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**The impact of child maltreatment on the risk of deliberate self-harm
among adolescents: A population-wide cohort study using linked
administrative records**

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ABSTRACT

Adolescents exposed to maltreatment have an elevated risk of deliberate self-harm (DSH). The aim of this study was to investigate longitudinally the effects of the number, timing, and type of maltreatment allegations on adolescent risk of having a DSH-related hospital admission, using linked data in Western Australia. A total of 351,372 children born between 1986 and 2000 were followed from birth up to the year 2010. Cox regression models were utilized, while controlling for a range of psychosocial covariates. Compared to children without allegations of maltreatment, children with unsubstantiated allegations only (aHR=1.04, 95%CI: 1.00-1.08, $p<.01$) and children with a substantiated allegation (aHR=1.10, 95%CI: 1.06-1.15, $p<.001$) all had significantly increased risk of DSH in adolescence. Among children with a substantiated allegation of maltreatment, the greater the number of allegations, the longer the exposure to maltreatment, and the more types of maltreatment experienced by a child, the higher the child's risk of DSH. However, this dose-response pattern was not found among children with unsubstantiated allegations only. This study calls for the early identification of children who are vulnerable to maltreatment, the better identification of the duration and severity of maltreatment experiences, and the provision of continued care and support, to reduce the child's DSH risk in adolescence.

KEYWORDS

Child maltreatment; Adolescent deliberate self-harm; Administrative data linkage; Birth cohort

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ETHICS APPROVAL

This study has been approved by the Department of Health Human Research Ethics Committee (2012 / 77), the University of Western Australia Human Research Ethics Office (RA / 4 / 1 / 6233), and the Western Australian Aboriginal Health Information and Ethics Committee (474).

Introduction

There is consistent evidence showing that child maltreatment is an important risk factor for adolescent deliberate self-harm (DSH) behaviors (Afifi, Boman, Fleisher, & Sareen, 2009; Brezo et al., 2008). DSH behaviors refer to behaviors performed directly and intentionally to cause physical destruction to oneself, regardless of suicidal intent (Nock, 2010). DSH is a major public health issue among young people, affecting 17% of those aged 15-24 years in Australia (Martin, Swannell, Hazell, Harrison, & Taylor, 2010), which is similar to the global prevalence of DSH, reported to be 16% (Muehlenkamp, Claes, Havertape, & Plener, 2012). Previous studies have shown that DSH is associated with a range of biological (e.g., low birthweight, high birth order), psychological (e.g., hopelessness, impulsive-aggressive trait, and low self-esteem), and social (e.g., socioeconomic disadvantage, victimization, and substance abuse) risk factors (Hawton, Saunders, & O'Connor, 2012). DSH is considered to be a maladaptive coping strategy used to regulate emotional pain that has resulted from adverse and traumatic experiences (Lang & Sharma-Patel, 2011; Yates, 2004).

Child maltreatment refers to behavior by parents or caregivers that results in children being abused, neglected or otherwise harmed, at risk of substantial harm, or where caregivers are unable to provide adequate care and protection (Australian Institute of Health and Welfare, 2016). Child maltreatment is generally classified into four different types: emotional abuse, physical abuse, sexual abuse, and neglect. Studies have shown that in both Australia and other high-income countries, the prevalence was 2% for neglect and 9% for each of the remaining types (Gilbert et al., 2009; Moore et al., 2015). Australian research has shown that 24% of DSH behaviors in males, and 33% in females may be attributed to child maltreatment (Moore et al., 2015). It has been shown that compared to other types of adverse psychosocial experiences, such as socioeconomic disadvantage, parental psychiatric disorders and substance abuse, and

domestic violence, child maltreatment confers higher risk of DSH among adolescents (Bruffaerts et al., 2010; Dube et al., 2001; Thompson et al., 2012).

Previous studies have suggested a number of possible mechanisms which underlie the association between child maltreatment and subsequent increased risk of DSH, and these come from a number of different perspectives, including neurological, social, and psychological disciplines. Evidence from neuroscience supports the plausibility of the detrimental effect of child maltreatment on the child's development at multiple levels of functioning (D. Cicchetti & Toth, 2005). Long-term exposure to an abusive or neglectful environment, particularly early in life, may affect the developing brain and disrupt sensory, affective, and cognitive processing capacities (National Scientific Council on the Developing Child, 2007; Streeck-Fischer & van der Kolk, 2000). These disruptions may increase the risk for internalizing and externalizing problems during adolescence, such as depression, anxiety, and over-response to toxic stress (Pechtel & Pizzagalli, 2011; Perry & Pollard, 1998), all of which may contribute to DSH behaviors. Maltreatment experience severely disrupts the child's attachment to parents at an early age (Carlson, Cicchetti, Barnett, & Braunwald, 1989; Dante Cicchetti & Barnett, 1991). This may consequently increase the risk of stress, anxiety, and depression, and hence DSH behaviors during adolescence (Schore, 2002; Streeck-Fischer & van der Kolk, 2000). Maltreatment has also been linked to low self-esteem (internalization of blame for maltreatment) and negative self-perception (e.g., self-hatred, shame, and unworthiness), both of which have been associated with increased risk of DSH behaviors (Glassman, Weierich, Hooley, Deliberto, & Nock, 2007; Gratz, Conrad, & Roemer, 2002).

A number of different social factors have been shown to influence the effect of child maltreatment on DSH behaviors. Maltreated children tend to live in abusive and chaotic familial environments, where various forms of psychosocial adversities cluster. Compared to non-maltreated children, maltreated children are more likely to experience social disadvantage,

such as single or teenage motherhood, and neighborhood socioeconomic disadvantage (Gilbert et al., 2009). Maltreated children are also more likely to have a parent who has alcohol and substance use problems (M. G. Dunn et al., 2002; Famularo, Kinscherff, & Fenton, 1992). Experience of these adversities makes the affected children more vulnerable to mental health problems and DSH behaviors (Hawton et al., 2012). Therefore, it is important to rigorously control for these psychosocial adversities in the examination of the association between child maltreatment and adolescent DSH.

Additionally, research on the impact of the timing of maltreatment on DSH behaviors has been inconclusive. Some studies have suggested that age at first maltreatment event influences DSH risk, however the evidence has been mixed. For example, Wan et al. found that exposure to maltreatment after 10 years of age was more closely associated with adolescent DSH risk, compared with exposure to maltreatment at an earlier age (E. C. Dunn, McLaughlin, Slopen, Rosand, & Smoller, 2013; Wan, Chen, Sun, & Tao, 2015). In contrast, Dunn et al. reported that maltreatment during early childhood (0-5 years of age) was associated with higher risk of having suicidal ideation in young adults, compared with maltreatment during adolescence (E. C. Dunn et al., 2013). Thus, the issue of whether maltreatment during certain development periods results in differential levels of risk for DSH behaviors is not clearly understood.

In addition to the lack of consensus around the impact of the timing of maltreatment, it is also unclear whether different types of maltreatment confer different levels of risk for DSH. To date, most studies have focused on the relationship between DSH risk and sexual and physical abuse. Comparatively, emotional abuse and neglect have received far less research attention, and the results are far more inconclusive. A review has suggested that sexual abuse may have a larger impact on DSH behavior than other types of maltreatment (Miller, Esposito-Smythers, Weismore, & Renshaw, 2013). Previous research has also shown an increased risk of DSH associated with experiencing multiple types, versus a single type, of maltreatment

(Anderson, Tiro, Price, Bender, & Kaslow, 2002; Brezo et al., 2008; Sansone, Gaither, & Songer, 2002).

Given the significant lack of clarity around the impact that different types of maltreatment, and the timing of maltreatment, has on DSH behaviors, this study aimed to investigate the effects of the number, timing, and type of maltreatment allegations on adolescent risk of having a DSH-related hospital admission. In order to achieve this, it was imperative to have a large sample size. Previous research in this field has been limited by small sample sizes. Furthermore, the majority of the existing studies adopted a cross-sectional design with self-reported child maltreatment experiences. This may lead to erroneous reporting of the timing of maltreatment. Large-scale longitudinal research that employs administrative records collected using standardized protocols to investigate child maltreatment, DSH-related hospital admissions, and important psychosocial adversities can address some of the main limitations in existing literature.

To date, there have been no longitudinal cohort studies to evaluate the association between child maltreatment and *hospitalized* DSH behavior during adolescence. Previous research has shown that one in eight adolescents with DSH behaviors present to hospitals or emergency departments for medical treatment (Hawton, Rodham, Evans, & Weatherall, 2002; Madge et al., 2008). These adolescents were found to be more likely to have suicidal behaviors and social disadvantage than adolescents who have DSH behaviors but do not present to hospitals or emergency departments for medical treatment (Hawton & Harriss, 2007; Rodham, Hawton, & Evans, 2004).

In this study, we utilized population-wide record linkage including administratively validated information on child maltreatment and DSH-related hospital admissions. Our primary aim was to examine whether there is increased risk of having a DSH-related hospital admission among adolescents who had an allegation of maltreatment than those who did not,

while taking into account early familial adversities and individual psychiatric history. We also aimed to evaluate the effect of the number, timing, and type of maltreatment on the risk of having a DSH-related hospital admission in adolescence.

Methods

Source population (birth cohort) and study period

This study was based on a birth cohort including all children born alive in WA between the years 1986 and 2000 (inclusive). A total of 373,074 children were identified, and were followed up from birth to the date of the first DSH-related hospital admission, death, 20th birthday, and 5th March 2010, whichever came first.

Data linkage

Data linkage in Western Australia

This study utilized administrative data routinely collected by government agencies in Western Australia (WA). The WA Data Linkage Branch (DLB), which is located within the WA Department of Health, has developed data linkage techniques to link records for individuals, over a number of different collections. Raw records are provided for linkage, and they include demographic information such as name, date of birth, residential address, sex, record date, and unique identifiers (e.g., hospital unique medical record number, electoral number). This information is cleaned and extracted for linking records from different data sources that belong to the same person. Where the unique identifiers are not available across all data sources, alternative information is compared using the probabilistic matching method that calculates the likelihood of multiple records belonging to the same person. De-identified linkage keys are generated for all the records by the DLB before the data are released to researchers. We used these de-identified linkage keys to merge individual records across different datasets used in this study. The linkage accuracy has been evaluated and has been

shown to be above 99%, with only 0.11% of invalid and missed links (Holman, Bass, Rouse, & Hobbs, 1999; Tromp, Ravelli, Bonsel, Hasman, & Reitsma, 2011). More information on data linkage in WA can be found on the DLB website (<http://www.datalinkage-wa.org/>).

Department for Child Protection and Family Support data

We utilized the records collected by the WA Department for Child Protection and Family Support (CPFS) to identify children who were the subject of a maltreatment allegation. Notification of concern about children's safety and welfare can be made by community members, professionals (e.g., police, school personnel, social workers, and health practitioner), the children themselves, their parents or other family members. The reports of concern may be notified directly to the Department for CPFS or indirectly through other agencies such as the police or hospitals. Reports deemed to require further action are assessed through the child protection statutory processes, including investigations and substantiations, which are carried out by the department officers. Investigations may be conducted in conjunction with the police where there are allegations of a crime. If there are reasonable grounds to believe that the child has been, is being, or is likely to be abused, neglected or otherwise harmed, the outcome of this investigation is recorded as a substantiated maltreatment allegation; otherwise it is recorded as an unsubstantiated maltreatment allegation, which means that there have been no reasonable grounds to substantiate prior, current or future abuse, neglect or harm to the child (Australian Institute of Health and Welfare, 2016; Australian Law Reform Commission, 1997).

Mandatory reporting of child sexual abuse started in WA in 2004. People responsible for mandatory reporting include doctors, nurses and midwives, police officers, teachers, and boarding supervisors (Government of Western Australia Department for Child Protection, 2008).

Information available from the Department for CPFS data includes types of maltreatment, and date of maltreatment allegation. The collection of Department for CPFS records became

fully operational in 1990, and for this study, the last record occurred on 5th March 2010. There were, however, some allegations recorded that occurred between 1986 and 1989, and we also utilized these records. It is important to note that the records from 1986 to 1989 were not a complete ascertainment of all maltreatment allegations that occurred during that period, but were the only ones that were available for use in this study.

While we may not have had full maltreatment ascertainment for these few years, we included children born 1986-89, because they made a large contribution to the number of maltreatment allegations, hence they improved robustness of statistical estimates. We conducted sensitivity analyses by excluding children born 1986-89 and found that the cumulative probability of having a DSH-related hospital admission in adolescence (i.e., between 10 and 19 years) was 2.65% for children with no allegations of maltreatment and 11.37% for children with an allegation. These results are comparable to those based on the larger sample, which included children born between 1986 and 1989 (see Table 2). This highlights that the under-reporting of maltreatment allegations for children born between 1986 and 1989 did not have a substantive influence on the identification of maltreatment allegations, thus we included children born 1986-1989 in the study.

Linkage to health related registers

Six health related registers in WA were linked, including the Birth Registrations and the Midwives Notification System (MNS), which includes all births in WA; the Hospital Morbidity Data System (HMDS), which contains all inpatient admission records (including psychiatric inpatients) from all hospitals; the Mental Health Information System (MHIS), which records all psychiatric outpatient contacts from all public hospitals; the Emergency Department Data Collection (EDDC), which contains all emergency department records in hospitals under contract with the WA government; as well as the Mortality Registrations, which records all deaths registered in WA. All data collections date back to 1980 and earlier, except the EDDC

dataset which includes records from 2002. Parental records were linked to their children's records by the Data Linkage Branch through the Family Connections system.

Identification of exposure

Exposure status of maltreatment was based on allegation records notified to the Department for CPFS during the study period. All children were categorized into three *exclusive* groups, depending on whether or not they had an allegation of maltreatment, and whether or not they had a substantiated allegation during the study period. These three groups were: children with no allegations of maltreatment, children with unsubstantiated allegations only, and children with at least one substantiated allegation. We differentiated children with at least one substantiated allegation from those with unsubstantiated allegations only because the former have experienced substantiated maltreatment, whereas the latter may not have experienced an actual maltreatment event (Australian Institute of Health and Welfare, 2016).

Number of allegations

We calculated the total number of substantiated and unsubstantiated allegation records for each child during the study period. We classified the cohort into four exclusive groups based on the total number of allegation records: 0 (n=329,912, 94% of all children had no allegations of maltreatment), 1 (n=16,418, 5%), 2-3 (n=4,419, 1%), and ≥ 4 (n=623, 0.2%).

Identification of Timing

The identification of the child's age at each allegation was derived from the Department for CPFS data, based on the date of allegation and the date of birth. We classified the cohort into three exclusive groups based on the ages at their allegations during the study period: children subject to allegations only during childhood (0-9 years), only during adolescence (10-19 years), and during both childhood and adolescence.

In this study, adolescence was defined as the period between the age of 10 and 19 years. This is in line with the definition used by the World Health Organization (World Health

Organization, 2014) and the UNICEF (UNICEF, 2012). This definition has also been used in the Lancet Commission on Adolescent Health and Wellbeing, who systematically reviewed the definition of adolescents used in previous research, and concluded that 10-19 years were the period of time when most individuals go through critical changes in biological, cognitive, and psychosocial domains in modern societies (Sawyer et al., 2012).

Identification of type of maltreatment

To determine the type of maltreatment, the Department for CPFS take into account both the perpetrators' maltreatment behaviors, and the harm/injury caused to the child (Department for Child Protection and Family Support of Western Australia, 2012). We followed the convention in government reports to classify psychological abuse as emotional abuse, because they are similar by definition (Department for Child Protection and Family Support of Western Australia, 2012). Therefore, we identified four types of maltreatment: emotional abuse, physical abuse, sexual abuse, and neglect.

For all children with allegations of maltreatment, we identified all maltreatment types experienced by them. We then identified if a child experienced only one type of maltreatment (e.g., emotional abuse) or multiple types of maltreatment (e.g., emotional abuse and another maltreatment type) based on *all* allegations experienced by the child during the study period. We did this in order to examine if experiencing multiple types of maltreatment was associated with significantly increased risk of DSH in adolescence, compared to experiencing only one type of maltreatment.

In addition, the primary type of maltreatment was available for substantiated allegations in the Department for CPFS data. The primary type of maltreatment refers to the type of abuse or neglect that is likely to be the most severe in the short term or to place the child at the highest risk in the short term. If such an assessment is not possible, the primary type is classified as the most obvious form of abuse or neglect (Australian Institute of Health and Welfare, 2016). For

children with a substantiated allegation, we conducted sensitivity analyses using only the primary type of maltreatment, and these analyses showed similar results to those based on all reported types of maltreatment. Therefore, we only presented the results based on all types of maltreatment in this study.

Identification of DSH-related hospital admissions

We identified whether a child had a DSH-related hospital admission between 10-19 years of age during the study period (1=yes, 0=no). Hospital admissions due to DSH were identified from the HMDS, the MHIS, and the EDDC datasets, and DSH-related deaths were identified from the Mortality Registrations. The identification of DSH was based on the International Statistical Classification of Diseases and Related Health Problems, 8th/9th Revisions, Clinical Modification (ICD-8/9-CM: E950-E959), and the 10th Revision, Australian Modification (ICD-10-AM: X60-X84). We followed the convention in previous studies to classify “events of undetermined intent” (ICD-8/9-CM: E980-E989; ICD-10-AM: Y10-Y34) as DSH-related episodes to address the issue of underreporting of DSH in the clinical setting (Hawton & Fortune, 2008; Speechley & Stavrakys, 1991). We also used two variables that are available in the EDDC dataset: “presenting problem” and “human intent of injury”, to identify any DSH-related emergency contacts.

Identification of covariates

We used the MNS and Birth Registrations datasets to identify a child’s sex and Aboriginality. If a child’s mother or father was recorded as Aboriginal in either of these two datasets, the child was identified as Aboriginal. Otherwise they were classified as non-Aboriginal.

Each record in the MNS contains information on maternal social factors known to be associated with the child’s risk for maltreatment and DSH behaviors (Dube et al., 2001). These factors include maternal age, maternal marital status, and maternal neighborhood

socioeconomic status, which was measured with the Socio-Economic Indexes for Areas (SEIFA) developed by the Australian Bureau of Statistics (ABS) (Australian Bureau of Statistics, 2008). The SEIFA index summarizes a wide range of social determinants of health such as income, educational attainment, and employment status. The SEIFA score for each neighborhood was constructed based on the census data collected from the households within each census district area, which contains approximately 250 dwellings. All three maternal social factors were coded categorically as shown in Table 1.

We used the HMDS, the MHIS, and the EDDC datasets to identify children's lifetime hospital admissions related to psychiatric disorders, and the parents' lifetime hospital admissions related to psychiatric disorders or DSH that occurred before the end of the study period. Psychiatric disorders were identified using ICD codes (ICD-8/9-CM: 290-319, ICD-10-AM: F01-F99). In addition, parental all-cause deaths were identified from the Mortality Registrations. All these factors were coded as dichotomies (0=no exposure, 1=with exposure).

Analytic strategy

We used Cox regression models to estimate the hazard ratio (HR) as a measure of the increased risk of DSH-related hospital admissions associated with maltreatment allegations, with age (from birth) as the underlying time scale. A censored time was defined as not having a DSH-related hospital admission during the study period, which terminated before the 20th birthday. Because DSH behaviors occur very rarely before the age of 10 years (Hawton et al., 2012), children who were younger than 10 at the end of the study period were excluded from all the analyses. We estimated the cumulative probability of having a DSH-related hospital admission during the adolescent years using the life-table method (Lee & Wang, 2003).

Given that a child's exposure status of maltreatment could change over time, we treated it as a time-varying variable in the Cox regression models. For example, we created a series of binary indicators of whether or not a child had a maltreatment allegation record during and

before a specific 1-year age interval (e.g., 0-1 (<1), 1-2 (<2), ..., 19-20 (<20)). Therefore, there were 20 such indicators for each child in the cohort. We further created a series of variables for the number of allegation records, and the type(s) of maltreatment experienced by a child within each 1-year age interval respectively.

We conducted Cox regression analyses to examine HRs in three sequential steps, and all the analyses were stratified by the exposure status. First, we estimated crude HRs using univariate regression models, including the exposure status of maltreatment allegations only. Second, we conducted multivariate regression analyses, adjusting for children's sex, Aboriginality, maternal age, maternal marital status, maternal neighborhood SES, parental hospital admissions related to psychiatric disorders or DSH behaviors, and parental all-cause deaths. Last, we further adjusted for children's hospital admissions related to psychiatric disorders. We did this because individual psychiatric disorders have a strong association with DSH (Edwards, Holden, Felitti, & Anda, 2003), and we were interested in the extent to which the effect of maltreatment on adolescent DSH is explained by individual psychiatric disorders. All the covariates were treated as time-invariant variables.

Children with at least one substantiated allegation may also have had unsubstantiated allegations, therefore we conducted sensitivity analyses to examine the effects of the number, timing, and type of maltreatment allegations on adolescent DSH risk, using only substantiated allegations, and all allegations (including both unsubstantiated and substantiated allegations) respectively. This sensitivity analysis showed little difference between the effects based on substantiated allegations and all allegations. Therefore, for children with a substantiated allegation, we reported the results based on substantiated allegations in the main text, and presented the results based on all allegations in the supplementary tables (Supplementary Tables 1-3).

Hazard ratios were reported with 95% confidence intervals (CIs). P values less than 0.05 were considered statistically significant, using two-sided testing. Because our preliminary results revealed no significant differences by sex, we presented the pooled results with boys and girls combined. All analyses were conducted using SAS® (EG) statistical software version 6.1 (SAS Institute Inc., Cary, NC, USA).

Results

Overall results

The birth cohort included a total of 351,372 children, after excluding 21,702 children who were younger than 10 years of age at the end of the study period. In total, 248,448 (71%) of the cohort had a censored time. The mean age of the cohort at the end of the study period was 15.5 years (median=16).

A total of 11,546 (3%) children in the cohort had unsubstantiated maltreatment allegations only and 9,914 (3%) had at least one substantiated allegation (of these children, 4,343 (44%) also had an unsubstantiated allegation). Table 1 shows that compared to children with no maltreatment allegations, those with an allegation were more likely to have a young/teen mother, a single mother, or a mother who resided in the most socioeconomically disadvantaged area at the time of the child's birth. Children with maltreatment allegations were also more likely to experience a psychiatric disorder, or have a parent with a psychiatric disorder or DSH behaviors, or who were deceased. Comparatively, children with unsubstantiated allegations only, and those with a substantiated allegation, had similar psychosocial characteristics (Table 1).

Table 2 shows that 2% (the cumulative probability) of children with no maltreatment allegations had a DSH-related hospital admission in adolescence during the study period. Comparatively, 7% of children with unsubstantiated allegations only, and 11% of those with a

substantiated allegation had a DSH-related hospital admission in adolescence. Compared with children without any allegation, there was increased risk of having a DSH-related hospital admission among children with unsubstantiated allegations only (adjusted HR or aHR=1.04, 95%CI: 1.00-1.08, $p<.01$), and an even greater risk of DSH among children with a substantiated allegation (aHR=1.10, 95%CI: 1.06-1.15, $p<.001$). The aHR of DSH for children with a substantiated allegation was 6% (95%CI: 1-11%, $p=.029$) higher than that for children with unsubstantiated allegations only, after taking into account the covariates.

Number of allegations

First, we wanted to examine whether the risk of DSH increased when the number of allegations increased, and we did this for both the children with substantiated allegations and those with unsubstantiated allegations only. Table 3 shows that among children with a *substantiated* allegation, the aHR of having a DSH-related hospital admission increased with the number of substantiated allegations of maltreatment. The aHR for children with more than one substantiated allegations was 1.21 (95%CI: 1.12-1.31, $p<.001$), which was 14% (95%CI: 4-24%, $p<.01$) higher than the aHR for children with a single substantiated allegation (aHR=1.07, 95%CI: 1.02-1.12, $p<.01$). However, among children with unsubstantiated allegations only, the aHRs were not found to increase with the number of allegations.

We then wanted to examine whether there was a difference in the risk of DSH *between* those with substantiated allegations and those with unsubstantiated allegations only, depending on the number of allegations. . Among children who had a *single* allegation of maltreatment, whether it was substantiated or not, the aHR of DSH-related hospital admissions did not significantly differ between children with unsubstantiated allegations only and children with a substantiated allegation. However, among children who had more than one maltreatment allegation, the aHR was significantly higher for children with substantiated allegations

(aHR=1.21, 95%CI: 1.12-1.31, $p<.001$) than those with unsubstantiated allegations only (aHR=1.04, 95%CI: 0.97-1.11) (aHR increased by 17%, 95%CI: 6-29%, $p<.01$).

Timing of allegations

In these analyses we wanted to explore whether the timing of maltreatment had an impact on the risk of DSH. Table 4 shows that among children with a *substantiated* allegation of maltreatment, the aHR of DSH-related hospital admissions was 1.13 (95%CI: 1.06-1.20, $p<.001$) for those with substantiated allegations occurring in adolescence only, which was higher, yet not significantly ($p=.084$), than the aHR for those with substantiated allegations occurring in childhood only (aHR=1.05, 95%CI: 1.00-1.11, $p=.073$). For children with substantiated allegations that occurred in both childhood and adolescence, the aHR increased to 1.34 (95%CI: 1.18-1.52, $p<.001$), which was 24% higher (95%CI: 9-41%, $p<.001$) than the aHR of DSH for children with substantiated allegations that occurred in only one period (i.e., either only in childhood or in adolescence).

Among children with unsubstantiated allegations only, the aHR of DSH-related hospital admissions was 1.12 (95%CI: 1.03-1.21, $p<.01$) for those with allegations occurring in adolescence only, which was significantly higher ($p=.033$) than the aHR for those with allegations occurring in childhood only (aHR=1.02, 95%CI: 0.98-1.06 See Table 4). However, among children with unsubstantiated allegations only, the dose-response effect associated with having allegations in both childhood and adolescence versus having allegations either only in childhood or adolescence was not found (aHR=0.99).

We compared the aHRs of DSH between children with unsubstantiated allegations only, and children with a substantiated allegation, by the timing of allegations. Among children who had allegations either only in childhood or only in adolescence, the aHR of DSH-related hospital admissions did not significantly differ between children with unsubstantiated allegations only (aHR=1.04, 95%CI: 1.00-1.08, $p=.055$) and children with a substantiated

allegation (aHR=1.08, 95%CI: 1.03-1.12, $p<.001$). However, among children who had allegations in both childhood and adolescence, the aHR was higher for children with a substantiated allegation than those with unsubstantiated allegations only (aHR increased by 22%, 95%CI: 1-48%, $p=.040$) (Table 4).

Type of maltreatment

Here we wanted to look at whether the different types of maltreatment conferred differing risk of DSH. Table 5 shows that different types of maltreatment were associated with a similar aHR of DSH-related hospital admissions among children with unsubstantiated allegations only, and children with a substantiated allegation.

Table 5 shows that among children with a *substantiated* allegation, experiencing multiple types of maltreatment was associated with increased risk (aHR) of DSH-related hospital admissions, compared to experiencing only one type of maltreatment. Although this additional increase was present for each maltreatment type, ranging from 10% for emotional abuse to 12% for physical abuse and sexual abuse, it was only significant for neglect (aHR increased by 1.18, 95%CI: 1.04-1.35, $p=0.013$). In contrast, among children with unsubstantiated allegations only, there was no significant difference in the aHR of DSH between experiencing multiple types of maltreatment and experiencing one type of maltreatment.

We then compared the aHRs of DSH between children with unsubstantiated allegations only and children with a substantiated allegation, by the type of allegations. Among children who experienced only *one* type of maltreatment, the aHR of DSH-related hospital admissions did not differ between children with a substantiated allegation and those with unsubstantiated allegations only, regardless of maltreatment type. For children who experienced multiple types of maltreatment, the aHR was on average 13% higher for children with a substantiated allegation than for those with unsubstantiated allegations only. However, this increase was only significant for neglect, that is, among children who experienced neglect and another type of

maltreatment, the aHR of DSH was 20% (95%CI: 5-38%, $p < .01$) higher for those with a substantiated allegation compared to those with unsubstantiated allegations only.

Discussion

The purpose of this study was to investigate the effects of the number, timing, and type of maltreatment allegations on adolescent risk of having a DSH-related hospital admission. First, we found that compared to children with no maltreatment allegations, children with any allegation, substantiated or unsubstantiated, were at higher risk of DSH. Further, after controlling for psychosocial risk factors, children with a *substantiated* allegation had increased risk of DSH compared to children with unsubstantiated allegations only. We also found that the greater the number of allegations, the longer the exposure to maltreatment, and the more types of maltreatment experienced by a child, the higher the child's risk of having a DSH-related hospital admission in adolescence. However, this risk pattern was only observed among children with at least one substantiated maltreatment allegation, but not among those with unsubstantiated allegations only.

Our findings are in line with previous studies showing that the risk for a number of different negative outcomes progressively increased for children with no maltreatment allegations, children with unsubstantiated allegations only, and children with a substantiated allegation. For example, Maclean, Taylor, & O'Donnell (2016) and O'Donnell et al., (2010a, 2010b) found that children with substantiated maltreatment allegations had poorer educational achievement and mental health outcomes when compared to children who had only unsubstantiated allegations. In addition, children with only unsubstantiated maltreatment allegations had worse outcomes on those measures when compared to children with no maltreatment allegations. Previous studies have shown that children with maltreatment allegations, either unsubstantiated or substantiated, experience many more psychosocial adversities than children without

maltreatment allegations (Maclean, Taylor, & O'Donnell, 2016; O'Donnell et al., 2010a, 2010b). This implies that all children with maltreatment allegations, whether they are substantiated or not, should receive appropriate early psychosocial interventions. These findings also suggest that while having unsubstantiated maltreatment allegations do generally indicate that there will be an increased risk across a number of negative outcomes, they may not necessarily involve maltreatment, or they may reflect less severe maltreatment, compared to substantiated allegations of maltreatment (Australian Institute of Health and Welfare, 2016).

For children with a substantiated allegation, being subjected to a greater number of allegations, or allegations in both childhood and adolescence may signify chronic exposure to an abusive or neglectful environment. Compared to children exposed to isolated incidents of maltreatment, those with chronic exposure to maltreatment are more likely to have problematic regulation of cognition, emotion, and behavior (Coohy, Renner, Hua, Zhang, & Whitney, 2011; Ethier, Lemelin, & Lacharite, 2004; van der Kolk, Perry, & Herman, 1991), insecure attachment to adults and peers (D. Cicchetti & Carlson, 1989), and increased impulsiveness and neuroticism (Braquehais, Oquendo, Baca-Garcia, & Sher, 2010; Heim & Nemeroff, 2001; Manly, Cicchetti, & Barnett, 1994). These developmental difficulties may persist over time into adolescence due to the prolonged experience of abuse or neglect, making the chronically affected children more vulnerable to DSH behaviors (Jonson-Reid, Kohl, & Drake, 2012).

There was an indication that children with allegations only in adolescence had higher risk of DSH than those with allegations only in childhood. This finding is supported by previous research showing that exposure to maltreatment during adolescence had a stronger and more pervasive effect on the development of adjustment difficulties, compared to childhood exposure to maltreatment (Thornberry, Henry, Ireland, & Smith, 2010). However, it should be noted that this finding may be due to the use of administrative data in this study. Maltreatment is often a chronic condition for many mistreated children (Gilbert et al., 2009), which may

imply that children with allegations only in adolescence may also have had childhood exposure to maltreatment before the allegations were notified to child protection agencies.

We did not find significant differences in adolescent DSH risk between maltreatment types. This finding is supported by evidence demonstrating that maltreatment experience in general causes underlying shared vulnerabilities, which increase DSH behaviors (Hoertel et al., 2015). However, we did find that for children with a substantiated maltreatment allegation, experiencing another type of maltreatment was associated with an increased risk of DSH, particularly among children who were neglected. This may be because these children's emotional needs are not adequately met, and their affective and behavioral problems are not properly addressed in a neglectful family environment (M. G. Dunn et al., 2002; Tyler, Allison, & Winsler, 2006). When these children experience more abusive events, their DSH risk may be aggravated due to neglectful parenting and the lack of family care and support. Previous research has suggested that different types of neglect (e.g., supervisory, emotional, or physical neglect) may have different impacts on children's development (Coohey, 2008). However, we were unable to explore the risk of adolescent DSH by neglect type in this study because that information is not well recorded in the datasets we used, and therefore the sample size for different neglect types was too small for robust analysis.

We also compared adolescent DSH risk among children with unsubstantiated allegations only, and children with a substantiated allegation. We found that among children subjected to *severe* maltreatment, such as experiencing multiple maltreatment allegations, allegations in both childhood and adolescence, and multiple types of maltreatment, children with a substantiated maltreatment allegation had higher risk of DSH than those with unsubstantiated allegations only. This implies that in the assessment of DSH risk among children with a maltreatment allegation, it is important to consider whether or not there is substantiated maltreatment, but more importantly, the chronicity of maltreatment and the multiplicity of

maltreatment type, which can characterize the nature of maltreatment, and play an important role in shaping adolescent DSH risk.

Strengths and limitations

By utilizing population-wide cross-jurisdictional data linked data, we were able to evaluate the influence of maltreatment on DSH-related hospital admissions in adolescence, adjusting for a comprehensive set of covariates. Importantly, standardized protocols and assessments, administered by authorized child protection agencies and health professionals, were used to identify child maltreatment events and DSH behaviors. Further, the identification of the timing of maltreatment allegations was not subjected to recall bias, which has been a common concern in self-reported data (Fergusson, Horwood, & Woodward, 2000; Wilsnack, Wonderlich, Kristjanson, Vogeltanz-Holm, & Wilsnack, 2002). We treated the exposure status of maltreatment in a time-varying manner, whereby we could identify the actual maltreatment experiences at each event time. These factors make this study unique in its ability to ensure more robust estimates for our outcomes.

However, this study should be interpreted in light of some limitations. This study utilized administrative records, which means that we may not have captured people with DSH behaviors who did not seek treatment at a hospital, or maltreatment events that were not notified to child protection agencies. Therefore, the number, timing, and type of maltreatment allegations identified from the Department for CPFS data may not be a full reflection of actual maltreatment experiences. More specifically, DSH-related hospital admissions and maltreatment allegations recorded in administrative data tend to represent more severe DSH behaviors and maltreatment events. Therefore, findings in this study may reflect the associations between these severe events. Nonetheless, based on the classifications constructed in this study, our results indicate important association between increased risk of adolescent DSH and the chronicity of maltreatment exposure and the multiplicity of maltreatment type.

In the child protection data, it could be the case that multiple allegations were made for the same incident. However, the Department for CPFS has minimized the duplicates in the allegation records, and more than 90% of maltreatment allegations occurred more than one month after the preceding allegation, hence reducing the likelihood that these records represent reports for the same incident. Additionally, although we included all allegations to capture as many types of maltreatment as we could, the incidence of experiencing multiple types of maltreatment may still be under-reported. Therefore, the effect of experiencing multiple types of maltreatment on adolescent DSH risk may be slightly over-estimated, particularly for children who were sexually abused, as only 29% of them were identified to experience another type of maltreatment (47% for neglect, 52% for physical abuse, and 82% for emotional abuse).

Future research should also examine the effects of specific forms of multiple types of maltreatment on adolescent DSH risk, because it may provide more insights into what types of maltreatment are likely to co-occur and confer a higher risk of DSH in adolescence. We could not examine this due to the small sample sizes. For example, the most common forms of multiple types of maltreatment in this study were “emotional abuse and physical abuse” (6% of all allegations), “emotional abuse and neglect” (5%), and “physical abuse and neglect” (4%).

In addition, we were unable to identify important covariates, such as domestic violence and having an incarcerated family member. However, these family adversities are closely interrelated with the covariates that we were able to identify in this study, such as having a teen mother, neighborhood socioeconomic disadvantage, and parental psychiatric disorders (including substance use disorders). Therefore, accounting for additional family adversities may only result in a small change in the results.

Further, childrearing environments may be an important factor in the effect of maltreatment on child development. Children who experience similar childrearing environments tend to have a similar risk of being maltreated, therefore this shared environment

should be controlled for in the analyses. However, information on shared environment is not readily available in the datasets we had access to. This issue has additional complexities, because it would be inappropriate to control for shared environments by simply controlling for an indicator of whether or not the children come from the same household, particularly for maltreated children who may be placed in different child protection facilities. Therefore, a good measure of shared environments should be considered in future research.

We were also unable to link to emigration records, thus maltreatment allegations or DSH-related hospital admissions that occurred outside WA could not be identified. However, a crude estimated rate of emigration from WA was less than 2% in the general population (ABS, 2004). Therefore, attrition related to emigration may only have a small influence on the results of this study. Last, for children born between 1986 and 1989, maltreatment allegations that occurred before 1990 may not have been captured in the Department for CPFS dataset, as this dataset did not become fully operational until 1990. Therefore, the crude and adjusted HRs may be under-estimated due to the under-reporting of maltreatment allegations for children born 1986-1989.

Implications

We found that children subject to maltreatment allegations, either unsubstantiated or substantiated, had an increased risk of DSH-related hospital admissions, therefore interventions to reduce DSH risk should target all children in contact with a child protection service. This study has demonstrated that it is not simply whether or not a child has a substantiated allegation that is associated with an increased risk for adolescent DSH. More importantly, it is also the chronicity of maltreatment and the multiplicity of maltreatment type that are a more powerful predictor of adolescent DSH, because these factors reveal the duration and severity of maltreatment experience. Therefore, child protection agencies should improve the collection

of information that facilitates the evaluation of *actual* duration and severity of maltreatment experiences.

This study has delivered a strong message that long-term exposure to maltreatment and experiencing multiple types of maltreatment increase adolescent DSH risk. This highlights the importance of early identification and continued support in the prevention of DSH behaviors among children vulnerable to maltreatment. It has been shown that early interventions can deliver long-term benefits to children's life-course development (Stronger Families Learning Exchange, 2002), in that early interventions are more cost-effective in the long-term than a later response to crises or treatment of the adverse outcomes of child maltreatment (e.g., increased risk of DSH behaviours). Psychosocial adversities may create, aggravate, or perpetuate the occurrence of child maltreatment in families with abusive and neglectful backgrounds. Therefore, appropriate health care and social support should be provided to these families from the early stage of child development, in order to promote their family functioning and reduce adolescent DSH risk in a sustainable manner. Additionally, given the difficulties in detecting the early signs of child maltreatment, the National Framework for Protecting Australia's Children 2009-2020 initiative calls for early interventions involving a variety of health services (e.g., hospital and community-based mental health services) and social resources (e.g., family supporting services) in the prevention of child maltreatment (Council of Australian Governments, 2009).

Conclusion

Children in contact with child protection agencies are at increased risk of having a DSH-related hospital admission in adolescence, regardless the reported maltreatment is substantiated or not. Among children who experienced substantiated maltreatment allegation, their DSH risk increased with the number of maltreatment allegations, the duration of exposure to

maltreatment, and the multiplicity of maltreatment types. The status of substantiation should not be considered alone in the assessment of DSH risk and future intervention. Instead, all reported maltreatment occurrences and the duration, timing, and type of maltreatment needs to be taken into careful consideration in prevention and treatment of child maltreatment and its harmful consequences. This study calls for the early identification of children vulnerable to maltreatment, and the provision of continued support to at-risk families and families with a history of child abuse and neglect to attenuate the detrimental effect of maltreatment experience on the child's socio-emotional functioning and in turn to reduce DSH risk in adolescence.

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Table 1 Psychosocial characteristics of children with different maltreatment histories

| Psychosocial factors | Child with no allegations | | Children with an allegation (n=21,460) | | | | Chi-square (p value) ¹ |
|---|---------------------------|-------|--|-------|--|-------|-----------------------------------|
| | (n=329,912) | | Unsubstantiated allegations only | | One or more substantiated allegation/s | | |
| | N. | % | (n=11,546) | | (n=9,914) | | |
| | N. | % | N. | % | N. | % | |
| Sex | | | | | | | |
| Male | 170,331 | 51.63 | 5,646 | 48.90 | 4,394 | 44.32 | 44.92 |
| Female | 159,581 | 48.37 | 5,900 | 51.10 | 5,520 | 55.68 | (<.0001) |
| Aboriginality | | | | | | | |
| Aboriginal | 17,953 | 5.44 | 2,431 | 21.05 | 3,075 | 31.02 | 277.51 |
| Non-Aboriginal | 311,959 | 94.56 | 9,115 | 78.95 | 6,839 | 68.98 | (<.0001) |
| Maternal age at child birth (year) | | | | | | | |
| < 20 (teenage motherhood) | 17,049 | 5.17 | 2,319 | 20.08 | 2,246 | 22.65 | |
| 20-24 (young motherhood) | 64,182 | 19.45 | 3,871 | 33.53 | 3,382 | 34.11 | 32.41 |
| 25-34 | 210,556 | 63.82 | 4,624 | 40.05 | 3,744 | 37.76 | (<.0001) |
| >=35 | 33,140 | 10.05 | 612 | 5.30 | 466 | 4.70 | |
| Missing | 4,985 | 1.51 | 120 | 1.04 | 76 | 0.77 | |
| Maternal marital status at child birth | | | | | | | |
| Married/De facto | 298,706 | 90.54 | 8,020 | 69.46 | 6,390 | 64.45 | 69.13 |
| Unmarried/Separated | 30,867 | 9.36 | 3,514 | 30.43 | 3,493 | 35.23 | (<.0001) |
| Missing | 339 | 0.10 | 12 | 0.10 | 31 | 0.31 | |
| Maternal neighbourhood SES (quartile) | | | | | | | |
| Q1 - most disadvantaged | 78,491 | 23.79 | 5,112 | 44.28 | 4,848 | 48.90 | |
| Q2 | 76,471 | 23.18 | 2,679 | 23.20 | 2,087 | 21.05 | 93.95 |
| Q3 | 73,782 | 22.36 | 1,628 | 14.10 | 1,206 | 12.16 | (<.0001) |
| Q4 - least disadvantaged | 63,958 | 19.39 | 823 | 7.13 | 510 | 5.14 | |
| Missing | 37,210 | 11.28 | 1,304 | 11.29 | 1,263 | 12.74 | |
| Parental psychiatric contact | | | | | | | |
| Yes | 92,914 | 28.16 | 7,644 | 66.20 | 7,449 | 75.14 | 203.91 |
| No | 236,998 | 71.84 | 3,902 | 33.80 | 2,465 | 24.86 | (<.0001) |
| Parental DSH-related contact | | | | | | | |
| Yes | 23,122 | 7.01 | 3,107 | 26.91 | 3,425 | 34.55 | 146.94 |
| No | 306,790 | 92.99 | 8,439 | 73.09 | 6,489 | 65.45 | (<.0001) |
| Parental all-cause death | | | | | | | |
| Yes | 9,180 | 2.78 | 754 | 6.53 | 782 | 7.89 | 14.79 |
| No | 320,732 | 97.22 | 10,792 | 93.47 | 9,132 | 92.11 | (0.0001) |
| Children's psychiatric contact | | | | | | | |
| Yes | 21,527 | 6.53 | 2,430 | 21.05 | 2,661 | 26.84 | 98.98 |
| No | 308,385 | 93.47 | 9,116 | 78.95 | 7,253 | 73.16 | (<.0001) |

¹ Pearson's Chi-squared analysis was conducted to compare the frequency distribution of the psychosocial characteristics between children with unsubstantiated allegations only and children with at least one substantiated allegation.

Table 2 Association between maltreatment history and the risk of having a DSH-related hospital admission in adolescence

| Maltreatment status | No. of children | Person-years during follow-up | No. of children with DSH | Cumulative probability 10-19 years (%) (s.e.) ¹ | Hazard ratio (HR) (95%CI) | | |
|---|-----------------|-------------------------------|--------------------------|--|---------------------------|-----------------------|-----------------------|
| | | | | | Crude ² | Adjusted ³ | Adjusted ⁴ |
| Children with no allegations | 329912 | 5279931 | 3786 | 2.31 (0.00039) | | Reference | |
| Children with unsubstantiated allegations only | 11546 | 189064 | 510 | 7.47 (0.00331) | 1.11 (1.07, 1.14) *** | 1.08 (1.04, 1.12) *** | 1.04 (1.00, 1.08) ** |
| Children with ≥ 1 substantiated allegation | 9914 | 158872 | 638 | 11.22 (0.00442) | 1.20 (1.16, 1.24) *** | 1.16 (1.12, 1.21) *** | 1.10 (1.06, 1.15) *** |

¹ Cumulative probability and the standard error (s.e.) were estimated using life-table method. ² Crude HRs were derived from univariate Cox regression models, only including the exposure variable indicating whether a child had (1=yes) or had not (0=no) become a subject of unsubstantiated or substantiated maltreatment during the study period. ³ Crude HRs were adjusted by child's sex (not for sex-specific results), Aboriginality (not for Aboriginality-specific results), maternal age, maternal marital status, and maternal neighbourhood SES at the child's birth, parental psychiatric and DSH-related hospital admission, and parental all-cause death, using multivariate Cox regression models. ⁴ HRs derived in the second step were further adjusted by children's psychiatric contact. * p<.05, ** p<.01, *** p<.001

Table 3 Association between number of allegations of maltreatment and the risk of having a DSH-related hospital admission in adolescence

| Number of allegations of maltreatment | No. of children | Person-years during follow-up | No. of children with DSH | Cumulative probability 10-19 years (%) (s.e.) ¹ | Hazard ratio (HR) (95%CI) | | |
|--|-----------------|-------------------------------|--------------------------|--|---------------------------|-----------------------|-----------------------|
| | | | | | Crude ² | Adjusted ³ | Adjusted ⁴ |
| Children with no allegations | | | | | | | |
| 0 | 329912 | 5279931 | 3786 | 2.31 (0.000386) | | Reference | |
| Children with unsubstantiated allegations only | | | | | | | |
| 1 | 8996 | 146115 | 369 | 7.23 (0.00378) | 1.10 (1.06, 1.14) *** | 1.07 (1.03, 1.12) *** | 1.04 (1.00, 1.08) |
| 2-3 | 2248 | 37594 | 116 | 7.87 (0.00727) | 1.12 (1.04, 1.20) ** | 1.09 (1.01, 1.17) * | 1.04 (0.97, 1.12) |
| ≥4 | 302 | 5355 | 25 | 10.46 (0.02020) | 1.16 (0.99, 1.37) | 1.11 (0.94, 1.32) | 1.03 (0.87, 1.22) |
| Children with a substantiated allegation ⁵ | | | | | | | |
| 1 | 7422 | 119249 | 408 | 9.69 (0.00480) | 1.16 (1.11, 1.21) *** | 1.13 (1.08, 1.18) *** | 1.07 (1.02, 1.12) ** |
| 2-3 | 2171 | 34423 | 191 | 15.25 (0.01080) | 1.33 (1.23, 1.44) *** | 1.27 (1.17, 1.38) *** | 1.20 (1.11, 1.31) *** |
| ≥4 | 321 | 5200 | 39 | 19.40 (0.03010) | 1.45 (1.21, 1.75) *** | 1.37 (1.13, 1.66) ** | 1.29 (1.07, 1.57) ** |

¹ Cumulative probability and the standard error (s.e.) were estimated using life-table method. ² Crude HRs were derived from univariate Cox regression models, only including the exposure variable indicating whether a child had (1=yes) or had not (0=no) become a subject of alleged maltreatment during the study period. ³ Crude HRs were adjusted by child's sex, Aboriginality, maternal age, maternal marital status, and maternal neighbourhood SES at the child's birth, parental psychiatric and DSH-related hospital admission, and parental all-cause death, using multivariate Cox regression models. ⁴ HRs derived in the second step were further adjusted by children's psychiatric contact. ⁵ Only substantiated allegations were considered for children with a substantiated allegation.

* p<.05, ** p<.01, *** p<.001

Table 4 Association between timing of allegations of maltreatment and the risk of having a DSH-related hospital admission in adolescence

| Timing of allegations/substantiations of maltreatment | No. of children ¹ | Person-years during follow-up | No. of children with DSH | Cumulative probability 10-19 years (%) (s.e.) ² | Hazard ratio (HR) (95%CI) | | |
|--|------------------------------|-------------------------------|--------------------------|--|---------------------------|-----------------------|-----------------------|
| | | | | | Crude ³ | Adjusted ⁴ | Adjusted ⁵ |
| Children with no allegations | | | | | | | |
| No allegations | 305605 | 5036861 | 3749 | 2.30 (0.000386) | | Reference | |
| Children with unsubstantiated allegations only | | | | | | | |
| Childhood only (0-9 years) | 7663 | 129224 | 307 | 6.25 (0.00357) | 1.08 (1.04, 1.12) *** | 1.05 (1.01, 1.10) * | 1.02 (0.98, 1.06) |
| Adolescence only (10-19 years) | 2625 | 43220 | 152 | 10.36 (0.00843) | 1.19 (1.10, 1.27) *** | 1.15 (1.07, 1.25) *** | 1.12 (1.03, 1.21) ** |
| Childhood and adolescence | 624 | 10280 | 42 | 11.03 (0.01700) | 1.20 (1.05, 1.38) ** | 1.16 (1.00, 1.35) * | 1.09 (0.94, 1.27) |
| Both childhood and adolescence versus only one period | --- | --- | --- | --- | 1.10 (0.95, 1.26) | 1.08 (0.93, 1.26) | 1.06 (0.91, 1.23) |
| Children with a substantiated allegation ⁶ | | | | | | | |
| Childhood only (0-9 years) | 5782 | 93636 | 277 | 8.40 (0.00510) | 1.14 (1.08, 1.19) *** | 1.10 (1.04, 1.16) *** | 1.05 (1.00, 1.11) |
| Adolescence only (10-19 years) | 2694 | 45640 | 238 | 13.34 (0.00843) | 1.23 (1.16, 1.31) *** | 1.20 (1.13, 1.28) *** | 1.13 (1.06, 1.20) *** |
| Childhood and adolescence | 814 | 13356 | 106 | 20.04 (0.01870) | 1.50 (1.34, 1.68) *** | 1.44 (1.27, 1.63) *** | 1.34 (1.18, 1.52) *** |
| Both childhood and adolescence versus only one period | --- | --- | --- | --- | 1.28 (1.14, 1.45) *** | 1.27 (1.11, 1.44) *** | 1.24 (1.09, 1.41) *** |

¹ A total of 25,565 children were younger than 10 years at the end of the study period, therefore their status of being subjected to allegations during adolescence could not be identified and thus they were excluded from these analyses. ² Cumulative probability and the standard error (s.e.) were estimated using life-table method. ³ Crude HRs were derived from univariate Cox regression models, only including the exposure variable indicating whether a child had (1=yes) or had not (0=no) become a subject of alleged maltreatment during the study period. ⁴ Crude HRs were adjusted by child's sex, Aboriginality, maternal age, maternal marital status, and maternal neighbourhood SES at the child's birth, parental psychiatric and DSH-related hospital admission, and parental all-cause death, using multivariate Cox regression models. ⁵ HRs derived in the second step were further adjusted by children's psychiatric contact. ⁶ Only substantiated allegations were considered for children with a substantiated allegation.

* p<.05, ** p<.01, *** p<.001

Table 5 Association between type of maltreatment and the risk of having a DSH-related hospital admission in adolescence

| Type of maltreatment | No. of Children ¹ | Person-Years during Follow-Up | No. of Children with DSH | Cumulative Probability 10-19 years (%) (s.e.) ² | Hazard Ratio (HR) (95%CI) | | |
|---|------------------------------|-------------------------------|--------------------------|--|---------------------------|-----------------------|-----------------------|
| | | | | | Crude ³ | Adjusted ⁴ | Adjusted ⁵ |
| Children with no allegations | | | | | | | |
| No substantiation | 329912 | 5279931 | 3786 | 2.31 (0.000386) | | Reference | |
| Children with unsubstantiated allegations only | | | | | | | |
| Emotional abuse | | | | | | | |
| Only type or with other types | 1471 | 23743 | 55 | 6.58 (0.00893) | 1.09 (1.00, 1.20) | 1.06 (0.96, 1.17) | 1.02 (0.92, 1.12) |
| Only type | 478 | 7483 | 14 | 6.02 (0.01660) | 1.08 (0.90, 1.29) | 1.03 (0.85, 1.25) | 1.00 (0.83, 1.22) |
| With other types | 993 | 16260 | 41 | 6.83 (0.01060) | 1.10 (0.99, 1.23) | 1.07 (0.95, 1.20) | 1.02 (0.91, 1.15) |
| Additional increase ⁶ | --- | --- | --- | --- | 1.02 (0.83, 1.26) | 1.04 (0.83, 1.30) | 1.02 (0.81, 1.28) |
| Physical abuse | | | | | | | |
| Only type or with other types | 4241 | 69407 | 208 | 8.35 (0.00582) | 1.13 (1.07, 1.19) *** | 1.10 (1.04, 1.17) ** | 1.06 (1.00, 1.12) |
| Only type | 2479 | 40134 | 110 | 7.81 (0.00750) | 1.12 (1.04, 1.20) ** | 1.09 (1.01, 1.17) * | 1.04 (0.97, 1.13) |
| With other types | 1762 | 29273 | 98 | 9.06 (0.00918) | 1.14 (1.06, 1.24) ** | 1.12 (1.03, 1.22) * | 1.07 (0.98, 1.17) |
| Additional increase ⁶ | --- | --- | --- | --- | 1.03 (0.92, 1.14) | 1.03 (0.92, 1.15) | 1.02 (0.91, 1.15) |
| Sexual abuse | | | | | | | |
| Only type or with other types | 4812 | 77469 | 224 | 8.31 (0.00556) | 1.12 (1.07, 1.18) *** | 1.10 (1.04, 1.16) *** | 1.05 (1.00, 1.11) |
| Only type | 3694 | 58749 | 151 | 7.68 (0.00630) | 1.11 (1.05, 1.18) *** | 1.09 (1.02, 1.16) ** | 1.05 (0.99, 1.12) |
| With other types | 1118 | 18720 | 73 | 10.03 (0.01150) | 1.16 (1.06, 1.28) ** | 1.13 (1.02, 1.26) * | 1.07 (0.96, 1.18) |
| Additional increase ⁶ | --- | --- | --- | --- | 1.05 (0.94, 1.17) | 1.04 (0.92, 1.17) | 1.02 (0.90, 1.15) |
| Neglect | | | | | | | |
| Only type or with other types | 3638 | 62026 | 161 | 6.55 (0.00513) | 1.08 (1.03, 1.14) ** | 1.05 (0.99, 1.11) | 1.02 (0.97, 1.08) |
| Only type | 2334 | 40067 | 93 | 5.78 (0.00596) | 1.07 (1.00, 1.14) * | 1.04 (0.97, 1.11) | 1.01 (0.95, 1.09) |
| With other types | 1304 | 21959 | 68 | 8.01 (0.00967) | 1.12 (1.02, 1.23) * | 1.08 (0.98, 1.19) | 1.04 (0.95, 1.15) |
| Additional increase ⁶ | --- | --- | --- | --- | 1.05 (0.94, 1.17) | 1.04 (0.93, 1.17) | 1.03 (0.91, 1.15) |

Table 5 (continued)

| Type of maltreatment | No. of Children ¹ | Person-Years during Follow-Up | No. of Children with DSH | Cumulative Probability 10-19 years (%) (s.e.) ² | Hazard Ratio (HR) (95%CI) | | |
|--|------------------------------|-------------------------------|--------------------------|--|---------------------------|-----------------------|-----------------------|
| | | | | | Crude ³ | Adjusted ⁴ | Adjusted ⁵ |
| Children with a substantiated allegation ⁷ | | | | | | | |
| Emotional abuse | | | | | | | |
| Only type or with other types | 1963 | 29501 | 113 | 11.87 (0.01150) | 1.28 (1.17, 1.41) *** | 1.22 (1.10, 1.35) *** | 1.14 (1.03, 1.26) * |
| Only type | 351 | 5117 | 9 | 5.98 (0.02050) | 1.12 (0.86, 1.45) | 1.08 (0.82, 1.43) | 1.05 (0.80, 1.39) |
| With other types | 1612 | 24384 | 104 | 12.93 (0.01300) | 1.31 (1.18, 1.45) *** | 1.24 (1.12, 1.39) *** | 1.16 (1.04, 1.29) ** |
| Additional increase ⁶ | --- | --- | --- | --- | 1.17 (0.89, 1.55) | 1.15 (0.86, 1.55) | 1.10 (0.82, 1.48) |
| Physical abuse | | | | | | | |
| Only type or with other types | 3938 | 63316 | 303 | 13.24 (0.00749) | 1.25 (1.18, 1.32) *** | 1.21 (1.14, 1.28) *** | 1.14 (1.07, 1.21) *** |
| Only type | 1881 | 31089 | 120 | 10.58 (0.00958) | 1.16 (1.08, 1.25) *** | 1.14 (1.05, 1.24) ** | 1.08 (1.00, 1.17) |
| With other types | 2057 | 32227 | 183 | 16.02 (0.01160) | 1.36 (1.26, 1.47) *** | 1.29 (1.19, 1.41) *** | 1.21 (1.11, 1.31) *** |
| Additional increase ⁶ | --- | --- | --- | --- | 1.17 (1.05, 1.31) ** | 1.13 (1.01, 1.27) * | 1.12 (0.99, 1.25) |
| Sexual abuse | | | | | | | |
| Only type or with other types | 3710 | 61560 | 288 | 11.93 (0.00690) | 1.21 (1.15, 1.28) *** | 1.17 (1.10, 1.24) *** | 1.11 (1.04, 1.17) *** |
| Only type | 2637 | 44133 | 174 | 10.18 (0.00764) | 1.16 (1.09, 1.24) *** | 1.13 (1.05, 1.21) *** | 1.07 (1.00, 1.15) * |
| With other types | 1073 | 17427 | 114 | 16.47 (0.01490) | 1.36 (1.23, 1.50) *** | 1.30 (1.16, 1.45) *** | 1.20 (1.08, 1.34) *** |
| Additional increase ⁶ | --- | --- | --- | --- | 1.17 (1.04, 1.32) ** | 1.15 (1.01, 1.31) * | 1.12 (0.99, 1.28) |
| Neglect | | | | | | | |
| Only type or with other types | 3942 | 60935 | 245 | 12.00 (0.00768) | 1.25 (1.17, 1.33) *** | 1.19 (1.12, 1.28) *** | 1.13 (1.06, 1.21) *** |
| Only type | 2093 | 32864 | 98 | 8.78 (0.00894) | 1.15 (1.06, 1.25) *** | 1.11 (1.01, 1.21) * | 1.06 (0.97, 1.16) |
| With other types | 1849 | 28071 | 147 | 16.12 (0.01320) | 1.40 (1.28, 1.54) *** | 1.33 (1.21, 1.48) *** | 1.25 (1.13, 1.39) *** |
| Additional increase ⁶ | --- | --- | --- | --- | 1.22 (1.08, 1.38) ** | 1.21 (1.06, 1.38) ** | 1.18 (1.04, 1.35) * |

¹ There was 178 child with allegation records whose types of maltreatment could not be identified in the dataset. ² Cumulative probability and the standard error (s.e.) were estimated using life-table method. ³ Crude HRs were derived from univariate Cox regression models, only including the exposure variable indicating whether a child had (1=yes) or had not (0=no) become a subject of alleged maltreatment during the study period. ⁴ Crude HRs were adjusted by

child's sex, Aboriginality, maternal age, maternal marital status, and maternal neighbourhood SES at the child's birth, parental psychiatric and DSH-related hospital admission, and parental all-cause death, using multivariate Cox regression models. ⁵ HRs derived in the second step were further adjusted by children's psychiatric contact. ⁶ An additional increase equates to a hazard ratio of DSH for exposure to an additional type of maltreatment compared to exposure to only one specific type of maltreatment. ⁷ Only substantiated allegations were considered for children with a substantiated allegation (including all alleged types of maltreatment, that is, not restricted to primary types of maltreatment).

* p<.05, ** p<.01, *** p<.001.

Supplementary Table 1 Association between number of allegations of maltreatment and the risk of having a DSH-related hospital admission in adolescence

| Number of allegations of maltreatment | No. of children | Person-years during follow-up | No. of children with DSH | Cumulative probability 10-19 years (%) (s.e.) ¹ | Hazard ratio (HR) (95%CI) | | |
|--|-----------------|-------------------------------|--------------------------|--|---------------------------|-----------------------|-----------------------|
| | | | | | Crude ² | Adjusted ³ | Adjusted ⁴ |
| Children with a substantiated allegation ⁵ | | | | | | | |
| 1 | 4674 | 74607 | 212 | 8.28 (0.00574) | 1.13 (1.07, 1.19) *** | 1.10 (1.03, 1.16) ** | 1.04 (0.99, 1.11) |
| 2-3 | 3558 | 56426 | 231 | 11.90 (0.00784) | 1.22 (1.15, 1.30) *** | 1.18 (1.10, 1.26) *** | 1.12 (1.04, 1.19) ** |
| ≥4 | 1682 | 27839 | 195 | 16.93 (0.01160) | 1.36 (1.26, 1.47) *** | 1.31 (1.20, 1.42) *** | 1.22 (1.12, 1.33) *** |

¹ Cumulative probability and the standard error (s.e.) were estimated using life-table method. ² Crude HRs were derived from univariate Cox regression models, only including the exposure variable indicating whether a child had (1=yes) or had not (0=no) become a subject of alleged maltreatment during the study period. ³ Crude HRs were adjusted by child's sex, Aboriginality, maternal age, maternal marital status, and maternal neighbourhood SES at the child's birth, parental psychiatric and DSH-related hospital admission, and parental all-cause death, using multivariate Cox regression models. ⁴ HRs derived in the second step were further adjusted by children's psychiatric contact. ⁵ All allegations (including both non-substantiated and substantiated) were considered for children with a substantiated allegation.

* p<.05, ** p<.01, *** p<.001

Supplementary Table 2 Association between timing of allegations of maltreatment and the risk of having a DSH-related hospital admission in adolescence

| Timing of allegations of maltreatment | No. of children ¹ | Person-years during follow-up | No. of children with DSH | Cumulative probability 10-19 years (%) (s.e.) ² | Hazard ratio (HR) (95%CI) | | |
|--|------------------------------|-------------------------------|--------------------------|--|---------------------------|-----------------------|-----------------------|
| | | | | | Crude ³ | Adjusted ⁴ | Adjusted ⁵ |
| Children with a substantiated allegation ⁶ | | | | | | | |
| Childhood only (0-9 years) | 5112 | 82864 | 207 | 7.14 (0.00504) | 1.11 (1.05, 1.16) *** | 1.07 (1.01, 1.13) * | 1.03 (0.97, 1.08) |
| Adolescence only (10-19 years) | 2055 | 34792 | 156 | 11.57 (0.00911) | 1.19 (1.11, 1.28) *** | 1.16 (1.08, 1.25) *** | 1.09 (1.01, 1.18) * |
| Childhood and adolescence | 2123 | 34976 | 258 | 19.12 (0.01140) | 1.44 (1.34, 1.55) *** | 1.39 (1.29, 1.51) *** | 1.29 (1.19, 1.39) *** |
| Both childhood and adolescence versus only one period | --- | --- | --- | --- | 1.27 (1.17, 1.38) *** | 1.27 (1.16, 1.39) *** | 1.23 (1.13, 1.34) *** |

¹ A total of 25,565 children were younger than 10 years of age at the end of the study period, therefore their status of being subjected to allegations during adolescence could not be identified and thus they were excluded from these analyses. ² Cumulative probability and the standard error (s.e.) were estimated using life-table method. ³ Crude HRs were derived from univariate Cox regression models, only including the exposure variable indicating whether a child had (1=yes) or had not (0=no) become a subject of alleged maltreatment during the study period. ⁴ Crude HRs were adjusted by child's sex, Aboriginality, maternal age, maternal marital status, and maternal neighbourhood SES at the child's birth, parental psychiatric and DSH-related hospital admission, and parental all-cause death, using multivariate Cox regression models. ⁵ HRs derived in the second step were further adjusted by children's psychiatric contact. ⁶ All allegations (including both non-substantiated and substantiated) were considered for children with a substantiated allegation.

* p<.05, ** p<.01, *** p<.001

Supplementary Table 3 Association between type of maltreatment and the risk of having a DSH-related hospital admission in adolescence

| Type of maltreatment | No. of Children ¹ | Person-Years during Follow-Up | No. of Children with DSH | Cumulative Probability 10-19 years (%) (s.e.) ² | Hazard Ratio (HR) (95%CI) | | |
|--|------------------------------|-------------------------------|--------------------------|--|---------------------------|-----------------------|-----------------------|
| | | | | | Crude ³ | Adjusted ⁴ | Adjusted ⁵ |
| Children with a substantiated allegation ⁷ | | | | | | | |
| Emotional abuse | | | | | | | |
| Only type or with other types | 2405 | 36741 | 161 | 13.31 (0.01070) | 1.30 (1.20, 1.41)*** | 1.25 (1.14, 1.36)*** | 1.17 (1.07, 1.27)*** |
| Only type | 216 | 3133 | 3 | 2.61 (0.01540) | 1.04 (0.73, 1.49) | 1.03 (0.69, 1.52) | 0.99 (0.67, 1.46) |
| With other types | 2189 | 33608 | 158 | 14.09 (0.01130) | 1.32 (1.22, 1.44)*** | 1.26 (1.15, 1.38)*** | 1.18 (1.08, 1.29)*** |
| Additional increase ⁶ | --- | --- | --- | --- | 1.27 (0.88, 1.83) | 1.23 (0.82, 1.84) | 1.19 (0.80, 1.78) |
| Physical abuse | | | | | | | |
| Only type or with other types | 4871 | 78324 | 378 | 13.17 (0.00667) | 1.25 (1.19, 1.31)*** | 1.21 (1.15, 1.28)*** | 1.14 (1.08, 1.20)*** |
| Only type | 1394 | 22882 | 70 | 8.50 (0.01020) | 1.12 (1.03, 1.23)* | 1.10 (1.00, 1.21)* | 1.05 (0.95, 1.15) |
| With other types | 3477 | 55442 | 308 | 15.15 (0.00844) | 1.32 (1.24, 1.40)*** | 1.27 (1.19, 1.35)*** | 1.18 (1.11, 1.26)*** |
| Additional increase ⁶ | --- | --- | --- | --- | 1.18 (1.06, 1.31)** | 1.15 (1.03, 1.29)* | 1.13 (1.01, 1.27)* |
| Sexual abuse | | | | | | | |
| Only type or with other types | 4586 | 75253 | 373 | 13.00 (0.00659) | 1.24 (1.18, 1.30)*** | 1.20 (1.14, 1.26)*** | 1.13 (1.07, 1.19)*** |
| Only type | 2165 | 35955 | 125 | 9.15 (0.00817) | 1.14 (1.06, 1.23)*** | 1.11 (1.03, 1.20)** | 1.06 (0.98, 1.14) |
| With other types | 2421 | 39298 | 248 | 16.57 (0.01010) | 1.34 (1.26, 1.44)*** | 1.30 (1.21, 1.39)*** | 1.21 (1.12, 1.30)*** |
| Additional increase ⁶ | --- | --- | --- | --- | 1.18 (1.07, 1.30)** | 1.17 (1.06, 1.30)** | 1.14 (1.03, 1.27)* |
| Neglect | | | | | | | |
| Only type or with other types | 4720 | 74218 | 321 | 12.41 (0.00688) | 1.25 (1.18, 1.31)*** | 1.20 (1.13, 1.27)*** | 1.14 (1.07, 1.21)*** |
| Only type | 1441 | 22612 | 53 | 7.24 (0.01010) | 1.10 (1.00, 1.22) | 1.06 (0.96, 1.18) | 1.03 (0.92, 1.14) |
| With other types | 3279 | 51606 | 268 | 14.62 (0.00879) | 1.31 (1.23, 1.40)*** | 1.26 (1.18, 1.35)*** | 1.19 (1.11, 1.28)*** |
| Additional increase ⁶ | --- | --- | --- | --- | 1.19 (1.06, 1.34)** | 1.19 (1.05, 1.35)** | 1.16 (1.02, 1.32)* |

¹ There was 178 child with allegation records whose types of maltreatment could not be identified in the dataset. ² Cumulative probability and the standard error (s.e.) were estimated using life-table method. ³ Crude HRs were derived from univariate Cox regression models, only including the exposure variable indicating whether a child had (1=yes) or had not (0=no) become a subject of alleged maltreatment during the study period. ⁴ Crude HRs were adjusted by

child's sex, Aboriginality, maternal age, maternal marital status, and maternal neighbourhood SES at the child's birth, parental psychiatric and DSH-related hospital admission, and parental all-cause death, using multivariate Cox regression models. ⁵ HRs derived in the second step were further adjusted by children's psychiatric contact. ⁶ An additional increase equates to a hazard ratio of DSH for exposure to an additional type of maltreatment compared to exposure to only one specific type of maltreatment. ⁷ Only substantiated allegations were considered for children with a substantiated allegation (including all alleged types of maltreatment, that is, not restricted to primary types of maltreatment).

* p<.05, ** p<.01, *** p<.001.