Unintentional Injuries Among Children of Parents with Diagnosed Mental Health Conditions in Alberta, Canada

by

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Abstract

Background: Unintentional Injuries (UI) are a leading cause of hospitalization among children in Alberta, Canada. A small body of global research has found the risk of UI to be higher among children of parents with mental health and addiction conditions (MHAC) as compared to children with parents without MHAC. However, the scope of research related to this phenomenon is limited and has yet to be conducted in Canada.

Objectives: This thesis includes three studies each with different objectives. Study 1 descriptively assessed the different types and causes of UIs among children of parents with mood and anxiety disorders (MAD) as compared to children in the general population of Alberta. Study 2 quantified and compared the risk of UI among children of parents with MAD as compared to children with parents without MAD in Alberta. Study 3 examined whether the risk of UI in children with parents with MAD is greater in the acute period following parental diagnosis and if the risk changes over time.

Methods: Study 1 used administrative health data to identify a study population of children with parents with MAD and children in the general Alberta population between the ages of 0-9 who had sustained an incident UI. Descriptive analyses identified the most common types and causes of injuries between the populations. Further analysis identified whether the different frequencies were statistically significant between the two populations. An analysis was also conducted to determine if injury types differed depending on how many parents in the household had MAD. Studies 2 and 3 were retrospective case control studies which used administrative health data to identify cases of infant, pre-school and school-aged children aged 0-9 with a UI and age-sex matched controls without a history of UI. Cases and controls were linked to their parental guardians, and parental MHAC status was identified. In study 2 conditional logistic regression

was used to determine the odds ratios (ORs) of the risk of UI given parental status of MAD compared to the risk of UI given parental status of no MAD. Unadjusted and adjusted ORs were calculated and reported with 95% confidence intervals (CI). In study 3 the time from parental diagnosis of MAD to the time of UI was calculated and categorized as being within 0-90 days and more than 90 days. Conditional logistic regression was used to determine ORs for the risk of UI given parental status of MAD compared to the risk of UI given parental status of no MAD. ORs were calculated separately for both time periods.

Results: Study 1 found children of parents with MAD to be prone to different types of injuries that are more severe and costly in nature. The frequency of injury types among children with parents with MAD was found to be similar regardless of the number of parents with MAD in the household. The causes of injuries were also found to be similar across children with parents with MAD and children in the general population. Study 2 found the crude, unadjusted risk of UI to be elevated among children whose parents had been diagnosed with anxiety disorders (infant OR=1.24; preschool OR=1.25; school-age OR=1.18) and mood disorders (infant OR=1.32; preschool OR=1.15; school-age OR=1.22) compared to children with parents with no MAD. The ORs remained positive, even following propensity score adjustment and adjustment for presence of other MHACs. Study 3 found the risk of UI among children with parents with anxiety and mood disorders was highest during the 0-90 -day period (OR = 1.23; OR=1.40), and decreased but remained positive following the 90-day period (OR=1.18; OR = 1.20).

Conclusion: Consistent with global research, children in Alberta with parents with MAD face a higher risk of UI compared to children with parents without MAD. However, a novel finding of this study is that not only is this risk of UI higher during the acute period following parental diagnosis, but children in this population continue to face an elevated risk of UI in the long-term

compared to children whose parents do not have a history of MAD. In conclusion, while interventions to support families of parents with MAD are important during the acute period following parental diagnosis, they should also be available long-term.

Preface

This thesis was part of a larger research project that received ethics approval from the University of Alberta Research Ethics Board, project name "Injury and Mental Health in Children and Youth", Ethics No. Pro00081438, July 3, 2018.

This thesis is an original work by Elizabeth Wishart. The research conducted and included in this thesis is part of a larger project primarily conceived and designed by Dr. Don Voaklander and Dr. Jason Randall, examining injury and mental health in children. This thesis used administrative data collected by Alberta Health Services (REQ-4429) specifically for the aforementioned project.

Dr. Voaklander was the supervisory author for all chapters and contributed greatly to the manuscript edits. Dr. Brian Rowe also contributed to further manuscript suggestions and edits. Dr. Randall contributed the data preparation and also assisted with some data analysis, primarily in Chapter 3.

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List of Abbreviations

ATT: Average Treatment effect on the Treated

UI: Unintentional Injury

CHAMPS: Children and Mentally ill ParentS

CI: Confidence Interval

COVID-19: COronaVIrus Disease 2019

DAD: Discharge Abstract Database

DSS: Dislocations Sprains and Strains

ED: Emergency Department

ICD: International Classification of Diseases

ID: Identifier

MAD: Mood and/or Anxiety Disorder

MHAC: Mental Health and Addiction Conditions

OR: Odds Ratio

SHS: Supervising for Home Safety

TBI: Traumatic Brain Injury

UI: Unintentional Injury

Chapter 1: Literature Review

Epidemiology and burden of unintentional injury in Children

An unintentional injury (UI) is defined as an injury that results without the intent to harm the victim (1). UIs can be differentiated from intentional injuries where the injury is caused with intent, whether it is self-inflicted or inflicted on the victim by someone else as is the case with child abuse or assault (1). Unintentional Injuries encompass a wide range of injuries, from falls to poisonings to drownings, and in Canada, are responsible for 86% of all childhood injuries (2). Given this statistic, it's not surprising that UI's have consistently been reported as a leading cause of emergency department visits, hospitalizations, and death. In Canada, UIs are the leading cause of death among children (3). To quantify this statistic, approximately 200 Canadian children die annually as a result of an UI (4); however, for every injury-related death, there are countless more injury-related ED visits and hospitalizations. Unintentional Injuries are the second leading cause of hospitalization among children aged 1-9 years in Canada, amounting to an average of 16,000 hospitalizations annually (4-5).

Among different types of UIs, falls have been identified as being responsible for nearly half of all UI-related hospitalizations and cost the Canadian economy $1.2 billion annually (4). The costs of injuries not only arise from acute care, but also from complications of injuries that may lead to life-long disabilities and impairments. Non-fatal injuries can still result in serious consequences, such as paralysis and impaired brain function (1), which, at worst, require life-long intervention and care. Unintentional falls are one of the most common causes of traumatic brain injuries (TBI) (6), which occur when an external force to the head disrupts brain function. TBIs are of unique concern when they occur in children, whose brains are still developing. TBI's can impair childhood development by limiting physical and social activity participation,

affecting learning and thinking, and overall impeding growth into a productive adult member of society (6). Furthermore, any UI that results in life-long disability accrues greater cost when the injury occurs so early on in one's life. This is factored into the overall costs of injury in Canada, which is estimated from the direct costs of treating the injury - the costs of hospitalization and care - and, the indirect costs of UIs - such as disability and premature death (2). Parachute, in conjunction with the Public Health Agency of Canada recently released a report on the Cost of Injury in Canada (2) determining the cost of unintentional injury to be $25 billion in 2018, which accounted for 10% of the overall $255 billion cost of health care in Canada that year (7). This is a number that the Canadian economy could stand to see reduced, and fortunately, there are ways in which this can be achieved.

Fortunately, many people believe UIs are almost always preventable. In fact, researchers have predicted that upwards of 90% of UIs are preventable (1). Injury prevention is multifaceted and successful injury prevention involves addressing multiple levels. With improvements in the environment (e.g., engineering, safety legislation, etc.), human (e.g., education/risk avoidance, protective equipment use, legislation enforcement, etc.) and, where appropriate, vehicle (e.g., air bags, seatbelts, visibility, etc.) factors, injury prevention is attainable. In Canada, many injury prevention strategies have been implemented and proven to be successful. Some commonplace, successful injury prevention strategies include bicycle helmets and seatbelt laws (1). Engineered helmets reduce the risk of injury to the head during contact sports, bicycle crashes and falls from motorized vehicles, while education about the risks of head injuries from bicycle crashes has guided legislation to mandate the use of bicycle helmets among children across all provinces in Canada (with the exception of Quebec and Saskatchewan) (8). Not only does injury prevention save lives, but studies show that for each dollar spent on a preventative measure, up to 30 times

that amount can be saved (9). While many injury prevention strategies focus on mitigating risks outside of the home, many risk factors for UIs arise from inside the home, including environmental factors (e.g., hazardous settings, community), parental factors (e.g., maternal education, maternal age, safety practices, etc.), and social determinants of health (e.g., socioeconomic status, housing, and the number of children in a family/residence) (9). In other words, common risk factors for UIs in children are multi-factorial and intersectional.

The children of parents who consistently utilize safety-equipment and engage in quality supervision around the home tend to have fewer and less severe UIs (10). Adequate supervision in a single-parent home is understandably harder to attain than in a multi-parent home. Likewise, supervising five children as compared to one demands more energy and attention on the part of the supervisor. Some injury prevention measures have focused on improving the safety of the home, such as installing engineered child locks on cupboards or setting up gates at the tops and bottoms of stairs, as well as educating parents on the importance of such active safety practices (11). Purchasing such safety equipment, however, might not be feasible for a parent in a low-income household. Furthermore, it's difficult to mandate safety practices in a private home the way interventions are legislated for public spaces such as roads, facilities and sidewalks. Other intervention strategies have targeted improving supervisory habits among parents by improving self-efficacy and educating on the importance of proximal and quality supervision.

One intervention that has targeted improving parent engagement in supervision is the Supervising for Home Safety (SHS) program (12). This intervention focused on educating parents about the importance of supervision and injury prevention (12). Parents without a learned understanding of UI risks tend to engage in poorer supervisory and safety practices. For example, children that grew up in an environment where injury prevention practices were not encouraged

by their parents, are more likely to carry over those practices as they become parents too. As well, parents with low self-efficacy tend to engage in poorer supervisory and safety practices (12-13). Using psychological strategies to improve parents perceptions about their parenting abilities, as well as reinforcing their understanding of the preventability of UIs and the vulnerability of their children, leads to self-driven and long-term engagement in safety-practices (12). The SHS program has seen success when delivered as both an individual and community-based program (12). Its versatility and success in improving supervisory practices among parents has promising implications on the future of child injury-prevention strategies, as ultimately, it is the responsibility of the child's caregiver to keep a safe home through supervisory tactics and the implementation of safe practices.

Although targeted inventions for injury prevention differ on a case-by-case basis, there has been an overall reduction in UI's in Canada. This suggests that existing injury prevention measures are having a positive impact. From 2006-10 there has been a 30% decrease in childhood deaths and a 13% decrease in childhood hospitalizations from UIs (4). Further reductions in hospitalizations and deaths following implementation of effective injury prevention strategies might result with more targeted interventions, and also with better uptake of existing interventions. Evidence shows that many effective injury prevention strategies are not utilized. For example, car seats reduce the risk of hospitalization by nearly 70% among children, yet are estimated to be used incorrectly by 44-81% of caregivers (1). Such gaps in use of injury-prevention strategies could be remedied with education. And, if there was full uptake of existing injury prevention measures, the overall burden of injury could be reduced by as much as 40% in Canada (1). Until there are more injury prevention measures and better uptake, UIs will remain a leading cause of ED visits, hospitalization, and deaths among Canadian children (1).

Epidemiology and burden of mental health and addictions conditions

Mental health and addictions conditions (MHAC) are defined in the Government of Canada's mental health report (14) as 'alterations in thinking, mood or behaviour (or some combination thereof) associated with significant distress and impaired functioning' (p.2). These MHACs include, but are not limited to, anxiety, mood disorders, substance disorders and chronic mental health problems (e.g., schizophrenia, personality disorders, etc.). It is estimated that at least 1 in 5 of all Canadians of all ages are affected by a mental health disorder each year (15). This statistic amounts to more than 5 million Canadians being afflicted with and seeking care for their mental health annually, resulting in mental illness being a leading cause of years lived with disability both within Canada, and globally (15-16). Similar to UI, the cost of MHAC to health care systems is based on acute-care as well as long-term costs. Many adults with MHAC have reduced economic productivity, absenteeism and presenteeism, and in some cases, are unable to work at all. Based on acute health care costs, absence from the workforce and reduced quality of life for those suffering from MHAC, the overall financial burden of MHAC in Canada is approximately $50 billion (15,17). Typically, MHAC are diagnosed in late adolescence or early adulthood - youth aged 15-24 are more at risk for having MHAC than all other age groups (18). Of concern, this age-range coincides with the time in life when many people are entering the workforce to become productive members of society, and also, becoming parents, meaning they are responsible for more than just their own wellbeing (19). Additionally, diagnosis of many MHAC, including depression, anxiety and suicidality among this age group has been steadily increasing over the past decade (20).

The global COVID-19 pandemic which was declared in March 2020 has contributed significantly to the burden of MHAC in society, and it is likely to have far reaching impacts

beyond the pandemic. Social isolation, working from home, screen time and financial considerations with the economic downturn, have magnified the fear and anxiety created by a global infections disease pandemic. Now is an especially crucial time to examine the implications of MHAC as the number of Canadian adults identifying with anxiety and depression has been increasing (21). Such increases in these symptoms are seemingly more pronounced among younger adults who are of child-bearing and parent age (25-44). A Statistics Canada survey on COVID-19 and mental health conducted among this age cohort, found depressive and anxiety-related symptoms increased from 18% and 15%, respectively, in the fall of 2020, to 23% and 20% in the spring of 2021 (22).

As MHAC are often chronic conditions, such a diagnosis can have unforeseen future implications and requires maintained care and attention (20). Importantly, many Canadians with MHAC, especially youth, identify gaps in care and less than satisfactory access to services. Treatment of MHAC continues to be underfunded in Canada. While MHAC affects 20% of the Canadian population over their lifetime, services for mental health account for only 7% of overall federal health spending, and provincially, only 6% in Alberta (23, 24). Besides being underfunded, other barriers to access mental health services are cited as time, availability and stigma (23). Stigma around MHAC continues to inhibit people from seeking care, leading to an underestimate in the burden of MHAC. For those comfortable with seeking care, wait times for intake appointments with therapists are often upwards of six months to a year (23). Moreover, once one is able to secure an appointment, cost and lack of insurance coverage for counselling and therapy sessions with non-physician providers (i.e., clinical psychologists) becomes yet another barrier to accessing high quality care (23). Lack of access to treatment not only affects

the person diagnosed, but also those who depend on that person, whether it be an employer, a colleague, a family member, or a child.

Many people with MHAC also happen to be parents. A Canadian survey estimated that 1 in 10 children under the age of 12 live with a parent who has a diagnosed psychiatric disorder, although this number is thought to be an underestimate (25). Of these parents, nearly 75% reported they did not receive adequate support for their illness in the year prior to the study (25). Among the 12% of children reported to have a parent with MHAC, most were found to be exposed to parents with substance abuse disorder, followed by mood and anxiety disorders (25) Specific to Canada, and other colonized parts of the world, MHAC disproportionately affects Indigenous peoples, and in turn, their families (26). Residential schools that operated across Canada until the late 20th century and the "60s scoop" (widespread adoption of Indigenous children by non-Indigenous families) served to strip Indigenous children of their Indigenous identity, forcing them to adopt a more Western appearance, style of life and language (27). Although Residential schools no longer exist or operate, their lasting effects through intergenerational trauma are still seen today resulting in, but not limited to, dysfunctional family structures stemming from MHAC and poor parenting modelling. To this day, there is an over representation of Indigenous children in the foster care system that can be traced back many decades (28).

An in-depth study from Sweden using the country's detailed population registry, found the prevalence of parental mental health conditions have been increasing, from 8% to nearly 11%, over the study's 10-year period (29). A follow up study to the Canadian survey exploring the prevalence of parental MHAC in Canada has yet to be completed; however, the trending increase in the prevalence of parental mental health found in Sweden, a comparable developed

country, is a concern. The Swedish study also examined varying trends between maternal and paternal mental health disorders, and found that while maternal MHAC exposure was more common for most disorders, exposure to paternal addictions and substance abuse was higher (29). The high, and possibly increasing, prevalence of parental MHAC has serious implications for the safety, health and well-being of the affected children. The impact of maternal mental health especially on the development of children has been well-documented (30). Children whose parents suffer with mental health issues are known to be at risk for adverse outcomes, including increased likelihood of developing mental health disorders themselves, increased morbidity, poor physical health, behavioural problems and UIs, ultimately leading to a disproportionate use of health services (25, 29, 31).

Existing research into parents with MHAC and risk of injury among children

Most research into the risk of injury among children with parents with MHAC focuses on intentional assault-related injury. There is, however, a growing body of published evidence regarding the increased risk of UIs among children with parents diagnosed with a MHAC. A study using the United Kingdom Millennium cohort focusing solely on maternal mental health found children with mothers with mental health conditions were at increased risk for recurring UIs, and the risk was elevated when the child was younger than five (32). A more recent study from Sweden examining a variety of both maternal and paternal mental health conditions found an increased risk of common UIs among children in all age-ranges from 0-17 (31). In this study, multiple types of mental health disorders, including more common disorders, such as anxiety and depression, as well as more severe psychotic disorders, were analyzed. Disorder diagnoses were based on clinical diagnoses as opposed to self-diagnoses, a less reliable method. This study

found the risk of injury was greatest among younger children and children with parents with more common mental health disorders, such as anxiety and mood disorders as opposed to schizophrenia and psychoses (31).

UIs in children are a consequence of the behaviours of both the child and their parent(s). The well-documented positive association between parental mental health status and risk of UI in children is likely related in part to differences in supervision and monitoring among parents with MHAC, and in part to increased behavioral problems seen in children of parents with MHAC (33). There is a strong association between parent supervision and monitoring and reduced child injury risk, yet parents without a diagnosis or history of mental health conditions more often employ safety prevention strategies than those with a diagnosis (33-34). Specifically, mothers with depression are less likely to engage in child safety practices such as using car seats in the vehicle or socket covers in the house (35). They are also less likely to have working smoke detectors in their house (36). There is also evidence that children of parents with MHAC are at greater risk of developing behavioural problems and that these adverse behaviours, such as impulsivity, hyperactivity or defiance, can increase UI risk (37). UIs are the product of an intersection of risk factors, through which behavioural and environmental factors interact in such a way that an individual is harmed without having intended to harm themselves (38). Where a parent has a MHAC, all these facets - parent behaviour, child behaviour, and home safety - are at higher risk of being negatively impaired. Existing epidemiological research into the increased risk of UIs among children with parents with MHAC, along with psychological research into the typical behaviours of parents with MHAC suggests a clear link between the challenges of parenting with a mental health condition and the increased risk of UI among their children. Currently, no such research into the association between parent mental health and childhood UI

risk has been conducted in Canada. Furthermore, little work has been conducted translating the global body of knowledge of this subject into targeted actions, such as policies for protecting the children of parents with MHAC and providing educational support for parents with mental illness about existing child injury prevention strategies (29, 31).

Current intervention programs for families with parental mental health conditions

Given the known burden of mental health conditions among parents there have been various intervention programs targeting such affected families which have been developed and tested across the globe. Many of these interventions, however, cite the main purpose of the intervention being to reduce transmission of mental health conditions among generations (39-41). Although considerable research exists to confirm children of parents with mental health conditions are at an increased risk of developing mental health conditions themselves, and the reduction in the burden of mental health conditions has important economic and societal benefits, these programs fail to target and mitigate other risks to children of parents with mental health conditions, such as UI (39-41).

Very little research is available on existing or piloted intervention programs in Canada. A 2013 study from Ontario surveyed provincial mental health agencies to assess what supports they offered to parents (42). This study found the majority of services offered by these agencies were simple referrals to other agencies (42). Referral strategies, while more attainable for most resource-strapped agencies, lack the integrative nature of more collaborative programs that tend to be more effective in supporting people (42-43). Most of the services provided by the referral agencies are in the form of parenting support groups. Many of these parenting support groups fail to address the immediate needs of children who would be left without care during support group

meetings unless prior arrangements are made by the parents. This means these support groups are far more usable for parents with older children, parents in financial positions to afford outside care, or parents with existing social and familial supports for childcare (42).

Another issue with existing intervention programs lies in recruitment and engagement. Stigma continues to be a barrier to access these programs, especially among fathers (42). Often there is reluctance among parents to seek professional help due to fear of judgment of their illness and competency as a parent, previous bad experiences with social services, or even concern of losing custody of children (44-45).

The successful piloted godparents program in Switzerland takes a more comprehensive approach to aiding parents with mental illness, focusing on improving the overall wellbeing of children while taking into account the general hesitation of parents to seek supports (44). A 'godparent' is a carefully vetted and matched layperson volunteer parent figure who cares for the child(ren) on occasion. During 'godparent' time, children remain living with their parents, but the child is able to spend time with another parent-like figure, allowing the parent the chance to rest and recharge. The godparent program was specifically designed to reach parents reluctant to seek professional support, and is available for parents of children in infancy up to 18 years (44). Furthermore, while parents are given a break from the burden and responsibilities of parenthood, children continue to foster resilience, such as through adaptability, in a safe and familiar environment with the godparent. Another pilot program that focuses more broadly on improving overall family dynamics and child wellbeing is the 'Let's Talk About Children' intervention developed in Finland (46). 'Let's Talk About Children' focuses on empowering parents through clinical sessions between parents and a trained clinician. Parent empowerment focuses on reducing parent stress and improving family dynamics and is available to parents of children in

infancy up to 18 years of age. Outcomes of the 'Let's Talk About Children' intervention included parents normalizing discussion about mental illness in the house, better identifying the need for external support, feeling empowered to seek out such supports and improved communication among the family members (46). Another program, from Australia, that broadly focuses on improving the wellbeing of children of parents with mental illness and overall familial dynamics is the CHAMPS program. This program used child peer support groups among children aged 8-12, with a focus on improving child coping skills, self-esteem, and overall family dynamics (49). Although reducing risk of UI to children of parents with MHAC could be an unintended and positive outcome of the intervention programs described, it was not a specifically studied or targeted outcome and has not been identified as such in other similar programs (44-47).

There are a variety of intervention programs for families of children with parents with MHAC with a multitude of objectives and courses of action - from clinical intervention to peer support groups to layperson support. Meta-analyses have determined intervention programs targeting families with parents with MHAC have been successful in their goals of improving behaviour among children and improving familial support and functioning (45). Among existing programs globally, however, there's a distinct lack of emphasis on the specific goal of improving the safety of children with regard to UIs.

Thesis Rationale and Contribution

Currently, limited research exists regarding the link between child UI and parental MHAC; however, what does exist suggests that parental mental health is indeed a risk factor for childhood UI (31, 34). Despite this, no documented research into this link has been conducted in

Canada, where UIs are a leading cause of childhood hospitalization and economic burden, and mental health conditions are increasingly prevalent with insufficient resources to match demands and needs (4-5, 20, 23). The purpose of this thesis is to examine the risks of UI in children with parents who have been diagnosed with mental health and addiction condition, specifically anxiety and mood disorders, in the province of Alberta, Canada, using both descriptive and analytic methods. This thesis seeks to examine and describe the different types of injury that populations of children with and without parents with mental health and addiction conditions are prone to. This thesis also seeks to determine if the overall risk of UI to children with parents with mental health and addiction conditions is in fact higher than children with parents with no history of mental health and addiction conditions and whether the risk of child UI changes with respect to time from parental diagnosis of mental health and addiction conditions.

The first study is a descriptive comparative analysis of the types, causes and frequency of injuries that occur in a subset of the general population of Alberta, Canada, and the types, causes and frequency of injuries that occur in a population of children in Alberta, Canada who have at least one parent with a diagnosis of a mental health condition

The second study is an analytic case-control study which uses conditional logistic regression to determine the odds of UI in children with parents with no history of a mental health condition compared to odds of UI in children with at least one parent with a diagnosis of that mental health condition of interest.

The third study also uses conditional logistic regression to determine the odds of UI in children immediately following parental diagnosis of a mental health condition of interest as compared to the odds of a child suffering an UI more than 90 days following parental diagnosis.

The results of this thesis will provide comprehensive insight into the risk of UI in children whose parent(s) have been diagnosed with a mental health condition living in Alberta, Canada.

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Chapter 2: Descriptive analysis of injuries occurring to children with parent(s) diagnosed with mental health issues

Introduction

Unintentional injuries (UI) are a leading cause of morbidity and mortality in children across the globe, and cost health care systems large amounts of money. The cost of injuries (including deaths, hospitalizations, ED visits and resulting disabilities) totaled $2.9 billion in 2018 among Canadian children aged 0-14, and nearly 90% of this figure was due to UIs specifically (1). Despite often being thought to be random, UIs are actually the product of an intersectionality of factors, through which behavioural and environmental factors interact in such a way that an individual is harmed without having intended to harm themselves (2). In the 1970s, there was a shift in understanding injuries as unfortunate "accidents" (e.g., divine intervention, nobody's fault) to consequences of preventable and controllable events. Strategies for prevention were introduced and included a focus on manipulating the environment in which children live and play, educating those tasked with caring for children, and legislative changes to reduce risk of the most common injury causes in children and youth (3). In Canada alone, the rate of hospitalizations for childhood injury decreased by 34% between 1994 and 2003 (4). Despite this steep decline, injuries are still a leading cause of death and disability among children in Canada and these statistics would suggest that strategies of prevention were and can be impactful. More recent research from around the world (5-7), however, have concluded that children of parents with mental health and addictions conditions (MHAC) are at a greater risk of UI than those children with parents without evidence of mental health conditions. Estimates range from 18-23% of children having at least one parent with some form of mental illness (5, 7), indicating a large population of children could be at greater risk of UI. Given that the increased risk of injury

among the population of children whose parents have been diagnosed with mental health conditions, it follows that strategies of prevention have not had as strong an impact in reducing injuries in children with parents with mental illness. To generate successful strategies of intervention, effective surveillance and in-depth collection and analysis of data regarding causes and types of injuries within the population being targeted are necessary (4). The increased risk of injury, and consequent lack of any targeted intervention in reducing this specific risk in children with parents with MHAC suggests there needs to be focused surveillance for this population. An examination of how the proportion of injury types and causes within children of parents with MHAC differs from that of children whose parents have no documented MHAC would be valuable.

This paper examines the most common injuries and causes of injuries within a population of children who have at least one parent with a diagnosed mood and/or anxiety disorder (the study population) and compares them to the types and causes of injuries among the general population in the province of Alberta in Canada. The purpose of this paper is to describe and compare injuries and causes between the two populations.

Methods

Data Sources

This study used administrative health data collected by the province of Alberta, in Canada. Different data sets were used to identify the study population and general populations of interest. Databases used are described in detail in Figure 1 of the appendix.

The study population was identified using administrative data collected between April 1, 1997 and March 31, 2018. Incident injuries among children aged 0-9 were identified from 2007

and onwards. Multiple data sets were linked to identify children in the study population and further linkage techniques were used to identify and determine mental health status of their parents. For the purposes of this study, 'parent' is an overarching term used to denote the child's legally recognized guardian(s), whether biological or not. The following data sources were linked and used to determine the study population: The Population Registry database was used to determine demographic information for all Alberta residents registered in the provincial health program, including age, sex, fiscal year of coverage, postal code and whether any individuals entered or left the province or registry. The Parent Cohort database contains information used to link children to their parents to identify children with injuries. The Inpatient Hospital database (Discharge Abstract Database {DAD}) was used to identify injuries among the children. The Practitioner Claims and Inpatient databases were also used to identify mental health disorder diagnoses for the parents in the year prior to injury. All diagnostic fields in the claims database were coded using International Classification of Diseases, Ninth Revision (ICD-9) codes. All diagnostic fields in the inpatient hospital database were coded using International Classification of Diseases, Tenth Revision (ICD-10)

The general population comparison group was identified using administrative data containing records of all inpatient injury hospitalizations from April 1, 2007 to March 31, 2018 among 0-9 year-olds. Injuries were coded using ICD-10. This data source also identified pertinent demographic information for all children in the general population cohort. The general population comparison group was identified as a subset of the population of Alberta. Thus, children in general population were not excluded if they had a parent with a MHAC. Children in the general population comparison group were considered a representative sample of children in the population of Alberta, some of whom do have parents with MHAC.

Study Sample

Children in both the general and study population were identified using a fictional recipient identifier (ID) so as to protect their identity. Children in both populations were further identified as belonging to one of three age groups based on age at incident injury. Children who obtained their incident injury between 0-3 years were considered infants; those who obtained their incident injury between 4-5 years were considered pre-school age; and those who obtained their incident injury between 6-9 years were considered school-age. Parents of children in the study population were identified using linkages between dependents and the heads of household recorded in the health insurance registry.

Study Variables

Injuries among children in both the study and general populations were identified using the most responsible diagnostic field of the inpatient database. The first three characters of the ICD-10 diagnostic codes V01 – Y98 were used to identify the external cause of each injury and the first three characters of ICD-10 diagnostic codes S00-T98 were used to determine the consequence of each external cause (i.e., type of injury).

Mental health disorders among parents of children in the study population were identified using diagnoses from the practitioner claims database or the inpatient database. The claims database contained three diagnostic fields which were used to identify anxiety and mood diagnoses using ICD-9 codes. Code 300 identified an anxiety diagnosis and codes 296, 309, and 311 identified a mood diagnosis. The hospital inpatient database contained 25 diagnostic fields which were used to identify anxiety and mood diagnoses using ICD-10 codes. Code F40 and F43

identified anxiety while codes F31-34, F38, F412, F530-31, and F432 were used to identify mood diagnoses.

Data collected from the 2016 Canadian Census were used to assess median household income and average maternal age at birth for both the parents of children in the study population and general population in the province of Alberta.

Analysis

Dichotomous data were reported as proportions; continuous data were reported as medians with standard deviations (SD) and means with interquartile ranges (IQR), as appropriate. Descriptive analyses were performed by calculating the frequency of different types and causes of injuries among each population of children. The frequency of different injury types was calculated for each age category within each population. The frequency of different injury causes was also calculated for each age category within each population. The chi-square test (χ^2) was used to compare the frequencies of injuries and causes between children in the general population and children with parents with either a mood and/or anxiety disorder (MAD) (study population). The significance level was initially set at $p \leq 0.05$, but was adjusted for multiple comparisons across the three tables in accordance with the Bonferroni correction. The corrected significance level was calculated to be $p <= 0.004$ (0.05/12 comparisons).

Results

Sample

Overall, 9,076 children were included in the study population and 397,744 children were included in the general population. Table 1.1 shows a comparison of median household income

and average maternal age for each of the populations studied – the general Alberta population, and the study population of children with parent(s) with a diagnosed mood and/or anxiety diagnosis. The average age at maternity in the general Alberta population in 2007 (the median year of childbirth for the study population) was 29.2, (8), while the average age at maternity in the study population was 28.6. The median household income in Alberta for the 2015 census year was $93,835 (9), while the median household income for the study population (as determined from the 2015 census) was $89,856.

Injury Types

The results of the descriptive analysis of injury types among the general population can be found in Table 2. A total of 397,744 incident injuries occurred to children in the general population between 2009 and 2018. The most common injuries among children in the general population were open wounds, superficial injuries, unspecified injuries, fractures, and dislocations, sprains and strains (DSS). The results of the frequency analysis for those injury types among each age group in the general population can be found in Table 2. All other injury types not within the defined top five were labeled as 'other injury type.' Across the entire general population and within each age group, more injuries occurred among males than females.

The results of the chi square test comparing the proportion of different injury types between children in the general population and the study population can be found in Table 3. Table 3 compares the most common injury types among the study population for each age group (infant, pre-school, school-age) with the frequency of those injury types among each age group in the general population. In the study population, the overall most common injury types were foreign body, fractures, intracranial injuries, open wounds and poisonings. The distribution of

these injuries varied within each age group. Across all three age group, however, fractures, foreign body, and intracranial injuries were consistently the most frequent respectively. Among all five injury types analyzed, there was a statistically significant ($p<0.004$) difference in frequency between the study population and the general population. This was consistent across all three age groups as well. Infant-aged children, pre-school-aged children, and school-aged children in the study population were all more likely to have fractures, foreign body injuries, intracranial injuries, open wounds, and poisonings than children of the same age group in the general population. All these differences were statistically significant. The risk was greatest for fractures and open wounds across all age groups. Fractures were between 6 and 9 times more frequent among children of parents with a diagnosed mood and/or anxiety disorder than children in the general population. Open wounds were between 4 and 9 times more frequent among children of parents with a diagnosed mood and/or anxiety disorder than children in the general population.

Due to the results of all the chi-square tests performed (comparing the frequency of injury types between children in the study population and general population) showing a significant positive risk of the examined injuries given parental diagnosis of mood or anxiety disorder, a possible dose-response relationship was further explored. The results exploring the aforementioned dose-response relationship are shown in Table 4. The frequency of the three most common injuries in the study population (fractures, foreign-body, and intracranial injuries) were compared for children in the study population with one parent with mood and/or anxiety diagnosis and children in the study population with two or more parents with a mood and/or anxiety diagnosis. Although children with at least one parent with a mood and/or anxiety diagnosis have a higher frequency of fractures, foreign body and intracranial injuries than

children in the general population, the frequencies of these injury types did not differ significantly when comparing between children with one parent with a mood and/or anxiety diagnosis and children with more than one parent with a mood and/or anxiety diagnosis.

Injury Causes

The results of the descriptive analysis of injury causes among the general population can be found in Table 5. The most common causes of injuries among the general population were (in no particular order) falls, animate mechanical forces, inanimate mechanical forces, and unspecified. The fifth most common cause was complications of medical care; however, this type of injury cause is a reflection of medical care and not potential parental cause. Consequently, for the purposes of this study, the sixth most common cause, overexertion, was identified and included in the frequency analysis. All other injury causes not within the defined top five were labeled as 'other injury causes.'

The results of the chi square test comparing the proportion of different injury causes between the general population and the study population can be found in Table 6. Table 6 compares the frequency of the most common injury causes in the study population for each age group (infant, pre-school, school-age) with the frequency of those injury causes among each age group in the general population. In the study population the most common causes of injury were (in no specific order), falls, inanimate mechanical forces, unspecified, poison, and vehicle-related (including occupants of motorcycles, busses, pickup trucks, and other land transport accidents). Among infant-aged children, the frequency of unspecified, vehicle-related and poisoning causes different significantly between the study and general population, with poisonings and vehicle-related causes being 3 and 2 times more likely in the study population, respectively. Among pre-

school-aged children, the frequency of all causes except poisonings (among females) different significantly between the study and general populations. The frequency of falls, poisonings (among males) and vehicle-related causes were more likely in the study population as compared to the general population. Among the school-aged children, the frequency of all causes of injury, except poisoning, were significantly different between the study and general population. The frequency of falls and vehicle-related causes were more likely in the study population as compared to the general population.

Table 1. 1 Descriptive characteristics of study populations.

	Populations	
Study Factors	General	MAD
Mean age at maternity (yrs)	29.2	28.6
Median income ($)	93,835	89,856

Table 2. 1 Distribution of the most common injuries recorded in the general Alberta population from 2008-2019 among the infant age group.

Disorder	Female		Male		Totals	
	n	%	n	%	n	%
DSS*	8134	2.0	6137	1.5	14271	3.6
Fracture	7876	2.0	8371	2.1	16247	4.1
Open wound	19780	5.0	31966	8.0	51746	13.0
Superficial wound	18340	4.6	21234	5.3	39574	9.9
Unspecified injury	13707	3.4	15284	3.8	28991	7.3
Other injury type	32777	8.2	38484	9.7	71261	17.9
Total	100614	25.3	121476	30.5	222090	55.8

*DSS: dislocations sprains and strains

Table 2. 2 Distribution of the most common injuries recorded in the general Alberta population from 2008-2019 among the pre-school age group.

Disorder	Female		Male		Totals	
	n	%	n	%	N	%
DSS*	1725	0.4	1552	0.4	3277	0.8
Fracture	4576	1.2	4972	1.3	9548	2.4
Open wound	8248	2.1	12869	3.2	21117	5.3
Superficial wound	4964	1.2	5298	1.3	10262	2.6
Unspecified injury	2396	0.6	2879	0.7	5275	1.3
Other injury type	6658	1.7	8212	2.1	14870	3.7
Total	28567	7.2	35782	9.0	64349	16.2

*Dislocations sprains and strains

Table 2. 3 Distribution of the most common injuries recorded in the general Alberta population from 2008-2019 among the school-age group.

Disorder	Female		Male		Totals	
	n	%	n	%	n	%
DSS*	5884	1.5	4731	1.2	10615	2.7
Fracture	10513	2.6	10819	2.7	21332	5.4
Open wound	11035	2.8	17315	4.4	28350	7.1
Superficial wound	9853	2.5	10367	2.6	20220	5.1
Unspecified injury	4637	1.2	5347	1.3	9984	2.5
Other injury type	9176	2.3	11628	2.9	20804	5.2
Total	51098	12.8	60207	15.1	111305	28.0

*Dislocations sprains and strains

Table 3. 1 Frequency of most common injuries among children in the study population with at least one parent with MAD compared with frequency among general population for infant aged children.

Injury	Sex	Gen pop		MAD		OR	95% CI	
		n	%	n	%			
Foreign body	Female	8614	3.9	290	7.8	2.29	2.02	2.61
	Male	7882	3.5	372	10.0	3.13	2.79	3.51
Fracture	Female	7876	3.5	549	14.7	5.92	5.33	6.58
	Male	8371	3.8	646	17.3	6.06	5.51	6.67
Intracranial	Female	1921	0.9	134	3.6	4.57	3.81	5.48
	Male	2063	0.9	199	5.3	6.10	5.24	7.11
Open wound	Female	19780	8.9	71	1.9	5.41	4.26	6.87
	Male	31966	14.4	104	2.8	6.81	5.59	8.29
Poison	Female	2632	1.2	158	4.2	3.97	3.35	4.69
	Male	2719	1.2	203	5.4	4.71	4.05	5.47
Other injury type	Female	59791	26.9	439	11.8	0.25	0.22	0.28
	Male	68475	30.8	562	15.1	0.29	0.26	0.31

Note: CI = confidence intervals; MAD = mood and anxiety disorders; OR = odds ratio.

Table 3. 2 Frequency of most common injuries among children in the study population with at least one parent with MAD compared with frequency among general population for pre-school aged children.

Injury	Sex	Gen pop		MAD		OR	95% CI	
		n	%	n	%			
Foreign body	Female	2071	3.2	93	4.6	1.63	1.31	2.03
	Male	2452	3.8	140	7.0	1.81	1.51	2.17
Fracture	Female	4576	7.1	532	26.4	9.62	8.31	11.14
	Male	4972	7.7	682	33.9	8.30	7.37	9.35
Intracranial	Female	569	0.9	44	2.2	2.78	2.03	3.81
	Male	811	1.3	75	3.7	2.90	2.27	3.70
Open wound	Female	8248	12.8	47	2.3	6.69	4.98	9.00
	Male	12869	20.0	66	3.3	9.57	7.46	12.28
Poison	Female	202	0.3	13	0.6	2.26	1.28	3.97
	Male	247	0.4	24	1.2	2.96	1.94	4.52
Other injury type	Female	12901	20.0	93	4.6	0.15	0.12	0.19
	Male	14431	22.4	204	10.1	0.31	0.26	0.36

Note: CI = confidence intervals; MAD = mood and anxiety disorders; OR = odds ratio.

Table 3. 3 Frequency of most common injuries among children in the study population with at least one parent with MAD compared with frequency among general population for school-aged children

Injury	Sex	Gen pop		MAD		OR	95% CI	
		n	%	n	%			
Foreign body	Female	1455	1.3	74	2.2	1.87	1.47	2.38
	Male	1958	1.8	136	4.1	2.28	1.90	2.73
Fracture	Female	10513	9.4	1003	30.1	9.22	8.21	10.35
	Male	10819	9.7	1174	35.2	7.25	6.60	7.97
Intracranial	Female	1296	1.2	77	2.3	2.20	1.74	2.78
	Male	2288	2.1	120	3.6	1.69	1.40	2.05
Open	Female	11035	9.9	90	2.7	4.08	3.29	5.06
	Male	17315	15.6	104	3.1	7.02	5.76	8.56
Poison	Female	126	0.1	11	0.3	3.15	1.70	5.85
	Male	161	0.1	16	0.5	3.15	1.88	5.27
Other injury type	Female	26673	24.0	168	5.0	0.12	0.10	0.14
	Male	27666	24.9	363	10.9	0.28	0.25	0.31

Note: CI = confidence intervals; MAD = mood and anxiety disorders; OR = odds ratio.

Table 4. 1 Comparison of frequency of most common injuries between children with one parent with a MAD and children with more than one parent with MAD.

Injury	Sex	2+ parents with MAD		1 parent with MAD		OR	95% CI	
		N	%	N	%			
Foreign body	Female	279	5.1	178	4.9	1.01	0.83	1.24
	Male	384	7.0	264	7.3	0.97	0.82	1.15
Fracture	Female	1256	23.0	828	22.9	0.96	0.84	1.09
	Male	1483	27.1	1019	28.2	0.96	0.85	1.07
Intracranial	Female	142	2.6	113	3.1	0.80	0.62	1.03
	Male	239	4.4	155	4.3	1.04	0.84	1.28
Other injury type	Female	684	12.5	406	11.2	0.89	0.77	1.03
	Male	1000	18.3	646	17.9	0.95	0.84	1.07

Note: CI = confidence intervals; MAD = mood and anxiety disorders; OR = odds ratio.

Table 5. 1 Distribution of most common causes of injuries recorded in the general Alberta population from 2008-2019 among the infant age group.

Cause	Female		Male		Total	
	n	%	n	%	n	%
Animate	8420	2.1	8423	2.1	16843	4.2
Fall	40708	10.2	49598	12.5	90306	22.7
Inanimate	22363	5.6	28403	7.1	50766	12.8
Overexertion	3966	1.0	2642	0.7	6608	1.7
Unspecified	10206	2.6	12333	3.1	22539	5.7
Other injury cause	14951	3.8	20077	5.0	35028	8.8
Total	100614	25.3	121476	30.5	222090	55.8

Table 5. 2 Distribution of most common causes of injuries recorded in the general Alberta population from 2008-2019 among the pre-school age group.

Cause	Female		Male		Total	
	n	%	n	%	n	%
Animate	2348	0.6	2512	0.6	4860	1.2
Fall	11903	3.0	14250	3.6	26153	6.6
Inanimate	8056	2.0	11214	2.8	19270	4.8
Overexertion	683	0.2	494	0.1	1177	0.3
Unspecified	2120	0.5	2792	0.7	4912	1.2
Other injury cause	3457	0.9	4520	1.1	7977	2.0
Total	28567	7.2	35782	9.0	64349	16.2

Table 5. 3 Distribution of most common causes of injuries recorded in the general Alberta population from 2008-2019 among the school-age group.

Cause	Female		Male		Total	
	n	%	n	%	n	%
Animate	3803	1.0	4938	1.2	8741	2.2
Fall	21030	5.3	22155	5.6	43185	10.9
Inanimate	12510	3.1	18116	4.6	30626	7.7
Overexertion	2340	0.6	1735	0.4	4075	1.0
Unspecified	4224	1.1	4553	1.1	8777	2.2
Other injury cause	7191	1.8	8710	2.2	15901	4.0
Total	51098	12.8	60207	15.1	111305	28.0

Table 6. 1 Frequency of most common causes of injury among children in the study population with at least one parent with MAD compared with frequency among general population for infant aged children.

Injury	Sex	Gen pop		MAD		OR	95% CI	
		n	%	n	%			
Fall	Female	40708	18.3	619	16.6	0.89*	0.81	0.99
	Male	49598	22.3	751	20.2	0.82	0.75	0.89
Inanimate	Female	22363	10.1	351	9.4	0.95*	0.85	1.07
	Male	28403	12.8	485	13.0	0.99*	0.90	1.10
Unspecified	Female	10206	4.6	111	3.0	0.64	0.53	0.78
	Male	12333	5.6	138	3.7	0.63	0.53	0.75
Poison	Female	4120	1.9	196	5.3	3.18	2.73	3.70
	Male	4629	2.1	257	6.9	3.55	3.10	4.05
Vehicle	Female	905	0.4	37	1.0	2.54	1.82	3.54
	Male	1081	0.5	45	1.2	2.46	1.82	3.32
Other injury cause	Female	22312	10.0	327	8.8	0.87	0.77	0.99
	Male	25432	11.5	410	11.0	0.92*	0.83	1.03

*not statistically significant; CI = confidence intervals, MAD = mood and anxiety disorders; OR = odds ratio.

Table 6. 2 Frequency of most common causes of injury among children in the study population with at least one parent with MAD compared with frequency among general population for pre-school aged children.

Injury	Sex	Gen pop		MAD		OR	95% CI	
		n	%	n	%			
Fall	Female	11903	18.5	480	23.8	1.96	1.71	2.26
	Male	14250	22.1	629	31.2	1.69	1.51	1.90
Inanimate	Female	8056	12.5	148	7.4	0.56	0.47	0.67
	Male	11214	17.4	245	12.2	0.57	0.49	0.65
Unspecified	Female	2120	3.3	22	1.1	0.34	0.22	0.53
	Male	2792	4.3	38	1.9	0.39	0.28	0.54
Poison	Female	386	0.6	16	0.8	1.45*	0.87	2.40
	Male	502	0.8	33	1.6	2.00	1.40	2.86
Vehicle	Female	642	1.0	48	2.4	2.70	1.99	3.65
	Male	738	1.1	70	3.5	2.97	2.30	3.82
Other injury cause	Female	5460	8.5	108	5.4	0.64	0.52	0.79
	Male	6286	9.8	176	8.7	0.81	0.69	0.96

*not statistically significant; CI = confidence intervals, MAD = mood and anxiety disorders; OR = odds ratio.

Table 6. 3 Frequency of most common causes of injury among children in the study population with at least one parent with MAD compared with frequency among general population for school-aged children

Injury	Sex	Gen pop		MAD		OR	95% CI	
		n	%	n	%			
Fall	Female	21030	18.9	813	24.4	1.91	1.71	2.12
	Male	22155	19.9	948	28.4	1.69	1.54	1.85
Inanimate	Female	12510	11.2	199	6.0	0.50	0.43	0.58
	Male	18116	16.3	318	9.5	0.46	0.41	0.52
Unspecified	Female	4224	3.8	45	1.3	0.36	0.27	0.49
	Male	4553	4.1	72	2.2	0.48	0.38	0.61
Poison	Female	379	0.3	15	0.4	1.43*	0.85	2.39
	Male	488	0.4	25	0.7	1.62	1.08	2.43
Vehicle	Female	1701	1.5	109	3.3	2.41	1.97	2.95
	Male	1661	1.5	156	4.7	3.13	2.64	3.71
Other injury cause	Female	11254	10.1	242	7.3	0.73	0.63	0.83
	Male	13234	11.9	394	11.8	0.92*	0.82	1.03

*not statistically significant; CI = confidence intervals, MAD = mood and anxiety disorders; OR = odds ratio.

Discussion

The results of this study suggest that children whose parents have been diagnosed with a mood and/or anxiety disorder are prone to different distributions of injury causes, and different types of injuries than children in the general population in the province of Alberta, Canada. This difference is more pronounced when comparing injury types.

The risk of childhood injury is multifaceted, with various factors coming into play affecting the types, frequency and severity of injury (10). Parents with mental illness are prone to different characteristics in their parenting that can affect the safety and wellbeing of their children. Maternal mental illness has been associated with lower parental confidence and a more permissive style of parenting (5). Parental mental health has also been shown to affect responsiveness and sensitivity to children's needs (5). Parents with mental illness may also tend to lack motivation leading to a reduced sense of responsibility and need for interaction with their

children (11). All these tendencies in parental behaviour may lead to different risks of injury for their children.

Among the general population, superficial injuries (such as bruises and non-venomous insect bites), and DSS were consistently more common among all age groups. Comparatively, fractures, intracranial injuries, presence of a foreign body, and open wounds were more common among children in all age groups among the study population. The higher prevalence of these types of injuries has implications. Concussions (a type of intracranial injury) in childhood can be associated with long-term consequences, such as poor academic performance and even mental illness later in life (12). The health economics of fractures and sprains has found the former costs health care systems upwards of 10x more to treat than the latter (13). It's possible that apathy and permissive parenting, more common in parents with mental illness, results in their children experiencing more severe and costly injuries. Proven effective practices for reducing the severity and incidence of childhood injury such as child gates, child proof medicine caps, car seats, bicycle helmets (3) may not be implemented as consistently by parents with mental illness if they are prone to feelings of incompetence (14-15). While a strong sense of parental self-efficacy is associated with providing a nurturing and, in-turn, safe, child environment, a lack of competence is associated with creating the opposite (16). It's also possible that the lack of motivation and pro-active parenting common in parents with mental illness means that they are less likely to respond to relatively minor injuries (such as a superficial scrape or low-grade sprain) by taking their affected children to the hospital in the way that a parent without a mental illness would (11). While parents with mental illness are prone to more passive styles of parenting, they are also prone to more punitive styles of parenting (16-17). Many studies have addressed the increased risk of assault-related injuries in children of parents with mental illness. Fractures and

intracranial injuries are among the most common injuries observed in abused children (18-19). Although this study only analyzed injuries coded as unintentional, the statistically significant higher proportion of intracranial injuries and fractures seen in the study population of children with parents with MHAC might suggest that some of these injuries are being miss-attributed by clinicians who record the data and/or coders in the medical records (18).

Due to the significant difference in all the types of injuries observed between the populations, the relationship between the frequency of the most common injury types in the study population was compared for children with one parent with a mood and/or anxiety diagnosis and children with two or more parents with a mood and/or anxiety diagnosis to determine whether the aforementioned top injuries are even more frequent when more than one parent has a mood and/or anxiety disorder. Such a dose-response relationship, however, was not identified. Whether one parent has a mood and/or anxiety disorder or both do, the frequency of the most common injuries (fractures, foreign body and intracranial injuries) remained consistent for all children in the study population. This is likely due to many factors, including the way modern families are structured. The US census bureau identified 25% of children with married parents under 15 have a stay-at-home mother. Rarely in the modern working-class home are there two parents tasked with caring for the child(ren) at a time. Whether a child has one or two parents with MHAC, they're most likely being supervised by only one of their parents the majority of the time. While a quarter of children have a stay-at-home mother, only 1% have a stay-at-home father, meaning most stay-at-home parents continue to be mothers (20). Most MHAC, including mood and anxiety disorders, are more common in women (21). There's also a higher rate of unemployment among adults with mental illness, which increases with the severity of the mental illness (22). By default, an unemployed parent is more likely to be the stay-at-home

parent and therefore the primary caregiver. Even among dual-parent households with only one parent presenting with a MHAC, it's likely the parent with MHAC is the primary caregiver and supervisor.

Due to the significant difference in all the leading injuries observed between the populations, the external causes of injuries across the populations of children were analyzed to further investigate possible differences. The comparison of injury causes were not as significantly different between the study and general population as they were for injury types. The implications of this are interesting and suggest that although the mechanisms of injury are somewhat similar across both populations, the outcome of injury (type) are quite different. Consistent with other research, falls presented the most common cause of injury for all age groups among both populations of children in this study. A Canadian study examining injuries among children aged 0-11 years found falls to be the most common cause of injury among boys and girls of all ages studied (23). These findings are backed by the Canadian Paediatric Society 2012 position statement on falls being a leading cause of hospitalization (4). Falls accounted for an average of 20% of injuries in the general infant population, and 18% of injuries among infants with parents with anxiety and/or mood disorders. However, in the pre-school and school-aged populations, falls among children with parent(s) with a mood and/or anxiety disorder increased to an average of approximately 27%, while the average remained 20% for pre-school and school-aged children in the general population. This difference is substantial when considering pre-school and school-age children account for more than 50% of the study population. A recent study out of Sweden found an increased risk of falls, poisoning and heat-related injuries (burns) in parents with mental illness (7). This same study found falls to be even more common in children with parents with mood, anxiety and stress-related disorders. It is estimated falls cost the

Canadian economy upwards of $1 billion dollars in 2010, suggesting that further investigation into the increased number of falls among children of parents with mental illness could be worthwhile (24). The results of this study also found the frequency of unspecified and inanimate mechanical force-related external causes to be lower in the study population as compared to the general population. This is likely due to the fact that the other causes of injury assessed – poisoning, falls and vehicle-related were so much more frequent in the study population, as consistent with the results discussed in the aforementioned Swedish study.

Increased risk of injury has also been related to lower household incomes and single parent households (23). The average median household income among parents with mood and anxiety disorders was found to be lower than the average household income among parents in the general Alberta population. As a province, however, Alberta consistently has one of the highest average household incomes of all provinces in Canada, and even with the reduced household income seen in parents with mental illness, it is still higher than the median household income seen across Canada ($70,336), a high-income country in the global community (9). Therefore, while the lower median household income seen in parents with mood and anxiety disorders may be a contributing factor to the different risks of injury, it is likely not a large part.

Strengths and Limitations

One of the strengths of this study was its use of administrative data which allowed access to large and comprehensive databases. Data were collected over a long period of time and from a large population of people in the province of Alberta, Canada. Another strength of this study is that by comparing the study population to a population that was not entirely composed of children without parents without MHAC, there is very little chance the effect estimates were

inflated. The results are more likely to be accurate and representative of the true frequency of UI and causes among children of parents with a mood and/or anxiety disorder.

A limitation of using administrative data is that because it is collected for administrative purposes, it lacks certain variables of interest, making it more difficult to explore some of the reasons behind the results. For example, behavioural factors that can affect health outcomes (e.g., alcohol use, smoking, diet/nutrition, exercise, sleep, etc.) are not recorded. Another limitation of administrative data is its validity (25). Administrative data may be prone to missing and inaccurately inputted health codes; however, due to the large size of the datasets used in this study, unless many injury or cause codes were coded incorrectly, such inaccuracies wouldn't invalidate the results of our study. Another limitation of this study is its quantitative focus, which doesn't provide a detailed picture of each injury in question. Finally, diagnostic codes used for billing and procedural reasons lack detail, meaning it's possible that some injuries coded as unintentional may have been assault related or vice-versa.

Conclusion

The results of this study show that the types and causes of injuries differ significantly across age groups and between children with parents with an anxiety and/or mood disorder and children in the general population of Alberta, Canada. The different risks of injury types and causes among children with parents with mental illness found in this study should be further investigated and addressed. Although UIs remain one of the most preventable and expensive burdens to the healthcare system in Canada, it's clear from the results of this study that the costs and risks of injury are not equally distributed amongst all families and children. Further research

into this area should investigate and quantitate the risk of UI among children with parents with mental illness to determine the severity and significance of this risk difference.

Appendix

Figure 1. Descriptions of data sources used in study.

Data Source	Description	Usage
Child Cohort file	Identification of all children in the study population from 1997-2018.	Used to identify age subgroup, date of index injury, and link children with parent(s).
Child Population Registry file	Demographic information for children in the study population from 1997-2018.	Used to link demographic information, including gender, to child cohort file.
2016 Canada Census	Contains household median total income for dissemination area for children in the study population.	Linked with child cohort file to identify median household total income for children in the study population.
Child Inpatient Claims (study population)	All injury-related hospitalizations for children in the study population aged 0-9 from 2007-2018.	Used to identify index injury types and causes among children in the study population.
Child Inpatient Claims (general population)	All injury-related hospitalizations for children aged 0-9 from 2009-18 in the province of Alberta.	Used to identify index injury types and causes among children in the general Alberta population.
Exclusion Table	Identification of unintentional injuries prior to the study period among children in the study population.	Used to exclude children in the study population with an unintentional injury before the recorded study period.
Parent Cohort file	Identification of all parents of cases and controls in the study population from 1997-2018.	Used to link parents to children in the study population.
Parent Population Registry file	Demographic information for parents of children in the study population from 1997-2018.	Used to identify demographic information for parents of children in the study population, such as age and sex.
Parent Practitioner claims	All practitioner claims related to mental illnesses in parents of children in the study population from 1997-2018.	Used to identify practitioner diagnoses of anxiety and mood disorders among parents of children in the study population.
Parent Inpatient Claims	All mental illness related hospitalizations for parents of children in the study population from 1997-2018.	Used to identify anxiety and mood-related hospitalizations among parents of children in the study population.

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Chapter 3: Risk of unintentional injury in children with a parent with a diagnosed mental illness.

Introduction

Unintentional injuries (UI) continue to be a leading cause of hospitalization and healthcare costs among children in Canada (1-2). While there have been successful efforts in the areas of education, legislation, enforcement and engineering to reduce the number of UIs, they remain a large burden on the health-care system, costing the Canadian economy billions of dollars annually as a result of acute care costs, as well as long-term and indirect costs stemming from disability and premature death (2-4). Estimates from researchers suggest that more than 90% of UIs are preventable, suggesting that much can still be done to further mitigate risks of UI among children (3).

One area of focus is on the quality of parent or guardian supervision and its proven association with the risk of child UI. Consistently, research has found that improving parent supervision leads to reduced severity and frequency of UI in their dependents (5). Parents with mental health and addictions conditions (MHAC) have been found to be less involved with, less responsive, and emotionally distant to their child's needs (6-7). In one survey, 93% of parents with a mental health condition believed their condition negatively affected their ability to parent (8). Furthermore, many parents feel side effects from medications prescribed for their mental health condition often limit their ability to parent successfully – tiring them out and dulling their moods (7, 9). Parents with MHAC identify less attachment with their children as well as difficulty distinguishing the source of their stress being that of their illness or childcare responsibilities (9).

There is an overwhelming burden of responsibility among mothers with MHAC between managing their illness, the home environment, and their child(s) care, and many identify difficulties finding the motivation and ability to successfully do so (6-7, 10). The impact of parent MHAC on child supervision as well as prior research establishing a link between increased risk of various types of injury in children of parents with MHAC is especially alarming given that an estimated 1 in 10 Canadian children live with a parent with a diagnosed mental health condition (11-12). Other estimates suggest at least 23% of all families having at least one parent with a diagnosed mental health condition (13). Additionally, a Swedish study found the prevalence of parental mental illness increased over a 10-year period from 2006-2016, suggesting prevalence of mental illnesses in developed countries has been on the rise (14).

The objective of study was to examine whether there is a greater risk of UI among children of parents with a mental health condition, specifically anxiety and mood disorders, as compared to children with parents with no history of the mental health condition of interest.

Methods

Data Sources

This study used administrative health data collected by the province of Alberta, in Canada from April 1, 1997 to March 31, 2018. The databases used are described in detail in the Appendix. Multiple data sets were linked to determine the study population of children aged 0-9 and their parents. The registry file contained demographic information for all registrants of Alberta's health program, such as date of birth, sex, fiscal year of coverage as well as if and when an individual entered or left the province. The Discharge Abstract Database (DAD) is a hospital inpatient database which was used to identify all records for inpatient admissions in the

province. The practitioner claims database was used to identify all fee-for-service services provided by doctors in the province. Alberta vital statistics registry was used to identify deaths, noting both the date and cause of death using International Classification of Disease, Tenth Revision (ICD-10). The Canada census from 2015 was used to determine median neighborhood income total for household by dissemination area.

Sample Selection

This is a retrospective study that used case control sampling methodology with replacement, meaning controls could later become cases upon onset of UI. The child and parent cohort datasets identified all parents and children in the study using a fictional recipient identifier (ID) consistent across both datasets that also allowed for later linkage between the two datasets. Cases were identified as having an injury based on the main diagnostic field followed by the external cause code to determine type of injury (unintentional or assault). For the purposes of this study, cases were identified as children under the age of 10 with an UI between April 1, 2007 and March 31, 2018. An exclusion database containing injury data from April 1, 1997 to March 31, 2007 was used to identify and exclude children with a prior UI. The date upon which a child sustained a UI and became a case was identified as the index date and was consistent for all controls matched to the case. Cases and controls were matched 1:5 on age, sex, and region of residence using a fictional match ID. Age of cases and controls was used to create further groupings, identifying children as being infant-aged (0-3), pre-school-aged (4-5), and school-aged (6-9) when the index date (date of control's injury) occurred. Parents of cases and controls were identified using linkages between dependents and the heads of household recorded in the health insurance registry. This allowed identification of all registered parents in the year prior to

the child's index date. For the purposes of this study, 'parent' is an overarching term used to denote the child's legally recognized guardian(s), whether biological or not. A dose-response relationship of parental MHAC was not part of the current analysis.

Study Variables

Linkage between parent and child cohort datasets and data sources allowed for identification of study variables. Children who were not linked to a parent were removed from the study cohort. A study flow diagram depicting inclusionary criteria for the study cohort can be found in the Appendix. Practitioner claims and hospital inpatient data for parents was linked to cases and controls allowing identification of parent mental health disorders prior to the index date, and retrospectively as far back as April 1, 1997. The parental mental health disorders of interest were anxiety, mood, psychosis, personality and substance use, and were identified using the International Classification of Diseases, Ninth Revision (ICD-9) codes listed in the practitioner claims and ICD-10 codes in the hospital inpatient databases diagnostic fields. Binary variables for each disorder were then created to identify presence or absence of the disorder. For parents with multiple diagnoses, the earliest date of diagnosis was retained for each disorder. For children with multiple parents with the same disorder diagnosis, the earliest date of diagnosis among all parents with that disorder was retained.

Median neighborhood income was used to derive ten deciles to rank income. Postal codes (0 in the second digit position indicating rural) were used to create a binary variable identifying rural dwelling. Child migration history determined from the registry database was used to create three binary variables: any recorded migration into the province, recorded migration into the province within five years of index date, and any recorded migration out of the province.

Birthdate was used to identify parent age at index date and create a mean parent age variable identifying the average age of all listed parents for each child at index date.

Statistical analysis

Propensity score models were used to control for potentially confounding variables for each of the three age-groups separately. Although matching on demographic variables in a case control study is one way to control for confounding, propensity score analysis allows for even more robust control (15). Propensity scores were calculated using a logistic regression model fitted with all potential confounding covariates. Several propensity score techniques exist to adjust for confounding; however, we used inverse probability of treatment weighting. In this method, the average treatment effect on the treated (ATT) is calculated using the propensity score (15). Asymmetric trimming was then used to ensure sufficient overlap in the propensity scores between cases and controls. Propensity scores were trimmed above the 99th percentile for controls and below the 1st percentile for the cases (16). A weighted regression was then conducted using the trimmed dataset to determine if the covariates between the cases and controls were sufficiently similar. If they were, balance was considered achieved. The following variables were controlled for in at least one (if not, all) of the age-group propensity score models: age, sex, rurality, median neighborhood income, migration history, previous registration and mean parent age.

Conditional logistic regression models were used to determine adjusted and unadjusted odd ratios (ORs) and 95% confidence intervals (CIs) associated with child UI and parental anxiety or mood diagnosis. The ORs calculated compared the odds of a child becoming a case (i.e., sustaining an UI) given a parent with a disorder diagnosis with the odds of a child being a

control given a parent with that disorder diagnosis. Because this study was a case-control design, ORs were used as the measure of association between parental mental health status and child UI outcome (17). ORs were calculated for each of the three age-groups separately. The non-propensity-score-adjusted (raw) data and the propensity-score adjusted data were used to determine the crude OR for each of the three age subgroups. The adjusted OR was determined using the raw data, but the model included the additional disorder diagnostic binary variables to adjust for the presence of other parent disorder diagnoses. For the conditional logistic regression model predicting the association between parent anxiety diagnosis and child UI, mood, substance, psychosis and personality disorder binary variables was adjusted for. For the model predicting the association between parent mood disorder and child UI, anxiety, substance, psychosis and personality disorder binary variables were adjusted for.

Results

Sample

In the study cohort of 136,183 parents, 57,237 parents had a diagnosis of anxiety and 39,616 parents had a diagnosis of a mood disorder. Among the 78,006 children in the study cohort, 43% were in infancy, 22% pre-school-aged and 35% were school-aged. The average age of children at index date was 4.3, and the cases were made up of a slight majority of males (56.9%). Further descriptive statistics for the study population can be found in Table 7.1.

Anxiety

The results of logistic regression models for children with parents with an anxiety diagnosis can be found in Table 8.1 The OR's for all regression analyses of children with parents

with an anxiety disorder were >1 and all statistically significant ($p<0.05$). A statistically significant OR above 1 indicates a higher risk of UI in children following parental diagnosis of anxiety compared to children with parent(s) with no history of anxiety disorder. Among both of the crude and the adjusted regression models, the association was most pronounced for infant and pre-school-aged-children. The crude conditional logistic regression model using the raw data resulted in the highest ORs. Using the propensity-score adjusted data to fit the crude logistic regression model decreased the OR's slightly, but only by $1/100^{th}$ for the infant and pre-school-aged children, and 3/100ths for the school-aged children. This decrease is negligible and the results were still significant ($p<0.05$). This suggests that the potentially confounding covariates were already well-matched between the cases and controls before the propensity-score adjustment. The adjusted conditional logistic regression model which used the raw data and adjusted for presence of other disorder diagnoses in the parents, including personality, psychosis, substance and mood disorders resulted in the lowest ORs, however, they remained significant and above 1 for all age-groups. The risk of UI among children with a parent with an anxiety disorder ranged from 1.1 to 1.25 ($P<0.05$) with the highest ORs being recorded from the initial unadjusted conditional logistic regression model among infants and pre-schoolers.

Mood

The ORs for the risk of UI among children with a parent with a diagnosed mood disorder were also >1 across all age groups and with each regression analysis - even being slightly higher than that of children with parents with an anxiety disorder. The results of the logistic regression models for children with parents with a mood diagnosis can be found in Table 8.2 The ORs for all regressions involving parents with mood disorders were above 1 and all, except one,

statistically significant ($p<0.05$). An OR above 1 indicates a higher risk of UI in children following parental diagnosis of a mood disorder compared to children with parent(s) without a mood disorder. The risk of UI for children with a parent with a diagnosed mood disorder was highest among infant-aged children, with an OR of 1.3 ($p<0.05$) calculated from the crude unadjusted regression analysis. The risk of UI was somewhat elevated for pre-school aged children across all three regressions, but the p-value was consistently higher. The results of the regression model adjusting for the other mental disorders (anxiety, psychosis, personality and substance disorders) were insignificant for the pre-school aged group with parents with a mood disorder ($p=0.48$). The higher p-values seen in the results of all three regressions for the pre-school-aged children are likely a result of this age demographic being the least populous leading to low statistical power.

Table 7. 1 Demographics of cases and controls in study cohort

Variable	Case	Control
Age (yrs)	4.3	4.3
Male (%)	7,297 (56.9)	36,719 (56.9)
Rural (%)	3,051 (23.8)	12,812 (19.9)
Age ranges		
Infant (%)	5,463 (42.6)	27,556 (42.7)
Pre-School (%)	2,798 (21.8)	14,034 (21.8)
School-age (%)	4,556 (35.6)	22,924 (35.5)
Parental Mental Health Condition		
Anxiety* (%)	7,948 (62.0)	36,926 (57.2)
Mood* (%)	5,986 (46.7)	26,671 (41.3)
Median (IQR) household income ($)	88,576 (48704)	92,416 (48549)
Median (IQR) parent age (yrs)	34.3 (8.5)	34.7 (8.5)
Single parent household (%)	3,778 (29.5)	15,517 (24.1)

*At least one parent with disorder

Table 8. 1 Risk of UI among children with a parent with a diagnosed anxiety disorder.

Age-group	Crude OR	95% CI		Crude OR*	95% CI*		Adjusted OR**	95% CI**	
Infant	1.24	1.17	1.32	1.23	1.15	1.30	1.11	1.04	1.18
Preschool	1.25	1.15	1.36	1.25	1.15	1.37	1.19	1.09	1.31
School-age	1.18	1.10	1.26	1.15	1.08	1.23	1.09	1.01	1.17

Note: CI = confidence intervals; OR = odds ratio.
*adjusted using propensity score data
**adjusted for other disorders (using non propensity score adjusted data)

Table 8. 2 Risk of UI among children with a parent with diagnosed mood disorder.

Age-group	crude	95% CI		crude*	95% CI*		adjusted**	95% CI**	
Infant	1.32	1.25	1.40	1.29	1.22	1.37	1.20	1.13	1.28
Preschool	1.15	1.06	1.25	1.15	1.05	1.25	1.03+	0.94	1.13
School-age	1.22	1.15	1.30	1.20	1.12	1.27	1.13	1.06	1.22

Note: CI = confidence intervals; OR = odds ratio.
*adjusted using propensity score data
**adjusted for other disorders (using non propensity score adjusted data)
+ results not statistically significant.

Discussion

The results of this study suggest that parental diagnosis of anxiety and mood disorders are associated with an increased risk of UI in their children aged 0-9. The risk of UI is most elevated in the youngest cohort, infant-aged children, but remained elevated through pre-school and school-aged children up to 9 years of age. The risk of UI was also found to be slightly higher for children with parents with mood disorders than with anxiety disorders. The results of nearly all the regression models, including the model adjusting for presence of other parental mental health disorders, were statistically significant. This suggests the association between parent anxiety and mood diagnosis and child UI exists even when other parent disorders are controlled for. Given the consistent results of the crude and adjusted conditional logistic regression analyses producing

ORs >1 ($p<0.05$), it's evident there is a significant positive association between parent anxiety and mood diagnosis and risk of UI in their child(ren).

These findings are consistent with prior research into the area of UI in children with parents with mental illness in other countries. To our knowledge, this is the first comprehensive study specifically examining the risk of UI among children of parents with MHAC. A recent study out of Sweden compared the rate of UIs among children with parents with and without mental health conditions and found the rates of all major categories of UI (falls, burns poisonings, drownings, transport-related) were higher among children with parents with MHAC (11). The results of the aforementioned Swedish study did not distinguish an elevated risk of UI specifically, but did find an elevated risk of all injury types among children of parents with mental health conditions (11). The elevated risk of injury was most pronounced in the first year of life, consistent with our study's findings that the risk of UI was highest among infant-aged (0-3) children relative to pre-school and school-aged children (11). A study from Japan specifically examined the risk of UI in children up to four months of age with mothers with postpartum depression (18). This study's analysis confirmed a positive association between UI in young infants and mothers with postpartum depression (OR = 1.6). Compared to our administrative database study, this study relied solely on questionnaires for data collection, and not clinical diagnosis of depression or health records of UI (18). As well, this study examined the risk of UI with relation to mental health conditions in mothers and not fathers.

The results of this, and other studies, consistently identifying a relationship between increased UIs in children of parents with mental health conditions is likely due to many factors, including the different behavioral tendencies found in parents with mental health conditions compared to those without a history of mental health conditions (6, 18). Previous research has

found UI's in children are strongly related to poor parental supervision (20). While depressed mothers are more likely to spend time supervising their children, this supervision is less proximal or intense, rendering the supervision mostly ineffective (18). Furthermore, depressed mothers have been found to be less likely to engage in child safety practices, such as installing socket covers, or smoke alarms (19). Utilizing child-safety products, such as baby gates to prevent falls down stairs, car seats to reduce injury in motor vehicle accents, socket covers to prevent electrocution or smoke alarms to prevent burn injuries is one arm of injury prevention that is highly correlated with reducing UIs (18-19).

Strengths and Limitations

One of the inherent limitations of administrative data is its proneness to missing or inaccurately entered data. Administrative data are collected for clinical and administrative use, meaning they are not collected for the purpose of scientific study and may not include all the risk factors for the study of interest. This can result in measurement error or unmeasured confounding. Notwithstanding these limitations, the strength of using administrative data in health research is that it offers comprehensive data on a large population of individuals. This large study population allowed us to draw conclusions for the province of Alberta, in Canada. A further strength of this study is the use of hospital and practitioner claims data that are derived from clinical diagnoses and not parent self-reports or questionnaires. The number of controls employed and compared to cases has been debated. While more is often better, a case: control ratio beyond 1:5 adds no additional statistical power (21). Another strength of this study's case-control design is that it allowed for control of potential confounding variables. Finally, further control for potential confounders was also done through the propensity score adjustment.

Conclusion

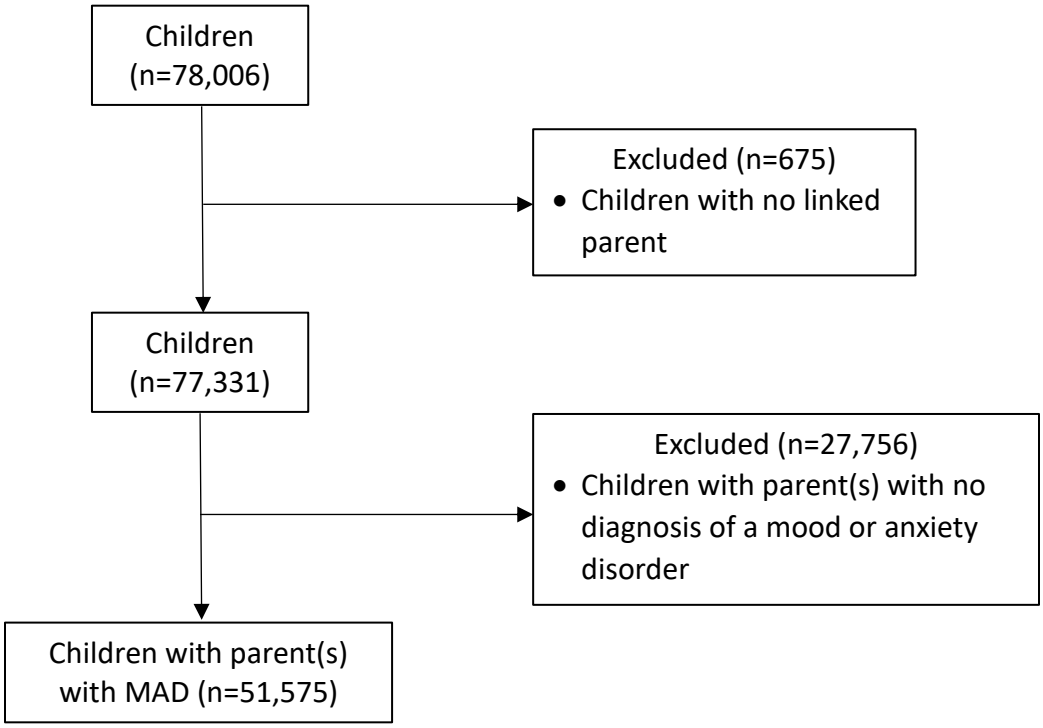
This study shows that parental mood and anxiety diagnoses are associated with higher risk of UI in their children. This is consistent with the small body of international literature that currently exists on this subject; however, is unique for Canada. The results of this study have important implications on understanding some of the risk factors of UI in children. Future research into methods of improving parental supervision strategies among parents with mental illness would be a logical next step.

Appendix

Figure 1. 1 Descriptions of data sources used in study.

Data Source	Description	Usage
Child Cohort file	Identification of all cases and controls in the study population from 1997-2018.	Used to identify whether case or control, age subgroup, date of index injury, and link children with parents.
Child Population Registry file	Demographic information for cases and controls in the study population from 1997-2018.	Used to identify and link demographic information, including gender, to child cohort file.
Exclusion Table	Identification of prior unintentional injuries among children in the study population.	Used to exclude children in the study population with an unintentional injury before the recorded study period (2007-2018).
2016 Canada Census	Contains household median total income for dissemination area for children in the study population.	Linked with child cohort file to identify median household total income for children in the study population.
Parent Cohort file	Identification of all parents of cases and controls in the study population from 1997-2018.	Used to link parents to children in the study population.
Parent Population Registry file	Demographic information for parents of children in the study population from 1997-2018.	Used to identify demographic information for parents of children in the study population, such as age and sex.
Parent Practitioner Claims	All practitioner claims related to mental illnesses in parents of children in the study population from 1997-2018.	Used to identify incident date of practitioner diagnosis of anxiety and mood disorders among parents of children in the study population.
Parent Inpatient Claims	All mental illness related hospitalizations for parents of children in the study population from 1997-2018.	Used to identify incident date of anxiety and mood-related hospitalization among parents of children in the study population.

Figure 2. 1 Flow diagram of children included in study.



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Chapter 4: Change in risk of unintentional injury in children from time of parental mental illness diagnosis

Introduction

A small body of literature currently exists that suggests parental mental illness results in an increased risk of unintentional injury (UI) in their children (1-2). Beyond establishing this link, however, there has been little research into the nuances of the relationship between parental mental health and addictions conditions (MHAC) and child UI. There is growing evidence that the difficulties of managing the demands of a mental health conditions and the well-being of a child are even more heightened during the acute period following diagnosis, such as adjusting to new medications and routines. The time-period following initial diagnosis of a mental disorder has been found to be a time of particular vulnerability. Patients have expressed difficulties integrating back into the community and acclimating to their diagnosis (3-4). For patients admitted to inpatient psychiatric care, there is a heightened risk of relapse, violent injury, and unintentional death following discharge (3, 5). The period immediately following discharge for patients treated in an inpatient psychiatric facility is cited as being the most critical for long-term community adaptation (3). Concerningly, the 3-month period following initial mental disorder diagnosis has been found to be a period of heightened risk – specifically for self-inflicted injury, including suicide, in individuals diagnosed with a variety of mental health disorders, including depression and anxiety (4-5).

Despite the likely importance of this period, there appears to be no research examining whether this acute risk is applicable to other types of injuries, such as unintentional ones to the dependents of the recently diagnosed individual. The objective of this study is to examine

whether risk of UI in children is greater during the acute time period following parent diagnosis, and to assess this risk of UI over the longer-term.

Methods

Data Sources

This study used administrative health data collected by the province of Alberta, in Canada from April 1, 1997 to March 31, 2018. The databases used are described in detail in Figure 1 of the appendix. Multiple data sets were linked to determine the study population of children aged 0-9 and their parents. The registry file contained demographic information for all registrants of Alberta's health program, such as date of birth, sex, fiscal year of coverage as well as if and when an individual entered or left the province. The hospital inpatient database was used to identify all records for inpatient admissions in the province. The claims database was used to identify all fee-for-service treatment by practitioners in the province. Alberta vital statistics was used to identify deaths, noting both the date and cause of death using International Classification of Disease, Tenth Revision (ICD)-10. The Canada census from 2015 was used to determine median neighborhood income total for households by dissemination area.

Sample Selection

This is a retrospective study that used case control sampling methodology with replacement, meaning controls could later become cases upon onset of UI. The child and parent cohort datasets identified all parents and children in the study using a fictional recipient identifier (ID) consistent across both datasets that also allowed for later linkage between the two datasets. For the purposes of this study, cases were identified as children under the age of 10 with a UI

between April 1, 2007 and March 31, 2018. Cases were identified as having an injury based on the main diagnostic field followed by the external cause code to determine type of injury (unintentional or assault). However, an exclusion database containing injury data from April 1, 1997 to March 31, 2007 was used to identify and exclude children with a prior UI. The date on which a child sustained a UI and became a case was identified as the index date and was consistent for all controls matched to the case. Cases and controls were matched 1:5 on age, sex, and region of residence using a fictional match ID. Age of cases and controls at index date was used to create further groupings, identifying children as being infant-aged (0-3), pre-school-aged (4-5), and school-aged (6-9).

Parents of cases and controls were identified using linkages between dependents and the heads of household recorded in the health insurance registry. This allowed identification of all registered parents in the year prior to the child's index date. For the purposes of this study, 'parent' is an overarching term used to denote the child's legally recognized guardian(s), whether biological or not.

Study Variables

Linkage between parent and child cohort datasets and the previously described data sources allowed for identification of the relevant study variables. Children who were not linked to a parent were removed from the study cohort. A study flow diagram depicting inclusionary criteria for the study cohort can be found in Figure 2 of the appendix. The practitioner claims and hospital inpatient data for parents was linked to cases and controls allowing identification of parent mental health disorders prior to the index date, going as far back as April 1, 1997. The mental health disorders of interest were anxiety and mood disorders and were identified using the

International Classification of Diseases, Ninth Revision (ICD-9) codes listed in the practitioner claims and ICD-10 codes in the hospital inpatient databases diagnostic fields. For parents with multiple diagnoses of the same disorder, the earliest date of diagnosis was retained for each disorder. For children with multiple parents with the same disorder diagnosis, the earliest date of diagnosis among all parents with said disorder was retained.

Time from earliest date of anxiety parental diagnosis to index date was calculated and used to create two binary time variables: anxiety time 1 and anxiety time 2. For anxiety time 1, a value of 1 was assigned to cases and controls with an index date within 90 days from parent anxiety diagnosis, while a value of 0 was assigned to all other cases and controls (i.e., those with an index date more than 90 days after parent anxiety diagnosis or with parent(s) with no anxiety diagnosis). For anxiety time 2, a value of 1 was assigned to cases and controls with an index date more than 90 days after parent anxiety diagnosis, while a value of 0 was assigned to cases and controls with an index date within 90 days from parent anxiety diagnosis or with parent(s) with no anxiety diagnosis. Time from earliest date of parental mood disorder diagnosis to index date was also calculated and used to create two more binary time variables: mood time 1 and mood time 2. For mood time 1, a value of 1 was used to identify cases and controls with an index date within 90 days of parent mood diagnosis, while a value of 0 was assigned to cases and controls with an index date more than 90 days after parent mood disorder diagnosis or with parent(s) with no mood diagnosis. For mood time 2, a value of 1 was assigned to cases and controls with an index date more than 90 days after parent mood diagnosis, while a value of 0 was assigned to cases and controls with an index date within 90 days from parent mood diagnosis or with parent(s) with no mood diagnosis.

Statistical analysis

Given this was a case control study design, unadjusted conditional logistic regression models were used to determine crude odd ratios (ORs) to measure the association of interest (6). The ORs calculated compared the odds of a child becoming a case (i.e., sustaining an UI) within a specified time period from parental disorder diagnosis with the odds of a child being a control within the same time period from parental diagnosis. ORs and 95% confidence intervals (CI's) were calculated separately for two distinct time periods: index date within 90 days of parental diagnosis and index date after 90 or more days from parental diagnosis. The ORs were calculated for the entire study population of children (infant, pre-school, and school-aged) combined. All age groups were combined for the conditional logistic regression analysis. Conditional logistic regression models were, however, run separately for each disorder, and for each time period of interest.

Results

Sample

For parents with an anxiety disorder diagnosis, the index date was within 90 days of parental diagnoses for 1% of the child study cohort. The index date was more than 90 days after parental anxiety diagnosis for 56.5% of the child study cohort. The average number of days between parental anxiety diagnosis and index date was 2715 days. For parents with a mood disorder diagnosis the index date was within 90 days of parental diagnosis for 0.85% of the child study cohort. The index date was more than 90 days after parent mood disorder diagnosis for 41% of the child study cohort. The average number of days between parental mood disorder diagnosis and index date was 2583 days. There was significant overlap of cases who had

parent(s) with both an anxiety and mood disorder diagnosis. Overall, 33% of children in the study cohort had a parent or parents with both a mood and anxiety diagnosis (Table 9.1). All age groups were combined for the regression analysis as the number of children with an index date within 90 days of parent disorder diagnosis was small. Power was deemed too low to effectively examine risk of child UI in the acute period following parental diagnosis if the regression models were run for each age group separately.

Anxiety

The results of logistic regression models for UI in children relative to time from parental anxiety diagnosis can be found in Table 10.1. For children aged 0-9 years, the OR for UI within 90 days from parent anxiety diagnosis was 1.23 ($p<0.05$). While the association between child UI and parent anxiety diagnosis remained positive, it was slightly lower after more than 90 days from diagnosis with an OR of 1.18 ($p<0.05$). A statistically significant OR above 1 indicates a higher risk of UI in children following parental diagnosis of anxiety relative to children with parent(s) with no history of an anxiety disorder.

Mood

The results of logistic regression models for UI in children relative to time from mood disorder diagnosis can be found in Table 10.2. For children aged 0-9 years, the OR for UI within 90 days from parent mood disorder diagnosis was 1.4 ($p<0.05$). Similarly to risk of UI in children of parent(s) with an anxiety disorder, the association between UI in children with parent(s) with a mood disorder diagnosis remained positive even after 90 days, but decreased to

1.2 ($p<0.05$). The risk of UI in children after parental mood diagnosis was elevated compared to that of parental anxiety diagnosis.

Table 9. 1 Descriptive characteristics comparing cases and controls.

Variable	**Case**	**Control**
Mean Age (yrs)	4.3	4.3
Male (%)	7,297 (56.9)	36,719 (56.9)
Anxiety*		
<= 90 days (%)	157 (1.2)	638 (1.0)
>90 days (%)	7791 (60.8)	36288 (56.3)
Median (IQR) days	2646 (2665.50)	2588 (2631.00)
Mood*		
<=90 days (%)	147 (1.2)	515 (0.8)
>90 days (%)	5839 (45.6)	26156 (40.5)
Median (IQR) days	2424.5 (2647)	2399 (2612)
Median (IQR) household income ($)	88,576 (48704)	92,416 (48549)
Median (IQR) parent age (yrs)	34.3 (8.5)	34.7 (8.5)
Single parent household (%)	3,778 (29.5)	15,517 (24.1)

Note: IQR = interquartile range.
*At least one parent with disorder diagnosis

Table 10. 1 Risk of UI following parent anxiety disorder diagnosis.

Time	OR	95% CI	
0-90 days	1.23	1.03	1.47
>90 days	1.18	1.14	1.23

Note: CI = confidence interval; OR = odds ratio; UI = unintentional injury.

Table 10. 2 Risk of UI following parent mood disorder diagnosis.

Time	OR	95% CI	
0-90 days	1.43	1.19	1.72
>90 days	1.20	1.16	1.25

Note: CI = confidence interval; OR = odds ratio; UI = unintentional injury.

Discussion

The results of this study suggest that the risk of UI among children with a parent with an anxiety or mood disorder diagnosis is elevated in the first 90 days following diagnosis and

remains elevated thereafter. A statistically significant OR above 1 indicates a higher risk of UI in children following parental diagnosis of anxiety or mood disorder relative to children with parent(s) with no history of an anxiety disorder. The OR for risk of UI following parental mood disorder diagnosis was elevated during both time periods relative to the OR for risk of UI following parental anxiety disorder diagnosis. However, the 95% CIs for both ORs overlapped suggesting the difference between risk of injury in the first 90 days following mood or anxiety disorder diagnosis isn't significantly different between the two disorders. Additionally, the risk of UI among children with a parent with an anxiety or mood disorder diagnosis remained elevated even following the acute 90-day period relative to children with parents with no history of mood or anxiety disorders. Also, for both disorders, the 95% CI for the ORs for both time periods overlapped suggesting the increased risk of UI among children of parents with anxiety or mood disorders is a long-term phenomenon. The overlapping ORs suggest the risk of UI is not significantly elevated in the acute period relative to the subacute period for children with parents with mood and/or anxiety disorders.

To our knowledge, this study is the first of its kind assessing the risk of UI in children with a parent with a mental disorder relative to time from parent disorder diagnosis. Other than self-inflicted injuries, little research has addressed the time-dependent risk of injury among individuals with mental illness or their dependents (4-5). Existing research regarding acute risks following mental illness diagnosis have found the risk of suicide and non-fatal self-harm to be much higher in the first three months following an individual's diagnosis and/or inpatient treatment for the mental illness (4-5). This is likely due to the fact that following diagnosis, the individual is still in the acute phase of illness with strong presentation of behavioral symptoms and associated negative outcomes. Furthermore, diagnosis of a mental illness can come with

feelings of despair and hopelessness that exacerbate existing symptoms (4). A diagnosis is not a cure, and it can take time for an individual to accept their diagnosis, effective treatments to establish stability and/or improvement and for patients/families to manage their symptoms. The reasons why an individual might be at higher risk for self-inflicted injury in the acute period following a mental illness crisis are likely similar to why the individual's dependent(s) might be at higher risk of UI. Behavioral tendencies of parents with depression and mood disorders include less proximal supervision, and lower engagement of safety practices (7-9). Parents with mental illness also cite feelings of inadequacy which are likely heightened immediately following diagnosis (10)

Strengths and limitations

Since this study used administrative data and there are both strengths and weaknesses of the method. One of the major limitations of administrative data is its proneness to missing or the validity of the entered data. Administrative data are collected for clinical and administrative use, meaning they are not collected for the purpose of scientific study and may not include all the outcome measures for the study of interest. This can result in measurement error or unmeasured confounding. Despite these limitations, one strength in this study's use of administrative data is that it offers data for a large population of individuals. This large study population allowed us to draw conclusions for the province of Alberta, in Canada. Another strength of this study was its use of hospital and practitioner claims data, meaning all parental mental illness disorders were identified through diagnoses in a medical setting and not parent self-reports or questionnaires. Yet another strength of this study's case-control design is that it allowed for control of potentially confounding variables. A limitation of this study was that most index dates occurred

well after 90 days from diagnosis (and actually averaged around 2000 days after diagnosis). This limited our ability to draw conclusions about more time periods. Another limitation of this study was the large overlap of parents with both mood and anxiety disorders. It's well known that anxiety and mood disorders are highly comorbid, which makes it hard to draw conclusions about the independent risk of each disorder as it relates to child UI.

Conclusion

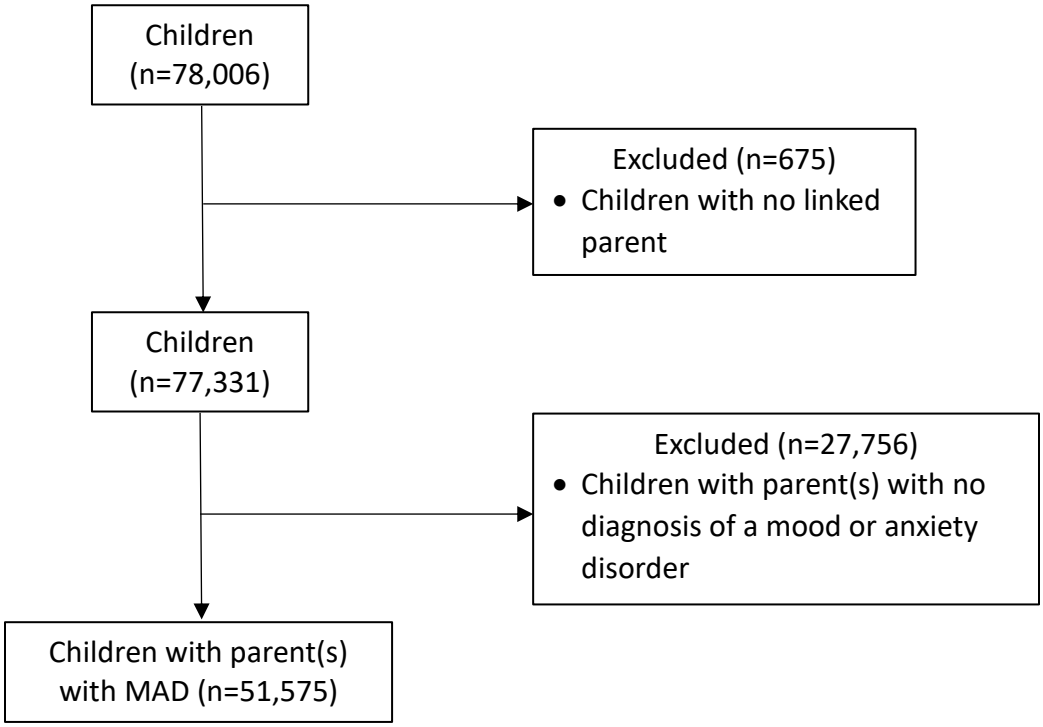
This study shows that there is an elevated risk of UI among children of parents with anxiety and/or mood disorders within three months of first parental diagnosis. This study also confirms that the risk of UI remains elevated in children of parents with anxiety and mood disorders even after the 90 day acute period, relative to children of parents with no history of mental illness. This study appears to be the first of its kind in terms of examining the risk of UI in dependents during the acute period following parental diagnosis. Since the risk of self-inflicted injury in the acute period following diagnosis of MHAC has been established in prior studies, the finding of a ***persistent i***ncreased risk of other injury types in the sub-acute period following diagnosis is surprising. What is surprising is that the risk doesn't dissipate, meaning injury prevention interventions need to be applied early and be sustained to protect children of parents with mental MHAC from UIs. Further research into this area would be good to better establish and understand the time-dependent link between parental mental health diagnosis and risk of UI in their children. The results of this study suggest that resources for parents with mental illness and their children should be made most available in the acute period following diagnosis, but also that parents and their children could benefit from long-term resource availability as well.

Appendix

Figure 3. 1 Descriptions of data sources used in study.

Data Source	Description	Usage
Child Cohort file	Identification of all cases and controls in the study population from 1997-2018.	Used to identify whether case or control, age subgroup, date of index injury, and link children with parents.
Child Population Registry file	Demographic information for cases and controls in the study population from 1997-2018.	Used to identify and link demographic information, including gender, to child cohort file.
Exclusion Table	Identification of prior unintentional injuries among children in the study population.	Used to exclude children in the study population with an unintentional injury before the recorded study period (2007-18).
2016 Canada Census	Contains household median total income for dissemination area for children in the study population.	Linked with child cohort file to identify median household total income for children in the study population.
Parent Cohort file	Identification of all parents of cases and controls in the study population from 1997-2018.	Used to link parents to children in the study population.
Parent Population Registry file	Demographic information for parents of children in the study population from 1997-2018.	Used to identify demographic information for parents of children in the study population, such as age and sex.
Parent Practitioner Claims	All practitioner claims related to mental illnesses in parents of children in the study population from 1997-2018.	Used to identify incident date of practitioner diagnosis of anxiety and mood disorders among parents of children in the study population.
Parent Inpatient Claims	All mental illness related hospitalizations for parents of children in the study population from 1997-2018.	Used to identify incident date of anxiety and mood-related hospitalizations among parents of children in the study population.

Figure 4. 1 Flow diagram of children included in study.



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Chapter 5: Thesis summary and Future Directions

The purpose of this thesis was to examine UIs in the context of children with parents with mental illness and children of parents with no history of mental health conditions. The first paper assessed the types of injuries and causes of injuries among children in the general population in the province of Albert in Canada, compared to children in the same geographic region with parents with mental illness. Following a clear difference in pattern of injury type and cause between the two populations, the second paper examined whether the risk of UI for children with parents with a mental health conditions was statistically higher than that of children with parents with no diagnosis of a mental illness using a retrospective case-control design and conditional logistic regression. The last paper further investigated the relationship between parental mental illness and child risk of injury to determine if the risk of UI changed relative to the time from parental diagnosis. This conclusion chapter will summarize the findings from each paper, identify how these findings contribute to the current body of literature, and propose future directions for research in the area to further strengthen our understanding of UI in children of parents with mental illness.

Findings

Injury Frequency/Causes: The first descriptive study (Chapter 2) employed simple analytic techniques to explore the differences in frequency of injury types and causes between the general population and the population of children whose parents have received a diagnosis of a mental health condition. The results of this study showed a significantly different distribution of injury types and causes in the population of children with parents with mental health conditions compared to children in the general population. Of particular interest was the far

larger proportion of intracranial injuries and fractures within the population of children with parents with mental health conditions. These types of UIs are particularly concerning, given their severity and long-term impacts on physical and mental development in children whose brains and bodies are changing and maturing rapidly (1, 2).

With regards to injury cause, falls were overwhelmingly the most common cause of injury in children with parents with mental health conditions compared to children in the general population. This finding has significant implications given that falls have been found to be the most common cause of child UI hospitalizations and cost the Canadian economy $1.2 billion annually (3). If a significant proportion of these costs arise from children of parents with mental health conditions, the increased frequency of falls among children in this population is worth further investigating. Moreover, falls prevention would perhaps be a wise injury intervention focus.

Injury Rates: The first analytic paper (Chapter 3) examined the risk of UI among children of parents diagnosed with anxiety and mood disorders compared to children of parents with no history of these mental health conditions using conditional logistic regression. Following the development of several models which controlled for the presence of other parental mental health conditions, we report crude risks of UI among children of parents with anxiety or mood disorders, as well as risk using propensity-score adjusted data to further control for potentially unmeasured confounding. The results of nearly all regression analyses performed identified a significantly increased risk of UI in children aged 0-9 with at least one parent with a mood or anxiety disorder diagnosis. Furthermore, the risk of UI was elevated in the youngest cohort of children (aged 0-3) with a parent with a diagnosed mental health condition, and among children with a parent with a mood disorder (as compared to an anxiety disorder). These results suggest a

focus on either MHAC and in the early years would represent evidence-based approaches to injury prevention initiatives.

Timing of Diagnosis and Injury: The second analytic paper (Chapter 4) built off the findings of the first, and further investigated the relationship between the increased risk of UI found in children with a parent diagnosed with a mental health condition. This study used conditional logistic regression to determine the risk of injury among children (aged 0-9) with parents with a history of anxiety or mood disorders compared to children with parents with no history of these mental health conditions during two distinct time periods: injury within 90 days from parental diagnosis, and injury more than 90 days after parental diagnosis. The results of this study found the risk of UI was greater within the acute 90-day period following parental diagnosis of a mood or anxiety disorder, and also that the risk of UI remained elevated (OR>1) even after the 90 day period. These findings were consistent with previous research indicating an increased risk of self-inflicted injury and death for children within 90 days of a mental health condition diagnosis in at least one of their parents (4). Previous research has not examined how the risk of other types of injuries, such as UI in dependents, changes relative to the time from mental health condition diagnosis. Once again, early intervention following a diagnosis would reflect an evidence-based approach.

Conclusion

The results of this program of research from each analysis conducted in the papers described above help to confirm some findings observed in previous non-Canadian research into the areas of child UI and parental mental health conditions. The results of the studies presented here also contribute new and valuable information to the existing small body of literature.

Most current research on the relationship between parental mental health conditions and child well-being has focused on the potential risks to childhood development behaviorally and socially (5-6). Furthermore, most research on the behavioral tendencies of parents with mental health conditions focuses on that of mothers. The rationale for this is cited as based on the fact that mothers are more likely to be the caretakers as compared to fathers (7). Most existing and historical research into parental mental health conditions and child injury has also focused on intentional or assault-related injuries stemming from abuse and neglect (8-10). Such research has unfortunately contributed to the discourse leading to stigma around parents with mental illness being neglectful and violent (11). Mothers with mental health conditions "have to prove they're able to parent, unlike everybody else who is able to assume they can parent until proven otherwise" (11). Furthermore, mothers with mental health conditions tend to have less confidence in their ability to parent which can result in a self-fulfilling prophecy (12), as parental self-efficacy has been linked with better parenting (13).

Recently, there has been a shift, and a small, but growing body of literature into the risk of UI to children of parents with mental health conditions has emerged. The existing research into this area has found that children of parents diagnosed with mental health conditions are at an increased risk of UI relative to children with parents with no history of mental health conditions. Given the high incidence of UI relative to assault-related injuries, and also that mothers with mental health conditions are just as likely as mothers with no history of mental health conditions to be parents (11) these findings have important implications. It is estimated that upwards of 90% of UIs are preventable (14), suggesting interventions targeting parents with mental illness could be very successful in reducing UI in their children.

Although parents, and mothers specifically (as this is where most of existing literature has focused), with mental illness are prone to different behavioural tendencies, such as poor supervision and less engagement in known child safety practices, qualitative research has also found many mothers with mental health conditions feel parenting gives them a strong sense of self-worth and self-fulfillment (12). Historically, mothers with mental health conditions were discouraged from becoming parents or not given the opportunity to parent (15). Diagnosis of a mental health condition was a life-sentence for emotional confinement and antiquated courses of treatment. Children were often taken into the care of the state or another (mentally healthy) relative immediately following birth (15). With changes in stigma, advances in psychotherapy, and the availability of more effective medical management, people with mental health conditions are now more frequently becoming parents. Given the stress parents have cited experiencing - managing their mental health condition(s) and the responsibilities of caring for their child(ren) – it's clear that more supports and education in engaging in active supervisory parental practices are needed. While there have been pilot projects conducted in other parts of the world, there seems to be a lack of emphasis on supporting parents with mental health conditions here in Alberta, Canada (16-18). Parents with mental health conditions deserve the opportunity to parent as much as any parent without a history of mental health conditions. Recognizing this right, they likely need more support in managing their responsibilities than parents without a history of mental health conditions. Sadly, this support is lacking in Canada. Future directions should look at implementing more accessible supports to parents with mental health conditions and a greater focus on documenting UIs in children of parents with mental health conditions. Most research has only focused on improving behavioral and social outcomes for children of parents with mental health conditions and the impact of such parenting supports and interventions have

neglected to address their impact on reducing UI (16-18). This is a significant oversight given how common and devastating child UIs can be, to the injured child and their family.

The results of this program of research have also laid the foundation for understanding when these supports would be most necessary, which needs to start immediately after parental diagnosis of a mental health condition and be sustained thereafter. Whether an intervention delivered within the first 90 days of a mental health-related diagnosis impacts the longer-term risk of UI to children, and whether this risk changes with age, would require further research attention. This should help direct the development and implementation of appropriate supports for parents with mental health conditions.

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