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Transgenerational concordance in parent-child transmission of suicidal behaviour – a register-based cohort study of 4 419 642 individuals in Denmark

Anne Ranning,^{1,2,3} Trine Madsen,^{1,2,4} Keith Hawton,^{5,6} Merete Nordentoft,^{1,2,7} and Annette Erlangsen^{1,2,8,9}

¹ CORE- Copenhagen Research Center for Mental Health, Mental Health Services in the Capital Region of Denmark, Copenhagen, Denmark

² Danish Research Institute for Suicide Prevention, Mental Health Centre Copenhagen, Copenhagen, Denmark

³ Department of Psychology, University of Copenhagen, Copenhagen, Denmark.

⁴ Section of Epidemiology, Department of Public Health, Faculty of Health, University of Copenhagen, Denmark

⁵ Centre for Suicide Research, University of Oxford, Oxford, United Kingdom

⁶ Oxford Health NHS Foundation Trust, Warneford Hospital, Oxford, United Kingdom

⁷ Department of clinical Medicine, Faculty of Health Sciences, University of Copenhagen

⁸ Department of Mental Health, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA

⁹ Center of Mental Health Research, Australian National University, Canberra, Australia

Corresponding author: Anne Ranning PhD, Copenhagen Research Center for Mental Health – CORE, Gentofte Hospitalsgade 28, opgang 15, 4, 2900 Hellerup, Denmark; E-mail: Anne.ranning@regionh.dk; Telephone: +45 30267320

Panel

Research in context

Evidence before this study

Higher rates of suicide attempt and suicide have been reported for individuals with parents with suicidal behaviour. However, this phenomenon could be explained by shared risk factors, such as mental illness and socioeconomic characteristics, or divergent risk factors, such as sex and age. We searched PubMed with the following string: (((child OR infant OR adolescent) OR ("Child of Impaired Parents"[Mesh] AND "Adult Children"[Mesh])) AND (mother OR father OR parents) AND (suicide OR suicide attempt OR self-harm)) for English language texts as well as reference lists of key papers. An initial search was updated in October 2021. No restriction on calendar time was applied. We found two systematic reviews on transgenerational transmission of suicidal behaviour. The evidence base draws equally on case-control and cohort studies from clinical- or population-based samples of small to moderate size, while a minority of studies did cover the entire population of a country. While population-based findings suggest that transmission of suicidal behaviour might be equally due to genetic factors and rearing, distinct periods of elevated risk were not identified. Higher risks of suicide attempt and suicide have been suggested after maternal than paternal suicidal behaviour. Still, conflicting evidence has emerged as to whether daughters and sons differ in their response to parental suicidal behaviour.

In a previous study, we found that children exposed to parental suicide attempt at young versus older ages had higher rates of suicide attempt themselves. The focus of the present study is on concordance in parent-child transmission of specific suicidal behaviour in terms of suicide attempt and suicide. We thus investigated both types of parental exposure and both types of outcomes in the children.

Also, we wanted to investigate whether the findings from the first study concerning exposure to parental suicide attempt also applied to children of parents who died by suicide. Importantly, it remains to be examined whether age of exposure is a relevant predictor for risks of suicide in children exposed to suicidal behaviour in parents.

Added value of this study

While accounting for relevant confounders, the current study extends the existing evidence by providing a comprehensive assessment of exposure to parental suicide attempt and suicide and associated rates of suicidal behaviour in children. A pattern of parent-child concordance in type of suicidal behaviour was demonstrated. We identified factors and ages associated with elevated rates of suicidal behaviour and found indications that the transmission also applied to choice of methods. Higher odds for violent methods were found for individuals exposed to parental suicide versus suicide attempt in parents. Exposure to parental suicide attempt or suicide in early childhood was associated with higher rates of suicide attempt and suicide when compared to exposure in late childhood.

Implications of all the available evidence

Our findings point to intergenerational transmission of both suicide attempt and suicide, in a pattern of parent-child concordance (i.e. parental suicide to suicide in children and parental suicide attempt to suicide attempt in child), which also might extend to suicide methods. Therefore, inquiry about familial suicidal behaviour should be included when assessing risk of suicide, while taking account of the individuals' age of exposure as well as type and methods of parental suicidal behaviour. Interventions directed at young age groups might be indicated for children exposed to parental suicidal behaviour to mitigate the excess risk of parent-child transmission.

Summary

Background

Suicidal behaviour runs in families, but the nature of transgenerational concordance needs elucidation. The aim of this study was to examine parent-child transmission by investigating whether presence and nature of parental suicidal behaviour was associated with suicidal behaviour in children.

Methods:

A retrospective cohort study was applied to data on 2 256 045 males and 2 163 597 females aged 10 years or older living in Denmark between 1980-2016. Exposure to parental suicide attempt and suicide was identified using information on hospital contacts and causes of death from national registers. We calculated incidence rate ratios (IRR) and cumulative hazards for children's suicide attempt and suicide, taking into account type of parental suicidal behaviour, child's age of exposure and sex.

Outcomes:

In all, 150 222 (3.4%) individuals were exposed to a parent with a suicide attempt, 31 564 (0.7%) suicide, and 12 834 (0.3%) both events. Individuals exposed to parental suicide attempt had higher rates of suicide attempt (IRR=2.7, 95% CI, 2.3-3.2) than individual exposed to parental suicide (IRR=1.8, 95% CI, 1.5-2.1), when compared to non-exposed. Correspondingly, higher rates of suicide were found for individuals exposed to parental suicide (3.2, 95% CI, 2.8-3.6) than those exposed to parental suicide attempt (2.4, 95% CI, 2.2-2.6). Individuals exposed to parental suicide had higher odds (2.0, 95% CI, 1.7-2.3) of violent suicidal methods than those exposed to suicide attempt alone.

Interpretation

A concordant pattern of higher rates of the same type of suicidal behaviour as the one of the parent was noticed, including type of suicide method. Preventive, family-oriented interventions are warranted to mitigate familial transmission of risk, as are clinical considerations of familial exposure in risk assessment of patients.

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Introduction

Suicidal behaviour is recognized as a critical public health problem worldwide, with suicide currently accounting for more than 700 000 deaths globally each year.¹ Suicidal behaviour, defined as suicide attempt or suicide, has been shown to cluster in families², with higher risk of suicide in offspring of parents who died by suicide,³ compared to un-exposed individuals, and in a previous study we found the same pattern of parent-child transmission of suicide attempt in individuals whose parents' attempted suicide⁴. A recent genetic study found evidence of homogeneity in the familial diathesis of suicidal behaviour, with higher correlations for parent to child suicide-suicide transmission and suicide attempt-suicide attempt transmission than for the heterogeneous parent to child transmission of suicide-suicide attempt and suicide attempt-suicide, respectively.⁵ However, level of confounding by age group, socio-economic position,⁶ and mental disorders³ in findings for parent to child transmission needs to be carefully addressed, ideally by applying a population-based cohort design. Risk of suicidal behaviour is not evenly distributed among age groups, which is why it is important to account for age of both parents and children at time of follow-up. The child's age at time of exposure is likely to be another important factor,^{4,7} suggesting that environmental circumstances could play an accentuated role during specific developmental stages of life, referred to as "sensitive periods".⁸ Explanatory factors, such as whether children have a tendency to replicate the parents' suicidal methods, as suggested for suicide contagion and clusters,⁹ remains to be assessed. Seemingly, mother to child transmission is stronger than that for father to child transmission,^{2,10} although some authors have found the opposite or no difference for associations between children's suicidal behaviour and that of parents according to their sex.^{2,5} Conflicting evidence has emerged as to whether daughters and sons differ in their response to parental suicidal behaviour.^{2,5}

The aim of this study was to expand the evidence by investigating concordance in the parent to child transmission of specific suicidal behaviour. We examined whether risk of suicidal behaviour in children differs with respect to type of parental suicidal behaviour, sex of parent, sex of child, child's age at exposure, and whether there was evidence of transmission of methods used for suicidal behaviour.

Methods

Study design and data sources

We applied a cohort study design to nationwide Danish longitudinal register data. The unique personal identification number assigned to all live-born children and new residents in Denmark since 1968 was used to link different registers on an individual level.¹¹ From the Civil Registration System (CRS), we obtained information on dates of birth, death, migration, and links between family members living in the same household. Information on suicide attempts and psychiatric diagnoses was retrieved from the Psychiatric Central Research Register (PCRR) and the National Patient Register (NPR), which have recorded data on all psychiatric and somatic inpatient admissions since 1969 and 1977, respectively. From 1995 onwards, both registries also included data on outpatient and emergency room contacts. Information about suicide and other deaths was obtained from the Cause of Death Register, available from 1970 for suicide deaths and 1980 for other causes. Data on education¹² and socio-demographic information for individuals and their parents were retrieved from other registers at Statistics Denmark.

Study population

All individuals born after 1953 and aged 10 years and older who were recorded as living in Denmark at some point during January 1st of 1980- December 31st of 2016 were included. Age 10 was chosen as there are very few cases of self-harm and suicide before this age.¹³ Also deliberate self-harm can more reliably be distinguished from accidental self-harm due to a certain level of maturity at this age. Birth cohorts born after 1953 have been shown to have an almost complete data linkage between children and legal parents.¹¹ The age-range of individuals during follow-up was 10 to 63 years. Adults listed as living with the child at first registration in the CRS were considered as parents, while later records of different legal parents allowed identification of potential step-parents (see appendix p 1). We censored individuals who migrated or died by other causes during study follow-up.

Exposures

We examined the following parental exposures, where ‘parental’ denotes the event of either a mother or a father: parental suicide attempt, parental suicide, and both events (i.e. suicide attempt and suicide in one or more parents). We identified suicide attempts recorded from somatic or psychiatric hospitals either as a diagnosis according to the International Classification of Diseases 8th or 10th revision (ICD-8: E9500–E9599; ICD-10: X60–X84) or as the reason for the contact. For the purpose of this study, we consider suicide attempt as any non-fatal intentional self-inflicted poisoning or injury, which may or may not have had fatal intent.¹⁴ Suicide deaths were identified in the Cause of Death Register (ICD-8 codes E950-E959 or ICD-10 codes X60-X84, Y87.0). Using data on family links, the first date of a parent’s suicide attempt or suicide was considered as date of beginning of exposure, also if this occurred before the birth of the individual or before inclusion in the study, i.e. below the age of 10 or prior to 1980.

Outcome measures

The examined outcomes were suicide attempt and death by suicide in individuals, identified using the same ICD codes and data sources as described above.

Covariates

We adjusted for *calendar period* (1980-1989, 1990-1999, 2000-2016) and *current age group* (10-14, 15-19, 20-24, 25-29, 30-39, 40-49, 50-63 years), *living with both parents* (no, yes), *sibling(s)* (no, yes), *parents separated* (no, yes), *mother's and father's age at child's birth* (<24, 24-29, 30-39, 40≤), *parents' level of education* based on International Standard Classification of Education¹⁵ (ISCED level: 0-2 basic education, ISCED level: 3-4 high school/vocational training, ISCED level 5-8: university degree or higher, ongoing/missing), *parents' socio-economic status* (employed/studying, unemployed, disability pension, retired/other/missing), *parents' mental disorders* (measured as none, any of the following disorders: schizophrenia spectrum, bipolar disorder, other affective disorders, anxiety and somatoform disorders, personality disorders, and other disorders). Covariates were entered in the analyses as time-dependent factors and were updated on a yearly or earlier basis.

Statistical analyses

Incidence rate ratios (IRR) were calculated using Poisson regression models. Rates of suicide attempt in individuals exposed to parental suicide attempt, parental death by suicide, or both types of suicidal behaviour were compared to that of individuals not exposed. The same procedure was used to compare rates of death by suicide in individuals. Multivariate regression models were constructed using time-varying covariates, where data was updated on a yearly basis or exact data

as available. Any over-dispersion was accounted for using Pearson or a Negative Binominal distribution. Two models were examined, Model 1: Basic adjustment for calendar period and current age group and Model 2, which in addition to Model 1, included living with both parents, siblings, parents separated, maternal and paternal age at child's birth, parents' level of education, parents' socio-economic status, and parents' mental disorders. Model 1 accounts for established confounders, while the additional covariates in Model 2 might act as mediators, i.e. be on the causal pathway between the examined exposure and outcome. When examining outcome of suicide attempt, individuals were censored at the date of a first suicide attempt. In interaction analyses we tested whether child sex modified the association between parental type of suicidal behavior and child rates of suicide attempt and suicide, respectively. Analyses stratified by parental suicidal behaviour, parental mental illness and child mental illness were conducted. We furthermore examined whether rates for child's suicide attempt and suicide differed with respect to child's age at parental suicidal behaviour (before birth - 1 year, 2-5 years, 6-14 years, and ≥ 15 years). In subgroup analyses of individuals exposed to parental suicidal behaviour who also themselves had suicidal behaviour, we examined by X^2 -test and logistic regression and crude estimates of whether child's risk of using a violent (*hanging, shooting, fire, jumping and moving object*) versus non-violent (*poisoning, drowning and cutting*) method depended on whether the exposure was to parental suicide attempt or suicide. Cumulative hazard curves were estimated using a Cox model to examine risk of SA in relation to exposure as well as child's age of exposure. These analyses accounted for competing risks due to death or emigration.

Data processing and analyses was performed using SAS Institute version 9.4. The project was approved by the Danish Data Protection Agency (RHP-2012-021).

Role of the funding source

The authors confirm that the funding source had no influence on the decisions regarding study design, data collection, analysis, interpretation of data, the writing of the report, and submission of the paper for publication.

Results

In all, 4 419 642 individuals aged 10-63 years were observed over 95 791 582 person-years during 1980-2016. Of these, 150 222 individuals (3.4%, mean age at exposure =11.7 years, SD=14.0) were exposed to at least one parent with a history of suicide attempt, 31 564 (0.7%, mean age at exposure 20.4, SD=11.4) to at least one parent who died by suicide, and 12 834 (0.3%) to both types of event. In all, 7872 suicide attempts occurred among individuals exposed to parental suicide attempt (n=6427), parental suicide (n=950), or both events (n=495), while 68 503 were observed among those not exposed (Table 1). Suicide occurred in 1015 individuals exposed to parental suicidal behaviour, i.e. parental suicide attempt (n=631), parental suicide (n=295), or both events (n=89) (Table 2). Among those not exposed, 9973 died by suicide during follow-up.

A suicide attempt rate of 239.1 per 100 000 person-years (95% CI, 233.6-245.3) was found for individuals exposed to parental suicide attempt, while those exposed to a parent's suicide had a rate of 132.7 (95% CI, 124.3-141.2) and those exposed to both events had a rate of 200.6 (95% CI, 182.9-218.3) (Table 3). The rate of suicide attempt in those not exposed was 75.2 (95% CI, 74.7-75.8).

When adjusting for relevant covariates in model 1, we found a higher incident rate ratio (IRR) of suicide attempt for individuals exposed to a parental suicide attempt (IRR, 2.7, 95% CI, 2.3-3.2) than for those exposed to parental suicide (IRR, 1.8, 95% CI, 1.5-2.1) or both events (IRR, 2.5, 95% CI, 2.1-3.0) in comparison to not exposed individuals. A maternal suicide attempt was associated with a 3.2-fold higher rate of suicide attempt in the child (IRR, 3.2, 95% CI, 2.6-3.8), while a paternal suicide attempt was linked to a 2.7 (IRR, 2.7, 95% CI, 2.2-3.3) higher rate when compared to those not exposed. Being exposed to suicidal behaviour in both parents was linked to a higher IRR (IRR, 5.8, 95% CI, 3.8-8.9). The highest IRR of suicide attempt (IRR, 1.8, 95% CI, 1.5-2.1). Differences in IRRs between exposure groups as well as age-group at exposure remained statistically significant in model 2. Highest IR for suicide attempt were found at age 15-19 years (Table 1). Analyses stratified by child's sex revealed a similar pattern (Appendix p 4). The interaction analyses exploring whether parental type of suicidal behaviour had different effects on girls' and boys' risk of suicide attempt and suicide, respectively, were insignificant, i.e. indicating no modifying effect by sex of child. Individuals exposed to parental suicidal behaviour were found to have excess rates of suicide attempt during adolescence and young adulthood (15-19 years: IRR, 6.4, 95% CI, 6.1-6.7), 20-14 years: IRR, 4.7, 95% CI, 4.5-4.9) (Appendix p 2-3).

Individuals exposed to parental suicide attempt had the highest lifetime cumulative hazard (CH) of suicide attempt (CH=0.07), whereas lower hazards of suicide attempt were noted for individuals exposed to parental suicide (CH=0.04) and among un-exposed individuals (CH=0.03) (Figure 1.) Parental suicide attempt and parental suicide before the child's 15th birthday were associated with cumulative hazards for suicide attempt in individuals of 0.10 and 0.06 respectively (Figure 2).

Individuals exposed to a suicide of a parent had a suicide rate of 40·2 (95% CI 35·6-44·8) per 100 000 person-years, while those exposed to a parental suicide attempt had a rate of 22·7 (95% CI 20·9-24·4) and those exposed to both of these events had a rate of 34·6 (95% CI, 27·4-41·8) (Table 4). Those not exposed had a suicide rate of 10·8 (95% CI, 10·6-11·1).

Higher IRRs for suicide were found for individuals exposed to parental suicide (3·2, 95% CI, 2·8-3·5) than parental suicide attempt (2·4, 95% CI, 2·2-2·6) when compared to individuals not exposed to any of these events, and adjusting for calendar period and age group. Individuals who experienced suicidal behaviour in more than one parent had an IRR of suicide of 4·4, 95% CI, 3·5-5·7 versus non-exposed. The highest IRR was noted for individuals exposed to parental suicide attempt at age 2-5 years (3·6, 95% CI, 2·7-4·9) when compared to those not exposed. With respect to parental suicide, the highest IRR was also found for individuals exposed at ages 2-5 years (4·1, 95% CI, 2·6-6·4). When additionally adjusting for socio-economic status and mental illness in model 2 the IRRs were attenuated but remained statistically significant. A pattern similar to the above was found in the models stratified by child's sex (Appendix p 5). Analyses stratified by mental illness showed higher rates of suicide and suicide attempt, respectively, in those categories where the child had mental illness compared to categories where only parents had either mental illness and/or suicidal behaviour (see IRR estimates appendix p 6-7). The highest lifetime cumulative hazard of suicide was found in individuals exposed to parental suicide (0·014) and was lower for those exposed to parental suicide attempt (0·008) and not exposed (0·004) (Figure 1). Individuals exposed to parental suicide attempt or suicide at a young age (before birth-age 5/age 6-14) had the highest cumulative hazards for suicide (Figure 2).

If the parent had had a suicide attempt by poisoning, this method was also the most used among their children who died by suicide (Appendix p 8). Similarly, hanging or poisoning were found to be the most used methods if the parent who died by suicide used this method. A higher proportion of individuals used violent methods among those exposed to suicide (16.6%) rather than a suicide attempt of a parent (7.0%, $p = .01$) (Table 5). In fact, individuals were more likely to use violent methods if exposed to a parental suicide (odds ratios (OR): 2.0, 95% CI, 2.0-2.3) or several parental suicidal events (OR: 1.5, 95% CI, 1.5-1.9) compared to suicide attempt alone (Appendix p 9).

Discussion

In this nationwide study, transgenerational transmission of suicidal behaviour was demonstrated in that exposure to parental suicidal behaviour was associated with increased rates of both suicide attempt and suicide. In absolute numbers, suicide attempt was the most prevalent outcome for both individuals exposed to parental suicide attempt and suicide, reflecting the relative incidence of these behaviours in the general population.^{13,16} However, our results show transgenerational concordance in the parent-child transmission of suicidal behaviour as individuals exposed to one type of parental suicidal behaviour had higher relative rates of the same type of behaviour themselves. The transmission included choice of method in that higher odds for individuals' utilization of violent methods were found when exposed to a violent parental suicidal method. Stronger transmission of both suicide attempt and suicide was associated with maternal than paternal suicidal behaviour. Also, stronger transmission of suicidal behaviour occurred in individuals exposed at a younger age than in those exposed at older ages.

Supporting previous findings, we found evidence of concordant parent-child transmission i.e. increased rates were identified for children with the same type of suicidal behaviour (i.e. non-fatal or fatal) as their parents than for dissimilar behaviour.⁵ The higher prevalence of violent methods of suicidal behaviour among children of parents who died by suicide may be an explanation for this, as lethality of methods could explain the higher rate of fatal outcome of suicidal behaviour in individuals whose parents died by suicide compared to those whose parents survived a suicide attempt. Social learning (i.e. the process of acquiring behaviours by imitating others), has been suggested as having an important environmental influence on both familial and non-familial transmission of suicidal behaviour.^{9,17} This may also play a role in individuals' choice of suicidal method, and explain the over-representation of violent methods in individuals whose parents died by suicide. The same mechanism might also explain the higher rate of suicidal behaviour associated with maternal versus paternal suicidal behaviour, as most children spend more time with mothers, thus having greater potential exposure to their suicidal behaviour. The pattern of concordance in parent-child transmission of suicidal behaviour persisted after adjustment for familial psychopathology, age, socio-economic factors and other known risk factors for the behaviour. However, other important factors may distinguish children of parents who died by suicide compared with those who made suicide attempts which were not accounted for by the information available in the registers, such as impulsive and aggressive behavioural traits.¹⁸

Our finding of attenuated associations in the parent-child transmission after adjustment for parental psychiatric disorders corroborate those family studies, which indicate that psychiatric disorders account for familial transmission of suicidality to a moderate degree.^{5,19} Another environmental factor of similar importance is exposure to a stressful home environment or insufficient nurturing during upbringing, including insecure or dysfunctional parent-child interactions.²⁰ In addition, intergenerational transmission of suicidal behaviour may be related to genetic factors, for instance

through transmission of psychiatric disorders and personality characteristics associated with elevated suicide risk.^{21,22} Although single gene-elements, i.e. nucleotide polymorphisms, have been linked with suicide attempt in molecular data, this association was partly due to psychiatric disorders.²² Indeed, we found, mental illness in the individuals themselves to be associated with rates of suicidal behaviour far exceeding those for exposure to mental illness and suicidal behaviour in the parents.

Our findings of elevated rates of both suicide attempts and suicide among children exposed to parental suicidal behaviour during early childhood compared to late adolescence corroborate previous findings.^{4,7} This suggests that environmental circumstances may play an accentuated influential role during early child development,⁸ a phenomenon which has been demonstrated for early exposure to a wide range of parental risk factors such as psychiatric and somatic disability pension²³ and traumatic life events²⁴. Early life-stressors, such as traumatic experience of parents' life-threatening behaviour and grief, have also been linked to poor emotional regulation and higher risks of psychopathology later in life²⁵, possibly contributing to higher risk of suicidal behaviour. Indeed, early exposure to stressful exposures may result in a longer period over which adverse effects might accumulate.

In terms of implications, our findings underscore the importance of enquiring about family history, including of suicide and attempted suicide in family members when assessing suicide risk in patients. In particular, information on timing of such acts might enable the clinician to be aware of the age at which patients were exposed to the behaviour, or whether the behaviour occurred before the patients' birth. Gaining information about methods involved in parental suicide or attempted suicide might assist in alerting the clinician to methods they should be particularly aware of when

assessing risk in patients and doing safety planning.²⁶ Also, the current age of the patient is an important factor in risk assessment considering the excess suicide attempt risks in the adolescent years.²⁷

In terms of preventive efforts, the time when a parent is hospitalized after a suicide attempt presents a unique opportunity to provide support for both the parent and their children. The fact that early exposure to parental suicidal behaviour imposed higher risk on children throughout their life-course underscores the importance of providing supportive intervention for affected families, focusing on reducing parental stress and improving quality of parent-child interaction, factors previously documented as problematic for parents at risk for suicidal behaviour.²⁰

Limitations to the study include that data was only available until 2016, and that data on suicide attempts, in particular emergency room presentations, were only available from 1995. Also, suicide attempts are considered to be under-recorded in Danish hospital registries.¹³ Additionally, many individuals do not seek hospital care after suicide attempts.²⁸ Altogether this implies an under-recording of exposure to parental suicide attempts and suicide death, thus, likely to bias our estimates in a conservative direction. The rates and cumulative risks are conservative estimates. The definition of parents was based on the adults living with the child at the time of birth may lead to misclassification. Furthermore, it prevented affirmative identification of biological parents. Also, possible correlations between siblings were not accounted for in the statistical analyses. Data on self-reported ethnicity are not collected in the Danish registers. Register data have a low level of detailed information on factors such as the quality of home environment and psychological wellbeing of children, resulting in multiple unmeasured, and potentially significant explanatory factors.

To conclude, the results of the study show inter-generational transmission of suicidal behaviour, demonstrating a pattern of parent-child concordance in type of suicidal behaviour as well as suicidal

methods. Bearing in mind the excess risk among individuals exposed at a young age, early preventive interventions are warranted as are clinical considerations of familial exposure in risk assessment of patients.

Contributors

AR, AE, TM, KH and MN conceived the idea for the study. AR, AE and TM selected the study design and made the plan for the analyses. AR, AE and TM conducted the data management, analyses and all had access to data. AR and AE wrote the first draft of the manuscript. KH drafted the section on clinical implications. All authors interpreted the results, commented upon the manuscript, and had the final responsibility for the decision to submit for publication.

Declaration of interests

We declare no competing interests.

Data sharing

Data for this study are property of Statistics Denmark and The Danish Health Data Authority. The data are available from these authorities, but restrictions apply.

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Figure 1. Cumulative hazard of suicide attempt and suicide according to exposure to parental suicide attempt and suicide.^a

^a Individuals exposed to parental suicidal behaviour prior to birth were excluded from these analyses (n=4,472,944). If children were exposed to multiple events of parental suicidal behaviours, age at first exposure was used. Follow-up commenced at age 10 and ended upon first migration out of the country, any/other cause of death, or December 31st of 2016, which ever occurred first.

Figure 2. Cumulative hazards of suicide attempt or suicide according to age of individuals at exposure to parental suicide or suicide attempt.^a

^a Individuals exposed to parental suicidal behaviour prior to birth were excluded from these analyses (n=4,472,944). If children were exposed to multiple events of parental suicidal behaviours, age at first exposure was used. Follow-up commenced at age 10 and ended upon first migration out of the country, any/other cause of death, or December 31st of 2016, which ever occurred first.