Original Contribution

Maternal Age at Child Birth, Birth Order, and Suicide at a Young Age: A Sibling Comparison

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Previous studies have reported strong associations between birth order, maternal age, and suicide, but these results might have been confounded by socioeconomic and other factors. To control for such factors, we compared suicide risk between siblings and studied how maternal age at child birth and birth order influenced risk in a cohort study of 1,690,306 Norwegians born in 1967–1996 who were followed up until 2008. Using stratified Cox regression, we compared suicide risk within families with 2 or more children in which one died from suicide. Altogether, 3,005 suicides occurred over a mean follow-up period of 15 years; 2,458 of these suicides occurred among 6,741 siblings within families of 2 or more siblings. Among siblings, a higher position in the birth order was positively associated with risk; each increase in birth order was associated with a 46% (adjusted hazard ratio = 1.46, 95% confidence interval: 1.29, 1.66) higher risk of suicide. For each 10-year increase in maternal age at child birth, the offspring's suicide risk was reduced by 57% (adjusted hazard ratio = 0.43, 95% confidence interval: 0.30, 0.62). Our study suggests that confounding due to familial factors is not likely to explain the associations of birth order and maternal age at child birth with suicide risk.

epidemiology; family characteristics; parity; public health; siblings; suicide

Abbreviations: aHR, adjusted hazard ratio; CI, confidence interval.

Editor's note: An invited commentary on this article appears on page 645.

Suicide is one of the most common causes of death among young adults in Western societies, and for each completed suicide, there are several people who attempted to end their lives (1, 2). Although mental illness and substance misuse contribute to a high proportion of suicides, impulsive behavior in moments of crisis, poverty, and serious physical illness are also important risk factors (3, 4).

Recent studies have indicated that birth order is associated with suicide risk, with later-born children experiencing an increased risk of suicide, whereas maternal age at child birth may be inversely related to risk among the offspring (5–9). It has been estimated that more than 20% of suicides might

be attributable to the combined effects of maternal age at child birth and birth order (9). If these estimates are correct, a better understanding of their underlying causal nature could provide important information about the family's role in the complex etiology of suicide.

The relationship between siblings and the relationships of siblings with their parents are unique for each individual within a family, and these interindividual differences may have profoundly different effects on a child's development (10) and later suicide risk. Thus, it has been suggested that older siblings benefit from receiving more parental attention than younger siblings (11). Furthermore, it has been speculated that short intervals between births may be associated with poorer mental health because of fetal undernutrition due to depletion of maternal nutritional reserves during the preceding pregnancy, which impacts neurodevelopment

(12). Such effects are likely to be stronger in third-born children than in second-born, in fourth-born children than in third-born, and so on. In relation to maternal age, the offspring of young mothers are at higher risk of several adverse psychosocial outcomes; this may be due to the limited social, psychological, and economic resources available to them (13, 14). Confounding due to familial socioeconomic position and genetic and environmental factors could also contribute to the observed associations. For example, the birth order effect could be confounded by family size (15), and young mothers themselves have an increased risk of psychiatric illness and low socioeconomic position (14). It is difficult to adequately control for the possible confounding effect of socioeconomic position and genetic influences on mental health with the limited data available in large record linkage studies. In previous studies, researchers have compared individuals from population samples in which information on family characteristics and possible confounders was often not available. One way to overcome this limitation is by carrying out a sibling comparison, that is, comparing risk in relation to maternal age and birth order within families, because a family design will control for shared factors that could have confounded the results of other studies (16).

We studied the associations of maternal age at child birth and offspring's birth order with the offspring's risk of suicide before the age of 42 years in Norway. Our main aim was to assess suicide risk among siblings within families in which a suicide occurred during follow-up. For comparison, we also studied suicide risk in the population as a whole.

MATERIALS AND METHODS

The study was based on linkage of data from the Medical Birth Registry of Norway (www.fhi.no/mbrn) with information on suicide obtained from the Norwegian Cause of Death Registry. The Medical Birth Registry was established in 1967, and information on virtually all births that have taken place in the country since then has been registered. The registry includes health and demographic information on mothers and their offspring at the time of birth.

Follow-up for suicide was conducted among participants who were born between January 1, 1967, and December 31, 1996, and were alive at 12 years of age; a total of 1,690,306 people were eligible for follow-up from the age of 12 years because suicides before the age of 12 are rare (17). Our analyses were based on 2 samples. The first sample consisted of the population as a whole, and the second sample ("sibling cohort") consisted of siblings within families with at least 2 children in which at least 1 sibling committed suicide. The exposure variables of interest were maternal age at child birth and the birth orders of siblings; we also included information on the offspring's sex and year of birth, the time interval between births, maternal marital status, and maternal and paternal educational levels at the time of birth (Table 1).

Suicides that occurred from when the offspring were 12 years of age until the end of follow-up (December 31, 2008) were identified through individual linkage with the Cause of Death Registry in Norway (http://www.ssb.no/english/dodsarsak). We used codes E950–E959 from the *International Classification of Disease*, Ninth Edition, and codes

X60–84 (suicide) from the *International Classification of Disease*, Tenth Edition, to indicate suicide. In most cases of sudden unexpected death, forensic autopsies were conducted to determine cause of death.

Siblings of the deceased were identified using the unique identification number of each mother; this enabled linkage of information between siblings within families with at least 2 siblings. The present study was approved by the Regional Committee for Medical Research Ethics in Central Norway.

Statistical analysis

In both the population as a whole and the sibling cohort, we assessed suicide risk using Cox proportional hazards models with age as the time axis. The participants were followed from the age of 12 years until death by suicide, death from another cause, emigration, or the end of follow-up (December 31, 2008), whichever occurred first. The oldest participants in the cohort were born in 1967 and were 41 years of age at the end of follow-up.

In both the population as a whole and the sibling cohort, we studied suicide risk related to birth order and maternal age at delivery. In multivariable analyses, we controlled for offspring sex, year of birth (1967–1976 vs. 1977–1999), maternal marital status (married/cohabiting or other), and maternal and paternal levels of education (recorded in 3 categories); in the analysis of maternal age at child birth, we also adjusted for birth order, and in the analysis of birth order, we also adjusted for maternal age at child birth. In the analysis of the population as a whole, we used a standard Cox regression approach, but in the sibling cohort, we used stratified Cox models to control for factors that were shared within families (18). This approach enabled us to compare associations with maternal age and birth order within sibships. In such an analysis, characteristics that are shared by siblings (e.g., socioeconomic position, parental history of mental illness) cannot have confounding effects on the estimated associations. We also carried out a test to investigate the possibility of effect measure differences of maternal age and birth order between sons and daughters.

In a separate analysis of the sibling cohort, we assessed whether the association of birth order with suicide risk differed depending on the time-interval since the prior birth (<2 years, 2–3 years, or >3 years). In additional analyses, we studied whether maternal age at child birth, as well as sibship size, could influence the association between birth order and suicide risk among siblings.

The proportional hazards assumptions were assessed on the basis of Schoenfeld residuals, and there was no evidence against the proportionality assumption. We used Stata, version 11 (StataCorp LP, College Station, Texas) for the statistical analyses.

RESULTS

Characteristics of the study population and the sibling cohort are presented in Table 1. In the population as a whole, 3,005 suicides occurred during more than 25 million person-years of follow-up (25,407,240 person-years during a mean follow-up of 15 years). Among these suicides, 2,458

Table 1.   Characteristics of the Total Population and the Cohort of Siblings Within the Total Population, Norway, 1967–2008

Characteristic	Total Cohort				Sibling Cohort			
	Suicides		Nonsuicides		Suicides		Nonsuicides	
	No.	%	No.	%	No.	%	No.	%
Mean maternal age[a]	25.6 (5.5)		26.6 (5.2)		25.1 (5.0)		26.4 (5.7)	
Birth order								
First	1,057	35	698,861	41	859	35	1,160	27
Second	1,065	35	538,108	35	927	38	1,339	31
Third	539	18	273,730	16	430	17	1,003	23
Fourth or higher	344	12	131,602	8	242	10	781	18
Sex								
Male	2,330	78	864,873	51	1,894	77	2,129	50
Female	675	22	822,428	49	564	23	2,154	50
Birth period								
1967–1976	1,943	65	610,337	36	1,496	61	2,312	54
1977–1999	1,062	35	1,076,964	64	962	39	1,971	46
Maternal marital status								
Married or cohabitating	2,566	85	1,506,493	89	2,124	86	3,793	89
Other	439	15	180,808	11	334	14	490	11
Maternal educational level								
Primary/lower secondary	1,028	34	451,153	27	819	34	1,503	35
Upper secondary	1,389	47	783,587	47	1,134	46	1,900	45
College/university	573	19	442,332	26	492	20	854	20
Paternal educational level								
Primary/lower secondary	928	31	394,827	24	730	30	1,322	31
Upper secondary	1,490	51	847,553	51	1,241	51	2,124	50
College/university	525	18	416,642	25	443	18	766	18
Total[b]	3,005		1,687,301		2,458		4,283	

[a] Values are expressed as mean (standard deviation).
[b] The total number varies because of missing data on parental educational levels. Because of rounding errors, percentages do not sum to 100.

occurred within the cohort of 6,741 siblings (111,472 person-years; mean follow-up, 17 years). Eighteen families experienced 2 suicides. The risk of suicide was over 3 times higher in males than in females and was increased in the offspring of mothers who were not married or cohabiting and in those with less educated fathers (see Web Table 1, available at http://aje.oxfordjournals.org/). The crude hazard ratio of being an only child versus being in a sibship with 2 or more siblings was 0.99 (95% confidence interval (CI): 0.86, 1.15).

Table 2 shows that having a higher position in the birth order was positively associated with suicide risk in the population as a whole. In the unadjusted analysis, suicide risk increased by 11% (hazard ratio = 1.11, 95% CI: 1.08, 1.15) for each increase in birth order category, and after adjustment for maternal age at delivery, offspring sex, time period of birth, maternal marital status, and parental educational level, the corresponding risk increase was 26% (adjusted hazard ratio (aHR) = 1.26, 95% CI: 1.20, 1.31). In relation to maternal age at child birth, there was an inverse association with suicide risk among the offspring. For each 10-year increase in maternal age, the unadjusted risk reduction was

14% (hazard ratio = 0.86, 95% CI: 0.80, 0.93), and after adjustment for birth order, offspring sex, time period of birth, maternal marital status, and parental educational level, the corresponding risk reduction was 30% (aHR = 0.70, 95% CI: 0.64, 0.77).

In the sibling cohort (Table 3), the unadjusted hazard ratios for birth order and suicide risk were similar to those observed for the total population, but we found no clear association for maternal age at child birth. However, after adjustment for maternal age at child birth and birth order in the same model, the associations among siblings were substantially stronger than were those observed in the total population. For each increase in birth order, the adjusted risk increase among siblings was 46% (aHR = 1.46, 95% CI: 1.29, 1.66). In relation to maternal age at child birth and offspring suicide risk, there was a risk reduction of 57% (aHR = 0.43, 95% CI: 0.30, 0.62) for each 10-year increase in maternal age.

There was no strong evidence that associations between suicide and birth order differed in male and female siblings (P for interaction = 0.41). For each increase in birth order category, the adjusted risk increase was 44% (aHR = 1.44,

Table 2.   Hazard Ratios for Suicide According to Maternal Age and Birth Order in the Total Population, Norway, 1967–2008

Characteristic	No. of Suicides	Crude[a]		Adjusted[b]	
		HR	95% CI	HR	95% CI
Birth order					
First	1,057	1.00	Referent	1.00	Referent
Second	1,065	1.22	1.12, 1.33	1.50	1.37, 1.65
Third	539	1.28	1.15, 1.42	1.73	1.53, 1.95
Fourth or later	344	1.42	1.26, 1.60	2.11	1.81, 2.47
Birth order trend	3,005	1.11	1.08, 1.15	1.26	1.20, 1.31
Maternal age, years					
<20	371	1.00	Referent	1.00	Referent
20–24	1,051	0.72	0.64, 0.81	0.74	0.65, 0.84
25–29	902	0.67	0.59, 0.75	0.63	0.55, 0.73
30–34	457	0.69	0.60, 0.79	0.57	0.48, 0.67
>34	224	0.71	0.60, 0.84	0.50	0.41, 0.61
Maternal age in 10-year intervals[c]	3,005[d]	0.86	0.80, 0.93	0.70	0.64, 0.77

Abbreviations: CI, confidence interval; HR, hazard ratio.
[a] Adjusted for sex, age (time variable), and birth period.
[b] Adjusted for sex, age (time variable), birth period, maternal age, birth order, and parental educational level and marital status.
[c] Maternal age at birth divided by 10.
[d] There were only 2,930 suicides included in the adjusted analysis as a result of participants who were excluded because of missing parental educational level data.

95% CI: 1.26, 1.64) among brothers and 51% (aHR = 1.51, 95% CI: 1.30, 1.76) among sisters. There was some statistical evidence that associations with maternal age differed in sons and daughters (*P* for interaction = 0.06). Among brothers, the risk declined by 60% (aHR = 0.40, 95% CI:

0.27, 0.58) with each 10-year increase in maternal age; the corresponding estimate for sisters was 49% (aHR = 0.51, 95% CI: 0.34, 0.76).

In Table 4, we stratified the analysis of birth order by time interval between births. The results showed that the positive

Table 3.   Hazard Ratios for Suicide According to Maternal Age and Birth Order Among Siblings Within Families, Norway, 1967–2008

	No. of Suicides	Crude[a]		Adjusted[b]	
		HR	95% CI	HR	95% CI
Birth order					
First	859	1.00	Referent	1.00	Referent
Second	927	1.29	1.15, 1.46	1.60	1.37, 1.86
Third	430	1.36	1.14, 1.62	2.12	1.62, 2.76
Fourth or later	242	1.55	1.18, 2.03	3.05	2.04, 4.58
Birth order trend	2,458	1.16	1.08, 1.25	1.46	1.29, 1.66
Maternal age, years					
<20	314	1.00	Referent	1.00	Referent
20–24	926	1.09	0.89, 1.34	0.87	0.69, 1.09
25–29	746	1.14	0.89, 1.46	0.72	0.52, 0.99
30–34	353	1.21	0.88, 1.67	0.62	0.40, 0.96
>34	119	1.21	0.77, 1.89	0.53	0.30, 0.94
Maternal age in 10-year intervals[c]	2,458	1.05	0.85, 1.30	0.43	0.30, 0.62

Abbreviations: CI, confidence interval; HR, hazard ratio.
[a] Adjusted for sex, age (time variable), and birth period.
[b] Adjusted for sex, age (time variable), birth period, maternal age, and birth order.
[c] Maternal age at birth divided by 10.

Table 4. Hazard Ratios for Suicide According to Birth Order Among Siblings Within Families, Stratified by Time Interval From the Birth of an Older Sibling, Norway, 1967–2008

Birth Order by Time After Preceding Child	No. of Suicides	Crude[a]		Adjusted[b]	
		HR	95% CI	HR	95% CI
<2 years					
First child[c]	859	1.00	Referent	1.00	Referent
Second child	253	1.39	1.04, 1.85	1.40	0.99, 1.97
Third child	109	1.95	1.22, 3.12	1.99	1.04, 3.83
Fourth child or more	69	3.34	1.59, 7.03	3.48	1.07, 11.35
Birth order trend	1,290	1.40	1.17, 1.69	1.41	1.04, 1.91
2–3 years					
First child[c]	859	1.00	Referent	1.00	Referent
Second child	436	1.34	1.14, 1.57	1.35	1.01, 1.81
Third child	163	1.32	0.98, 1.77	1.34	0.75, 2.42
Fourth child or more	102	1.61	1.02, 2.55	1.66	0.63, 4.37
Birth order trend	1,560	1.20	1.08, 1.34	1.24	0.93, 1.67
>3 years					
First child[c]	859	1.00	Referent	1.00	Referent
Second child	238	1.01	0.81, 1.27	1.75	1.20, 2.56
Third child	158	1.10	0.79, 1.52	2.65	1.49, 4.72
Fourth child or more	71	1.06	0.58, 1.92	3.46	1.44, 8.37
Birth order trend	1,326	1.02	0.89, 1.17	1.49	1.14, 1.95

Abbreviations: CI, confidence interval; HR, hazard ratio.
[a] Adjusted for sex, age (time variable), and birth period.
[b] Adjusted for sex, age (time variable), birth period, maternal age, and birth order.
[c] All analyses relative to the first child ($n = 859$).

association with suicide risk was strongest if the time interval between births was relatively short (P for interaction = 0.001). Thus, the crude hazard ratio per birth order category was 1.40 (95% CI: 1.17, 1.69) if the time interval was less than 2 years compared with 1.20 (95% CI: 1.08, 1.34) if the interval was between 2 and 3 years and 1.02 (95% CI: 0.89, 1.17) if the interval was 3 years or more. The effect measure modification was attenuated after adjustment for maternal age (P for interaction = 0.03). In separate analyses (Web Table 2), we stratified the association of birth order by sibship size. The positive association of birth order with suicide risk did not substantially differ by size of the sibship. A model excluding 90 multiple births (175 individuals) from the sibling cohort gave almost identical results as those shown in Table 3.

DISCUSSION

In the present large prospective study of suicide before 42 years of age, we found a strong increase in suicide risk with increasing birth order and a strongly reduced risk with increasing maternal age at child birth. We analyzed suicide risk among siblings within families, and therefore the results cannot be explained by early life factors that are expected to have similar influence on siblings.

Strengths and limitations

The main strength of these analyses is the large sample size (2,458 suicides in the analysis of siblings within affected families) that makes chance an unlikely explanation for our findings. Another important strength is that we could assess suicide risk among siblings within families, and therefore important factors that are shared between siblings were taken into account by the study design. These factors include parental educational levels, the socioeconomic situation of the household, parental mental illness, and other shared factors that could be relevant for suicide risk (3).

However, we cannot exclude the possibility that comparisons within families may be vulnerable to time-dependent factors that could influence the internal family environment and have different effects on the siblings. Relevant examples include parental divorce, placement into foster care, the onset of serious mental illness in a parent, domestic violence, or other events that have occurred at different stages of the siblings' lives when age is related the effects of such factors (19, 20). However, these factors could also be considered as possible mediating factors, rather than confounders, because they can be neither causes of maternal age at child birth nor determinants of birth order.

Naturally, birth order is highly correlated with maternal age, and in the analyses of each factor, careful adjustment for

the other factor is essential. This is particularly important because the results of birth order and maternal age show opposite effects on suicide risk. Thus, without adjustment for maternal age, the positive association of birth order would be much weaker than the adjusted association because of the underlying inverse effect of maternal age at child birth.

It is possible that suicide is underreported in the Cause of Death Registry, but this would only bias our results if the underreporting were associated with maternal age at child birth or with birth order. However, the prospective approach of the study makes such a bias unlikely.

Previous studies

The results of a few previous studies have suggested that maternal age at child birth is inversely associated with suicide risk in offspring (5, 6, 9) and that birth order is positively associated with the risk of suicide (5–9). It has also been suggested that low maternal age at child birth is associated with an increased risk of suicide attempts (21). The association of maternal age at child birth in our study was stronger and displayed a linear relation with suicide risk, whereas the results of other studies (6, 9) suggested that the increased risk may be restricted to the offspring of very young mothers (<20 years of age). Family designs with comparisons of siblings have not been previously used in relation to suicide risk, and the advantage of controlling for shared family factors provided by the sibling design of our study may have contributed to the stronger associations. Furthermore, more than 80% of the suicides in our study were included in the sibling cohort, making the results fairly representative of families being exposed to a suicide.

Possible mechanisms

The results from the present study indicate that the associations of maternal age and birth order with suicide are not confounded by socioeconomic or genetic factors. There are several possible mechanisms for the observed associations.

The linear reduction in suicide risk associated with increasing maternal age at child birth may seem surprising because both maternal and paternal age are positively associated with the offspring's risk of serious psychiatric conditions, including schizophrenia, that are associated with increased risk of suicide (22–24). Although serious mental illness is an important risk factor for suicide, these conditions may be too rare to compete with the impact of low social, psychological, and economic resources faced by many young mothers.

The inverse association of maternal age with the offspring's risk of suicide could also be related to the possible stressful situation for younger mothers, as young mothers are more likely to have mental health and family problems, as well as problems at school and with education, employment, and housing (14). Furthermore, it has been suggested that stressful pregnancies may influence fetal brain development and possibly influence the psychological development and mental health of the child (25).

The results from the present study support the view that family relationships and bonds made in early childhood may have an influence on psychiatric morbidity and suicide risk later in life (26–28). Many studies have suggested that first-born children have a more prominent position in the family than subsequently born siblings, and it has been consistently reported that birth order is inversely associated with intelligence (11, 29). Possibly, our findings related to birth order may be relevant within a similar context, suggesting that the older siblings may benefit from this position by a higher degree of stimulation and support during their early years. It is also possible that younger siblings are more easily bullied by older siblings, and it has been repeatedly reported that bullying is a strong risk factor for suicide (30). The strong positive unadjusted association of birth order with suicide was stronger in families with short intervals between births, which supports the theory that decreased nutrition has an impact on the developing brain (12). However, this finding could partly be explained by the protective effect of increasing maternal age.

Implications

Although several twin studies have found only marginal effects of shared family environmental factors on mental health (10), the results of our study strongly indicate that family factors that are not shared by siblings might operate from an early age and influence suicide risk. Furthermore, early motherhood, especially teenage pregnancy, is associated with several adverse psychosocial outcomes in their offspring (14). The incidence of early motherhood varies considerably worldwide (31), and the results of the present study underscore the potential importance of offering support to young mothers and their offspring.

Conclusion

The inverse association of maternal age at childbirth and the positive association of birth order with suicide risk among siblings strongly indicate that family factors that are not shared by siblings may operate from an early age and influence suicide risk. Our study suggests that confounding due to familial factors is not likely to explain the associations of birth order and maternal age at child birth with suicide risk.

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