91	0.74, 1.14	0.90	0.72, 1.12
Other heart disease								
First	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent
Second	0.97	0.89, 1.05	1.16	0.66, 2.05	0.91	0.83, 1.01	0.89	0.81, 0.99
Third	0.91	0.80, 1.04	1.40	0.44, 4.42	0.81	0.69, 0.96	0.79	0.66, 0.93
Fourth or higher	0.94	0.78, 1.14	Merged ^d		0.83	0.66, 1.04	0.77	0.61, 0.98
Cerebrovascular disease								
First	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent
Second	0.89	0.80, 0.99	0.60	0.20, 1.79	0.90	0.79, 1.03	0.90	0.79, 1.03
Third	0.85	0.71, 1.01	0.17	0.01, 2.40	0.89	0.72, 1.10	0.87	0.70, 1.09
Fourth or higher	0.81	0.63, 1.05	Merged ^d		0.92	0.68, 1.25	0.90	0.66, 1.24
Cancer								
First	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent
Second	0.99	0.96, 1.03	0.86	0.64, 1.15	0.99	0.95, 1.03	0.99	0.95, 1.03
Third	1.02	0.96, 1.08	1.05	0.58, 1.90	1.04	0.97, 1.12	1.04	0.97, 1.12
Fourth or higher	0.98	0.90, 1.07	1.02	0.32, 3.30	1.00	0.91, 1.11	0.99	0.90, 1.10
Suicide								
First	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent
Second	1.25	1.17, 1.34	1.31	1.00, 1.71	1.18	1.07, 1.31	1.17	1.05, 1.30
Third	1.43	1.28, 1.58	1.62	0.95, 2.75	1.44	1.22, 1.70	1.43	1.20, 1.69
Fourth or higher	1.79	1.54, 2.08	1.68	0.68, 4.16	1.61	1.27, 2.04	1.63	1.27, 2.08
Other external cause								
First	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent
Second	1.14	1.07, 1.20	1.12	0.94, 1.32	1.05	0.95, 1.15	1.03	0.93, 1.14
Third	1.24	1.13, 1.36	1.19	0.86, 1.65	1.16	0.99, 1.34	1.13	0.97, 1.32
Fourth or higher	1.29	1.13, 1.47	1.10	0.61, 1.99	1.24	1.00, 1.53	1.18	0.94, 1.47
Any other cause								
First	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent
Second	0.98	0.94, 1.03	0.97	0.77, 1.22	0.98	0.93, 1.04	0.97	0.91, 1.04
Third	1.04	0.96, 1.12	0.81	0.53, 1.25	1.05	0.96, 1.16	1.02	0.92, 1.13
Fourth or higher	1.01	0.90, 1.12	0.76	0.35, 1.65	1.07	0.94, 1.23	1.04	0.90, 1.21

Abbreviations: CI, confidence interval; HR, hazard ratio; ICD-8, *International Classification of Diseases, Eighth Revision*; ICD-9, *International Classification of Diseases, Ninth Revision*; ICD-10, *International Classification of Diseases, Tenth Revision*.

^a “Myocardial infarction” refers to the ICD-8 codes 410 and 795, ICD-9 codes 410 and 798, and ICD-10 codes I21 and I46. “Other heart diseases” refers to ICD-8 codes 411–429, ICD-9 codes 411–429, and ICD-10 codes I22–I52. “Cerebrovascular disease” refers to ICD-8 codes 430–438, ICD-9 codes 430–438, and ICD-10 codes I60–I69. “All cancer” refers to ICD-8 codes 140–239, ICD-9 codes 140–239, and ICD-10 codes C00–D48. “Suicide” refers to ICD-8 codes E950–E959, ICD-9 codes E950–E959, and ICD-10 codes X60–X84. “Other external causes” refers to ICD-8 codes E807–E949 and E960–E999, ICD-9 codes E800–E949 and E960–E999, and ICD-10 codes V01–X59 and X85–Y98. “All other causes” refers to all other *International Classification of Diseases* codes.

^b The hazard ratios are adjusted for age, period, sex, and maternal age at child’s birth.

^c Additionally adjusted for marital status, socioeconomic status, and socioeconomic order.

^d Category has been merged with the preceding category.

Table 4. Risk of Suicide by Birth Order and Sex, the Swedish Work and Mortality Data, 1981–2002^a

Birth order	Born 1932–1980				Born 1932–1955				Born 1967–1980			
	Men		Women		Men		Women		Men		Women	
	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI
First	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent
Second	1.20	1.10, 1.29	1.37	1.23, 1.52	1.10	0.97, 1.25	1.35	1.15, 1.59	1.24	0.92, 1.66	1.48	0.99, 2.20
Third	1.45	1.29, 1.64	1.38	1.19, 1.60	1.45	1.21, 1.75	1.45	1.16, 1.81	1.89	1.07, 3.34	1.23	0.60, 2.54
Fourth or higher	1.88	1.60, 2.21	1.61	1.33, 1.95	1.69	1.31, 2.18	1.48	1.10, 1.99	1.81	0.67, 4.85	1.51	0.37, 6.12

Abbreviations: CI, confidence interval; HR, hazard ratio.

^a The results are based on separate models for sibling groups born in 1932–1980, 1932–1955, and 1967–1980, respectively. Each model, which includes both sexes, adjusts for the joint effect of sex and birth order, as well as the main effects of age, period, sex, and maternal age at child's birth. To obtain the effect of birth order for men and women, respectively, we switched the reference group.

DISCUSSION

In this large-scale follow-up study based on the Swedish population register, higher birth order was found to be associated with a greater risk of suicide and, to some extent, death from other external causes, but not with any other main causes of death, such as myocardial infarction, other heart diseases, cerebrovascular disease, or cancer. Hence, a birth order effect was found for these Swedish subjects, albeit the effect size was notably smaller than that suggested by Norwegian data (6).

The overall association between birth order and suicide risk might be explained in a number of ways. Early-life circumstances can lead to altered risk of disease throughout the life course, also known as the latency model (16), meaning that birth order might exert an effect on health during a sensitive period of human development (21, 22). The most recent hypothesis is about within-family bullying and aggression among siblings (8). It argues that older children might bully younger children, and the lower a child is on the family “pecking order,” the more likely that child is to be bullied. Research into the lasting emotional consequences of sibling aggression has been neglected relative to other forms of aggression (e.g., that among peers). Nevertheless, it is also possible that later-born siblings are more protected and pampered by older siblings.

Furthermore, it has been claimed that later-born persons tend to identify less with their parents (3, 12), which could lead to mental and psychiatric health problems. There is also a possibility of weaker attachment between later-born children and their parents because of parents' limited time and emotional resources (23, 24). Infants and young children have a need for a secure relationship with adult caregivers, without which normal social and emotional development will not occur (13, 14). Lower levels of attachment to parents because of restrictions in quality time could give rise to emotional and behavioral problems, separation stress, and psychiatric disorders, thereby contributing to a higher suicide risk among later-born siblings.

The biological depletion of mothers and other risk factors in utero have been proposed as underlying the often observed higher mortality risk of children born toward the end of large sibling groups. Examples of such risk factors are greater maternal stress, higher cortisol levels, and higher maternal antibody

levels with higher birth order, which can influence fetal development (3). It is possible that mothers experience increased maternal stress during second and third pregnancies, which may have a negative influence on fetal brain development. High cortisol levels could have a lifelong influence on the hypothalamic-pituitary-adrenal axis, resulting in hypercortisolemia in adulthood, which has been linked to depression (1). However, because we found associations primarily with suicide and not with other causes of death, it is less plausible that the mechanism is related to general susceptibility, such as through hypothalamic-pituitary-adrenal axis disturbance or maternal stress.

Resource theory suggests that there is a finite amount of parental resources (i.e., time and attention) to be divided among siblings, and that parental investment declines as the family grows in size (9–11). Thus, children of higher birth order are born into conditions characterized by lower access to parental attention and supervision (11). Such limited access to parental time may result in less attention paid to the health and safety of these children during their first years of life, including attention to their psychological and emotional development. Children who enjoy greater parental attention early in life may additionally develop greater resilience or self-esteem (16). Some empirical evidence suggests that higher birth order is associated with lower intelligence quotient, education, and cognitive skills (25–27), perhaps as a consequence of less attention from and quality time with parents (27). Such factors are associated with a higher suicide risk and could, to some extent, explain our findings. However, because cognitive skills are likely to predict social status and socioeconomic rank within the family, adjustment for such factors would reduce the excess suicide risk of later-born siblings, and this is not what we found.

Our results suggest that associations between birth order and suicide also manifest in earlier-born sibling cohorts, and not only in fairly young people, as indicated by previous research from Norway (6). The birth order effect on suicide still seems to be weaker in the former group, presumably because life circumstances and social conditions in adulthood become increasingly important. Yet, birth order might be considered an early-life circumstance that determines mental health across the life course (19) because we found associations in both younger and older birth cohorts. In accordance

Table 5. Risk of Suicide by Birth Order in the Sibling Group Born in 1932–1955 According to Models With Different Sets of Control Variables, Swedish Work and Mortality Data, 1981–2002

Birth Order	Model 1 ^a		Model 2 ^b		Model 3 ^c		Model 4 ^d		Model 5 ^e		Model 6 ^f		Model 7 ^g		Model 8 ^h	
	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI
First	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent
Second	1.18	1.07, 1.31	1.18	1.06, 1.31	1.17	1.05, 1.30	1.17	1.05, 1.30	1.17	1.05, 1.30	1.17	1.05, 1.30	1.17	1.05, 1.30	1.17	1.05, 1.30
Third	1.44	1.22, 1.70	1.47	1.24, 1.74	1.39	1.18, 1.65	1.40	1.19, 1.66	1.43	1.20, 1.69	1.44	1.21, 1.70	1.39	1.18, 1.65	1.43	1.20, 1.69
Fourth or higher	1.61	1.27, 2.04	1.66	1.30, 2.11	1.57	1.23, 2.00	1.57	1.23, 2.00	1.62	1.27, 2.07	1.62	1.27, 2.07	1.58	1.24, 2.01	1.63	1.27, 2.08

Abbreviations: CI, confidence interval; HR, hazard ratio.

^a Adjusted for age, period, sex, and maternal age at child's birth.

^b Adjusted for model 1 variables plus marital status.

^c Adjusted for model 1 variables plus socioeconomic status.

^d Adjusted for model 1 variables plus socioeconomic rank within the sibling group in adulthood.

^e Adjusted for model 1 variables plus marital status and socioeconomic status.

^f Adjusted for model 1 variables plus marital status and socioeconomic rank within the sibling group in adulthood.

^g Adjusted for model 1 variables plus socioeconomic status and socioeconomic rank within the sibling group in adulthood.

^h Adjusted for model 1 variables plus marital status, socioeconomic status, and socioeconomic rank within the sibling group in adulthood.

with this argument, our findings seem to support the latency model rather than the trajectory model.

Our focus on older cohorts allowed us to test whether marital status, socioeconomic position, and socioeconomic rank within the family mediate the birth order effect. If a child of higher birth order receives less support during childhood, it might result in a worse socioeconomic position in adulthood, which in turn might affect the suicide risk compared with offspring of lower birth order. Our findings suggest that socio-demographic factors within families do not influence the association between birth order and suicide. Consequently, these findings are also consistent with the latency model, because later-born children's within-family socioeconomic positions and likelihood of getting married did not explain their higher suicide risk.

Despite the strengths of this study, such as the use of total population register data, longitudinal follow-up, and reliable information on deaths from suicide and other included variables, some limitations should be noted. More detailed individual information is required to uncover the actual causal mechanisms that link birth order and suicide. Such information could also minimize the possibility of omitted variable bias. Ideally, one would have access to more detailed data on personal and relational characteristics and information on additional variables that are associated with presence of psychiatric disorders (e.g., alcohol and drug consumption, criminality), which were unfortunately not included in our data. Moreover, examining attempted suicide is likely to provide more precision and even greater statistical power, especially among younger people. Unfortunately, we did not have information on attempted suicide in our data. Nevertheless, attempted suicide could also be considered to reflect another phenomenon, because it includes a broader spectrum of self-harming actions. An important contribution of this study compared with previous research on birth order and suicide is the use of family-fixed effects models. Our fixed effects regressions controlled for factors that siblings share within the family. These specifications use only the within-family variation and, therefore, neatly account for inherent problems in standard nonstratified models, such as the influence of genetic factors and environmental factors shared in childhood that are time invariant. However, many of the potential mechanisms vary over time and cannot be adjusted for in the models. Parents face different time and financial constraints over their lifetimes, which may prevent them from equalizing their resources and investments across children, and there could be a changing composition of parental characteristics that contribute to different home environments. From this perspective, it might be fruitful to incorporate birth order effects into a life course perspective, accounting for critical events and periods in both parents' and offspring's lives.

In summary, our study provided evidence for an association between birth order and suicide in Sweden, which corroborates earlier findings from Norway (6), albeit our suggested effect sizes are smaller. Because persons' own socio-demographic factors as observed in adulthood were found not to influence the relationship, and only modest sex differences were observed, the mechanisms that link birth order and completed suicide need to be further investigated. Almost 1 million people die from suicide each year, and suicide is among

the 3 leading causes of death in people less than 25 years of age (28). It is therefore of utmost importance to continue exploring the mechanisms linking birth order and suicide. The current findings also call for an investigation of whether these studies conducted in Nordic countries can be replicated in societies that are dissimilar with respect to social conditions, health, economic institutions, and family environment. Some research has been performed outside the Nordic countries (29), but it would be especially important to study whether the effects of birth order on suicide can be found in profoundly dissimilar contexts, such as developing countries and countries with striking inequalities.

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