CENTER FOR
ECONOMIC
BEHAVIOR &
INEQUALITY

CEBI WORKING PAPER SERIES

Working Paper 10/20

SHORT- AND LONG-TERM CONSEQUENCES OF SERIOUS PARENTAL HEALTH SHOCKS

Ida Lykke Kristiansen

ISSN 2596-44TX

CEBI
Department of Economics
University of Copenhagen
www.cebi.ku.dk

Short- and Long-Term Consequences of Serious Parental Health Shocks*

Ida Lykke Kristiansen

University of Copenhagen, Department of Economics & CEBI, Denmark

March 25, 2020

Abstract

I show that serious, yet common, parental health shocks in childhood have immediate and lasting effects on mental health and human capital formation for children. Children who experience a parental health shock are more likely to have therapy and take anti-depressant medication following the shock. These children have lower test scores and school enrollment rates. The effect occurs immediately following the shock and persists at least into early adulthood. I find that the effect on test scores is no different for children in high- and low-income families, but the families react differently to the shock; children from low-income families are more likely to be prescribed anti-depressants following the shock, while children from high-income families are more likely to have therapy. In addition, I find suggestive evidence that children who take anti-depressants following a parental health shock have lower educational attainments in early adulthood, while therapy doesn't have harmful long-term effects.

*I am thankful to many who have discussed this paper with me and who have provided useful comments and feedback, particularly Torben Heien Nielsen, Søren Leth-Petersen, Miriam Wüst, David Chan, Peter Lundborg and Gordon Dahl, participants in seminars at CEBI, VIVE and the ESPE 2018 conference.
Contact information. `ilk@econ.ku.dk`. The activities of The Center for Economic Behavior and Inequality (CEBI) is funded by the Danish National Research Foundation

1 Introduction

In the US, 2.9 million children live with a parent who have been diagnosed with cancer (Weaver et al., 2010) and 5 % of American children have lost their mother or father (Owens, 2008). In an average primary school class in Denmark, two to three children will experience a serious health event affecting their mother or father, and one child will lose a parent before graduating high school (own calculations). When a parent falls ill the entire family may be affected. It can reduce the time the child spends with the parent (Morefield, 2010), and it may alter the family's financial resources (Meyer and Mok, 2019; Dobkin et al., 2018).[1] Experiencing a parent passing amplifies the risk of mental health problems (Appel et al., 2016, 2013) and raises the child's level of stress, not only immediately after the shock, but also much later with an elevated level of cortisol detectable 30 years after the parental loss (Nicolson, 2004).

I study the effect of serious parental illness and death during childhood (11.8 % and 4.8 % of the sample), using administrative data for all children born in Denmark between 1972 and 1998. More specifically, I examine the consequences of parental hospitalizations with the diagnoses cancer (6.9 %) and acute cardiovascular disease (5.6 %) on the child's mental health, measured by use of therapy and anti-depressant consumption, and the child's educational achievement, measured by school test scores and post-compulsory school enrollment.

Using an event study method, I find an immediate and lasting negative response to a serious parental health shock on measures related to the child's mental health. One year after the parental health shock, the use of therapy increases 2.4 percentage points compared to the years before the shock. Anti-depressant consumption increases at a steeper rate compared to the pre-period, and four years after a serious parental health shock the child has a 2.3 percentage point higher probability of consuming anti-depressants.[2]

Emotional distress can impact other outcomes such as educational achievements (Conti et al., 2014), and increased levels of cortisol have been shown to impact test outcomes negatively (Heissel et al., 2018; Suor et al., 2015). I therefore investigate whether there is an immediate impact on the child's test score and school enrollment, possibly caused by a decline in psychological well-being. I exploit the randomness in the exact timing of a parental health shock within a short period of time in a quasi-experimental design. Experiencing a parent's hospitalization

[1] In the Danish setting individuals are insured through the public system, household income is stable following a serious non-fatal health shock (Fadlon and Nielsen, 2015; Heinesen and Kolodziejczyk, 2013).

[2] This corresponds to an increase of 300 %. In comparison Rossin-Slater et al. (2019) finds an increase of 21.4 percent on anti-depressant consumption two years after exposed to fatal school shootings in the US

with cancer or an acute cardiovascular disease shortly before an exam decreases the child's test score significantly by 9.8 percent of a standard deviation. In addition, the shock reduces school enrollment significantly from one to five years after the ninth grade, resulting in an increased probability of having compulsory education as the highest level of completed education five years after having completed ninth grade.[3] The results indicate that emotional distress impacts the child's school achievements, and that time before educational decision-making is a sensitive period for later educational attainments.

I study whether some factors mitigate the negative effects. I find no evidence that the immediate negative impact on test score varies between families with different incomes or nuclear and divorced families. However, families react differently with regards to mental health treatment. Children from low-income families are more likely to get anti-depressants following the shock, whereas children from high-income families are slightly more likely to get therapy. Children from divorced families are more likely to get therapy and anti-depressant medication following a serious parental health shock compared to children in nuclear families. This suggests that family structure can be a mitigating factor. The results indicate that children from different types of families are affected in a similar way when looking at school test scores. What seems to differ across families is the behavioral response to the shock.

To investigate how a serious health shock to the mother or father affects the child in the long term, I use a sibling fixed effects design. I utilize variation between biological siblings who experience a parental illness at the same point in time, but at different ages. I find that shocks in early childhood have a larger negative effect on later outcomes compared to shocks in later childhood. On average, every additional year with a healthy parent decreases the probability of having therapy and taking anti-depressants during childhood and early adulthood by 0.1-0.4 percentage points per year and increases the grade point average (GPA) by 1.6 percent of a standard deviation. The results are consistent with the predictions from the *The Skill Formation Model* (cf. Cunha and Heckman (2007)). One potential explanation is that parental investments yield a higher return in early childhood compared to later childhood.

Mental health problems during childhood can be damaging for the child's human capital formation, even more than physical health problems during childhood (Lundborg et al., 2014; Currie, 2009; Currie and Stabile, 2006). I investigate whether use of therapy or anti-depressant medication following the serious parental health shock can mitigate the negative long-term ef-

[3]Ninth grade is the last year of compulsory education in Denmark

fects. I exploit differences in prescription rates between doctors as an instrument for the child's use of treatment. The results suggest that children who are prescribed anti-depressant medication following a parental health shock have lower educational attainments in early adulthood, indicating harmful effects of anti-depressant use during childhood as a response to a serious parental health shock. Using therapy following the parental health shock does not seem to have the same harmful effects on educational attainments.

A growing body of empirical literature, mostly in a developing country setting, estimates the effect of parental health shocks. Only a few papers focus on non-fatal parental health shocks and find negative or no effect of poor self-reported health measures on the child's educational attainments (Luca and Bloom, 2018; Le and Nguyen, 2017; Bratti and Mendola, 2014). Rellstab et al. (2020) study the effect of experiencing a parent's health shock on adult children's employment and wages and find no effect using data from the Netherlands. Studies focusing on parental death conclude, in line with this paper, that an adverse health event can have negative consequences for the child's educational attainments (Luca and Bloom, 2018; Kailaheimo-Lönnqvist and Erola, 2016; Senne, 2014; Cas et al., 2014; Gimenez et al., 2013; Chen et al., 2009; Ainsworth et al., 2005; Gertler et al., 2004) as well as adult earnings (Adda et al., 2011; Fronstin et al., 2001). Norén (2020) find negative effects of a parental death on adult children's income and employment using Swedish data. However, the effect already exist in the years leading up to the time of death, possibly caused by parental illness and the children needing to care for their parents. Norén (2020), however, do not find any employment or income effects from experiencing a parent suffering from a stroke.

I contribute to the literature in three ways: First, I complement the studies of parental deaths with non-fatal health shocks, which are more commonly experienced. Focusing entirely on death may underestimate the effect, as most deaths are caused by disease and the negative effects may coincide with the occurrence of the illness, thus before death. More children may experience a non-fatal parental health shock in the future as medical advances improve survival rates (OECD, 2018) and as parents tend to be older (OECD Family Database, 2018) and health shocks are age dependent. Second, I study how the negative effects progress, by separating the effect of a parental health shock into an immediate and permanent effect. Only few studies make this division (Cas et al., 2014; Senne, 2014; Gimenez et al., 2013). The underlying mechanisms may differ, thus, dividing the effect into an immediate and permanent effect is important for potential policy implications. Lastly, to the best of my knowledge, I am the first to quantify the effect of a serious parental health shock on the child's mental health while accounting non-random selection into a health shock.

The remainder of the paper is organized as follows: Section 2 describes relevant background information and the data set. Section 3 presents the research designs. Section 4 presents the results and robustness checks. Finally, the paper is concluded in section 5.

2 Background

2.1 Institutional setting

Health care system: Health care is universal in Denmark and the universal public health insurance covers most costs related to illness. Following a non-fatal health shock the workplace is required to pay wages for at least four weeks of illness, and family income remains stable (Fadlon and Nielsen, 2015; Heinesen and Kolodziejczyk, 2013). If an illness is prolonged, sickness benefits are paid by the state and income is insured through the public sector. In the case of death, the widow is not entitled to income compensation, and the household income is thereby affected (Fadlon and Nielsen, 2015).

School system: Compulsory education lasts nine years (first to ninth grade). Children usually start first grade in the calendar year they turn seven, and, thereby, finish ninth grade the year they turn 16.[4] During the period of this analysis, ninth grade exams were not compulsory, and the children did not need to pass the exams to proceed in the educational system. After finishing ninth grade, children can choose to attend an optional tenth grade, enroll in senior secondary education or leave school and take up unskilled labor. Before enrollment in tenth grade or senior secondary schooling the child needs to apply around 6 months before. Almost half of the children graduating from ninth grade choose to do tenth grade, and around 8 percent leave the education system after finishing ninth grade.

Support to children of ill parents: When a patient is seriously ill, it is recommended that the health care workers always identify whether the patient has children. If that is the case, the health care worker should provide the patient with relevant information about how to talk to their children about illness and provide the parents and children with information

[4]Around 10 percent of children start the year they turn eight and consequently finish ninth grade the year they turn 17.

about support systems (Sundhedsstyrelsen, 2012).[5] However, a report by The Danish Nurse Organization (*Dansk Sygeplejeråd*) indicates that only half of the surveyed health care workers comply with the recommendations, and deviations from the guidelines are primarily caused by lack of knowledge and time (Dansk Sygeplejeråd, 2018).

The child can get support within the public sector: Close relatives of the seriously ill or deceased, can, with a referral from their General Practitioner (GP) access subsidized psychological treatment (Retsinformation, 1992). The GP acts as a gatekeeper; to get a referral, the patient must be in a crisis triggered by the adverse health event (Psykologer i Danmark, 2018).[6] In Denmark it is recommended that anti-depressants for children be managed by a psychiatrist.[7] To be prescribed anti-depressant medication, the child needs a GP referral to a psychiatrist; therefore the GP affects the child's probability of being prescribed and consequently taking the drug. Options outside the public system also exist. A report from one of the leading organizations providing free support to children of ill or deceased parents, *Børn, Unge og Sorg*, states that they supported 1,000 children in 2018, which is a small fraction of the children who experienced a serious parental health shock or parental death in that year. The report from *Børn, Unge og Sorg* also states that 5 out of 10 children consult their GP for support before reaching out to the organization (Børn, Unge og Sorg, 2018). Hence, the GP may have a great deal of influence on the type of treatment the child receives following a serious parental health event.[8]

2.2 Data

The data set contains unique identifiers for children born in Denmark between 1972 and 2015. I link data on the children to their ill parent's hospital records and potential death records

[5]These recommendations were made in 2012 by the Danish Health Authority. The children in the analysis experienced a serious parental health shock between 1980 and 2015, hence in most cases before the recommendations were made.

[6]The GP learns how to diagnose and treat patients with mental disorders as part of their training. With further education, the GP can provide therapy to his patients through the public health system. Around 85 percent of GPs provide therapy to their patients. The reasons for therapeutic consultations are primarily related to stress and depression, but also illness of a close family member and grief (Region Sjælland, 2014; Region Midtjylland, 2012).

[7]92 percent of the children who are taking anti-depressants in the dataset get prescribed the drug by a psychiatric. In Denmark anti-depressants to children can be used to treat depression, OCD and anxiety. The use of anti-depressants are however not the preferred medication for treatment of OCD (Retsinformation, 2013). The medical guidelines state that anti-depressants for children are rarely necessary, and should be considered as a supplement to psychotherapy (Retsinformation, 2013).

[8]The Danish Cancer Society (*Kræftens Bekæmpelse*) has support groups for children who are affected by cancer in one way or the other, however these groups are located in the largest cities of Denmark, so are not available for all children. In the period of analysis, many schools formed action plans for how to handle children who lose a parent. In 1997 4% of schools had plans for how to help the child, by 2013, this number was increased to 93%. However only 7% of schools use these plans in cases of serious illness (Kræftens Bekæmpelse, 2014). In the data available, I observe whether the child receives support through the public system, but there is no data available for Non-governmental Organisations (NGOs).

and merge the data on the child's educational attainment, measured by exam results in the ninth grade and school enrollment at different points in time. Furthermore, I add background characteristics of the parents, e.g. education, income, age etc. I identify a parental health shock as the first hospital admission with one of the two diagnoses - acute cardiovascular diseases or cancer. I focus on these two diagnoses because of their high incidence in Denmark and in other developed countries (Flachs et al., 2015). For a small sub sample of children born in later cohorts, I have test scores before the ninth grade, measured between sixth and eighth grades. I add variables related to the child's mental health, measured by the child having had therapy under the public health system or had at least one prescription for anti-depressants filled. See Appendix A.1 for a detailed description of the outcome variables.

Table 1: Summary Statistics

			Cancer		Cardiovascular Disease		Death	
	No shock	Health Shock	Father	Mother	Father	Mother	Father	Mother
Outcomes								
Math score	**0.007**	**-0.068**	0.006	**0.033**	**-0.198**	**-0.247**	**-0.246**	**-0.214**
Missing math score	**0.014**	**0.016**	0.014	0.014	**0.019**	**0.020**	**0.024**	**0.023**
GPA	**0.005**	**-0.046**	**0.035**	**0.058**	**-0.177**	**-0.231**	**-0.215**	**-0.191**
Not enrolled in school	**0.070**	**0.079**	0.073	0.071	**0.088**	**0.092**	**0.101**	**0.093**
Ninth grade as highest completed education	**0.732**	**0.744**	**0.724**	**0.719**	**0.770**	**0.786**	**0.793**	**0.788**
Anti-depressants, childhood	**0.035**	**0.042**	**0.041**	**0.040**	**0.042**	**0.049**	**0.059**	**0.050**
Anti-depressants, adulthood	**0.088**	**0.101**	**0.098**	**0.096**	**0.107**	**0.116**	**0.128**	**0.124**
Therapy, childhood	**0.066**	**0.091**	**0.096**	**0.090**	**0.090**	**0.099**	**0.145**	**0.146**
Therapy, adulthood	**0.103**	**0.126**	**0.127**	**0.126**	**0.129**	**0.132**	**0.159**	**0.166**
Child characteristics								
Male	0.509	0.511	0.508	0.508	0.514	0.515	0.507	0.510
First born	**0.556**	**0.507**	**0.503**	**0.508**	**0.496**	**0.517**	**0.535**	**0.523**
Siblings	**0.812**	**0.770**	**0.768**	**0.774**	**0.765**	**0.753**	**0.693**	**0.702**
Number of siblings	**2.225**	**2.165**	**2.161**	**2.124**	2.212	**2.154**	**2.053**	**2.044**
Non-Danish ethnic background	**0.045**	**0.043**	**0.038**	**0.024**	**0.066**	0.047	0.045	**0.028**
Family characteristics								
Income Father	170.6	169.7	**172.7**	**176.5**	**161.5**	**166.3**	**143.0**	170.5
Income Mother	148.2	148.6	**152.0**	**149.8**	**146.5**	**145.9**	**152.0**	**136.2**
Father compulsory school	**0.245**	**0.272**	0.252	**0.224**	**0.332**	**0.319**	**0.375**	**0.313**
Father college education	0.207	0.203	**0.229**	**0.241**	**0.158**	**0.150**	**0.146**	**0.174**
Mother compulsory school	**0.303**	**0.329**	**0.298**	**0.276**	**0.381**	**0.423**	**0.428**	**0.423**
Mother college education	0.241	0.240	**0.269**	**0.288**	**0.192**	**0.170**	**0.188**	**0.196**
Mother's age at child's birth	**27.3**	**28.9**	**29.2**	**29.5**	**28.5**	**28.2**	**28.4**	**29.4**
Father's age at child's birth	**29.9**	**32.2**	**33.3**	**31.9**	**32.8**	**30.9**	**33.0**	**31.9**
Observations	1,252,781	167,737	42,276	57,662	54,074	26,203	46,983	22,308
Share		11.8%	3.0%	4.1%	3.8%	1.8%	3.3%	1.6%
			6.9%		5.6%		4.8%	

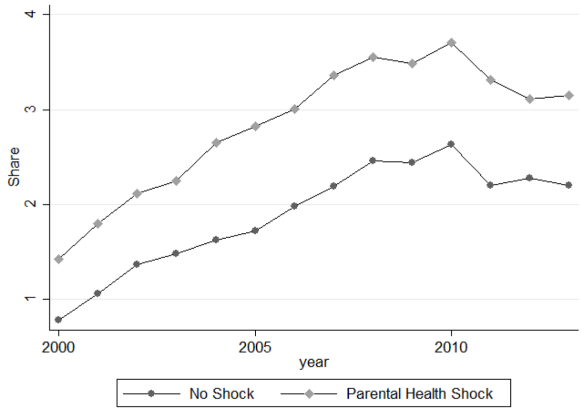
Notes: **Bold text** indicates that the difference is significant at the five percent level or less. The codes used for the health shocks can be found in Appendix Table A.1. Parent's income is measured in the first five years of the child's life and is measured in DKK 1000s in 2010 prices. Anti-depressants and therapy during childhood is measured as use between ages 14 and 18 and use during adulthood is measured between ages 20 and 25. Not enrolled in school is measured two years after completing ninth grade. Ninth grade as highest completed education is measured 5 years after finishing ninth grade. For the columns father and mother, cancer, cardiovascular disease and death, each variable is tested with a t-test against families who do not experience this specific shock. There are 2,608 (1,500) children who experience that their father (mother) gets both cancer and an acute cardiovascular disease, while 13,360 (11,482) of the children who experience that their father (mother) gets cancer, also lose their father (mother). The same is true for 6,560 (2,329) of the children who experience that their father (mother) gets diagnosed with an acute cardiovascular disease and 6,607 children experience that both their mother and father get ill during their first 20 years of life and 1,527 lose both parents.

Table 1 shows descriptive statistics for the full sample of children and the sample of children who experience a parent's health shock between ages 0 and 20. The table is divided according to the type of parental health shock; cancer, cardiovascular disease or death, of either the mother or the father. The bottom of the table shows the number and share of children who experience the different health shocks. Roughly 12 percent of the children experience either a mother or father being hospitalized with an acute cardiovascular disease or cancer during their first 20 years of life. Four percent of children experience that their mother has cancer and the same share experience their father has an acute cardiovascular disease. Almost 5 percent of the children lose a parent during childhood. Most cases of death are a result of disease; 40 percent of maternal deaths are caused by cancer, 10 percent are caused by cardiovascular diseases, cf. appendix A.1b. The same tendency is apparent in the case of the fathers.

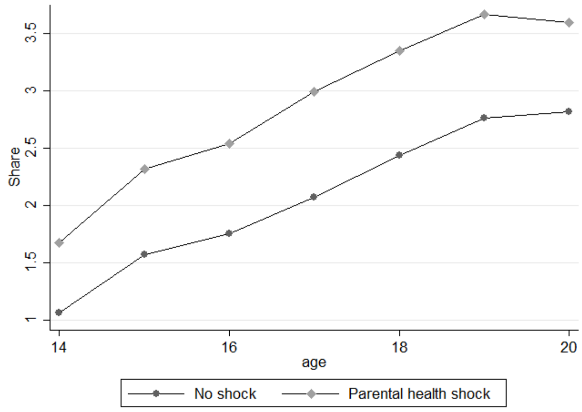
From Table 1 it is apparent that there exists a socio-economic gradient in the occurrence of the different types of health shocks. Cardiovascular diseases and death are most frequent in families with low incomes and short education, and the children achieve test score around 20 percent of a standard deviation lower than the average. Families who experience cancer, on average, have higher incomes and are more likely to have a college degree, and children have above average test scores.[9] Comparing families who experience a specific type of health shock with families that don't will most likely overestimate the effect in cases of cardiovascular disease and death and underestimate the effect in cases of cancer, because of the correlation with background characteristics. To circumvent selection bias, I restrict the sample in the analyses to children who all experience a parental health shock, but at different points in time.

Children who experience a parental health shock have a higher probability of getting therapy in a given year compared to children who do not experience a parental health shock, and the difference between the two groups of children seems to become slightly larger in the later years, cf. Figure 1 panel (*a*). Figure 1 panel (*b*) shows the share of children using therapy at a given age. The figure shows that the use of therapy becomes more common in later childhood and early adulthood. The tendencies are the same with regard to anti-depressants, see Figure 1 panels (*c*) and (*d*). There exists a selection into treatment of mental health problems, Appendix Table 8 columns (1) and (2), show that girls, children of parent's with a short education and a low income are more likely to use therapy and take anti-depressants following a serious parental health shock.

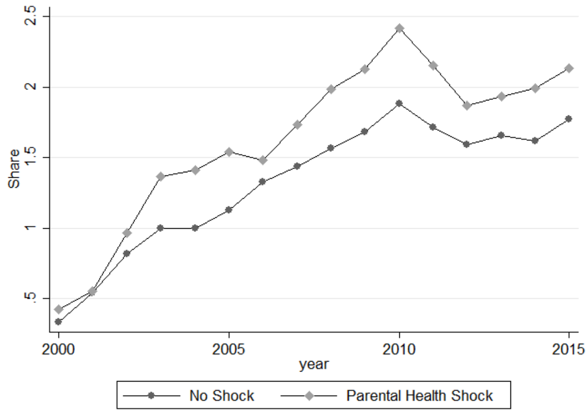
[9]For some of the most common types of cancer in the dataset; breast, prostate and melanoma (cf. appendix A.1a), the occurrence is higher in high income groups (Dalton et al., 2008).



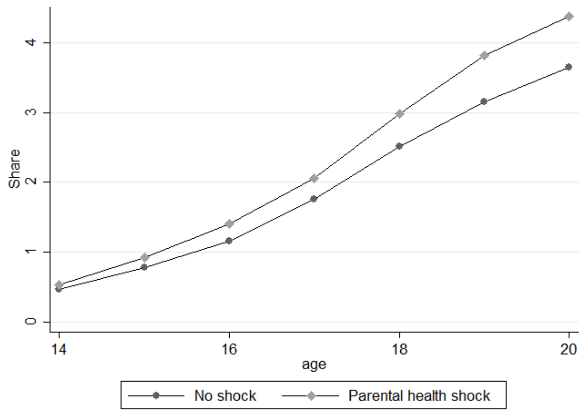
(a) Therapy use by years



(b) Therapy use by age



(c) Anti-depressant consumption by years



(d) Anti-depressant consumption by age

Figure 1: Use of therapy and anti-depressants

Notes: Panels (*a*) and (*c*) show the share of children, between ages 14 and 18 for each year having therapy and taking anti-depressants. See Appendix Figures A.2a and A.2b for Figures (*a*) and (*c*) presented by the different health shocks. Panels (*b*) and (*d*) show the use of therapy and anti-depressants by the child's age. Data before 2000 are not shown because there were too few treated individuals.

3 Research design

In this section I describe the methods used in the analysis. To study the dynamics of the effect, I divide the analysis into two: An immediate reaction and the long-term effect of the parental health shock, and consequently, I use different methods. To estimate the immediate response I use an event study method and a quasi-experimental design. I use the event study to estimate the effect on outcomes related to the child's mental health, as the data is high frequent. In most cases I only observe the child's school test scores once. Therefore, to measure the effect on test scores, I use a quasi-experiential method instead. In order to estimate the effect of a parental health shock in the long-term, I use a Sibling Fixed Effects approach, to account for non-random timing of the shock.

3.1 Short-term effect

3.1.1 Event study design

I study the effect of a serious parental health shock on the child's mental health, using an event study approach. I estimate how the use of therapy and anti-depressant medication evolve over time relative to the adverse parental health event. The analysis is performed for the group of children who have experienced a parent's health shock between the ages 14 and 18 and who were born between 1984 and 1998. To estimate the effect, I use the following equation:

$$Y_{ir} = \gamma_t + \delta_i + X_{it} \cdot \beta + \sum_{\tau=-4}^{-2} \delta_\tau \cdot 1(r_{it} = \tau) + \sum_{\tau=0}^{5} \delta_\tau \cdot 1(r_{it} = \tau) + u_{it} \tag{1}$$

Y_{ir} is use of therapy or anti-depressant medication at the relative time period r. γ_t is a calendar year fixed effect and δ_i is individual fixed effects. X_{it} is a vector of control variables related to the child and the family. r is relative time to the adverse parental health event measured in years and u_{it} is an idiosyncratic error term. The coefficients of interest, δ_τ, describe how use of therapy or anti-depressants in a specific relative time period compare to the pre-period. In the main specification I consider a time period of five years before and after the parental health shock.

For this approach to give causal estimates, the parallel trend assumption needs to be met. Furthermore, conditional on the individual fixed effects, the included control variables, and conditional on experiencing a serious parental health shock within the observation window, the exact timing of the parental health shock must be uncorrelated with the outcome variable. There should be no anticipation of the parental health shock, and hence, there should be no pre-trend in the outcome variable.

3.1.2 Quasi-experimental design

To study the effect of a parental health shock on the child's test scores and school enrollment, I use a quasi-experimental design. I use this method because test scores are only observed once for the majority of children, and in the case of both test scores and school enrollment, there are specific dates where the outcome variable is determined. To estimate the effect, I exploit that the exact timing of a serious parental health event may be as good as random within a short period of time. Effectively, I compare children experiencing the parental health shock shortly before a cut-off, e.g. the school exam or application deadline for senior secondary schooling, to children who experience the shock shortly after the cut-off. While the test scores or school enrollment will be affected by the parental health shock if the shock happens before the cut-off, the outcome will be unaffected if it happens afterwards.[10] I estimate the following equation:

$$Y_i = \beta_0 + \beta_1 \cdot pre_i + X_i \cdot \delta + u_i \tag{2}$$

Y_i is the outcome of interest. X_i is a vector of control variables, including e.g., family income, child gender and birth order, and u_i is an idiosyncratic error term. pre_i is a dummy variable indicating whether the child has experienced the parental health shock before the cut-off. In the case of test scores, I use the date of the ninth grade written math exam as a cut-off, and for school enrollment I use the date of the application deadline.[11] The regression is estimated on the sub sample of children experiencing the parental health shock within the interval of time between one year prior to and one year after the relevant cut-off.

Causality relies on the assumption that the exact timing of the parental health shock is uncorrelated with unobserved characteristics. The identifying assumption cannot be tested. Instead, I investigate whether the two groups of children who experience the shock before and after the cut-off are similar in observable characteristics. If the two groups of children are similar, the assumption seems more plausible. In a limited sub sample of children, I can compare test-scores before either group of children experience the health shock. In the results section, I show that there are no differences in the children's test scores before the shock happens. Further, I regress all control variables on the variable *pre*, indicating whether the parental health shock occurs before the exam. Appendix Table A.2 shows the result. The joint F-test is not significantly different from zero, indicating that family characteristics do not jointly predict whether the parental health shock occurs before or after the exam, conditional on experiencing the shock within the window of time. These tests indicate that the identifying assumption seems likely to hold, and that the estimation results from regression equation (1) offer a causal

[10] An exception is in the case of death, where the parent can be ill before dying, and the child can be affected by the illness. Furthermore, in some cases of illness, the family could anticipate the hospitalization and the child could be affected sometime before the hospitalization. This will bias the results towards zero.

[11] The application deadline to senior secondary school and tenth grade is 1 March. Using 1 March as a cut-off between the treatment and the control groups will most likely underestimate the true effect, as part of the control group (who experience a parental health shock between the application deadline and the time of registration, which is 1 October) will be partly treated before the outcome is measured. Even though this group have applied for senior secondary school entrance or tenth grade, they could choose not to attend.

interpretation of the immediate effect of experiencing a parental health shock.

3.2 Long-term effect

The goal of the long-term analysis is to determine whether the effect of a parental health shock differs across different parts of childhood. The challenge in estimating this effect is not only selection into the shock, but also the selection in the timing of the shock. To circumvent these challenges, I employ a Sibling Fixed Effect estimation.

3.2.1 Sibling fixed effects

I exploit variation between biological siblings who experience the shock at the same point in time but at different ages by using a fixed effects design. Biological siblings have presumably been brought up in a similar environment. Comparing biological siblings will account for family characteristics that are time invariant, as well as factors that are correlated with the timing of the shock. I estimate the following equations:

$$Y_{ij} = \beta_0 + \sum_{n=2}^{N} \beta_n \cdot I(age_{ij} = n) + X_{ij} \cdot \delta + f_j + u_{ij} \tag{3}$$

$$Y_{ij} = \beta_0 + \beta_1 \cdot age_{ij} + X_{ij} \cdot \delta + f_j + u_{ij} \tag{4}$$

Y_{ij} is the outcome measure of interest for child i in family j. X_{ij} is a vector of sibling specific control variables (gender, birth parity and birth cohort). f_j captures observed and unobserved characteristics that are family-specific and constant between siblings. The variable age_{ij} indicates the child's age at the time of the parental health shock. Equation (3) includes age non-parametrically and equation (4) includes age linearly. While equation (3) doesn't rely on parameter assumptions, equation (4) provides more statistical power. In equation (3) age one is the omitted reference category.

I estimate the regressions conditional on at least two children in the family experiencing the parental health shock before the outcome is measured or at age 16. Unbiased estimates rely on the assumption that in the absence of the shock, there would be no difference in the outcome variable when controlling for child specific characteristics and birth order.

4 Results

In this section I present the results on the immediate and long-term effects of experiencing a serious parental health shock. First, I present the results from the short-term analysis regarding mental health, followed by the immediate effect on the child's test scores and school enrollment. I investigate whether the effects on mental health outcomes and test scores differ depending on family characteristics. Then, I present the results of the long-term effect of a parental health shock during childhood. Finally, I study whether the long-term negative impact of a parental health shock can be mitigated by treatment of mental health problems. Unless otherwise mentioned, I use the joint health shock, i.e., a mother or father hospitalized with either cancer or acute cardiovascular disease, in the analysis.

4.1 The short-term effect

4.1.1 Mental health

Figure 2 shows the estimated coefficients on the child's use of therapy and anti-depressant medication from equation (1). The graphs show that children are more likely to get therapy and take anti-depressant medication following a serious parental health shock compared to before the shock, indicating that the children have more mental health problems following the health shock. The effects are not only immediate, but persist for at least 5 years following the shock. Panel (a) shows a jump in the use of therapy at the time of the shock. One year after a serious parental health shock the child is 2.4 percentage points more likely to be having therapy than before the shock. This jump may be caused by the institutional setting explained in section 2.1, that the children are more likely to be eligible for therapy in the public system following a serious parental health shock. The children is eligible for subsidized therapy if the GP assesses that the child is in a state of crisis triggered by the adverse event. The graph shows that the children take up opportunities to have therapy but also suggests that there is an immediate negative effect on the child's mental health from a serious parental health shock. The effect on therapy is persistent, as the effect is still significant 5 years after the parental hospitalization. The use of anti-depressants increases more rapidly following the shock; four years after the parental health shock, the use of anti-depressants has increased by 2 percentage points compared to before the parental health shock. The same pattern is evident when looking at other types of psychotropic drugs, such as anti-psychotics, anti-anxiety, sleeping medication and sedatives see Appendix

Table A.5. [12]

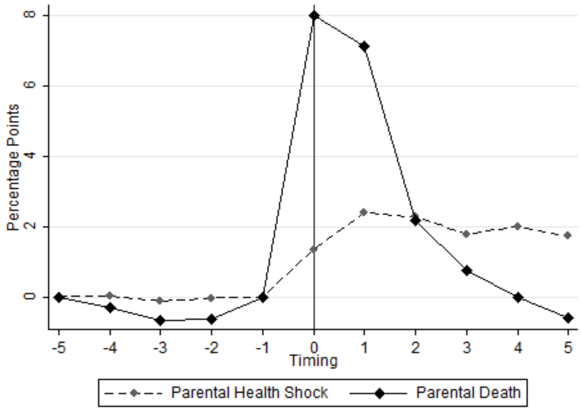
The uptake of therapy and anti-depressants is greater for the group of children who lose a parent. One year after a parent's death, the child is 8 percentage points more likely to be in therapy than before the shock. Interestingly, the uptake of therapy disappears 3 years after the parent's death, while the uptake of therapy for children who experience a serious parental shock persists at least 5 years following the shock. The result is, however, primarily (but not entirely) driven by children who experience a serious parental health shock and later lose their parent (results available upon request). In the case of anti-depressant consumption, the effect is 1 percentage point higher at each relative time for children who experience a parent dying compared to a serious parental health shock, and it persists at least 5 years following the parental health shock.[13] Figure 2 panels (*c*) and (*d*) show the effect by child gender. Girls respond more to the parental health shock in their use of therapy and anti-depressants compared to boys. It is, however, not apparent whether experiencing a parent's health shock has different effects on childhood mental health, or whether the take up of treatment is different for boys and girls.

In most cases we do not observe evidence of a pre-trend, so that, conditional on the control variable and of experience the shock within the given time window, there is no anticipation effect. Only in the case of parental death do we observe a pre-trend in the case of use of therapy (panel (*a*)). One explanation is that the children are already affected by the parental health shock, as most parental deaths are caused by a serious illness.

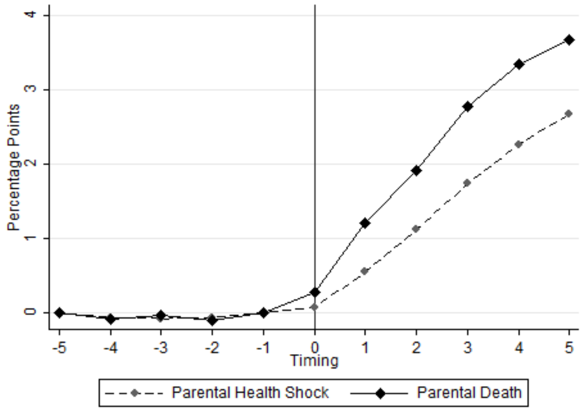
To ensure that the results are not driven by the large year and age trends shown in Figure 1, I assign a random placebo shock to children born in the same birth cohorts, but who experience a shock later during early adulthood. This analysis cannot reproduce the results from Figure 2. The results from Figure 2 are robust to removing the individual fixed effects. Running the regression for each age, gives the same result (results available upon request).

[12] The opposite pattern is, however, seen in the case of psychostimulant drugs used to treat ADHD. The children are around 0.2 percentage points less likely to be prescribed ADHD medication following the parental health shock, compared to before. One explanation is adverse drug to drug interaction between ADHD medication and anti-depressants. Of the three most used psychostimulant drugs in children aged 0-17 in Denmark (Methylphenidate, Atomoxetin, Lisdexamfetamin) all have either potential problematic or problematic combinations with one or more antidepressant medications (e.g. Sertraline, Paroxetine, Venlafaxine, Isocarboxazid, Moclobemide) (Sundhedsdatastyrelsen, 2020; lægemiddelstyrelsen, 2020)

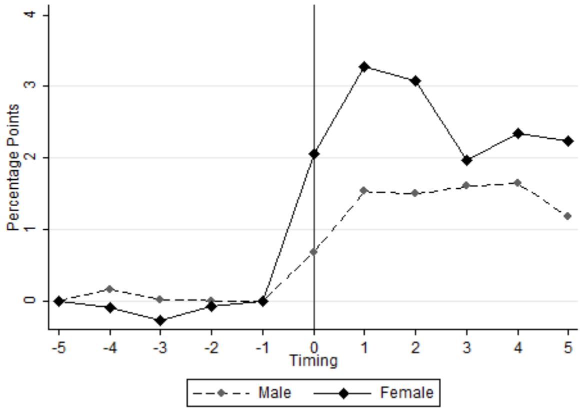
[13] Looking at other types of psychotropic drugs in the case of losing a parent, the same effect is seen as in the case of a parental health shock (results available upon request).



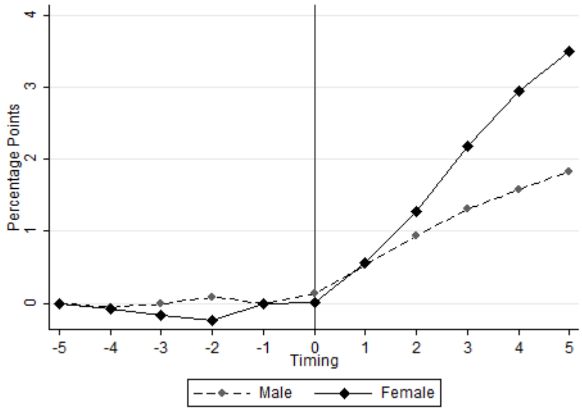
(a) Use of therapy



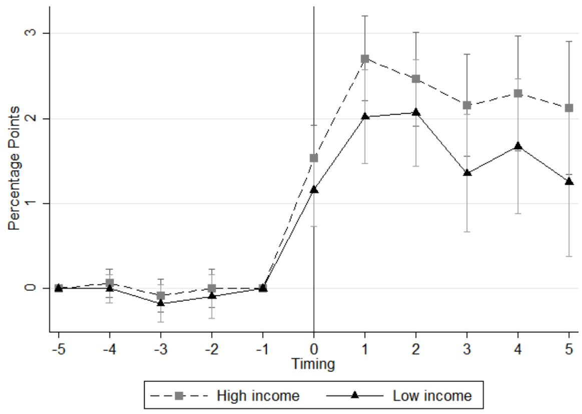
(b) Use of anti-depressants



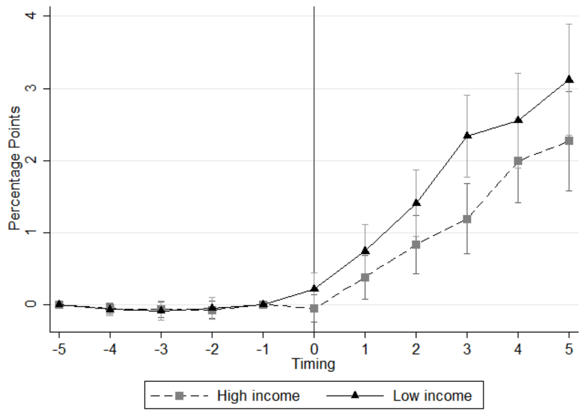
(c) Use of therapy, depending on child gender



(d) Use of anti-depressants, depending on child gender



(e) Use of therapy, depending on family income



(f) Use of anti-depressants, depending on family income

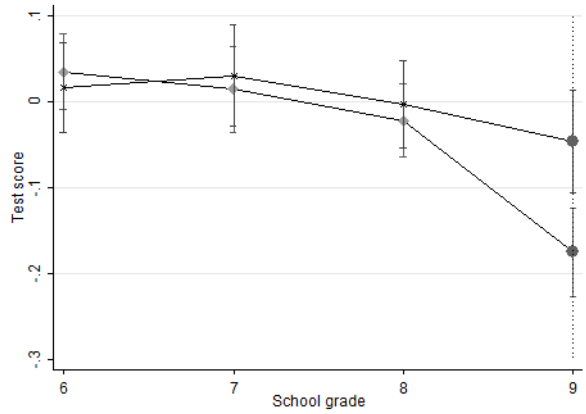
Figure 2: Impact of a severe parental health shock on child use of therapy and anti-depressants
Notes: The graphs show the point estimates from regression (1), showing the use of therapy and anti-depressant medication in relative time compared to a serious parental health shock. All specifications include calendar year controls and individual fixed effects. Standard errors are clustered at the individual level. Regression results are presented in Tables A.3 and A.4.

4.1.2 Test scores and school enrollment

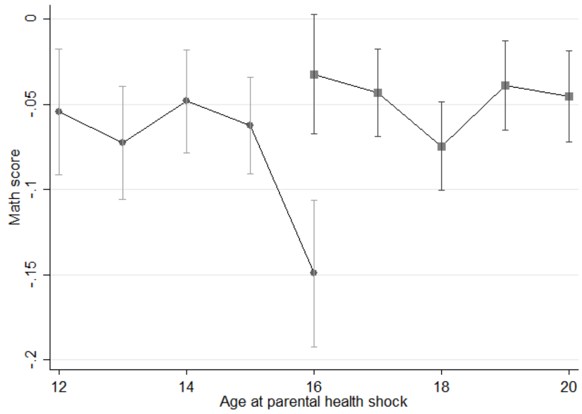
In this section I investigate whether there exists an immediate impact on the child's academic outcomes, measured by test scores and school enrollment. I use a quasi-experimental approach. Effectively, I compare children who experience the parental health shock shortly before the outcome is determined, with children who experience the shock shortly after. Figure 3 panel (a) shows test scores in sixth to eighth grades and the ninth grade exam score, for a small group of children for whom test scores in earlier grades exist. I separate the children into two groups, children who experienced the shock within one year before the ninth grade exam (indicated with a dot) and those who experienced the shock within one year after the ninth grade exam (indicated with a "x"). The figure shows no difference in school performance between the two groups before the shock occurs, indicating that the timing of the adverse parental health event is uncorrelated with prior school performance. The figure reveals an immediate negative impact of the parental health shock on the child's school achievements at the exam, as the group of children who have experienced the shock score 15 percent of a standard deviation lower than children who haven't experienced the shock yet. Panel (b) shows the same pattern for a larger group of children. This graph shows the written math scores in ninth grade for children who experience the shock before and after the time of the exam. Comparing children who experience the shock the year they turn 16 (the year most children take the ninth grade exam) where one group of children experience the shock before and the other after, shows a decrease in test scores of around 13 percent of a standard deviation for the group of children who experience the shock before the exam.

Table 2 reports the estimated effect of experiencing a serious parental health shock before the written math exam, from equation (2), in the larger sample of children. Children who experience the shock one year before the exam achieve a test score that is 9.8 percent of a standard deviation lower in math, compared to children who experience the shock after the exam. This confirms the result from Figure 3 panels (a) and (b).[14] As the effect appears immediately following the shock, fewer parental investments or family financial resources are not likely to be the driving mechanism, as the effect of these mechanisms would presumably need time to accumulate. Instead, a plausible mechanism may be declining child well-being,

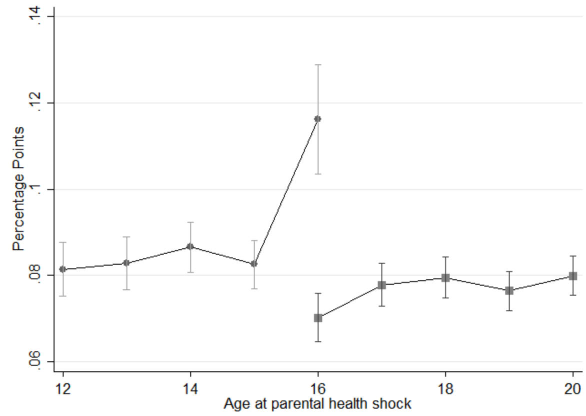
[14]See also Appendix Table A.6 panels (1) and (2) for the effect separated on cancer and cardiovascular disease. The effect is similar, however slightly larger, in the case of cardiovascular disease compared to cancer. Using a sibling or an individual fixed effect estimation gives very similar results, see Appendix A.6. The results are also similar for the written Danish exam score.



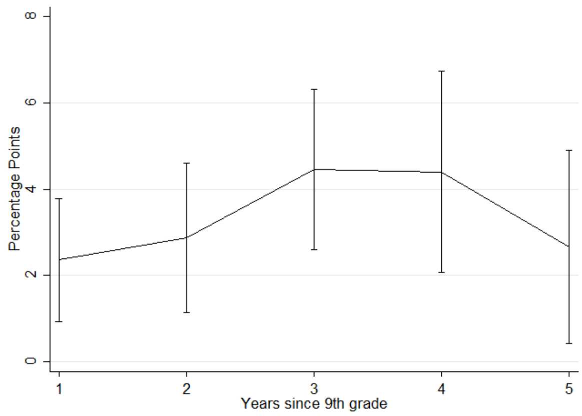
(a) Standardized test scores in 6th-8th grade and exam score in ninth grade



(b) Written math exam scores and age at parental health shock



(c) No school enrollment and age at parental health shock



(d) No school enrollment

Figure 3: Impact of a serious parental health shock on test scores and school enrollment
Notes: Panel (*a*) shows test scores for children experiencing a parental health shock prior to (indicated with a dot) or after the ninth grade exam (indicated with a "x") and 95 percent confidence intervals. The pre-exam group, experience the parental health shock between the eighth grade test and ninth grade exam. Around 2500 children are included in the graph. Panel (*b*) shows written math exam scores for children who experienced the shock before and after the time of the exam; 73,700 children are included in the graph. Panel (*c*) shows the share of children not enrolled in school depending on whether they experienced the parental health shock before or after the time of the application deadline. Panel (*d*) shows estimates of the effect of experiencing a parental health shock prior to the application deadline compared to after on the probability of not being enrolled in school one to five years after ninth grade.

causing the child to perform worse at the exam. Children who lose a parent have increased cortisol responses to a stressful task (Luecken, 2000), and the level of stress can have negative impacts on a child's academic achievements (Heissel et al., 2018). This mechanism is supported by the results from section 4.1.1.

Children who experience a parental death shortly before the exam is 21 percent of a standard deviation lower compared to losing a parent after the exam. Boys are more sensitive to an adverse parental health event with regards to test scores in the short term, while the opposite was true in the case of variables related to the child's mental health. In the case of health shocks, children seem most affected by a health shock to a parent of the same gender: The differences are, however, not statistically significant.

The results from Table 2 may be a conservative estimate of the true effect for three reasons: 1) I only observe the children who attend the exam. Children who experience the parental health shock before the ninth grade exam are also less likely to attend the exam (results not shown) and children who attend the exam despite the parental health shock differ systematically from the children who do not attend the exam. Using the limited sample of children for whom I have test scores in the sixth to eighth grades shows that children who experience the shock before the exam and who are absent at the exam are more likely to achieve lower test scores before the adverse parental health shock happens compared to children who attend the exam despite the adverse conditions. 2) In cases of less acute illness, the parent may wait to inform the children about the health shock until after the exam, in which case part of the treatment group may not be affected by the shock yet. 3) Some health shocks could, to some extend, be anticipated, or begin before a hospital admission (when the shock is registered in this analysis), if that is the case, part of the control group may already be affected by the health shock.

Table 2: Immediate response of a serious parental health shock on math exam scores

	Health Shock			Death		
	Father or Mother	Father	Mother	Father or Mother	Father	Mother
Math Score	-0.098***	-0.089***	-0.114***	-0.209***	-0.202***	-0.225**
	(0.025)	(0.032)	(0.034)	(0.060)	(0.075)	(0.087)
Observations	10472	5791	5138	1666	1012	726
Boy	-0.132***	-0.145***	-0.121***	-0.372***	-0.263**	-0.411***
	(0.034)	(0.044)	(0.047)	(0.086)	(0.113)	(0.119)
Observations	5277	2908	2557	809	492	346
Girl	-0.053	-0.016	-0.099**	-0.039	-0.106	-0.054
	(0.037)	(0.047)	(0.050)	(0.087)	(0.103)	(0.133)
Observations	5195	2883	2581	857	520	380

Notes: *** p<0.01, ** p<0.05, * p<0.1. The table shows the estimate for the variable *pre*, indicating whether the child has experienced the health shock prior to the ninth grade math exam, estimated under the condition that the child has experienced the parental health shock within one year prior to or after the ninth grade written exam. Math score is standardized with mean zero and standard deviation one. Control variables: child's gender, child's age at the time of the parental health shock, mother's and fathers's income groups, mother's and father's highest level of completed education, mother's and father's age at the time of the child's birth, ethnic background, indicator variable for whether the child have siblings and if the child is the first born and birth cohort dummies. Robust standard errors in parentheses.

Panel (c) in Figure 3 shows that children who experience a parent's health shock prior to the application deadline to tenth grade and senior secondary schooling during ninth grade have a higher probability of *not* being enrolled in school one year following ninth grade compared to children who experience the shock after the application deadline. Panel (d) summarizes the results from equation (2) for school enrollment one to five years after finishing ninth grade. Experiencing the parental health shock before the time of the application deadline increases the probability of not being enrolled in school by 2.3 percentage points the year of finishing ninth grade, and this effect persists at least five years after finishing ninth grade. Consequently, four to five years after the ninth grade, children who experience the shock before the application deadline have a 6.5 percentage point (18 percent) increased probability of having compulsory education (ninth grade) as their highest level of completed education. The results indicate that time before educational decision-making is important for long-term educational attainments, and the immediate effect of a parental health shock can transfer into long-term consequences. See the regression results in Appendix Table A.7.[15]

4.1.3 Mitigating factors: Family characteristics and structure

I investigate whether the effects found differ across family income and for children who live in nuclear or divorced families. The first column of Table 3 shows the immediate effect on test scores and the interaction with family income and family structure. Looking at the immediate impact on the child's ninth grade math score, there are no significant differences between children from high- and low-income families nor between the effect on test scores for children in nuclear and divorced families. However when looking at the type of treatment the children receive following a serious parental health shock, it appears that children from families with low incomes are more likely to be prescribed anti-depressant treatment following the shock, while children from high-income families are slightly more likely to have therapy, this difference is, however, not statisticaly significantly. This pattern is also seen in the event graph in Figure 2 panels (e) and (f). While the immediate negative effect on test score are no different for children in nuclear and divorced families, the children in nuclear families are less likely to be prescribed anti-depressants and to have therapy, this suggests that living with both parents at the time of the health shock can be a mitigating factor in the short term. Living with both parents at the time of the shock may create a more stable environment for the child.

These results indicate that children from different types of families are affected in a similar way when looking at test scores. What seems to differ across families is the behavioral response to the parental health shock in the way the child is treated for their emotional problems.

[15] The effect on highest completed education is estimated for children who are not enrolled in school. Estimating the effect for all children in the sample (unconditional on school enrollment) produces similar but smaller results. Using the time of registration of educational enrollment (1 October) instead of the time of application as a cut-off, produces similar results (results not shown).

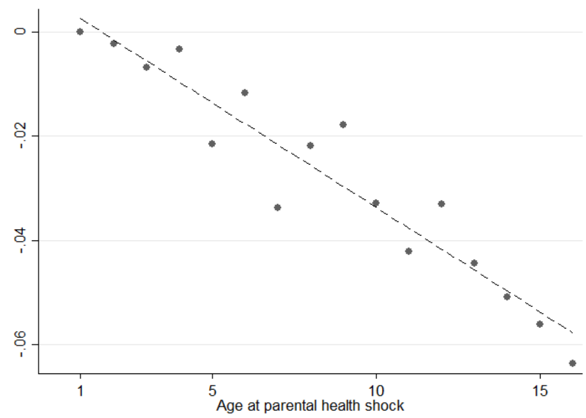
Table 3: Short-term heterogeneous treatment effects

	Test score (1)	Anti-depressants (2)	Therapy (3)
Treatment	-0.096*** (0.031)	0.022*** (0.002)	0.017*** (0.003)
Treatment # high income	-0.020 (0.037)	-0.010*** (0.002)	0.002 (0.003)
Treatment	-0.118*** (0.036)	0.030*** (0.003)	0.022*** (0.003)
Treatment # nuclear family	-0.038 (0.039)	-0.092*** (0.003)	-0.006* (0.003)
N	10450	20012	19943

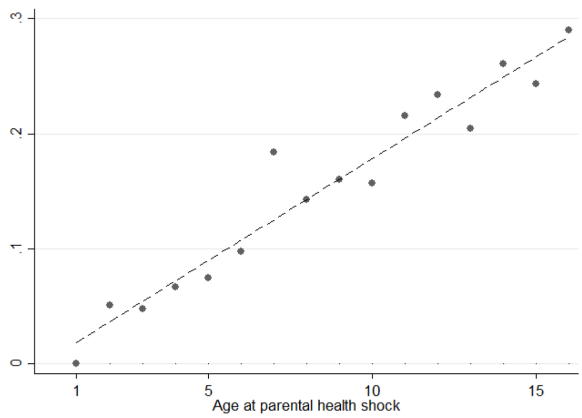
Notes: *** p<0.01, ** p<0.05, * p<0.1. See notes to Table 2 for standard errors and control variables. Income is based on the mother's income in the first five years of the child's life. Low income is defined as having a mother in the lowest income quartile. High income is defined as having a mother in the highest income quartile. A nuclear family is defined as the biological parents and the child live together at the time of the parental health shock. Use of anti-depressants and therapy in the short-term analysis is measured three years after the shock.

4.2 Long-term effects

To assess how the child's age at the time of a serious parental health shock affects the child's mental health, GPA and school enrollment, I use a sibling fixed effect design. The results from the analysis are presented in this section.



(a) Anti-depressants during early adulthood



(b) GPA ninth grade

Figure 4: Age at parental health shock and anti-depressant consumption in early adulthood and GPA in ninth grade

Notes: The figure shows estimates from a non-parametric estimation of the effect of experiencing a serious parental health shock at each age relative to a parental health shock at age one. Control variables: Child gender, an indicator variable for first born child, birth cohort and family fixed effects. Anti-depressants during early adulthood is measured as having at least one prescription for anti-depressants filled between ages 20 and 25.

4.2.1 Mental health

First, I investigate how the age at the time of the parental health shock affects the mental health of the child during childhood and early adulthood. Figure 4 panel (a) shows the results of the non-parametric estimation. The graph shows that the older the child is at the time of the parental health shock, the lower is the probability of taking anti-depressants during early adulthood. Table 4 panel A shows the results of equation (4) with age included linearly in the regression, the results with age-dummies can be found in Appendix Table A.8. What stands out from the table is that the child's mental health, measured by having at least one prescription filled for anti-depressants or having therapy during childhood and early adulthood, is negatively affected following the parental health shock, and shocks in early childhood have a larger negative impact on the child's mental health compared to shocks in the later childhood.

Postponing the parental health shock by one year reduces the child's probability of having therapy by 0.1 percentage points during childhood and 0.2 percentage points in early adulthood. Experiencing the parental health shock one year later during childhood also decreases the probability of being prescribed anti-depressant medication by 0.2 percentage points during childhood and 0.4 percentage points in early adulthood per year. In the case of a parent's death, the effect on the probability of having therapy during childhood, switches sign. Losing a parent later during childhood seems to increase the probability of having therapy compared to experiencing a parental health earlier during childhood. This effect may be explained by the large immediate response, as seen in Figure 2 panel (a). The effect on the child's mental health does not differ depending on child gender or whether it is the mother or the father who is affected by a health shock (Results not shown).

4.2.2 School achievements

Table 4 panel B shows the results with regards to the child's GPA and school enrollment. The estimates from the non-parametric estimation are also depicted in Figure 4 panel (b). Experiencing the parental health shock one year later during childhood increases the child's GPA by 1.6 percent of a standard deviation, on average. This result indicates that the parental health shock has negative long-term effects on the child's human capital formation. Experiencing the shock one year later also reduces the probability of not being enrolled in school two years after ninth grade by 0.3 percentage points. From Appendix Table A.8, it appears that shocks during later childhood that are driving the effect on school enrollment. This could indicate

Table 4: Linear estimates of age at parental health shock on the child's mental health and educational achievements

	Parental Health Shock		Parental Death	
	Childhood	Adulthood	Childhood	Adulthood
	(1)	(2)	(3)	(4)
Panel A: Mental health				
Anti-depressants	-0.002***	-0.004***	-0.002	-0.008***
	(0.001)	(0.001)	(0.001)	(0.002)
Mean of dep.var.	0.036	0.110	0.044	0.134
Therapy	-0.001**	-0.002***	0.003**	-0.002
	(0.001)	(0.001)	(0.001)	(0.001)
Mean of dep.var.	0.064	0.083	0.118	0.107
Observations	99276	99276	32393	32393
Panel B: Educational Achievements				
GPA	0.016***		0.012	
	(0.005)		(0.009)	
Mean of dep.var.	-0.040		-0.204	
No. of obs.	38546		12276	
No school enrollment, two years after ninth grade	0.005***		0.006**	
	(0.001)		(0.002)	
Mean of dep.var.	0.154		0.193	
Observations	70890		25371	

Notes: *** p<0.01, ** p<0.05, * p<0.1. Each column presents the results of linear estimates of the effects of age at the parental health shock from equation (4). Mental health outcomes in childhood correspond to atleast one occurrence of anti-depressants or therapy between ages 14 and 18, and adulthood is measured between ages 20 and 25. GPA is measured in ninth grade. School enrollment is measured two years after the child finish ninth grade. Control variables: Child gender, an indicator variable for first born child, birth cohort and family fixed effects. Standard errors are clustered at the family level.

that time around educational decision-making is sensitive for later educational attainments, as also found in the short-term analysis. Separating the effects on the specific health shocks, child gender or on shocks to the mother's or father's health does not change the results (results not shown).

4.3 Mitigating factor: Mental health

In this section, I investigate whether the effect of the shock can be mitigated by treating mental health problems following the parental health shock. Mental health problems during childhood may be damaging for development, as they may result in the child to utilizing less of their full potential (Currie and Stabile, 2006). In section 4.2, I found that experiencing a serious parental health shock earlier during childhood decreased the child's school achievements. One potential mechanism for the decline in test scores and enrollment could be worse mental health. In this section I investigate whether some of the negative long-term consequences of a parental health shock, the part that could be caused by declining mental health, can be mitigated through therapeutic or medical treatment for mental health problems.

In order to answer this question, I exploit variations in GPs' behavior as a source of external variation, as use therapy and anti-depressant medications aren't randomly assigned in the population. I exploit that some GPs are more likely to refer the child to a therapist and some GPs are more likely to refer the child to a psychiatrist to be prescribed anti-depressants. For each GP, I calculate the share of child patients that is prescribed therapy or antidepressants within a year period, and exclude the focal child from the calculations. The share of children receiving treatment is used as an instrument for the child's own probability of receiving therapy or anti-depressants. The instruments are based on all children, but the instruments are only used for children who all experience a parent's health shock. A more detailed description of the method and check of first stage, exclusion restriction and monotonicity of the instruments can be found in Appendix A.2. This part of the analysis is explorative and should be interpreted with caution. The results found in the analysis are large in magnitude and have large standard errors. For that reason I will not interpret the point estimates as the causal effects, but rather consider the results as an indicator of the sign of the effect.

Table 5 columns (1) and (2) show the results using OLS, columns (3) and (4) show the reduced form estimation, and columns (5) and (6) show the results using 2SLS with the two instruments. The results from the reduced form and 2SLS estimation show suggestive evidence that being prescribed anti-depressants following a parental health shock increases the probability of having compulsory school as the highest level of completed education for the marginal child taking anti-depressant medication. The effect is seen five years following ninth grade and at age 25. Professional psychiatric therapy does not seem to have the same impact on educational attainment. The results from the OLS estimation suggest that use of therapy and anti-depressant medication following the serious parental health shock both have harmful long-term effects on the child's educational attainment. The differences between the OLS and 2SLS estimates indicate that treatment is indeed endogenous and an IV approach should be preferred compared to OLS. One mechanism for this result could be a medical explanation. Medical research suggests that anti-depressant medication, which has transitory effects in adults, could have permanent effects on children, as it could alter the development of the maturing childhood brain (Andersen and Navalta, 2004). In Appendix A.2 I show that the result is robust to several different specifications.

The children in this analysis have experienced a serious parental health shock, and may take anti-depressant medication or have therapy as a response to this traumatic event. The cause of

Table 5: The effect of having therapy or taking anti-depressant medication on the probability of having compulsory education as highest educational attainment five years after ninth grade and at age 25

	OLS		Reduced Form		2SLS	
	5 years after 9th grade (1)	Age 25 (2)	5 years after 9th grade (3)	Age 25 (4)	5 years after 9th grade (5)	Age 25 (6)
Therapy	0.053***	0.041**			-0.286*	-0.170
	(0.013)	(0.017)			(0.171)	(0.287)
Anti-depressants	0.164***	0.225***			0.772*	1.613**
	(0.021)	(0.031)			(0.398)	(0.763)
GP Therapy share			-0.283	0.091		
			(0.204)	(0.317)		
GP Anti-depressant share			0.471*	0.843**		
			(0.241)	(0.369)		
Observations	25,285	16,536	25,285	16,536	25,285	16,536
First Stage F-statistics					23.55	10.23

Notes: *** p<0.01, ** p<0.05, * p<0.1. The IV estimate is estimated with linear Two Stage Least Squares, with GP ratio of patients using therapy or anti-depressants as an instrument for the child's own treatment one year after the parental health shock (for compulsory school five years after ninth grade), and one to five years after the shock (for compulsory school at age 25). The regression is conditioned on experiencing the parental health shock at ages 14 to 18. Control variables: the gender of the child, mother's and father's income groups, mother's and father's highest completed education, mother's and father's age at the time of the child's birth, ethnic background, indicator variable for whether the child have siblings and if the child is the first born, birth cohort fixed effects and municipality fixed effects. Standard errors are clustered at the GP level and is shown in parentheses.

the mental health problems may, in this case, be external rather than internal, for this specific group of children. The results from this analysis may, for that reason, not apply to a broader group of children. Children in different circumstances may benefit from medical treatment of childhood depression. Only treatment in the public health system is observed in the data. Other types of treatment exists, for example, support groups or therapy supplied by NGOs. The use of anti-depressants could be correlated with the absence of other types of treatment that I cannot account for in the analysis. The result could, for that reason, also be a signal of an omission of other types of treatment that are not therapy supplied by the public health system.

5 Conclusion

In this paper, I investigate the short- and long-term effects of serious, but common, parental health shocks during childhood, using Danish administrative data. Experiencing a serious parental health shock has an immediate negative impact on the child's mental health, measured by increased use of therapy and anti-depressant medication, and on school test scores and school enrollment. The immediate effect on the child's academic attainments indicate that emotional distress can have important immediate but also long-term implications, as time before making decisions about future education may be a sensitive period for later educational attainments. Looking at differences between children from families with high and low incomes, the results suggest that, while the immediate effect on test scores is the same for the two groups of children, the families may react differently. Children from low income families are more likely to be prescribed anti-depressant medication, while children from high income families are slightly more likely to have therapy following a serious parental health shock. Looking at the long-term implications of anti-depressant medication and therapy using a general practitioner instrument design suggests that use of anti-depressant medication following a serious parental health shock could have negative long-term effects on educational attainment, while the effect of therapy seems to be positive but insignificant. These results suggest that the behavioral differences between families to the child's emotional reaction can have unintended consequences for inequality.

References

Adda, J., A. Bjorklund, and H. Holmlund (2011). The role of mothers and fathers in providing skills: Evidence from parental deaths. *IZA Discussion Paper 5425*.

Ainsworth, M., K. Beegle, and G. Koda (2005). The impact of adult mortality and parental deaths on primary schooling in north-western tanzania. *The Journal of Development Studies 41*(3), 412–439.

Andersen, S. L. and C. P. Navalta (2004). Altering the course of neurodevelopment: A framework for understanding the enduring effects of psychotropic drugs. *International Journal of Developmental Neuroscience 22*(5-6), 423–440.

Appel, C. W., C. Johansen, J. Christensen, K. Frederiksen, H. Hjalgrim, S. O. Dalton, A. Dencker, J. Dige, P. Bøge, A. Dyregrov, et al. (2016). Risk of use of antidepressants among children and young adults exposed to the death of a parent. *Epidemiology 27*(4), 578–585.

Appel, C. W., C. Johansen, I. Deltour, K. Frederiksen, H. Hjalgrim, S. O. Dalton, A. Dencker, J. Dige, P. Bøge, B. A. Rix, et al. (2013). Early parental death and risk of hospitalization for affective disorder in adulthood. *Epidemiology 24*(4), 608–615.

Borghans, L., B. H. Golsteyn, J. J. Heckman, and J. E. Humphries (2016). What grades and achievement tests measure. *Proceedings of the National Academy of Sciences 113*(47), 13354–13359.

Bratti, M. and M. Mendola (2014). Parental health and child schooling. *Journal of Health Economics 35*, 94–108.

Børn, Unge og Sorg (2018). Årsrapport 2018.

Cas, A. G., E. Frankenberg, W. Suriastini, and D. Thomas (2014). The impact of parental death on child well-being: Evidence from the indian ocean tsunami. *Demography 51*(2), 437–457.

Chen, S. H., Y.-C. Chen, and J.-T. Liu (2009). The impact of unexpected maternal death on education: First evidence from three national administrative data links. *American Economic Review 99*(2), 149–53.

Conti, G., J. Heckman, A. Ben-Arieh, F. Casas, I. Frønes, and J. Korbin (2014). Handbook of child well-being. *2014). Economics of Child Well-being.*

Cunha, F. and J. Heckman (2007). The technology of skill formation. *American Economic Review 97*(2), 31–47.

Currie, J. (2009). Healthy, wealthy, and wise: Socioeconomic status, poor health in childhood, and human capital development. *Journal of Economic Literature 47*(1), 87–122.

Currie, J. and M. Stabile (2006). Child mental health and human capital accumulation: The case of adhd. *Journal of Health Economics 25*(6), 1094–1118.

Dalton, S. O., J. Schüz, G. Engholm, C. Johansen, S. K. Kjær, M. Steding-Jessen, H. H. Storm, and J. H. Olsen (2008). Social inequality in incidence of and survival from cancer in a population-based study in denmark, 1994–2003: summary of findings. *European Journal of Cancer 44*(14), 2074–2085.

Dansk Sygeplejeråd (2018). Tabelnotat - dsr og børn, unge og sorg.

Dobkin, C., A. Finkelstein, R. Kluender, and M. J. Notowidigdo (2018). The economic consequences of hospital admissions. *American Economic Review 108*(2), 308–52.

Doyle Jr, J. J. (2007). Child protection and child outcomes: Measuring the effects of foster care. *American Economic Review 97*(5), 1583–1610.

Fadlon, I. and T. H. Nielsen (2015). Family labor supply responses to severe health shocks. Technical Report 21352, National Bureau of Economic Research.

Flachs, E. M., L. Eriksen, M. B. Koch, J. T. Ryd, E. P. Dibba, L. Skov-Ettrup, and K. Juel (2015). *Sygdomsbyrden i Danmark: Sygdomme.* Sundhedsstyrelsen.

Fronstin, P., D. H. Greenberg, and P. K. Robins (2001). Parental Disruption and The Labour Market Performance of Children When They Reach Adulthood. *Journal of Population Economics 14*, 137–172.

Gertler, P., D. I. Levine, and M. Ames (2004). Schooling and parental death. *Review of Economics and Statistics 86*(1), 211–225.

Gimenez, L., S.-Y. Chou, J.-T. Liu, and J.-L. Liu (2013). Parental loss and children's well-being. *Journal of Human Resources 48*(4), 1035–1071.

Heinesen, E. and C. Kolodziejczyk (2013). Effects of breast and colorectal cancer on labour market outcomes—average effects and educational gradients. *Journal of Health Economics 32*(6), 1028–1042.

Heissel, J. A., E. K. Adam, J. L. Doleac, D. N. Figlio, and J. Meer (2018). Testing, stress, and performance: How students respond physiologically to high-stakes testing. *Education Finance and Policy*, 1–50.

Kailaheimo-Lönnqvist, S. and J. Erola (2016). The effect of early parental death on children's university education. *Working Papers on Social and Economic Issues 12*, 2016.

Kræftens Bekæmpelse (2014). Evaluering af skolers brug af sorghandleplaner.

Le, H. T. and H. T. Nguyen (2017). Parental health and children's cognitive and noncognitive development: New evidence from the longitudinal survey of australian children. *Health Economics 26*(12), 1767–1788.

lægemiddelstyrelsen (2020). medstat. http://www.medicinkombination.dk/. Accessed: 2020-03-21.

Luca, D. L. and D. E. Bloom (2018). Returns to Parental Health : Evidence from Indonesia. *IZA Discussion Paper* (11987).

Luecken, L. J. (2000). Parental caring and loss during childhood and adult cortisol responses to stress. *Psychology and Health 15*(6), 841–851.

Lundborg, P., A. Nilsson, and D.-O. Rooth (2014). Adolescent health and adult labor market outcomes. *Journal of Health Economics 37*, 25–40.

Meyer, B. D. and W. K. Mok (2019). Disability, earnings, income and consumption. *Journal of Public Economics 171*, 51–69.

Morefield, B. (2010). Parental health events and children's skill development. *University of North Carolina at Greensboro-Department of Economics Working Papers*, 10–11.

Nicolson, N. A. (2004). Childhood parental loss and cortisol levels in adult men. *Psychoneuroendocrinology 29*(8), 1012–1018.

Norén, A. (2020). Sick of my parents? consequences of parental ill health on adult children. Technical Report 1.

OECD (2018). *Health At A Glance: Europe 2018: State of Health in the EU Cycle.* OECD Publishing, Paris.

OECD Family Database (2018). Sf2.3 age of mothers at childbirth and age-specific fertility. Accessed: 2019-05-24.

Owens, D. (2008). Recognizing the needs of bereaved children in palliative care. *Journal of Hospice & Palliative Nursing 10*(1), 14–16.

Psykologer i Danmark (2018). Offentlige tilskudsordninger. https://psykologeridanmark.dk/psykologernes-arbejde/praktiserende-psykolog/offentlige-tilskudsordninger/. Accessed: 2019-03-03.

Region Midtjylland (2012). Samtaleterapi - ydelse 6101.

Region Sjælland (2014). Samtaleterapi i almen praksis - en analyse i region sjælland.

Rellstab, S., P. Bakx, P. García-Gómez, and E. van Doorslaer (2020). The kids are alright-labour market effects of unexpected parental hospitalisations in the netherlands. *Journal of Health Economics 69*, 102275.

Retsinformation (1992). Bekendtgørelse om forsøgsordning med tilskud til psykologbehandling for voldsofre og andre særligt udsatte grupper. https://www.retsinformation.dk/Forms/R0710.aspx?id=46362. Accessed: 2019-03-04.

Retsinformation (2013). Vejledning om medikamentel behandling af børn og unge med psykiske lidelser. https://www.retsinformation.dk/Forms/R0710.aspx?id=146409. Accessed: 2019-03-04.

Rossin-Slater, M., M. Schnell, H. Schwandt, S. Trejo, and L. Uniat (2019). Local exposure to school shootings and youth antidepressant use. *NBER Working Paper* (26563).

Senne, J.-N. (2014). Death and schooling decisions over the short and long run in rural madagascar. *Journal of Population Economics 27*(2), 497–528.

Stock, J. H., J. H. Wright, and M. Yogo (2002). A survey of weak instruments and weak identification in generalized method of moments. *Journal of Business & Economic Statistics 20*(4), 518–529.

Sundhedsdatastyrelsen (2020). medstat. https://medstat.dk/. Accessed: 2020-03-21.

Sundhedsstyrelsen (2012). Anbefalinger til sundhedspersoners møde med pårørende til alvorligt syge.

Suor, J. H., M. L. Sturge-Apple, P. T. Davies, D. Cicchetti, and L. G. Manning (2015). Tracing differential pathways of risk: Associations among family adversity, cortisol, and cognitive functioning in childhood. *Child Development 86*(4), 1142–1158.

Weaver, K. E., J. H. Rowland, C. M. Alfano, and T. S. McNeel (2010). Parental cancer and the family. *Cancer 116*(18), 4395–4401.

A Appendix

A.1 Outcome variables

The sample in the different analyses differs due to data constraints. For example, ninth grade exam test scores are available in the younger cohorts; those graduating between 2002 and 2015. Highest level of competed education is best measured at later ages, thus, is only available for the older cohorts. Table 6 provides an overview of the sample for the different outcome variables. In the following I describe the construction of the different outcome measures. In the dataset used in the analysis, I exclude children who are not in the administrative data at age 18. This can be caused by death or emigration. I exclude children of parents who weren't between 18 and 50 years of age at the time of childbirth. I link several administrative data sets.

Test scores: I construct standardized test scores by school year in the written exams in math and Danish, and an average scores over mandatory ninth grade exams (GPA). Within each school year, the written exams are performed at the exact same time nationwide. The students get the same assignment and an external teacher marks the exams. I use the test scores in the written exams to measure the short-term effect, as I observe whether the parental health shock happens before or after the exam. The dates of the written exams are published annually by the Ministry of Education. I exclude children who attend the make-up exam. Very few children (453) take the make-up exam (e.g. available, if the child is sick at the ordinary exam).

To investigate the long-term effect, I use the child's GPA since an average is less volatile than a single score, and may for that reason, give a more accurate picture of the child's abilities. Some of the test scores included in the GPA are marked by the child's own teachers. The teachers may know about the parental health shock, which may influence the score they give. I exclude children who do not attend the exam the year they turn 16 or 17: 99 percent of the children attend the exam during this age interval. During the period examined in this study, ninth grade exams were not mandatory and a child did not need to attend the ninth grade exam to enter senior secondary education.

Thus, the ninth grade exams have little influence on the child's later life, test scores and GPAs are good proxies for later life outcomes (Borghans et al., 2016). A problem occurs if the family or child manipulate the timing of the shock relative to the exam. Looking at the distribution of observations around the exam cut-off, shows no clear jump around the cut-off, suggesting that the parents cannot impact the timing of the shock (figure not shown). For a few birth cohorts, I also observe test scores from the National Tests, which is a standardized test performed in the second to eight grades. As the data is only available for a small number of birth cohorts.

School enrollment and highest completed level of education: School enrollment is measured at 1 October. To enroll in the optional tenth grade or senior secondary education, the child has to apply by 1 March of the same year. Up until 1991 the application deadline was 15 March. I will not take account of this. In the analysis I measure the child's school enrollment and highest level of completed education the year they graduate ninth grade (year 1) up until 5 years after ninth grade.

Anti-depressants consumption: I measure whether the child's has had at least of prescription filled for anti-depressants and other prescription drugs in the years around the parental health shock (-/+ 1 to 5 years), during childhood (ages 14 to 18) and early adulthood (ages 20 to 25). I observe filled prescriptions in the period from 1996 to 2016. Anti-depressants are defined as medications with the ATC-code N06A.

Psychological therapy: Psychological therapy is defined as a session with a psychologist in the public health sector or therapeutic conversations with a GP. I measure the effect around the parental health shock (-/+ 1 to 5 years), during childhood (ages 14 to 18) and early adulthood (ages 20 to 25). The child could get support by a NGO, which is not be observed in the data. Psychological treatment is defined as doctor visits with the codes 63 and the following codes 804003, 804021-804027, 804050, 804063, 804106, 804116, 80600, 806101

Table 6: Overview of the outcome variables

Outcome	Years available	age at measurement	Birth cohorts used
Test Scores 6nd-8th grade	2010-2016	13-15	1995-1998
9th grade exam scores, math, Danish and GPA	2002-2014	16-17	1986-1998
School enrollment	1981-2015	16-21	1972-1995
Highest education achieved	1981-2015	16-21	1972-1995
Highest education achieved	1981-2015	25	1972-1989
Prescription drugs during childhood	1995-2015	14-18	1984-1998
Prescription drugs during early adulthood	1995-2015	20-25	1975-1996
Psychological treatment during childhood	1995-2015	14-18	1984-1998
Psychological treatment as an adult	1995-2015	20-25	1975-1996

A.2 Instrumental variable approach

The use of anti-depressants and therapy are increasingly common among children, and the prevalence is higher for children who experience a serious parental health event, cf. Figure 1. I estimate whether psychological therapy and anti-depressant medication as a response to a parent's health shock have long-term effects for the child, using an Instrumental Variable approach. The perfect experiment is a setting where children are randomly assigned to therapy, anti-depressants or nothing following a serious parental health shock.

I exploit differences between GPs' practice styles as a source of external variation. I create two distinct instruments; one specifies the share of patients who received therapy, and one specifies the share with filled anti-depressants prescriptions. The instruments are calculated for each GP, for patients in a given age range and year range. The calculation of the instrument includes all children, except the child herself, assuming that the GP treats the sub-sample of children who experience a parent's health shock, similar to the full sample of children. I perform the analysis for children who experience a parent's health shock between the ages 14 and 18 and who were born in the birth cohorts 1980 to 1998. Getting therapy or taking anti-depressant medication may be less endogenous in this sample of children, as the parental health shock is an external factor that impacts the child's mental health and, hence, probability of treatment.

Figure 5, panels (a) and (c) show the distribution of the instruments. The figures substantiate the variation I use in the analysis; while the 10th percentile GP gave therapy (prescribed anti-depressants) to less than 0.4 (0.2) percent of children, the 90th percentile GP gave treatment to 4.2 (3.6) percent of child patients. The types of treatment investigated are low frequency, which introduces some uncertainty to the estimation and the results should be interpreted with caution. However, there does seem to be variation in the use of therapy and anti-depressants that correlates with GP behavior, cf. Figure 5 panel (b) and (d).

I estimate the following equations using linear Two Stage Least Squares.

$$Therapy_{ij} = \alpha_0 + \alpha_1 \cdot \delta_j^{therapy} + \alpha_2 \cdot \delta_j^{anti-depressants} + X_{ij} \cdot \beta + u_{ij}$$

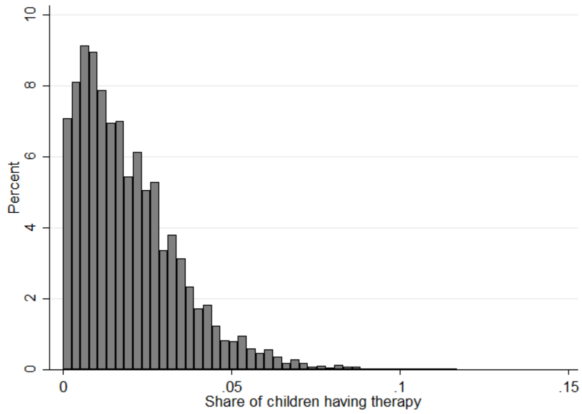
$$Anti-depressant_{ij} = \gamma_0 + \gamma_1 \cdot \delta_j^{therapy} + \gamma_2 \cdot \delta_j^{anti-depressants} + X_{ij} \cdot \beta + u_{ij}$$

$$Y_i = \beta_0 + \beta_1 \cdot \widehat{Therapy}_{ij} + \beta_2 \cdot Anti-\widehat{depressants}_{ij} + X_i \cdot \alpha + u_i$$

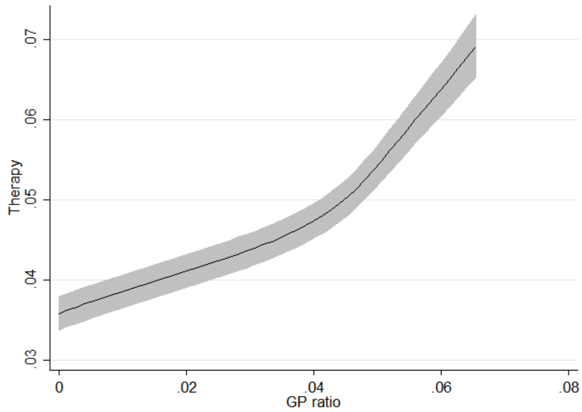
$Therapy_{ij}$ and $Anti-depressant_{ij}$ indicate whether child i has therapy or takes anti-

Figure 5: Instrument variation and first stage relationship

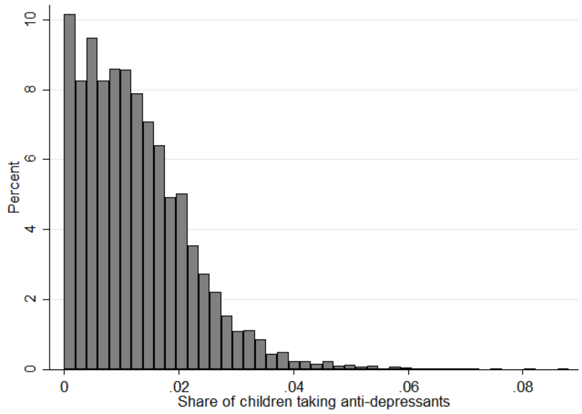
(a) Psychological therapy instrument



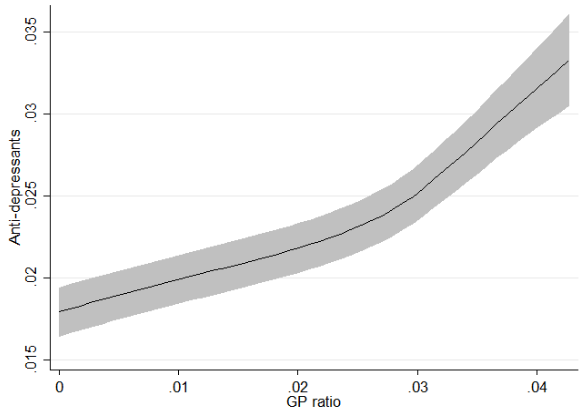
(b) Psychological therapy instrument on own probability of therapy



(c) Anti-depression instrument



(d) Anti-depression instrument on own probability of using the drug



Notes: Panels (a) and (c) show the distribution of the two instruments. The instruments are the share of children in a given age and year range having therapy or consuming anti-depressants for a particular GP, leaving the focal child out of the calculation. Year is divided into four intervals: 1995-2000, 2001-2005, 2006-2010, 2011-2015. Therapy can be either therapy with a psychologist, or therapeutic conversations with the GP. Anti-depressant use is measured as at least one filled prescription one year after the parental health shock. The top one percent of the distribution of the instrument is excluded in panels (b) and (d).

depressants following a parental health shock, and has GP j at the time as the shock. $\delta_j^{therapy}$ is the share of children between ages 14 and 18 in a given year range (1995-2000, 2001-2005, 2006-2010, 2011-2015) having therapy and doctor j as their GP. $\delta^{anti-depressants}$ is the share of GP j's patients taking anti-depressants. $\widehat{Therapy_i}$ and $Anti - \widehat{depressants_i}$ are the predicted use of therapy and anti-depressants from the first-stage equations. Y_i is the outcome variable of interest, X_i is a vector of family and child-specific control variables. In addition, I include municipality fixed effects to control for area specific differences.

The analysis provides meaningful results if the following conditions hold:

Relevant Instrument: The GP's practice style must affect the child's probability of treatment. Figure 5 panels (*b*) and (*d*) show a graphical representation of the first stage conditions and Table 7 reports the first stage estimates for three different specifications. The figure and table show that increasing the GP's share of children having therapy and taking anti-depressants increases the child's own probability of receiving treatment following the parental health shock. The estimates are fairly consistent while adding more controls, highly significant, and the F-test of exogeneity has a value above the critical level of 10 (Stock et al., 2002). The first stage estimates for the use of therapy are above one, indicating that children experiencing a parent's health shock are more likely to get this treatment compared to the average child. In case of anti-depressants, the estimates are close to, but below one. The two instruments are correlated, but the share of children taking anti-depressants is not a good instrument for the use of therapy and vice versa.

Table 7: First Stage Regression

	(1)	(2)	(3)
Psychological Therapy			
Share of children having therapy	1.459***	1.506***	1.425***
	(0.130)	(0.135)	(0.138)
Share of children taking AD	0.187	0.238*	0.198
	(0.130)	(0.138)	(0.142)
Anti-depressants			
Share of children having therapy	0.169**	0.079	0.100
	(0.084)	(0.087)	(0.093)
Share of children taking AD	0.944***	0.821***	0.825***
	(0.107)	(0.109)	(0.115)
F-test of exogeneity	45.83	36.17	32.27
Observations	24,159	24,159	24,098
Family controls	No	Yes	Yes
Municipality Fixed effects	No	No	Yes

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered at the GP-level. The instruments are calculated as the share of children in a given age range taking anti-depressants (AD) or having therapy, leaving the focal child out of the calculation. Therapy can be either therapy with a psychologist, or therapeutic conversations with the GP. Anti-depressant use is measured as at least one filled prescription one year after the parental health shock. The sample is children from the birth cohorts 1981-1996 who experienced a parental health shock between ages 14 and 18. The top one percent of the distribution of the instruments are excluded. The F-statistics is the Craigh-Donald Wald F-statistics.

Exclusion Restriction: The GP's practice style should only affect the child's outcome, Y_i, through the pathway given in the first stage equations and difference in practice style should be supply side driven, rather than driven by the demand. As a test of the Exclusion Restriction, I

Table 8: Correlation between anti-depressant use, use of therapy, the instruments and family characteristics

	AD	Therapy	Instrument	
			GP therapy share	GP AD share
	(1)	(2)	(3)	(4)
Male	-0.069***	-0.129***	-0.000	-0.000
	(0.004)	(0.005)	(0.000)	(0.000)
Mother, second income quartile	-0.005	-0.006	0.000	-0.000
	(0.005)	(0.007)	(0.000)	(0.000)
Mother, third income quartile	-0.008	-0.003	0.000	-0.000
	(0.005)	(0.007)	(0.000)	(0.000)
Mother, fourth income quartile	-0.015***	-0.016**	0.000	0.000
	(0.005)	(0.007)	(0.000)	(0.000)
Father, second income quartile	-0.004	-0.001	-0.000	0.000
	(0.005)	(0.007)	(0.000)	(0.000)
Father, third income quartile	-0.011**	-0.013**	-0.000	0.000
	(0.005)	(0.006)	(0.000)	(0.000)
Father, fourth income quartile	-0.017***	-0.011*	0.000	0.000
	(0.005)	(0.007)	(0.000)	(0.000)
Mother, compulsory school	0.027***	0.018***	-0.000	0.000
	(0.004)	(0.006)	(0.000)	(0.000)
Mother, college education	-0.002	0.005	-0.000	-0.000
	(0.005)	(0.007)	(0.000)	(0.000)
Father, compulsory school	0.019***	0.012**	-0.000	-0.000
	(0.005)	(0.006)	(0.000)	(0.000)
Father, college education	0.008	-0.004	0.000	0.000
	(0.005)	(0.007)	(0.000)	(0.000)
Non-Danish ethnic background	-0.048***	-0.081***	-0.001**	-0.002***
	(0.008)	(0.011)	(0.000)	(0.000)
Mother's age at child's birth	-0.001	-0.001*	0.000	0.000
	(0.001)	(0.001)	(0.000)	(0.000)
Father's age at child's birth	0.000	0.001	-0.000***	-0.000**
	(0.000)	(0.001)	(0.000)	(0.000)
First born	-0.004	0.002	-0.000	0.000
	(0.005)	(0.006)	(0.000)	(0.000)
Siblings	-0.023***	-0.036***	-0.000	-0.000
	(0.006)	(0.007)	(0.000)	(0.000)
Constant	0.125***	0.215***	0.009***	0.006***
	(0.017)	(0.022)	(0.001)	(0.001)
Observations	25,402	25,402	25,402	25,402
R-squared	0.061	0.052	0.292	0.308

Notes: *** p<0.01, ** p<0.05, * p<0.1. The regression also includes dummies for the child's birth year. These variables are excluded in the table.

regress the instruments as a dependent variable on family and child characteristics, the results are shown in Table 8 columns (3) and (4). The results suggest that family and child characteristics do not jointly explain the variation in the instruments. Thus GPs seem to be quasi-randomly assigned between children.[16]

Monotonicity: The last assumption implies that a child who would get treatment from a GP with a low prescription rate would also receive treatment from a GP with a high prescription rate. The monotonic increase in treatment probability with the instrument shown in Figure 5 panels (*b*) and (*d*), provides some support for the Monotonicity Condition (Doyle Jr, 2007).

A.2.1 Robustness check

There are several threats to the identification in the IV analysis. First, the families could choose a GP based on the probability of receiving treatment. This would threaten the identification, as the results could be subject to a selection bias. To circumvent selection, I use the child's GP

[16] One variable is, however, strongly significant; Children from families with a non-ethic Danish background are less likely to have a GP who refers children to therapy or prescribes anti-depressant medication. Excluding this group of children does not change the results.

at the time of the parental health, to limit the time to change GP based on prescription rates. Using the child's GP one year before the parental health shock, produce similar but less precise results, cf. Table 9 column (2) and (3).

As a check of the selection into treatment, I chose an outcome variable that is determined before the parental health shock. Table 9 column (1) shows the result with GPA in ninth grade as an outcome variable. The estimation is performed for the group of children who experience the parental health shock after the exam, so the shock should not impact the GPA scores. The results show no significant effect, and the parameter values have the opposite signs compared to the main results. This indicates that there is no selection into treatment, based on predetermined variables.[17]

While I do control for municipality fixed effects, the municipalities in Denmark are large and there exists large variation within each municipality. Some of the effect found could, for that reason, be area specific effects that the municipality fixed effects do not properly account for. To circumvent this threat, I construct GP specific variables to account for neighborhood characteristics that summarize patient characteristics. I create four variables: The mean of the mothers' and fathers' incomes, and the shares of the mothers and fathers that have a college degree. Adding these four variables to the estimation does not change the results, see Table 9 columns (4) and (5). This gives some comfort that the differences between the doctors are not demand driven, but driven by differences in practice styles between the doctors. Using one endogenous variable and one instrument at a time and controling for the other type of treatment, does not change the results. Using an IV probit model produces the same quantitative results. Results are not shown.

[17] The 2SLS estimation on therapy and anti-depressants for this specific subgroup of children gives the same results as in the main analysis. Results not shown.

Table 9: Instrumental variable estimation - Robustness checks

		GP before shock		GP patient controls	
	GPA	+5 years	Age 25	+5 years	Age 25
	(1)	(2)	(3)	(4)	(5)
Therapy	-0.378	-0.212	-0.162	-0.257	-0.118
	(0.515)	(0.202)	(0.325)	(0.171)	(0.286)
Anti-depressants	1.254	0.772**	1.064	0.776*	1.623**
	(1.204)	(0.372)	(0.796)	(0.396)	(0.759)
Observations	16,546	21,061	14,109	25,285	16,536
F-Statistics	13.17	23.03	7.71	23.55	10.25

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered at the GP-level. The instruments are calculated as the share of children in a given age range taking anti-depressants (AD) or having therapy, leaving the focal child out of the calculation. Therapy can be either therapy with a psychologist, or therapeutic conversations with the GP. Anti-depressant use is measured as at least one filled prescription one year after the parental health shock. The sample is children from the birth cohorts 1981-1996 who experienced a parental health shock between ages 14 and 18. The top one percent of the distribution of the instruments are excluded. The F-statistics is the Craigh-Donald Wald F-statistics.

A.3 Figures and tables

Table A.1: Codes used for health shocks

		ICD 8	ICD 10
Cancer		140-99, 200-209	C, D00-D09
	Prostate	185-187	C60-C65
	Cervix & ovary	180-184	C53-C56
	Lung	161-162	C32-C34
	Colon	153	C18
	Stomach	140-151	C00-C16
	Skin & bones	170, 172, 173	C40-C44
Cardiovascular Diseases		410-414, 430-438	I20-I25, I60-I69
	Heart	410-414	I20-I25
	Brain	430-438	I60-I69

Table A.2: F-test, Short-term analysis. Do family characteristics predict whether the parental health shock happens before or after the ninth grade math exam?

	Health shock	Mother	Father
	(1)	(2)	(6)
Male	0.003	0.001	0.002
	(0.010)	(0.014)	(0.013)
Mother, second income quartile	-0.003	0.020	-0.025
	(0.015)	(0.021)	(0.020)
Mother, third income quartile	-0.013	0.002	-0.037*
	(0.015)	(0.021)	(0.019)
Mother, fourth income quartile	0.017	0.024	0.007
	(0.015)	(0.021)	(0.020)
Father, second income quartile	-0.035**	-0.030	-0.045**
	(0.014)	(0.021)	(0.019)
Father, third income quartile	-0.029**	-0.032	-0.027
	(0.014)	(0.021)	(0.019)
Father, fourth income quartile	-0.027*	-0.019	-0.033*
	(0.015)	(0.021)	(0.019)
Mother compulsory school	0.001	-0.010	0.013
	(0.012)	(0.017)	(0.016)
Mother college education	0.004	-0.002	0.009
	(0.013)	(0.018)	(0.018)
Father compulsory school	-0.005	0.004	-0.024
	(0.012)	(0.018)	(0.016)
Farther college education	0.012	0.004	0.014
	(0.014)	(0.020)	(0.019)
Non-Danish ethic background	0.017	0.047	0.003
	(0.025)	(0.043)	(0.030)
Mother's age at child's birth	-0.002	-0.001	-0.001
	(0.001)	(0.002)	(0.002)
Father's age at child's birth	0.001	0.001	-0.000
	(0.001)	(0.002)	(0.001)
First born	0.007	0.012	0.001
	(0.012)	(0.017)	(0.016)
Siblings	-0.002	0.012	-0.023
	(0.015)	(0.021)	(0.020)
Constant	0.546***	0.488***	0.601***
	(0.046)	(0.066)	(0.061)
Observations	10,641	5,302	5,932
R-squared	0.002	0.002	0.003
F-test	1.108	0.550	1.293
Prob > F	0.341	0.921	0.191

Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses

Table A.3: Event study use of therapy

	Health Shock	Boys	Girls	Death
	(1)	(2)	(3)	(4)
-4	0.000	0.002	-0.001	-0.003
	(0.001)	(0.002)	(0.002)	(0.003)
-3	-0.001	0.000	-0.003	-0.007**
	(0.001)	(0.001)	(0.002)	(0.003)
-2	-0.000	-0.000	-0.001	-0.006**
	(0.001)	(0.002)	(0.002)	(0.003)
0	0.013***	0.007***	0.020***	0.080***
	(0.002)	(0.002)	(0.003)	(0.004)
1	0.024***	0.015***	0.033***	0.071***
	(0.002)	(0.002)	(0.004)	(0.004)
2	0.023***	0.015***	0.031***	0.022***
	(0.002)	(0.003)	(0.004)	(0.005)
3	0.018***	0.016***	0.020***	0.007
	(0.003)	(0.003)	(0.005)	(0.006)
4	0.020***	0.016***	0.023***	-0.000
	(0.003)	(0.003)	(0.006)	(0.006)
5	0.017***	0.012***	0.022***	-0.006
	(0.004)	(0.004)	(0.006)	(0.007)
Constant	-0.004	-0.002	-0.006	-0.010
	(0.005)	(0.006)	(0.009)	(0.010)
Observations	219,912	112,475	107,437	95,195
Number of individuals	19,992	10,225	9,767	8,655
R-squared	0.018	0.010	0.027	0.040

Notes:*** p<0.01, ** p<0.05, * p<0.1. Control Variables: Calendar year dummies and individual fixed effects. Standard errors are clustered at the individual level.

Table A.4: Event study use of anti-depressants

	Health Shock	Boys	Girls	Death
	(1)	(2)	(3)	(4)
-4	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.002)	(0.002)
-3	-0.001	-0.000	-0.002	-0.000
	(0.001)	(0.001)	(0.002)	(0.002)
-2	-0.001	0.001	-0.002	-0.001
	(0.001)	(0.001)	(0.002)	(0.002)
0	0.001	0.001	0.000	0.003
	(0.001)	(0.002)	(0.002)	(0.003)
1	0.005***	0.005***	0.006**	0.012***
	(0.002)	(0.002)	(0.003)	(0.003)
2	0.011***	0.009***	0.013***	0.019***
	(0.002)	(0.002)	(0.003)	(0.003)
3	0.017***	0.013***	0.022***	0.028***
	(0.002)	(0.002)	(0.004)	(0.004)
4	0.023***	0.016***	0.029***	0.033***
	(0.003)	(0.003)	(0.004)	(0.005)
5	0.027***	0.018***	0.035***	0.037***
	(0.003)	(0.003)	(0.005)	(0.005)
Constant	0.001	0.002	0.000	-0.001
	(0.004)	(0.005)	(0.007)	(0.007)
Observations	219,912	112,475	107,437	95,195
Number of individuals	19,992	10,225	9,767	8,655
R-squared	0.026	0.013	0.039	0.037

Notes:*** p<0.01, ** p<0.05, * p<0.1. Control Variables: Calendar year dummies and individual fixed effects. Standard errors are clustered at the individual level.

Table A.5: Event study use of psychotropic drugs, severe parental health shock

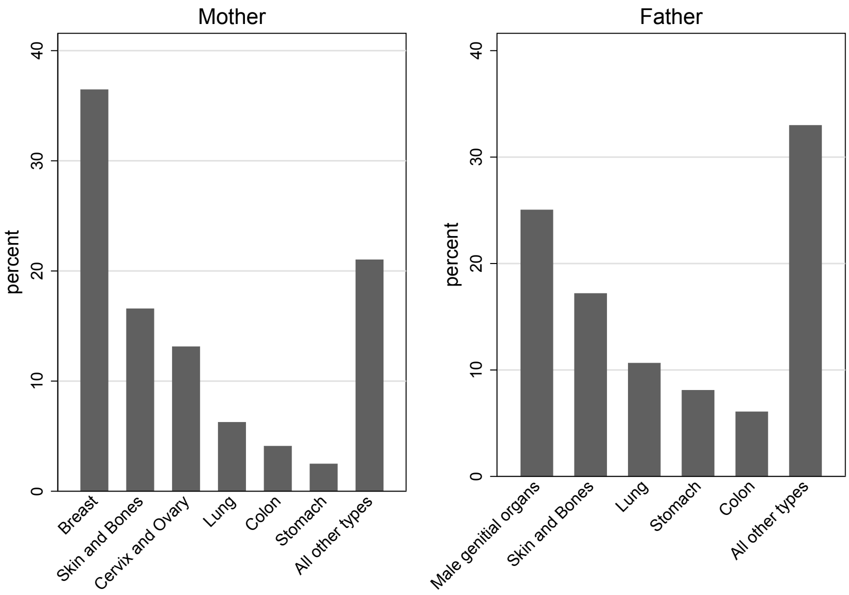
	Antipsychotics (1)	Anxiolytics (2)	Hypnotics and sedatives (3)	Psychostimulants (4)
-4	-0.000	-0.000	-0.000*	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
-3	-0.001**	-0.001***	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
-2	-0.000	-0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
0	0.000	0.001	0.001**	-0.001*
	(0.000)	(0.001)	(0.000)	(0.000)
1	0.001	0.002***	0.002***	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
2	0.002***	0.003***	0.003***	-0.001**
	(0.001)	(0.001)	(0.001)	(0.001)
3	0.003***	0.004***	0.005***	-0.002**
	(0.001)	(0.001)	(0.001)	(0.001)
4	0.003***	0.005***	0.005***	-0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
5	0.004**	0.006***	0.005***	-0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
Constant	-0.001	-0.000	0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Observations	219,912	219,912	219,912	219,912
Number of individuals	19,992	19,992	19,992	19,992
R-squared	0.007	0.002	0.004	0.003

Notes:*** p<0.01, ** p<0.05, * p<0.1. Control Variables: Calendar year dummies and individual fixed effects. Standard errors are clustered at the individual level. The following ATC codes are used: Antipsychotics: N05A, Anxiolytics: N05B, Hypnotics and sedatives: N05C, Psychostimulants, agents used for ADHD and nootropics: N06B.

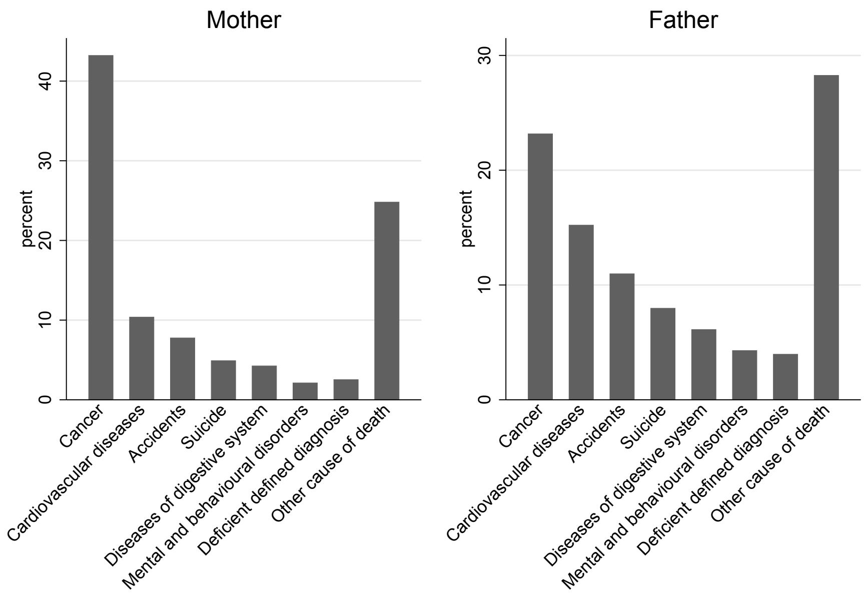
Table A.6: Immediate effect of a serious parental health shock on exam scores, Robustness check

	Father (1)	Mother (2)	Danish score (3)	siblings fixed effects (4)	Individual fixed effects (5)
Joint health shock			-0.0770***	-0.119**	-0.0954***
			(0.0238)	(0.0542)	(0.0192)
Observations			10,463	3,273	10,950
Cardiovascular Diseases	-0.095**	-0.199***			
	(0.044)	(0.064)			
Observations	3125	1447			
Cancer	-0.075*	-0.075*			
	(0.045)	(0.040)			
Observations	2804	3768			
Number of family				1,654	
Number of individuals					3,603

Notes: *** p<0.01, ** p<0.05, * p<0.1. The table shows the estimate for the variable *pre*, indicating whether the child has experienced the health shock prior to the ninth grade math exam, estimated under the condition that the child has experienced the parental health shock within one year prior to or after the ninth grade written exam. Math score is standardized with mean zero and standard deviation one. Control variables: child's gender, child's age at the time of the parental health shock, mother's and fathers's income groups, mother's and father's highest level of completed education, mother's and father's age at the time of the child's birth, ethnic background, indicator variable for whether the child have siblings and if the child is the first born and birth cohort dummies. Robust standard errors in parentheses.



(a) Type of cancer



(b) Causes of death

Figure A.1: Type of cancer and cause of death, by mother and father

Notes: See Appendix Table A.1 for the diagnosis codes. The figure shows the distribution of parents cancer types for all children experiencing a parent getting cancer between the ages of 0 and 20.

Figure A.2: Anti-depressant consumption and use of therapy across years by the specific parental health shock

(a) Use of therapy (b) Anti-depressants

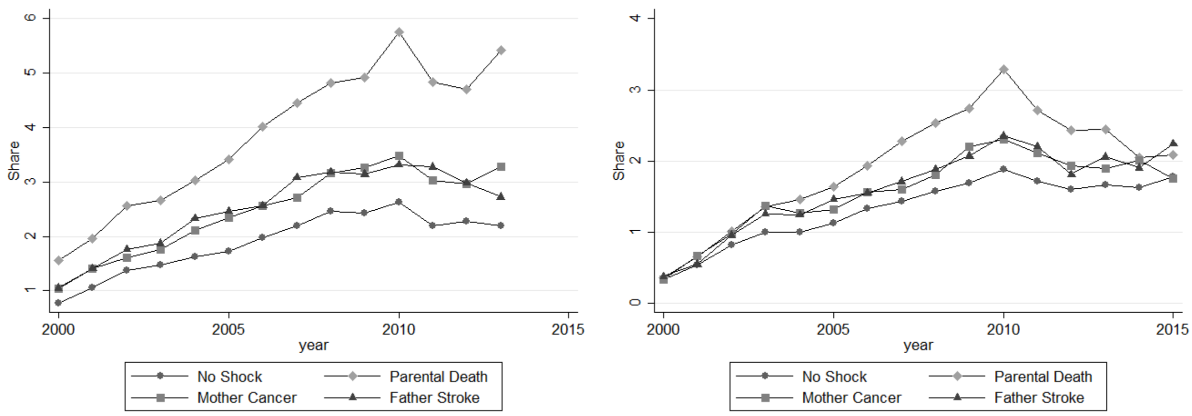


Table A.7: Immediate effect of a serious parental health shock on school enrollment and highest educational attainment

	Year 1	Year 2	Year 3	Year 4	Year 5
Not enrolled in school	0.029***	0.033***	0.049***	0.059***	0.029***
	(0.007)	(0.008)	(0.009)	(0.011)	(0.011)
Mean of dep.var.	8.5	15.5	18.0	42.6	60.4
Observations	14,198	14,198	14,198	14,198	14,198
Ninth grade as highest completed education	0	0	0	0.056***	0.065***
	(.)	(.)	(.)	(0.016)	(0.015)
Mean of dep.var.	100	99.9	98.6	47.3	36.1
Observations	1171	2172	2531	5723	6937

Notes: *** p<0.01, ** p<0.05, * p<0.1. Estimated using a linear probability model. The table shows the estimate for the variable pre, indicating whether the child has experienced the health shock prior to the application deadline for senior secondary schooling, which occurs in ninth grade, estimated under the condition that the child has experienced the parental health shock within one year prior to or after the application deadline. The effect on ninth grade as highest level of completed education is estimated conditional on no school enrollment, cannot be estimated in the first years after finishing ninth grade, as all children have compulsory school as their highest level of completed education at that time. Control variables: the gender of the child, the child's age at the time of the parental health shock, mother's and father's income groups, mother's and father's highest level of completed education, mother's and father's age at the time of the child's birth, ethnic background, indicator variable for whether the child have siblings and if the child is the first born and birth cohort dummies. Robust standard errors in parentheses.

Table A.8: Long-term effect, age dummies

	GPA		No school enrollment	
	Health Shock	Death	Health Shock	Death
Age 1	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)
Age 2	0.070	-0.036	0.003	0.001
	(0.057)	(0.108)	(0.018)	(0.042)
Age 3	0.053	0.007	0.037**	0.021
	(0.051)	(0.096)	(0.017)	(0.039)
Age 4	0.082	0.061	0.021	0.039
	(0.052)	(0.107)	(0.016)	(0.037)
Age 5	0.080	0.026	0.049***	0.025
	(0.055)	(0.102)	(0.017)	(0.037)
Age 6	0.108*	0.097	0.029*	-0.004
	(0.057)	(0.107)	(0.017)	(0.038)
Age 7	0.188***	0.083	0.040**	0.046
	(0.059)	(0.110)	(0.017)	(0.038)
Age 8	0.153**	0.100	0.037**	0.055
	(0.061)	(0.115)	(0.018)	(0.038)
Age 9	0.160**	0.164	0.045**	0.082**
	(0.063)	(0.118)	(0.018)	(0.039)
Age 10	0.166**	0.135	0.057***	0.061
	(0.065)	(0.120)	(0.019)	(0.040)
Age 11	0.222***	0.106	0.042**	0.058
	(0.069)	(0.126)	(0.019)	(0.041)
Age 12	0.224***	0.055	0.078***	0.072*
	(0.072)	(0.130)	(0.020)	(0.042)
Age 13	0.208***	0.192	0.066***	0.073*
	(0.076)	(0.137)	(0.021)	(0.043)
Age 14	0.265***	0.222	0.082***	0.084*
	(0.080)	(0.144)	(0.022)	(0.045)
Age 15	0.249***	0.140	0.069***	0.083*
	(0.084)	(0.147)	(0.023)	(0.046)
Age 16	0.276***	0.194	0.072***	0.103**
	(0.094)	(0.168)	(0.024)	(0.048)
Constant	-0.148**	-0.216*	0.095***	0.110***
	(0.060)	(0.114)	(0.017)	(0.039)
Observations	38546	12276	70890	25371

Notes: *** p<0.01, ** p<0.05, * p<0.1 The standard errors are clustered at the family level. A sibling fixed effect estimation is used. The child is included in the analysis if at least two children in the family have experienced the parental health shock prior to the ninth grade exam. The effect is measured relative to a shock at age 1. Control variables: Child gender and an indicator variable for first born child.