Psychiatric diagnoses of children affected by their parents' traumatic brain injury: the 1987 Finnish Birth Cohort study

Lotta Kinnunen, M.D.[a, b], Mika Niemelä, Ph.D.[c], Helinä Hakko, Ph.D.[d], Jouko Miettunen, Ph.D.[a, b], Marko Merikukka, MHc.[c], Vesa Karttunen, M.D., Ph.D.[e], Tiina Ristikari, Ph.D.[c], Mika Gissler, Ph.D.[f], Sami Räsänen, M.D., Ph.D.[d]

a. Center for Life Course Health Research, University of Oulu, Oulu, Finland

b. Medical Research Center Oulu, Oulu University Hospital and University of Oulu, Oulu, Finland

c. National Institute for Health and Welfare, Department of Welfare, Oulu, Finland

d. Oulu University Hospital, Department of Psychiatry, Oulu, Finland

e. Oulu University Hospital, Department of Neurology, Oulu, Finland

f. National Institute for Health and Welfare, Information Services Department, Helsinki, Finland; Research Centre for Child Psychiatry, University of Turku, Turku, Finland; and Karolinska Institute, Department of Neurobiology, Care Sciences and Society, Division of Family Medicine, Stockholm, Sweden

Address of correspondence: Lotta Kinnunen, Licentiate of Medicine, Center for Life Course Health Research, P.O. Box 5000, 90014 University of Oulu, Finland, Fax. +358 8 5315037, Tel.: +358 40 7496490. Email: lotta.kinnunen@student.oulu.fi

Abstract

Background: Children affected by parental traumatic brain injury (TBI) are documented to access more specialised psychiatric services compared to their peers. It remains unknown if the service use indicates psychiatric disorders.

Objective: To investigate whether parental TBI increases the overall risk for psychiatric disorders and the risk for specific psychiatric diagnoses in the children affected by parental TBI.

Methods: The 1987 Finnish Birth Cohort (n = 59 476) were followed up through national registers from birth to the end of 2008. The diagnoses of cohort members and their parents were obtained from the Care Register of Health Care, provided by the National Institute of Health and Welfare.

Results: During the 21-year follow-up, the likelihood for psychiatric diagnoses being assessed in psychiatric care was significantly increased in males with any mental disorder (odds ratio (OR) = 1.43), substance-use-related disorders (OR = 1.71) and behavioural and emotional disorders (OR = 1.75), and in females with disorders of psychological development (OR = 1.85).

Conclusions: Children affected by parental TBI are at increased risk for psychiatric disorders: males for externalising disorders and females for developmental disorders. Observed gender interactions in the association between parental TBI and the psychiatric disorders of children warrants further study.

Keywords: Children, psychiatric diagnoses, mental health, parental TBI

Introduction

A traumatic brain injury (TBI) is a common incident affecting a notable portion of the working age population (1, 2, 3, 4). The frequency of TBI among adults implies that many children will grow up facing the problems that follow parental TBI. Further, a recent nationwide follow-up study in Finland showed that 2.6% of children had a parent with TBI before the age of 21 (5). Thus, it is essential to understand the long-term implications of parental TBI for the children affected by it.

Parental and family adversities, such as severe illnesses and mental illnesses, are reported to associate with increased levels of psychological problems among children (6, 7, 8, 9). Parental mental illnesses are shown to increase the risk of psychological symptoms and mental disorders in children (6, 10). Further, emotional and behavioural difficulties are identified in the siblings of children with special health care needs (11). Similarly, parental TBI may cause mental health difficulties among children.

Some evidence has indicated that parental brain injury is associated with adverse psychological outcomes in children (5, 7, 8, 12, 13). Adolescents have reported symptoms of anxiety and depression following parental TBI (8). Further, children affected by parental brain injury are reported to suffer from post-traumatic stress symptoms more than other children (7). A recent qualitative study of parental brain injury revealed that the children affected by it struggle with both the changed parental role and emotional distancing between the parent and child (14).

Parental TBI is a stressful event for the family and for children in particular (5, 8, 15, 16). Parental TBI affects the parents and their families in various ways (15, 17, 18). First, parental TBI affects the injured parent. A TBI may cause permanent changes in a parent's personality, cognitive capacity and psychological well-being (18, 19, 20, 21, 22). A parent with TBI may suffer from elevated levels of distress and psychological symptoms (18, 22, 23, 24, 25, 26, 27). Further, a parent with TBI may suffer from long-lasting changes in behaviour and communication (22, 28, 29, 30). TBI is considered a risk factor for organic psychiatric disorders, which can present with different kinds of clinical appearances (22, 31, 32), in other words, TBI can cause similar interaction difficulties to psychiatric disorders. These changes in parents affected by TBI may pose a threat to their children's mental health.

Second, the changes in parents with a TBI can have major effects on family life. The entire family may be affected by changes in communication; intimate relationships; work capacity; and social, physical and psychological functioning. A normal everyday life can be profoundly changed due to the challenging behaviour of a parent with a TBI. Changes include demanding economic situations (33) and unemployment (18), as well as adverse changes in spousal interactions, and marital stability and satisfaction (18, 34, 35, 36, 37). Healthy spouses are overburdened with responsibilities and feel distressed (15, 38, 39, 40, 41). Children coping with parental TBI face enormous challenges since both parents are profoundly affected.

Third, parenting can be compromised by parental TBI. Previous studies have shown that parenting is challenging for parents with a TBI (42). For instance, parents with a TBI can feel uncertain about their role as a parent, leading to difficulties with setting boundaries and goals (42). It is evident that multiple burdens on a family have, for example, an impact on the

family atmosphere and mutual communication between parents and children. All of these changes in a parent and in family life may have an effect on children.

It has recently been documented that children with parental TBI access more specialised psychiatric services compared to their peers (5). The study revealed that almost a quarter (23%) of children who had faced parental TBI before the age of 21 had accessed specialised psychiatric services (5). An increased use of a specialised level of psychiatric care may indicate that parental TBI causes more severe outcomes among children than was previously presumed (e.g. 8): not only symptoms but also psychiatric disorders. Earlier research findings, however, have not comprehensively examined at population level whether parental TBI increases the risk for psychiatric disorders in children and, if so, which specific psychiatric diagnoses are emphasized among children affected by parental TBI. In this nationwide study, we investigate whether parental TBI increases the overall risk for psychiatric disorders among children affected by parental TBI. Further, we investigate which psychiatric diagnoses are given to the children affected by parental TBI in specialized health care. All analyses are stratified by gender because the prevalence of psychiatric disorders in the general population is known to show marked gender differences (43, 44).

Methods

Data from the 1987 Finnish Birth Cohort study population

The 1987 Finnish Birth Cohort (FBC) covers all children (60 069 in total) born alive in Finland in 1987. The cohort data are a collection of health, social welfare and sociodemographic data on cohort members and their parents, collated from Finnish registers.

The FBC study was based on Finnish Medical Birth Register data and was later complemented with follow-up information, for example, information on health status. Children surviving the perinatal period were included in the 21-year follow-up study, extending to the end of 2008 (n = 59 476). At the end of the follow-up, 58 320 cohort members (98.1%) were alive and living in Finland. The data are stored and maintained at the National Institute for Health and Welfare, Finland (45, 46).

Psychiatric diagnoses of cohort members

The Care Register of Health Care (CRHC) holds data on all inpatient care episodes at all hospitals since 1969 and all specialised-level outpatient visits in public hospitals since 1998 (47, 48, 49). In our study, the CRHC was used for collecting data on cohort members' psychiatric diagnoses as assessed either in outpatient or inpatient settings in specialised-level care from birth up to December 31, 2008. The diagnosis codes applied in the study are based on the International Classification of Diseases (ICD; both the 9th revision from 1987 to 1995 and the 10th revision from 1996 onwards). The validity of the information from the CRHC varies from satisfactory to very good (47).

Parental TBI diagnoses

The TBI diagnoses of a cohort member's biological mother or father were collected from the CRHC. Parental hospital-treated inpatient TBI diagnoses fell in the period between January 1, 1987, and December 31, 2008. TBI was defined using the ICD (9th and 10th) coding. Accordingly, parents with a diagnosis of a skull fracture, brain contusion or other intracranial injuries (including hematomas) were included (the diagnoses ICD-9 800, 801, 803, 851–854

and ICD-10 S02.0–S02.11, S06.1–S06.9, S07.1), as well as those with a diagnosis of post-concussion syndrome or a sequela of a TBI (ICD-9 9050A, 9070A; ICD-10 F07.2, T90.5). The reference group consists of all other children born in 1987 that had no parent with a TBI during the follow-up period. The severity of TBI was not included in this study since our previous study showed that both mild and severe parental TBI are associated with the use of psychiatric services in children (5).

Covariates

The covariates used in this study were the mother's age (in years) at the offspring's birth (MAGE), the father being known in 1987 (FSTATUS), the highest socioeconomic status of either parent (SES), the highest level of education completed by either parent (EDU), the death of a parent during the follow-up period of 1987–2008 (DEATH) and either parent have had in- or outpatient treatment due to a mental disorder during the follow-up period 1987–2008 (PSYCH).

Information on parental socioeconomic status was obtained from the Finnish Central Population Register and Statistics Finland in 2009. SES was defined using the categories white-collar workers, lower white-collar workers, blue-collar workers and others (the latter including, for example, farmers, students, housewives, entrepreneurs and retired persons) (Statistics Finland 1989, 1990). Data on educational achievements were obtained from Statistics Finland in 2008 and classified into the following four levels: tertiary level (12 years or more of education), lower tertiary level (11–12 years), secondary level (9–11 years) and primary level (up to 9 years). The biological father was unknown for 821 cohort members, of which 403 were girls and 418 were boys.

Covariates were selected on the basis of the existing literature. MAGE has been associated with children's mental health disorders. The offspring of young mothers are at risk of different mental health disorders (50). Parental SES and EDU have been linked with adverse health and psychological outcomes of the children in earlier studies (48, 51, 52, 53). Parental death is a risk factor for children's mental health problems (54, 55, 56, 57, 58). It is well established that parental mental disorders are associated with an increased risk of psychological symptoms and mental disorders in children (6, 10), hence parental psychiatric diagnoses were used as a covariate in this study.

In additional analyses, we further adjusted for social welfare benefits received by either parent, as an indicator of the economic status of the family, during the follow-up period (1987–2008). Social welfare benefits can precede and/or follow parental TBI and can be regarded as a potential mediator of the association. Receiving social welfare benefits is linked to poverty, which is associated with adverse psychological outcomes for children (45, 59).

Statistical analyses

We used binary logistic regression to estimate ORs and 95% confidence intervals (CIs) for the association of parental TBI with children's psychiatric diagnoses. An analysis was performed including several variables (SES, EDU, MAGE, FSTATUS, DEATH and PSYCH: see above) as covariates in the logistic model. Maternal TBI was analysed with maternal covariates and paternal TBI was analysed with paternal covariates. The data analyses were conducted using SPSS version 21.

Results

Overall

Table 1 shows the prevalence of parental TBI and psychiatric disorders in adolescents from the 1987 FBC. A total of 613 (1.0%) fathers had a TBI compared to 162 (0.3%) mothers. Of the cohort, 1.4% of cohort males and 1.2% of cohort females had a parent with a TBI. The most common psychiatric diagnoses among cohort members were affective disorders (5.1%), anxiety disorders (4.3%) and behavioural and emotional disorders (3.4%).

(Insert Table 1 about here)

Parental TBI and the psychiatric diagnoses of children

As presented in Table 2, for female cohort members, the bivariate analyses showed a statistically significant association of parental TBI with any mental disorder (21.1% vs. 14.3%, $p < 0.001$), as well as with affective disorders (10.1% vs. 7.0%, $p = 0.021$), anxiety disorders (8.2% vs. 5.5%, $p = 0.032$) and disorders of psychological development (3.1% vs. 1.4%, $p = 0.008$). When adjusting for covariates, disorders of psychological development (OR = 1.85, 95%, CI 1.00–3.43, $p = 0.05$) among female cohort members were slightly significantly related with parental TBI. In male cohort members, parental TBI was statistically significantly associated with any mental disorder (19.7% vs. 11.5%, $p < 0.001$) and also with substance-use–related disorders (4.8% vs. 1.9%, $p < 0.001$), disorders of psychological development (5.0% vs. 3.2%, $p = 0.041$) and behavioural and emotional disorders (8.9% vs. 3.7%, $p < 0.001$). After adjusting the covariates, the association remained

significant in terms of any mental disorder (OR = 1.43, 95% CI 1.11–1.83, p = 0.005), substance-use–related disorders (OR = 1.71, 95% CI 1.07–2.72, p = 0.025), and behavioural and emotional disorders (OR = 1.75, 95% CI 1.23–2.48, p = 0.002) among male cohort members.

(Insert Table 2 about here)

Maternal TBI and the psychiatric diagnoses of children

Additional analyses showed that maternal TBI (Supplemental Table 1) was significantly associated with any mental disorder (25.3% vs. 14.4%, p = 0.007) and anxiety disorder (12.0% vs. 5.6%, p = 0.037) among female cohort members, although when adjusting for covariates, no statistically significant association between maternal TBI and psychiatric disorders was observed. In male cohort members, significant associations were found between maternal TBI and any mental disorder (18.4% vs. 11.6%, p = 0.048), substance-use–related disorders (6.9% vs. 1.9%, p = 0.007), and affective disorders (8.0% vs. 3.2%, p = 0.021). In adjusted analyses, only the association of maternal TBI with substance-use–related disorders among male cohort members remained statistically significant (OR = 2.56, 95% CI 1.10–6.00, p = 0.030).

Paternal TBI and the psychiatric diagnoses of children

Further, in female cohort members, paternal TBI (Supplemental Table 2) was associated with any mental disorder (19.9% vs. 14.4%, p = 0.008), which became statistically insignificant after adjustment for the covariates. In male cohort members, significant associations were

observed between paternal TBI and any mental disorder (19.9% vs. 11.5%, $p < 0.001$), substance-use–related disorders (4.2% vs. 1.9%, $p = 0.003$), disorders of psychological development (5.4% vs. 3.2%, $p = 0.026$) and behavioural and emotional disorders (9.6% vs. 3.7%, $p < 0.001$). After adjustment for covariates, the paternal TBI association with any mental disorder (OR = 1.45, 95% CI 1.09–1.91, $p = 0.009$) and behavioural and emotional disorders (OR = 1.92, 95% CI 1.31–2.81, $p = 0.001$) among male cohort members remained statistically significant.

Additional analyses with social welfare benefits

Additional adjustment for the social welfare benefits covariate attenuated the risk estimates, but did not change the overall pattern (not shown). After including social welfare benefits as an adjusting factor, the association between parental TBI and any mental disorder (OR = 1.31, 95% CI 1.02–1.68, $p = 0.036$) and behavioural and emotional disorders (OR = 1.56, 95% CI 1.10–2.20, $p = 0.013$) among male cohort members remained statistically significant. Furthermore, the association of paternal TBI with behavioural and emotional disorders (OR = 1.67, 95% CI 1.14–2.46, $p = 0.008$) among male cohort members remained statistically significant after adjusting for social welfare benefits being received by the father. Other analyses were statistically insignificant when adding social welfare benefits as a covariate. Parental TBI's association with both substance-use–related disorders among males and disorders of psychological development among females became statistically insignificant after the adjustment.

Discussion

The main purpose of this study was to determine both whether parental TBI increases the overall risk for psychiatric disorders among the children affected by parental TBI and which psychiatric disorders were diagnosed among affected children. A major finding was that children affected by parental TBI are at increased risk for psychiatric disorders. Since reverse associations were not found, the clinical relevance of our finding is emphasized. The evidence was more notable in males compared to females. Furthermore, the results of this nationwide follow-up study indicate that males with parental TBI were more likely to suffer from any mental disorder, substance-use–related disorders as well as behavioural and emotional disorders than children without parental TBI, while female cohort members showed an increased likelihood of being diagnosed with disorders of psychological development compared to children without parental TBI. Very serious psychiatric diagnoses (i.e. schizophrenia and other psychotic disorders) did not occur more frequently among the cohort members affected by parental TBI in comparison to their peers. These results are in line with the recent study, which revealed more prevalent use of specialised psychiatric services among children affected by parental TBI (5). However, the finding of the increased risk of psychiatric disorders among children affected by parental TBI discloses that parental TBI causes more severe outcomes than was previously presumed, not only psychiatric symptoms (e.g. 8) and service use (5) but also psychiatric disorders.

Parental and paternal TBI increased the risk of any mental disorders and behavioural and emotional disorders among males. Substance use among the males was more prevalent when the mother was affected by TBI. In comparison, parental TBI increased disorders of psychological development among females. The way psychiatric disorders are expressed

differs according to sex, that is, males seemed to have externalising psychiatric disorders including substance-use-related disorders, and behavioural and emotional disorders (e.g. attention-deficit disorders). This finding is in line with previous studies documenting that externalising disorders are more common among men and internalising disorders among women (43, 44). Mental disorders can be broadly grouped into externalising disorders (including attention-deficit, conduct and substance-use–related disorders) and internalising disorders (including depressive and anxiety disorders) (43). Externalising symptoms are likely to be more apparent and seeking medical help is likely to be more noticeable. Internalising symptoms, including the signs of depression (e.g. social withdrawal, fatigue and sadness), may be more invisible; hence, females with internalising psychiatric symptoms either may not seek or may not get specialised psychiatric care. Thus, females with internalising symptoms and disorders may be treated in primary health care. Our study only examined psychiatric diagnoses set in specialised health care, which could explain why female cohort members' internalising disorders were not significant in this study.

Psychiatric diagnoses are based on the existence of a clinically recognizable set of symptoms that fill the criteria of a specific psychiatric disorder (60). Many factors influence whether an individual will develop a psychiatric disorder. Risk factors make an individual more likely to develop a disorder while resilience factors can help to reduce the risk of the disorder (61). In clinical practice, clinicians try to avoid giving a psychiatric disorder diagnosis immediately after crises and adverse life events. There are specific diagnoses for describing the reactions to crises and adverse life events. The reactions to stressful events are grouped within anxiety disorders, which were not significant in this study. This finding indicates that parental TBI may have long-term effects on children in terms of psychiatric disorders, as opposed to acute stress reactions.

An adjustment for social welfare benefits had an influence on the risk estimates in this study. Receiving social welfare benefits indicates a difficult economic situation. Family poverty in the course of children's early life has been linked to increased levels of poor mental health (51, 59). According to our study, if either parent had received social welfare benefits, the risk estimates were attenuated. This implies that economic disadvantage plays a role in mediating the effects of parental TBI. However, after adjusting for either parent receiving social welfare benefits, the association of parental TBI with any mental disorders, and behavioural and emotional disorders among male cohort members remained significant. Similarly, paternal TBI remained significantly associated with behavioural and emotional disorders among male cohort members. This indicates that males in particular are at increased risk of mental disorders following parental TBI, especially if it is paternal TBI, and the association is not completely due to a disadvantaged economic situation.

The effects of parental TBI on children might be mediated by the parental TBI's effects on the affected parent (i.e. personality changes, cognitive impairment and psychological distress) or by the secondary effect on the family (e.g. changed marital status and a weakened socioeconomic situation). As found with psychiatric disorders, the similar behaviour changes and distress resulting from a parent being affected by TBI have an impact on parenting (42). Further, parental TBI involves interpersonal loss, since one parent has a brain injury and the other parent may be overburdened with caring for them (38). Both the injured and uninjured parent may suffer from depressive symptoms (12, 41). Thus, the children's main support network, their parents, is diminished. Children may also be required to take on the role of carer. The challenges of TBI – including distress, reduced social activity, mental health problems and changes in role expectations – may lead to marital difficulties and diminished

marital quality (18, 34, 37, 62, 63, 64, 65, 66). Parental alcohol and substance-abuse problems occur frequently before and after TBI injuries (67, 68, 69, 70). Family violence is a known risk following a TBI – for example, marital aggression increases after a head injury (71). Family economic difficulties often follow the injury. The unemployment rate is relatively high among adults who have had a TBI (18, 72, 73). Unemployment affects various dimensions of the physical, psychological and social health of a parent and influences the entire family, and most importantly, the children. According to our study, economic difficulties (i.e. either parent receiving social welfare benefits) appear to account for some of parental TBI's impact on children. In sum, parental TBI puts children at risk for mental health problems as they face both common and more specific challenges following parental TBI. Common challenges include parental mental health problems and marital difficulties. More specific challenges accompanying parental TBI comprise household dysfunctions, and emotional and physical abuse (18, 33, 36, 65, 67, 68, 69, 71). All of these challenges are often described as adverse childhood events (ACEs) in the relevant literature (74, 75, 76, 77).

ACEs are of major interest in the recent research on the risk factors for mental health problems in children and adults (74, 75, 76, 77). It is known that ACEs can precede many psychiatric disorders (10, 58, 59); hence, traumatic events in childhood (e.g. parental TBI) may have an effect on children that may in turn lead to psychiatric disorders among some individuals. It is widely agreed that more than one ACE occurring at the same time (as is the case with parental TBI) increases difficulties for children. The cumulative effects of ACEs are significantly associated with an increased risk of mental health problems over the child's lifetime (74, 76, 77). Several of the above-mentioned ACEs can follow parental TBI; hence, parental TBI is a major challenge for all family members, for both the injured and uninjured parent as well as for the children living in the family. A TBI-affected family faces a broad

spectrum of challenges that may affect children in many ways. Moreover, this study confirms that parental TBI itself can be seen as a major risk factor for mental disorders in children; hence, we suggest that parental TBI should be considered an ACE.

Contacts with health and social services are more frequent with families affected by parental TBI. These contacts give an opportunity to reach the families and to provide them with support. Parenting and child development can be supported, for example, through social assistance services and most importantly through the adult health care units in which an injured parent is treated. Unfortunately, the need for support for families with a parent with TBI is often unrecognized (42, 78). Yet, according to this study, children affected by parental TBI are at increased risk of mental disorders; hence, the intervention actions, such as adopting a child-focused approach when treating a parent with TBI, should be taken more seriously than before. This study highlights the unmet needs in a vulnerable demographic: children. With these findings on how parental TBI increases psychiatric disorders among children affected by parental TBI, future research should focus more widely on gender interactions in the association between parental TBI and the mental disorders of the affected children, as well as focussing on intervention strategies.

Strengths and limitations

To our knowledge, no other study to date has determined the psychiatric diagnoses of children affected by parental TBI. A major strength of the study is the data, which consists of all children born in Finland in 1987. The Finnish specialised health service diagnoses are reliable and implicate the seriousness of the problem. For statistical and research purposes, the quality of the CRHC has been shown to be good and reliable (47, 48, 49). This study also

covers the key development periods of childhood and adolescence, periods when personality develops and children are more vulnerable to external effects.

However, this study also has several limitations. The study only included register data. However, the use of national registers caused no harm to the cohort members. The timing of the events is based on the use of services and cannot be estimated systematically. The time of the cohort members' exposure to parental TBI is unknown. Data on outpatient care are missing from the time of birth up to the age of 11 (1998). The size of a family is not measured and so is not included in the analyses. It is not known if the injured parent actually lived with the child. There is no information on siblings. Associations may also be missed because of a lack of power in the psychiatric diagnosis classes that have a small number of cases. However, the results are more likely underestimates since many cases of children's psychiatric problems are only treated in primary care or are not treated at all. The comparison group of children without parental TBI may have other risk factors, such as another serious parental illnesses (although this is also true for the affected children). Finally, the study was conducted in Finland, a country with a strong social protection system; hence, the results may not be generalizable worldwide.

Conclusion

In conclusion, our study findings indicate that children are at increased risk for psychiatric disorders following parental TBI. Gender specificity in the prevalence of psychiatric disorders was clearly seen with male children having externalising disorders and females having developmental disorders. Parental TBI seems to not lead to very serious psychiatric diagnoses (i.e. psychosis) among children. The gender of the child and the parent seems to be

an important mediator between the association of parental TBI and child psychiatric diagnoses, which requires future analyses. Further, these findings justify preventive actions focused on children affected by parental TBI.

Declaration of interests

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper. This study was supported by the Academy of Finland (#268336, 288960), the PSYCOHORTS consortium (funded by the Academy of Finland), the Juho Vainio Foundation, the Finnish Cultural Foundation, the Alma and KA Snellman Foundation and the National Institute for Health and Welfare, Finland.

References

1. Brazinova A, Rehorcikova V, Taylor MS, Buckova V, Majdan M, Psota M, Peeters W, Feigin V, Theadom A, Holkovic L, Synnot A. Epidemiology of traumatic brain injury in Europe: a living systematic review. J Neurotrauma. 2016;33:1–30.

2. Langlois JA, Rutland-Brown W, Wald MM. The epidemiology and impact of traumatic brain injury: a brief overview. J Head Trauma Rehabil. 2006;21(5):375–378.

3. Peeters W, van den Brande R, Polinder S, Brazinova A, Steyerberg EW, Lingsma HF, Maas AI. Epidemiology of traumatic brain injury in Europe. Acta Neurochir (Wien). 2015;157(10):1683–96.

4. Tagliaferri F, Compagnone C, Korsic M, Servadei F, Kraus J. A systematic review of brain injury epidemiology in Europe. Acta Neurochir (Wien). 2006;148(3):255–268.

5. Niemelä M, Kinnunen L, Paananen R, Hakko H, Merikukka M, Karttunen V, Gissler M, Räsänen S. Parents' traumatic brain injury increases their children's risk for use of psychiatric care: the 1987 Finnish Birth Cohort study. Gen Hosp Psychiatry. 2014;36(3):337–341.

6. Gladstone BM, Boydell KM, Seeman MV, McKeever PD. Children's experiences of parental mental illness: a literature review. Early Interv Psychiatry. 2011;5(4):271–289.

7. Kieffer-Kristensen R, Teasdale TW, Bilenberg N. Post-traumatic stress symptoms and psychological functioning in children of parents with acquired brain injury. Brain Inj. 2011;25(7–8):752–760.

8. Partovi D. Impact of parental traumatic brain injury on adolescents [dissertation]. [San Francisco (USA)]: Alliant International University; 2012. 141 p.

9. Sieh DS, Meijer AM, Oort FJ, Visser-Meily JM, Van der Leij DA. Problem behavior in children of chronically ill parents: a meta-analysis. Clin Child Fam Psychol Rev. 2010;13(4):384–397.

10. Barnes J, Stein A. Effects of parental physical and psychiatric illness on child development. In: Gelder MG, Lopes-Ibor JJ, Andreasen NC, editors. New Oxford Textbook of Psychiatry, Volume 2. Oxford (UK): Oxford University Press; 2003. p.1848–55.

11. Giallo R, Roberts R, Emerson E, Wood C, Gavidia-Payne S. The emotional and behavioural functioning of siblings of children with special health care needs across childhood. Res Dev Disabil. 2014;35(4):814–25.

12. Pessar LF, Coad ML, Linn RT, Willer BS. The effects of parental traumatic brain injury on the behavior of parents and children. Brain Inj. 1993;7(3):231–240.

13. Tiar AM, Dumas JE. Impact of parental acquired brain injury on children: review of the literature and conceptual model. Brain Inj. 2015;29(9):1005–17.

14. Rohleder P, Lambieb j, Haleb E. A qualitative study of the emotional coping and support needs of children living with a parent with a brain injury. Brain Inj. 2017;31(2):199–207.

15. Anderson MI, Parmenter TR, Mok M. The relationship between neurobehavioural problems of severe traumatic brain injury (TBI), family functioning and the psychological well-being of the spouse/caregiver: path model analysis. Brain Inj. 2002;16(9):743–757.

16. Kieffer-Kristensen R, Teasdale TW. Parental stress and marital relationships among patients with brain injury and their spouses. NeuroRehabilitation. 2011;28(4):321–330.

17. Hall K, Karzmark P, Stevens M, Englander J, O'Hare P, Wright J. Family stressors in traumatic brain injury: a two-year follow-up. Arch Phys Med Rehabil. 1994;75(8):876–884.

18. Hoofien D, Gilboa A, Vakil E, Donovick PJ. Traumatic brain injury (TBI) 10–20 years later: a comprehensive outcome study of psychiatric symptomatology, cognitive abilities and psychosocial functioning. Brain Inj. 2001;15(3):189–209.

19. Franulic, A, Horta E, Maturana R, Scherpenisse J, Carbonell C. Organic personality disorder after traumatic brain injury: cognitive, anatomic and psychosocial factors. A six-month follow-up. Brain Inj. 2000;14(5):431–439.

20. MacNiven E, Finlayson MA. The interplay between emotional and cognitive recovery after closed head injury. Brain Inj. 1993;7(3):241–246.

21. Parker RS. The spectrum of emotional distress and personality changes after minor head injury incurred in a motor vehicle accident. Brain Inj. 1996;10(4):287–302.

22. van Reekum R, Cohen T, Wong J. Can traumatic brain injury cause psychiatric disorders? J Neuropsychiatry Clin Neurosci. 2000;12(3):316–327.

23. Fann, JR, Katon WJ, Uomoto JM, Esselman PC. Psychiatric disorders and functional disability in outpatients with traumatic brain injuries. Am J Psychiatry. 1995;152(10):1493–1499.

24. Jorge RE, Robinson RG, Starkstein SE, Arndt SV. Influence of major depression on 1-year outcome in patients with traumatic brain injury. J Neurosurg. 1994;81(5):726–733.

25. van Reekum R, Bolago I, Finlayson MAJ, Garner S, Links PS. Psychiatric disorders after traumatic brain injury. Brain Inj. 1996;10(5):319–327.

26. Rosenthal M, Christensen BK, Ross TP. Depression following traumatic brain injury. Arch Phys Med Rehabil. 1998;79(1):90–103.

27. Jorge RE, Robinson RG, Ardnt SV, Starkstein SE, Forrester AW, Geisler F. Depression following traumatic brain injury: a one-year longitudinal study. J Affect Dis. 1993;27(4):233–243.

28. Levin HS, Grossman RG. Behavioral sequelae of closed head injury: a quantitative study. Arch Neurol. 1978;35(11):720–727.

29. Tam S, McKay A, Sloan S, Ponsford J. The experience of challenging behaviours following severe TBI: a family perspective. Brain Inj. 2015;29(7–8):813–821.

30. Thurman D, Alverson C, Dunn K, Guerrero J, Sniezek J. Traumatic brain injury in the United States: a public health perspective. J Head Trauma Rehabil. 1999;14(6):602–615.

31. Gualtieri T, Cox DR. The delayed neurobehavioral sequelae of traumatic brain injury. Brain Inj. 1991;5(3):219–232.

32. Silver JM, Hales RE, Yudofsky SC. Neuropsychiatric aspects of traumatic brain injury. In: Yudofsky SC, Hales RE, editors. Essentials of neuropsychiatry and behavioral neurosciences, 2nd edition. Arlington (USA): American Psychiatric Publishing, Inc; 2010. p. 223–274.

33. Brooks N, McKinlay W, Symington C, Beattie A, Campsie L. Return to work within the first seven years of severe head injury. Brain Inj. 1987;1(1):5–19.

34. Blais MC, Boisvert JM. Psychological and marital adjustment in couples following a traumatic brain injury (TBI): a critical review. Brain Inj. 2005;19(14):1223–1235.

35. Godwin E, Chappell B, Kreutzer J. Relationships after TBI: a grounded research study. Brain Inj. 2014;28(4):398–413.

36. Hammond FM, Davis CS, Cook JR, Philbrick P, Hirsch MA. Relational dimension of irritability following traumatic brain injury: a qualitative analysis. Brain Inj. 2012;26(11):1287–1296.

37. Hammond FM, Davis CS, Whiteside OY, Philbrick P, Hirsch MA. Marital adjustment and stability following traumatic brain injury: a pilot qualitative analysis of spouse perspectives. J Head Trauma Rehabil. 2011;26(1):69–78.

38. Kratz AL, Sander AM, Brickell TA, Lange RT, Carlozzi NE. Traumatic brain injury caregivers: a qualitative analysis of spouse and parent perspectives on quality of life. Neuropsychol Rehabil. 2017;27(1):16–37.

39. Ennis N, Rosenbloom BN, Canzian S, Topolovec-Vranic J. Depression and anxiety in parent versus spouse caregivers of adult patients with traumatic brain injury: a systematic review. Neuropsychol Rehabil. 2013;23(1):1–18.

40. Kreutzer JS, Rapport LJ, Marwitz JH, Harrison-Felix C, Hart T, Glenn M, Hammond F. Caregivers' well-being after traumatic brain injury: a multicenter prospective investigation. Arch Phys Med Rehabil. 2009;90(6):939–946.

41. Harris JK, Godfrey HP, Partridge FM, Knight RG. Caregiver depression following traumatic brain injury (TBI): a consequence of adverse effects on family members? Brain Inj. 2001;15(3):223–238.

42. Uysal S, Hibbard MR, Robillard D, Pappadopulos E, Jaffe M. The effect of parental traumatic brain injury on parenting and child behavior. J Head Trauma Rehabil. 1998;13(6):57–71.

43. Boyd A, Van de Velde S, Vilagut G, de Graaf R, O'Neill S, Florescu S, Alonso J, Kovess-Masfety V; EU-WMH Investigators. Gender differences in mental disorders and suicidality in Europe: results from a large cross-sectional population-based study. J Affect Disord. 2015;173:245–254.

44. Riecher-Rössler, A. Prospects for the classification of mental disorders in women. Eur Psychiatry. 2010;25(4):189–196.

45. Ristikari T, Törmäkangas L, Lappi A, Haapakorva P, Kiilakoski T, Merikukka M, Hautakoski A, Pekkarinen E, Gissler M. Suomi nuorten kasvuympäristönä 25 vuoden seuranta vuonna 1987 Suomessa syntyneistä nuorista aikuisista. Helsinki: National Institute for Health and Welfare; 2016 Aug 9. Report No.: 9, ISSN 1798-0070.

46. Paananen R, Gissler M. Cohort profile: the 1987 Finnish Birth Cohort. Int J Epidemiol. 2012;41(4):941–5.

47. Sund R. Quality of the Finnish Hospital Discharge Register: a systematic review. Scand J Public Health. 2012;40(6):505–15.

48. Gissler M, Haukka J. Finnish health and social welfare registers in epidemiological research. Norsk Epidemiologi. 2004;14(1):113–120.

49. Keskimäki I, Aro S. Accuracy of data on diagnosis, procedures and accidents in the Finnish Hospital Discharge Register. Int J Health Sci. 1991;2(1):15–21.

50. McGrath JJ, Petersen L, Agerbo E, Mors O, Mortensen PB, Pedersen CB. A comprehensive assessment of parental age and psychiatric disorders. JAMA Psychiatry. 2014;71(3):301–309.

51. Najman JM, Hayatbakhsh MR, Clavarino A, Bor W, O'Callaghan MJ, Williams GM. Family poverty over the early life course and recurrent adolescent and young adult anxiety and depression: a longitudinal study. Am J Public Health. 2010;100(9):1719–23.

52. Muntaner C, Eaton WW, Diala C, Kessler RC, Sorlie PD. Social class assets, organizational control and the prevalence of common groups of psychiatric disorders. Soc Sci Med. 1998;47(12):2043–2053.

53. Dohrenwend BP, Levav I, Shrout PE, Schwartz S, Naveh G, Link BG, Skodol AE, Stueve A. Socioeconomic status and psychiatric disorders: the causation-selection issue. Science. 1992;255(5047):946–952.

54. Appel CW, Johansen C, Deltour I, Frederiksen K, Hjalgrim H, Dalton SO, Dencker A, Dige J, Bøge P, Rix BA, et al. Early parental death and risk of hospitalization for affective disorder in adulthood. Epidemiology. 2013;24(4):608–615.

55. Guldin MB, Li J, Pedersen HS, Obel C, Agerbo E, Gissler M, Cnattingius S, Olsen J, Vestergaard M. Incidence of suicide among persons who had a parent who died during their childhood: a population-based cohort study. JAMA Psychiatry. 2015;72(12):1227–1234.

56. Brent, D, Melhem, N, Donohoe, MB, Walker, M. The incidence and course of depression in bereaved youth 21 months after the loss of a parent to suicide, accident, or sudden natural death. Am J Psychiatry. 2009;166(7):786–794.

57. Siegel K, Karus D, Ravei VH. Adjustment of children facing the death of a parent due to cancer. J Am Acad Child and Adolesc Psychiatry. 1996;35(4):442–450.

58. Berg L, Rostila M, Hjern A. Parental death during childhood and depression in young adults – a national cohort study. J Child Psychol Psychiatry. 2016;57(9):1092–1098.

59. Kalil A, Duncan GJ, Ziol-Guest KM. Early childhood poverty: short- and long-run consequences over the lifespan. In: Shanahan MJ, Mortimer JT, Kirkpatrick Johnson M, editors. Handbook of the life course. Springer International Publishing; 2016. p. 341-354.

60. The ICD-10 classification of mental and behavioral disorders: clinical descriptions and diagnostic guidelines, 10th edition. Geneva (Switzerland): World Health Organization (WHO); 1992.

61. Rutter M. Resilience in the face of adversity: protective factors and resistance to psychiatric disorder. Br J Psychiatry. 1985;147:598–611.

62. Knox L, Douglas JM, Bigby C. 'The biggest thing is trying to live for two people': spousal experiences of supporting decision-making participation for partners with TBI. Brain Inj. 2015;29(6):745–757.

63. Kreutzer JS, Marwitz JH, Hsu N, Williams K, Riddick A. Marital stability after brain injury: an investigation and analysis. NeuroRehabilitation. 2007;22(1):53–59.

64. Blais MC, Boisvert JM. Psychological adjustment and marital satisfaction following head injury. Which critical personal characteristics should both partners develop? Brain Inj. 2007;21(4):357–372.

65. Douglas JM, Spellacy FJ. Correlates of depression in adults with severe traumatic brain injury and their carers. Brain Inj. 2000;14(1):71–88.

66. Liss M, Willer B. Traumatic brain injury and marital relationships: a literature review. Int J Rehabil Res. 1990;13(4):309–320.

67. Unsworth DJ, Mathias JL. Traumatic brain injury and alcohol/substance abuse: a Bayesian meta-analysis comparing the outcomes of people with and without a history of abuse. J Clin Exp Neuropsychol. 2017;39(6):547–562.

68. West SL. Substance use among persons with traumatic brain injury: a review. NeuroRehabilitation. 2011;29(1):1–8.

69. Parry-Jones BL, Vaughan FL, Miles Cox W. Traumatic brain injury and substance misuse: a systematic review of prevalence and outcomes research (1994–2004). Neuropsychol Rehabil. 2006;16(5):537–560.

70. Taylor LA, Kreutzer JS, Demm SR, Meade MA. Traumatic brain injury and substance abuse: a review and analysis of the literature. Neuropsychol Rehabil. 2003;13(1–2):165–188.

71. Rosenbaum A, Hoge SK, Adelman SA, Warnken WJ, Fletcher KE, Kane RL. Head injury in partner-abusive men. J Consult Clin Psychol. 1994;62(6):1187–1193.

72. Asikainen I, Kaste M, Sarna S. Predicting late outcome for patients with traumatic brain injury referred to a rehabilitation programme: a study of 508 Finnish patients 5 years or more after injury. Brain Inj. 1998;12(2)95–107.

73. Dawson DR, Chipman M. The disablement experienced by traumatically brain-injured adults living in the community. Brain Inj. 1995;9(4):339–353.

74. Oladeji BD, Makanjuola VA, Gureje O. Family-related adverse childhood experiences as risk factors for psychiatric disorders in Nigeria. Br J Psychiatry. 2010;196(3):186–191.

75. Schilling EA, Aseltine RH Jr, Gore S. Adverse childhood experiences and mental health in young adults: a longitudinal survey. BMC Public Health. 2007;7:30.

76. Chapman DP, Whitfield CL, Felitti VJ, Dube SR, Edwards VJ, Anda RF. Adverse childhood experiences and the risk of depressive disorders in adulthood. J Affect Dis. 2004;82(2):217–225.

77. Dube SR, Anda RF, Felitti VJ, Chapman DP, Williamson DF, Giles WH. Childhood abuse, household dysfunction, and the risk of attempted suicide throughout the life span: findings from the adverse childhood experiences study. JAMA. 2001;286(24):3089–3096.

78. Dillahunt-Aspillaga C, Jorgensen-Smith T, Ehlke S, Sosinski M, Monroe D, Thor J. Traumatic brain injury: unmet support needs of caregivers and families in Florida. Plos One. 2013;8(12):e82896.

Table 1. Traumatic brain injury (TBI) of parent(s) and mental disorder among the members of the 1987 Finnish Birth cohort.

	Members of the 1987 Finnish Birth Cohort		
	Total	Males	Females
	(n= **59 476**)	(n= **30 435**)	(n= **29 041**)
TBI OF PARENTS *			
TBI of a parent after the birth of offspring, n (%)*			
Mother with TBI	162 (0.3)	87 (0.3)	75 (0.3)
Father with TBI	613 (1.0)	332 (1.1)	281 (1.0)
Either parent with TBI	772 (1.3)	417 (1.4)	355 (1.2)
MENTAL DISORDERS AMONG CHILDREN **			
*Any mental disorder among cohort members, n (%)***			
Substance-use–related disorders (F10-19)	*1087 (1.8)*	*591 (1.9)*	*496 (1.7)*
Schizophrenia and other psychotic disorders (F20-29)	*569 (1.0)*	*276 (0.9)*	*293 (1.0)*
Affective disorders (F30-39)	*3014 (5.1)*	*972 (3.2)*	*2042 (7.0)*
Anxiety disorders (F40-49)	*2551 (4.3)*	*932 (3.1)*	*1619 (5.6)*
Behavioural syndromes associated with physiological disturbances and physical factors (F50-59)	*851 (1.4)*	*175 (0.6)*	*676 (2.3)*
Personality disorders (F60-69)	*496 (0.8)*	*194 (0.6)*	*302 (1.0)*
Disorders of psychological development (F80-89)	*1410 (2.4)*	*994 (3.3)*	*416 (1.4)*
Behavioural and emotional disorders (F90-98)	*2023 (3.4)*	*1152 (3.8)*	*871 (3.0)*

* First hospital-treated TBI diagnosis of parent(s) after the birth of the cohort member up to 31.12.2008.

** Psychiatric diagnosis (ICD-10: F10-69, F80-98) of cohort members after birth up to 31.12.2008 assessed either in outpatient or inpatient settings of specialised level care.

Table 2. Association of parental TBI to the mental disorder of offspring, the 1987 Finnish birth cohort.

	Parent(s) with TBI					Association of parental TBI to mental disorder of cohort members			
	Yes		No						
	n	%	n	%	p-value	Adj. OR	95%CI	p-value	Statistically significant covariates in either parent of cohort members
FEMALES (n=29 041)	(n=355)		(n=28 686)						
Any mental disorder	75	21.1	4109	14.3	<0.001	1.24	0.95-1.61	0.112	all
Substance-use–related disorders (F10-19)	8	2.3	488	1.7	0.425	0.98	0.48-1.99	0.947	SES, EDU, MAGE, DEATH, PSYCH
Schizophrenia and other psychotic disorders (F20-29)	5	1.4	288	1.0	0.414	1.08	0.44-2.66	0.861	FSTATUS, DEATH, PSYCH
Affective disorders (F30-39)	36	10.1	2006	7.0	0.021	1.15	0.81-1.63	0.440	MAGE, FSTATUS, EDU, DEATH, PSYCH
Anxiety disorders (F40-49)	29	8.2	1590	5.5	0.032	1.14	0.77-1.68	0.517	EDU, MAGE, DEATH, PSYCH
Behavioural syndromes associated with physiological disturbances and physical factors (F50-59)	9	2.5	667	2.3	0.794	1.09	0.56-2.13	0.807	---
Personality disorders (F60-69)	5	1.4	297	1.0	0.425	1.03	0.42-2.54	0.940	MAGE, DEATH, PSYCH
Disorders of psychological development (F80-89)	11	3.1	405	1.4	0.008	1.85	1.00-3.43	0.050	EDU, PSYCH
Behavioural and emotional disorders (F90-98)	13	3.7	858	3.0	0.461	0.96	0.55-1.68	0.885	EDU, FSTATUS, DEATH, PSYCH
MALES (n=30 435)	(n=417)		(n=30 018)						
Any mental disorder	82	19.7	3451	11.5	<0.001	1.43	1.11-1.83	0.005	all
Substance-use–related disorders (F10-19)	20	4.8	571	1.9	<0.001	1.71	1.07-2.72	0.025	MAGE, DEATH, PSYCH
Schizophrenia and other psychotic disorders (F20-29)	4	1.0	272	0.9	0.793	0.81	0.30-2.20	0.679	PSYCH
Affective disorders (F30-39)	17	4.1	955	3.2	0.302	0.92	0.56-1.51	0.750	SES, EDU, DEATH, PSYCH
Anxiety disorders (F40-49)	17	4.1	915	3.0	0.226	0.97	0.59-1.60	0.920	EDU, FSTATUS, DEATH, PSYCH
Behavioural syndromes associated with physiological disturbances and physical factors (F50-59)	3	0.7	172	0.6	0.520	1.10	0.35-3.50	0.867	PSYCH
Personality disorders (F60-69)	5	1.2	189	0.6	0.197	1.27	0.51-3.15	0.600	FSTATUS, EDU, PSYCH
Disorders of psychological development (F80-89)	21	5.0	973	3.2	0.041	1.36	0.87-2.14	0.175	SES, EDU, PSYCH
Behavioural and emotional disorders (F90-98)	37	8.9	1115	3.7	<0.001	1.75	1.23-2.48	0.002	all

OR, odds ratio; CI, confidence interval; MAGE, mother's age in years at offspring's birth; FSTATUS, father known (yes, no) in 1987; SES, highest socioeconomic status of either parent (white collar worker, lower white collar worker, blue collar worker, other); EDU, highest level of education completed by either parent (tertiary level, lower level tertiary, secondary level, primary level); DEATH, death of a parent (yes, no) during follow-up time 1987-2008; PSYCH, either parent have had in- or outpatient treatment due to a mental disorder (yes, no); all: MAGE, FSTATUS, SES, EDU, DEATH, PSYCH.

Supplemental Table 1. Association of <u>maternal</u> traumatic brain injury (TBI) to the mental disorder of offspring, the 1987 Finnish birth cohort.

	Mother with TBI					Association of maternal TBI to mental disorder of cohort members			
	Yes		No						
	n	%	n	%	p-value	Adj. OR	95%CI	p-value	Statistically significant covariates in mothers of cohort members
FEMALES (n=29 041)	(n=75)		(n=28 966)						
Any mental disorder	19	25.3	4165	14.4	0.007	1.60	0.94-2.72	0.081	all
Substance-use–related disorders (F10-19)	2	2.7	494	1.7	0.367	1.13	0.27-4.65	0.870	MAGE, MDEATH, MPSYCH
Schizophrenia and other psychotic disorders (F20-29)	1	1.3	292	1.0	0.533	1.01	0.14-7.36	0.990	MSES, MDEATH
Affective disorders (F30-39)	8	10.7	2034	7.0	0.218	1.25	0.60-2.63	0.550	all
Anxiety disorders (F40-49)	9	12.0	1610	5.6	0.037	1.86	0.92-3.76	0.086	all
Behavioural syndromes associated with physiological disturbances and physical factors (F50-59)	3	4.0	673	2.3	0.254	1.87	0.59-5.97	0.292	MAGE
Personality disorders (F60-69)	0	0	302	1.0	1.000	ne			
Disorders of psychological development (F80-89)	3	4.0	413	1.4	0.093	2.53	0.79-8.11	0.119	MSES
Behavioural and emotional disorders (F90-98)	3	4.0	868	3.0	0.493	1.00	0.31-3.22	0.993	all
MALES (n=30 435)	(n=87)		(n=30 348)						
Any mental disorder	16	18.4	3517	11.6	0.048	1.28	0.74-2.22	0.384	all
Substance-use–related disorders (F10-19)	6	6.9	585	1.9	0.007	2.56	1.10-6.00	0.030	all
Schizophrenia and other psychotic disorders (F20-29)	1	1.1	275	0.9	0.548	1.00	0.13-7.02	0.973	MPSYCH
Affective disorders (F30-39)	7	8.0	965	3.2	0.021	1.85	0.84-4.06	0.126	MSES, MEDU, MDEATH, MPSYCH
Anxiety disorders (F40-49)	3	3.4	929	3.1	0.750	0.79	0.25-2.53	0.694	MSES, MDEATH, MPSYCH
Behavioural syndromes associated with physiological disturbances and physical factors (F50-59)	0	0	175	0.6	1.000	ne			
Personality disorders (F60-69)	1	1.1	193	0.6	0.427	1.18	0.16-8.59	0.871	MAGE, MEDU, MDEATH, MPSYCH
Disorders of psychological development (F80-89)	3	3.4	991	3.3	0.763	0.88	0.28-2.80	0.828	MAGE, MEDU, MPSYCH
Behavioural and emotional disorders (F90-98)	5	5.7	1147	3.8	0.387	1.06	0.42-2.64	0.905	all

OR, odds ratio; CI, confidence interval; MAGE, mother's age in years at offspring's birth; MSES, socioeconomic status of mother (white collar worker, lower white collar worker, blue collar worker, other); MEDU, mother's highest level of education (tertiary level, lower level tertiary, secondary level, primary level); MDEATH, mother's death (yes, no) during follow-up time 1987-2008; MPSYCH, mother have had in- or outpatient treatment due to a mental disorder during follow-up time 1987-2008 (yes, no); all: MAGE, MSES, MEDU, MDEATH, MPSYCH.

Supplemental Table 2. Association of paternal traumatic brain injury (TBI) to the mental disorder of offspring, the 1987 Finnish birth cohort.

	Father with TBI					Association of paternal TBI to mental disorder of cohort members			
	Yes		No						
	n	%	n	%	p-value	Adj. OR	95%CI	p-value	Statistically significant covariates in fathers of cohort members
FEMALES (n=29 041)	(n=281)		(n=28 760)						
Any mental disorder	56	19.9	4128	14.4	0.008	1.10	0.81-1.49	0.531	FEDU, FSTATUS, FDEATH, FPSYCH
Substance-use–related disorders (F10-19)	6	2.1	490	1.7	0.487	0.92	0.40-2.09	0.838	FEDU, FPSYCH
Schizophrenia and other psychotic disorders (F20-29)	4	1.4	289	1.0	0.373	1.05	0.38-2.88	0.923	FSTATUS, FPSYCH
Affective disorders (F30-39)	28	10.0	2014	7.0	0.053	1.06	0.71-1.58	0.773	FEDU, FSTATUS, FDEATH, FPSYCH
Anxiety disorders (F40-49)	20	7.1	1599	5.6	0.257	0.90	0.57-1.44	0.675	FDEATH, FPSYCH
Behavioural syndromes associated with physiological disturbances and physical factors (F50-59)	6	2.1	670	2.3	0.830	0.87	0.38-1.97	0.736	--
Personality disorders (F60-69)	5	1.8	297	1.0	0.222	1.32	0.53-3.27	0.546	FPSYCH
Disorders of psychological development (F80-89)	8	2.8	408	1.4	0.067	1.56	0.76-3.20	0.229	FPSYCH
Behavioural and emotional disorders (F90-98)	10	3.6	861	3.0	0.581	0.94	0.49-1.79	0.851	FSTATUS, FEDU, FPSYCH
MALES (n=30 435)	(n=332)		(n=30 103)						
Any mental disorder	66	19.9	3467	11.5	<0.001	1.45	1.09-1.91	0.009	FEDU, FSTATUS, FDEATH, FPSYCH
Substance-use–related disorders (F10-19)	14	4.2	577	1.9	0.003	1.48	0.85-2.57	0.168	FEDU, FSTATUS, FDEATH, FPSYCH
Schizophrenia and other psychotic disorders (F20-29)	3	0.9	4	1.4	0.995	0.75	0.24-2.39	0.631	FDEATH
Affective disorders (F30-39)	10	3.0	962	3.2	0.850	0.67	0.35-1.27	0.217	FEDU, FDEATH, FPSYCH
Anxiety disorders (F40-49)	14	4.2	918	3.0	0.220	1.00	0.58-1.72	0.988	FSTATUS, FDEATH, FPSYCH
Behavioural syndromes associated with physiological disturbances and physical factors (F50-59)	3	0.9	172	0.6	0.444	1.39	0.43-4.44	0.581	--
Personality disorders (F60-69)	4	1.2	190	0.6	0.163	1.25	0.45-3.43	0.670	FPSYCH
Disorders of psychological development (F80-89)	18	5.4	976	3.2	0.026	1.50	0.92-2.44	0.100	FEDU
Behavioural and emotional disorders (F90-98)	32	9.6	1120	3.7	<0.001	1.92	1.31-2.81	0.001	FEDU, FSTATUS, FDEATH, FPSYCH

OR, odds ratio; CI, confidence interval; FSTATUS, father known (yes, no) in 1987; FSES, socioeconomic status of father (white collar worker, lower white collar worker, blue collar worker, other); FEDU, father's highest level of education (tertiary level, lower level tertiary, secondary level, primary level); FDEATH, father's death (yes, no)

during follow-up time 1987-2008; FPSYCH, father have had in- or outpatient treatment due to a mental disorder during follow-up time 1987-2008 (yes, no); all: FSTATUS, FSES, FEDU, FDEATH, FPSYCH.