

Mental Health in Adulthood after Prenatal Exposure to Maternal Stress due to Sudden Loss of Close Relatives.

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Topic

It is well-established that unanticipated loss of a close family member has a marked impact on the mental health of a person left behind (e.g., Broos et al., 2025; Guldin et al., 2017; Kristensen et al., 2012; Pitman et al., 2020). The premise of the current study is that the mental health effects resulting from such life events may ripple through the family even more widely than commonly considered. Specifically, we assess the long-term mental health implications of being born to a mother who was exposed during pregnancy to the sudden loss of a parent or sibling.

Maternal losses during pregnancy have been linked to poorer mental health in offspring, yet causal evidence on in-utero effects remains limited. Since losses during pregnancy and mental health problems are more likely to occur to certain socio-economic groups, previous findings comparing those exposed to maternal loss in utero with the general population may partly reflect social differences rather than true effects. Our study accounts for these factors by comparing those exposed in utero to those exposed shortly after birth, to provide novel causal evidence on the long-term mental health consequences for offspring of maternal loss during pregnancy.

Theoretical focus

A substantial body of work exists on the direct mental health implications of one person's sudden death on the mental health of a loved one (e.g., Broos et al., 2025; Guldin et al., 2017; Hamdan et al., 2020; Kristensen et al., 2012; Pitman et al., 2020). We connect this health spillover literature to the work on the developmental origins of health and disease (Barker, 2004), and explore whether *indirect* spillover effects, i.e., from a pregnant woman's parent or sibling via the pregnant woman to her offspring in utero, can also be noted. This is to be expected because exposure to maternal stress in-utero takes place at a critical period for the development of health and disease, i.e., a limited time window in which an exposure can have adverse or protective effects on development and subsequent disease outcome (Barker, 2004; Kuh et al., 2003).

Raised levels of maternal stress may eventually increase cortisol levels a fetus is exposed to (Togher et al., 2014), which may be damaging to the fetus (Beijers et al., 2014). The excess cortisol

may cause the fetal hypothalamic-pituitary-adrenal (HPA) axis to be programmed for survival in high-stress environments (McGowan & Matthews, 2018; Ruffaner-Hanson et al., 2023), implying a mismatch between expected and actual postnatal environment (Dieckmann & Czamara, 2024). Hyperactivity of the HPA-axis implies increased responsivity to stressors, which may put individuals at long-term increased risk for mental health problems (Braithwaite et al., 2014; Class et al., 2014; Kim et al., 2015; Kingsbury et al., 2016; Van Den Bergh et al., 2017).

Data

We draw on administrative data from multiple sources covering the full population of Norway. Using the Norwegian Population Register we identified mothers, their parents, full siblings, their children and their children's month and year of birth. These records were then matched to the Norwegian Cause of Death Register via the unique personal identification number, to determine whether a mother had lost a parent or sibling to an accident (ICD-10, codes V01–X59, Y85–Y86), stroke (ICD-10, codes I60-I69), suicide (ICD-10, codes X60-X84, Y87.0) or acute heart attack (ICD-10, codes I21-I22).

We use routinely collected data from the Control and Distribution of Health Reimbursement database (KUHR) and the Norwegian Patient Register (NPR) for the period 2008-2019 for our outcome variable, which captures mental healthcare services use as a proxy for mental health. We coded people as users of mental healthcare services in a particular calendar year when the KUHR or NPR registers indicated that in that specific year they had had at least one face-to-face general practice consultation where a symptom or diagnosis of a mental health problem was reported (International Classification of Primary Care (Version 2, ICPC-2) codes P01-P99), or at least one specialist consultation where a mental disorder (International Classification of Disease (version 10, ICD-10) codes F01-F99) was reported as a main or secondary diagnosis.

Methods

To address selection issues caused by the social gradient in both exposure and outcome, we adopt an approach that centers on the *timing* of the exposure. This design builds on the premise that treatment and control group are similar in terms of confounding characteristics, but differ on whether the loss occurred during or, instead, shortly after pregnancy. This accounts for unobserved characteristics that may set eventually exposed individuals apart from those that are not exposed to maternal losses around pregnancy. Hence, our estimates are not susceptible to bias due to residual confounding related to unobserved characteristics that may influence both

the mother's risk of exposure to unexpected loss of close kin and her offspring's likelihood of using mental healthcare.

Moreover, we use a broader definition of mental health than prior studies have done. This approach allows us to shed light on milder mental health concerns that, while not always confined to specialized care or tied to specific diagnoses, are still serious enough to require medical attention. Lastly, we focus on sudden deaths only, rather than all causes of death. With anticipated deaths, the exposure is partly also the stress that derives from experiencing a long illness or sickbed in a relative, rather than from the actual loss of a relative. In study designs like ours, where the control group consists of individuals that are exposed shortly after birth, this may lead to underestimation of effects.

We estimate linear probability models using pooled ordinary least squares regression. Our outcome variable captures whether or not an individual used mental healthcare in year t . Our central explanatory variable captures the timing of maternal bereavement. In the simplest model this variable is dichotomous, distinguishing between maternal exposure during pregnancy versus after giving birth. In a second model, it is a vector of indicators capturing the timing of maternal exposure during pregnancy in a more refined way (first, second, or third trimester), with maternal bereavement occurring post-birth as the reference category.

We include categorical explanatory variables for the individuals age (16-24 (ref), 25-33, 34-42, 43-51, 52-59) and for calendar year to account for age- and period-specific patterns of mental healthcare use. Models are adjusted for the individuals birth month and sex. Standard errors clustered at the individual to account for repeated measures data.

Findings

Exposure to maternal loss in utero significantly increases the probability of using mental health care in later life with 1.03 percentage point (95% CI [0.10, 1.95], $p = .030$), compared to exposure to maternal exposure to loss post birth. More specifically, as also shown in figure 1 below, relative to their counterparts born to mothers exposed after giving birth, our results show that maternal exposure in trimester 1 (1.69 p.p., 95% CI [0.24, 3.14], $p = .022$) and in trimester 3 (1.80 p.p., 95% CI [0.30, 3.14], $p = .022$) was associated with a raised risk of the child's mental healthcare use later in life. No significant effect was found for exposure in trimester 2 and the coefficient estimate was close to zero (0.029 p.p., 95% CI [-1.19, 1.25], $p = .963$).

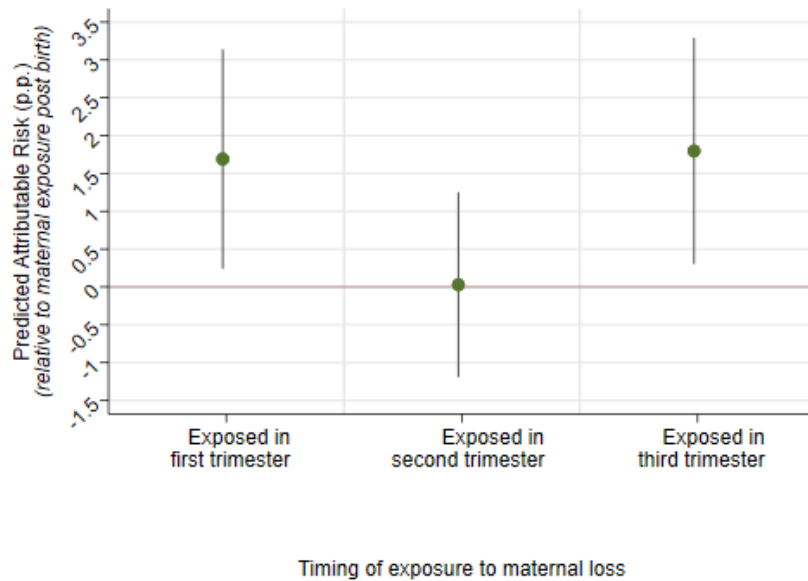


Figure 1: Survival curves for married men and women, by individual own education and partner’s education

Additional analyses show that results are particularly driven by parents, rather than siblings. Moreover, they are particularly driven by natural causes of death (i.e., strokes and acute heart attacks) rather than external causes of death (i.e., suicides and accidents). Lastly, they are mostly driven by GP-visits related to mental health, rather than by specialized mental healthcare treatments. We also repeat our analyses including all causes of death to enable better comparison with earlier research; effect sizes are arguably smaller and statistical significance is weaker.

Discussion

Although mental health impact of a sudden loss of a close relative is large, bereaved persons also tend to recover swiftly after sudden losses (Bélanger et al., 2024; Broos et al., 2025; Hart et al., 2022). Less is known about the intergenerational mental health impact if such losses occur during a pregnancy. Drawing on Norwegian register data, we estimated linear probability models to investigate what the impact of sudden maternal losses of close relatives during pregnancy on later-life mental health of offspring, compared to those who experienced similar events shortly after pregnancy. Our findings highlight that maternal distress during pregnancy has long-term implications for offspring mental health, especially when exposed in the first or last trimester. Increased attention for maternal mental health concerns is therefore crucial to prevent effects from spanning generations and to help reduce health disparities associated with social inequalities.

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