

**An epidemiological investigation of physical-mental multimorbidity: Findings from the
2014 Ontario Child Health Study**

by

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Author's Declaration

This thesis consists of material all of which I authored or co-authored: see Statement of Contributions included in the thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Statement of Contributions

This thesis contains in part, three manuscripts, that in collaboration with my dissertation committee members, were submitted for publication in peer-reviewed journals. References provided in manuscripts conform to journal-specific requirements.

Exceptions to sole authorship are as follows:

Chapter 5: Reaume, S.V., Dubin, J.A., Perlman, C., Ferro, M.A. An epidemiological study of physical-mental multimorbidity in youth.

Chapter 6: Reaume, S.V., Dubin, J.A., Perlman, C., Ferro, M.A. Health functioning moderates the association between physical and mental illness in childhood.

Chapter 7: Reaume, S.V., Dubin, J.A., Perlman, C., Ferro, M.A. Mental health service contact in children with and without physical-mental multimorbidity.

As lead author in these three manuscripts, I was responsible for conducting background research, conceptualizing research questions and study designs, conducting analytic and statistical analyses, interpreting statistical results, drafting manuscripts, and managing manuscript submissions and revisions to journals. The co-authors listed provided important guidance during each step of the research and provided valuable feedback on draft manuscripts. Dr. Mark Ferro was instrumental in all aspects of research and in gaining access to the 2014 OCHS dataset, a unique resource that was critical to being able to conduct these studies. I was the sole author of Chapters 1-4 and 8, which were not written for publication.

Abstract

Children living with chronic physical illnesses such as diabetes and epilepsy, are at increased risk for developing mental illness. The co-occurrence of at least one physical and at least one mental illness, known as multimorbidity, is not surprising as children living with physical illness and their families endure financial and psychosocial challenges, predisposing these children to experience mental health declines. Child multimorbidity is common. Approximately 25% of children live with physical illnesses that require long-term management and as many as 58% of these children are also diagnosed with a mental illness. The effects of multimorbidity are pervasive, burdening children, families, and the health, social and educational systems. Thus, there is a pressing need to address the mental health challenges of children living with physical illness. A proactive, preventive, public health approach requires a comprehensive understanding of child multimorbidity in a Canadian context.

Despite the underlying risk of mental illness across various physical illnesses, child mental health research often excludes childhood physical illness as a determinant of mental illness. Of the research that does exist, samples include older adolescents and young adults with chronic physical illness or include high-risk clinical samples. Research using epidemiological samples, inclusive of young children, has not been conducted since the seminal 1983 Ontario Child Health Study. As survivorship of children living with chronic physical illness has substantially increased with these children living well into adulthood, and as the designs and needs of healthcare and mental health care systems have changed since 1983, this research answers calls to the public health concern of child multimorbidity.

To address these knowledge gaps, the following dissertation identified which factors influence the association between chronic physical illness and mental illness (any, mood, anxiety, behavioural and neurodevelopmental disorders), including mediating and moderating

factors, and examines differences in mental health service contact based on child health status (healthy, physical illness only, mental illness only, and multimorbid). Three distinct studies, with each study examining one of these main dissertation objectives, have been written for publication. These studies made use of data from the 2014 Ontario Child Health Study-a cross-sectional, epidemiological study of 10,802 children aged 4 to 17 years from 6,587 households from across 240 neighbourhoods.

1) Study 1 objectives included:

- a. Estimating the lifetime prevalence of childhood chronic physical illness and the six-month prevalence of mental illness and multimorbidity in children;
- b. Quantifying associations between physical illness and mental disorder, including number of illnesses; and
- c. Examining factors associated with mental disorder, after adjusting for chronic physical illness.

2) Study 2 objectives included:

- a. Examining moderating effects of child sex, age, health functioning, mental health service contact, and household income on associations between physical and mental illnesses; and
- b. Exploring the potential mediating effect of family functioning on physical-mental multimorbidity.

3) Study 3 objectives included:

- a. Estimating the six-month prevalence of health status and types of mental health service contact;

- b. Quantifying adjusted associations between child health status and type of mental health service contact; and
- c. Quantifying adjusted associations between child health status and number of different types of mental health service contacts.

In a sample of 10,303 children, the first manuscript estimated childhood chronic physical illness to be 27.8%, while 14.8% of children had mental disorder and 5.4% had multimorbidity. Physical illness was not associated with mental disorders. An ordinal regression illustrated children with two physical illnesses, as compared to no physical illnesses, had increased odds for having any, mood, and anxiety disorders. There were no associations found between children with one or three or more physical illnesses and mental disorders. Notably, health functioning demonstrated a dose-response across health status categories, with healthy children having highest scores and multimorbid children having lowest scores. These findings demonstrate the need for targeted and routine mental health screening in youth with two physical illnesses. Preventative mental health interventions should focus on preventing declines in health functioning.

The second manuscript used the subsample of index children (n=6,242). Physical illness was associated with increased odds of mood disorder. Health functioning moderated physical-mental illness associations, such that better health functioning in children with physical illness versus without physical illness, had higher odds for any mental illness, anxiety disorder, and attention-deficit hyperactivity disorder. There were no associations found in children with poorer health functioning and physical illness. No other child or household factors moderated associations and family functioning did not mediate physical-mental multimorbidity. These findings suggest physical-mental multimorbidity is nuanced, with differential effects of physical

illness on childhood mental illness. Targeted mental health screening is needed for children living with chronic physical illnesses resulting in better health functioning.

The third manuscript estimated 21.4% of children had mental health service contact within the last six months. Regardless of child health status, contact was highest in school-based settings. Children with multimorbidity had higher odds for having every type of mental health service contact (any, general medicine, urgent medicine, alternative, school-based, and specialized mental health) than healthy controls. A dose-response was also observed, such that the number of types of mental health service contacts increased from physical illness to mental illness to multimorbidity. These findings support mental health resource allocation for school-based services. Further research is needed to understand barriers and facilitators of mental health service use including integrated health and mental health care for children with multimorbidity.

The findings from this dissertation fill critical knowledge gaps in child physical-mental multimorbidity research. Taken together, these findings show health functioning and not just the mere presence of physical illness is important to consider when examining the nuances and impact of physical illness on child mental health. Moreover, findings show mental health-related contact is similar across child health status. Findings also inform policy, intervention, and clinical research directions. From a policy lens, resources should be allocated to school-based mental health services. Universal mental health intervention efforts, regardless of child health status, should focus on preventing overall-health functioning declines. Regular mental health screenings for children living with chronic physical illness should occur, with early intervention efforts aimed at reducing the incidence of multimorbidity. Vigilant and routine screening is needed for children living with two physical illnesses and for children with better health functioning. Future longitudinal research is needed to elucidate mediating factors in physical-

mental multimorbidity. Given proper supports within integrated health services, the incidence and impact of child multimorbidity can be reduced and children living with physical illness can have improved mental health outcomes.

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Dedication

For Lucas and Leo.

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List of Abbreviations

ADHD	Attention-Deficit Hyperactivity Disorder
aOR	Adjusted Odds Ratio
CI	Confidence Interval
CD	Conduct Disorder
CPI	Chronic Physical Illness
DSM-V	Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition
GAD	Generalized Anxiety Disorder
HUI	Health Utility Index Mark III
MD	Mental Disorder
MDD	Major Depressive Disorder
MI	Mental Illness
OCHS	2014 Ontario Child Health Study
OCHS-EBS	Ontario Child Health Study- Emotional Behavioural Scales
ODD	Oppositional Defiant Disorder
OR	Odds Ratio
PMK	Person Most Knowledgeable
SAD	Separation Anxiety Disorder
SAS	Statistical Analysis Software
SE	Standard Error
SOP	Social Phobia

Chapter 1: Introduction

Children, defined in this dissertation as children aged 4 to 17 years, is a critical period of development. Physical, mental, emotional, and social development during childhood influences health and behaviour trajectories in adulthood (Perrin et al., 2019; Stewart et al., 2015; Wodchis et al., 2016). While the impact of adverse childhood experiences on adult well-being has been extensively examined, a critical determinant of health has been largely unstudied in child health research (Romano et al., 2018). For children living with chronic physical illness-conditions lasting six months or longer, the impact of physical illness on youth, their families, and health and education systems are pervasive and burdensome (Brady et al., 2021; Chen et al., 2006; Schwartz & Feudtner, 2019). Health-related technological advances have increased survival rates in children with chronic physical illnesses, with these children living well into adulthood. Epidemiological studies estimate approximately 25% of children to be living with chronic physical illness (Compas et al., 2012; Van Cleave et al., 2010), with 90% of these children becoming adults with chronic physical illness (Ontario Association of Community Care Access Centres, 2013). Thus, there is an urgent public health need to address the sequelae of negative effects of childhood physical illness.

Similar to childhood physical illness, the onset of most adult mental disorders begins in childhood and adolescence (Malla et al., 2018; Stewart et al., 2015). While mental disorders in children are common, those living with chronic physical illness are disproportionately affected. Of the 25% of youth with physical illness, approximately 58% of youth in clinical samples are diagnosed with a mental disorder (Butler et al., 2018). In the general population, approximately 15% to 30% of children with chronic physical illness also have mental illness (Ferro, 2016; Merikangas et al., 2015; Tegethoff et al., 2015).

Child multimorbidity, herein defined in this dissertation as the co-occurrence of at least one chronic physical illness and at least one mental disorder, is associated with many adverse outcomes, compounded by the required management and pervasiveness of both types of illnesses. Risk factors of both physical and mental illnesses, if left unaddressed, could exacerbate health and social inequities that continue into adulthood. Elucidating risk factors for physical-mental multimorbidity in children can assist with interrupting this sequelae. Efforts for targeted mental health screening and recommendations for integrated health and mental health services will help prevent multimorbidity and improve the well-being of youth living with chronic physical illness.

This dissertation examines relationships between chronic physical illness and mental disorders, including its nuances, across eight chapters. Chapter 2 summarizes academic literature relating to childhood multimorbidity. Chapter 3 identifies knowledge gaps in the literature, providing a rationale for this dissertation. Objectives and specific hypotheses for all three research questions are also stated. Chapter 4 provides general methodology of the dissertation, with specific methodology for each research question in its own chapter. Chapters 5, 6, and 7 are manuscripts, each addressing the three main research questions of this dissertation and are formatted according to journal publication requirements. Lastly, Chapter 8 is an integrated discussion based on the overall findings of the dissertation and its implications for policy, intervention, and practice. Recommendations for future research are also discussed in Chapter 8.

Chapter 2: Background

Children living with chronic physical illness, such as diabetes and epilepsy, endure psychosocial and emotional challenges, predisposing them to an increased risk for developing mental illness (Butler et al., 2018; Ferro & Boyle, 2015; Ferro, Lipman et al., 2021; Schwartz & Feudtner, 2019). Child multimorbidity, the co-occurrence of at least one physical and at least one mental illness, is common (Butler et al., 2018; Ferro, 2016; Tegethoff et al., 2015; Van Der Lee et al., 2007). While 25% of Canadian children live with a physical illness that require long-term management, as many as 58% of these children are additionally diagnosed with a mental illness (Butler et al., 2018; Van Cleave et al., 2010). Child multimorbidity is also chronic in nature. At least 90% of children with chronic physical illness become adults with chronic physical illness (Ontario Association of CCACs, 2013), while most adult mental illnesses begin in adolescence (Malla et al., 2018). Given the prevalence and chronicity of child multimorbidity, a proactive and preventative public health approach is needed. A preventative public health approach requires a comprehensive understanding of child multimorbidity within a Canadian context, an exercise not conducted since 1983, in the seminal Ontario Child Health Study (OCHS).

2.1 Child Multimorbidity Outcomes

Children living with chronic physical illness are triply disadvantaged — they live with the stress of managing their illness, have higher odds of mental illness and risk-taking behaviours than their healthy peers, and have a lower prevalence of protective factors (e.g., optimistic thinking, school connectedness, and positive relationships) (Nylander et al., 2014). The consequences of negative risk-taking behaviours are often more serious in this population as the underlying physical illness may trigger life-threatening outcomes (Bukstein & Horner, 2010). Chronic physical illness is often disregarded as an individual-level determinant of mental illness

in children, unintentionally disregarding mental health needs in this population (Bennett et al., 2015; Ferro, 2016; Romano et al., 2018; Van Der Lee et al., 2007).

The sequelae of chronic physical illness includes biopsychosocial burdens on children, their families, and healthcare systems. Upon diagnosis of a mental illness in children with chronic physical illness, there are additional adverse outcomes to consider than the outcomes of children living with physical illness only. Child multimorbidity is associated with greater symptom severity and functioning impairment in both physical and mental health domains (Merikangas et al., 2015), lower quality of life (Butler et al., 2018), lower educational attainment (Grella et al., 2001), and increased morbidity and mortality (Ferro et al., 2017; Qadeer et al., 2017). There is an increased likelihood of substance use disorder, suicidality, and poor physical illness management (Bernstein et al., 2013; Butler et al., 2018; Ferro et al., 2017; Lee et al., 2013; Qadeer et al., 2017; Qadeer et al., 2018; Waters et al., 2008). Poor social and employment outcomes are also associated with child multimorbidity (Eiser et al., 1992; Gadalla, 2009; Helseth et al., 2016; Martinez & Ericikan, 2009). The effects of multimorbidity on children can impact family functioning, parental employment, household income, and leave families navigating fragmented health and mental health care systems (De Hert et al., 2011; Ferro & Boyle, 2015; McCarthy et al., 2016; Miodrag et al., 2015; Newacheck & Kim, 2005; Pinquart, 2018; Yung, 2016). In turn, parents of children with mental illness have increased stress and are four times more likely to be diagnosed themselves with mental illness than parents of children without mental illness (Bennett et al., 2012; Hatton & Emerson., 2009; Herring et al., 2006; Kim et al., 2007; Patel et al., 2007). Ultimately, the sequelae of childhood physical illness can be mitigated if mental health declines are prevented, enhancing the well-being of children and improving outcomes in adulthood.

2.2 Identifying Risk Factors of Multimorbidity

There are many factors that moderate and mediate the negative effects of chronic physical illness on the mental health of children. The interplay of individual characteristics such as living with a chronic physical illness and contextual factors in families are often underlying conditions for adverse childhood experiences, resulting in mental illness (Butler et al., 2018). Protective factors, such as positive parent-child relationships, and positive experiences in schools and communities can reduce the odds of mental illness in children that have had adverse experiences (Cheung et al., 2017). Examining access to mental health services can also promote protective factors and reduce risk factors of mental illness. Despite identifying factors that influence the association between chronic physical illness and mental illness, there are mixed findings regarding which factors act as mediators and which act as moderators. Clarifying these factors can assist with identifying at-risk children, whom can then be screened and treated for mental illness.

2.3 Individual and Family-Level Factors in the Association Between CPI and MI

Individual-level factors can influence the association between chronic physical illness and mental illness. Child self-concept and self-esteem have been found to mediate the association (Ferro & Boyle, 2013, 2015). Sense of belonging, as evidenced by relationships with parents, siblings, peers, and teachers can modify the directionality and strength of the association between physical and mental illness (Giallo et al., 2014; Tasker & Stonebridge, 2016). Furthermore, severity of the chronic physical illness and related pain have both been found to mediate and moderate the relationship between chronic physical illness and mental illness (Eiser et al., 1992; Ferro, 2016; Merikangas et al., 2015; Qadeer et al., 2017). The risk of mental illness also increases with additional physical diagnoses and severity of functional limitations (Ireys et

al., 1994; Ferro et al., 2024b; Waters et al., 2008; Wolock et al., 2020). The sex of the child in relation to type of chronic physical illness can also influence the strength and direction of association between physical and mental illness (Ferro, 2016; Pless et al., 1993).

Family-level factors also influence the association between chronic physical illness and mental illness. Research indicates that poor child mental health is associated with family dysfunction (Sell et al., 2021). There are mixed findings regarding whether household income influences the relationship between chronic physical illness and mental illness, most often differentiating between countries that have socialized medicine and countries that do not (Butler et al., 2018; Guyard et al., 2017; Helseth et al., 2016; Mondor et al., 2018).

2.4 Non-Categorical Approach

A non-categorical approach to examining mental illness risk for children living with chronic physical illnesses is supported in current literature. Rather than placing importance on the label of a diagnosis, a non-categorical approach focuses on the consequences of a chronic physical illness that influences the risk of mental illness. These consequences include three domains: 1) functional limitations; 2) a dependence on compensating mechanisms; and 3) a dependence on medical service use or need beyond routine and age-appropriate care (Stein & Silver, 1999). Approximately 47% of children living with chronic physical illness have consequences in only one domain while a substantial number of children have consequences in multiple domains (Stein & Silver, 1999). The non-categorical approach has been supported in child multimorbidity research as there is a common underlying risk of mental illness across varying chronic physical illnesses such as asthma and epilepsy (Ferro, 2016; Ferro et al., 2015; Ferro, Lipman et al., 2021; Ireys et al., 1994; Reaume & Ferro, 2019; Suryavanshi & Yang, 2016). The non-categorical approach is also supported over-time as the chronicity of

multimorbidity is unrelated to the type of physical or mental illness (Reaume & Ferro, 2019). Thus, the homogeneity of mental illness risk and persistence across various physical illnesses highlights the importance of examining modifiable individual-level and family-level mediators and moderators in this relationship.

2.5 Mental Health Care Settings and Providers in Ontario

Mental health services in Ontario are provided in community care, primary care, and tertiary care. Community care consists of services provided in schools, private clinics, youth hubs, agencies (including specialized mental health and addiction agencies), and residential centres. Primary care includes family health teams with physicians and allied health professionals providing mental health support. Tertiary care, provided in hospitals, offer acute care in emergency departments and inpatient and outpatient services (Brien et al., 2015). Mental health service providers are categorized as general health care providers (e.g., family doctor, pediatrician, nurse, specialist), mental health specialists (e.g., social worker, counsellor, psychologist, psychiatrist), helplines (e.g., crisis hotlines), and alternative providers (e.g., naturopath, religious counsellor) (Georgiades et al., 2019). All of these mental health service providers are found working in various mental health service settings.

Across all settings and providers, demand for services has increased (Waddell et al., 2019). The increase in help-seeking behaviour is attributed to both an increase in mental health emergencies, especially suicidality, as well as a decrease in mental health stigma, which in-turn, promotes help-seeking behaviours (Roumeliotis et al., 2024; Waddell et al., 2019). Mental health services for children are limited, with long wait times, resulting in clinical and public health problems (Gandhi et al., 2016; Pickett et al., 2012; Roumeliotis et al., 2024; Wang, 2005; Wang et al., 2007). Even when the need for support is identified, only one-third of children have had

contact with a mental health provider, putting the burden of mental health care on emergency departments (Anderson et al., 2013; Kowalewski et al., 2011; Reid et al., 2011). Across all mental health care settings, acute care in emergency departments has seen the most drastic rise in service access (Gandhi et al., 2016). Despite recent efforts to address child mental health in Ontario, such as virtual care and increasing mental health dollars in schools, these deficits remain (Government of Ontario, 2020). Additional barriers to mental health services include lack of physical and mental health integrated care and poor care coordination across systems (Government of Ontario, 2020), long wait times (Canadian Mental Health Association, 2018; Children's Mental Health Ontario, 2020), a large shortage of mental health care providers (Canadian Mental Health Association, 2018), and lack of financial coverage for mental health services (Canadian Mental Health Association, 2018; Sutherland & Stonebridge, 2016). These barriers create missed opportunities to support children with their mental health, especially at risk-children living with chronic physical illness.

2.6 Andersen's Behavioral Model of Health Service Use

As illustrated in Figure 1, The Andersen Behavioral Model of Health Service Use outlines multiple factors that influence pathways to mental health care. Andersen suggests access to and use of health services is a function of individual characteristics that shape their predisposition to use services (e.g., sex, age, race, health beliefs), factors which enable use (e.g., family support, income, access to insurance), and need for care (e.g., perceived need and evaluated/actual need for services) (Andersen, 2008). Cross-sectional epidemiological studies and systematic reviews of individuals receiving mental health care shows need factors (both perceived and evaluated need) explain access to care more than predisposing or enabling factors (Babitsch et al., 2012; Graham et al., 2017; Roberts et al., 2018; Soleimanvandiazar et al., 2020).

Contextual-level characteristics were later added to the model to explain structural and environmental influences of health care utilization (Babitsch et al., 2012). Contextual-level factors include healthcare system organization, environmental, and health provider-related factors related to utilization (Babitsch et al., 2012). Contextual factors are measured at the aggregate level and are useful for evaluating patterns of service use and identifying patients who may over or underutilize services (Babitsch et al., 2012). Together, individual-level and contextual-level characteristics explain equitable service utilization. Equitable access occurs when need variables account for most of the variance in health care utilization rather than when predisposing and enabling factors account for the majority of variance in who receives care (Andersen, 2008). Identifying influential factors of pathways to mental health care based on health status can assist in creating equitable care for all youth. Andersen's Behavioral Model of Health Service Use was used to identify, organize, and justify the individual and family level factors influencing mental health help-seeking behaviours in Study 3 of this dissertation.

Figure 1. Andersen's Behavioral Model of Health Service Use

Multiple individual-level factors influence mental health need and help-seeking behaviour (Findlay & Sunderland, 2014; Reaume et al., 2021; Roberts et al., 2018). Females and males have both been linked to higher mental health service use, while immigrants are less likely to access services (Findlay & Sunderland, 2014; Wichstrom et al., 2014). A perception of need for support, receiving past support, and satisfaction with past mental health services have been associated with higher mental health service use and fewer health problems (Graham et al., 2017; Roberts et al., 2018).

Specific to chronic physical illness, a Canadian population-based study found 29% of children and young adults aged 15 to 24 years living with two or more chronic physical illnesses consulted with mental health care professionals, compared to 8% of youth without physical illness (Findlay & Sunderland, 2014). Young adults with comorbid physical and mental illness are more likely to access mental health services and report less unmet mental health need than young adults living with a single illness (Reaume et al., 2021). Treating mental health needs upstream may explain how multimorbid adults, in a high-risk and small sample, had lower odds of receiving inpatient psychiatric services and shorter lengths of stays in hospital (Ferro et al., 2019). With severe mental illness usually being preceded by less severe, and more treatable illness, using opportunities to provide early interventions are crucial to improve the overall well-being of children, prevent psychiatric emergency department visits, and prevent subsequent health deteriorations in children living with chronic physical illness (Allison et al., 2013; DeLuca, 2020).

Family-level factors influencing mental health help-seeking behaviours includes household income and family functioning. While an American study found older children and children living in poorer neighbourhoods had more unmet mental health needs (An, 2016),

Canadian and Norwegian research has either not found an effect of socio-economic status on mental health service access or has found low social economic status to be associated with higher service use (Findlay & Sunderland, 2014; Wichstrom et al., 2014). Family functioning is also associated with mental health service use, where families with good family functioning report less service use (DiMatteo et al., 2004; Glick et al., 2011; Koutra et al., 2015; Leucht & Heres, 2006). Family functioning has also been found to mediate the association between child multimorbidity and length of psychiatric hospital stay, with better functioning resulting in shorter lengths of stay (Ferro et al., 2019).

Chapter 3: Rationale, Objectives, and Hypotheses

Childhood and adolescent physical and mental illness often continue into adulthood, altering adulthood trajectories and well-being (Chen et al., 2006; Perrin et al., 2019; Suryavanshi & Yang, 2016; Wodchis et al., 2016). The many inequities related to childhood mental illness include race, trauma, household income, and family functioning (Helseth et al., 2016; Ferro & Boyle, 2015; Owais et al., 2022). Chronic physical illness, a determinant of childhood mental illness, is overlooked in the literature (Ferro, 2016; Romano et al., 2018). These inequities must be addressed before they create a sequelae of adverse outcomes throughout the life course. An examination of the association between childhood physical and mental illness, including the nuances of this association is needed because critical knowledge gaps remain.

3.1 Study 1

Contemporary Canadian and American epidemiological studies estimate child multimorbidity to be between 15% to 30% (Ferro, 2016; Tegethoff et al., 2015). However, these studies used samples that exclusively included older adolescents and young adults. Specific to samples that include children and adolescents, only the seminal 1983 OCHS exists which reported odds ratios for four mental disorders by age category and child sex. Children living with chronic physical illness, with functional limitations, had three times of risk of mental disorder whereas children with physical illness but without functional limitations had a twofold risk for mental illness compared to healthy peers (Cadman et al., 1987). Including children and adolescents in contemporary samples is critical for preventing mental illness in children living with chronic physical illness.

Moreover, epidemiological studies often use non-standardized mental illness diagnostic criteria (Helseth et al., 2016). Assessments of burden, incidence and prevalence estimates are difficult when non-standardized mental illness diagnostic criteria are used. Determining child multimorbidity estimates by using mental illness measures that align with standardized diagnostic criteria (e.g., Diagnostic and Statistical Manual of Mental Disorders) is critical to conducting public health surveillance. Population-level intervention recommendations made with contemporary epidemiological data contributes to evidence-based findings that can inform child health policy, prevention, and intervention efforts.

3.1.1 Study 1 Objectives and Hypotheses

The objectives of Study 1 were to: 1) estimate the lifetime prevalence of chronic physical illness and six-month prevalence of mental disorder and multimorbidity, in a sample of children and; 2) quantify associations between chronic physical illness and mental disorder, including the number of physical and mental morbidities. Secondary objectives included examining risk factors for mental disorder after controlling for the effect of chronic physical illness.

Regarding Objective 1, prevalences estimates were hypothesized to be approximately 25% for chronic physical illness, approximately 20% for mental disorder, and approximately 10% for child multimorbidity. For Objective 2, it was hypothesized that a cumulative effect would be found; children with more physical illnesses would have higher odds of mental disorders. Regarding the secondary objectives, hypotheses included: females would have higher odds of mood and anxiety disorders vs. males, Indigenous children would have higher odds for all mental disorders vs. White children, household income would not be associated with childhood mental disorder, and lower health utility (i.e., health functioning) would increase odds of all mental disorders.

3.2 Study 2

Risk factors of childhood mental illness, including in samples of children living with chronic physical illness, are well documented in the literature (see sections 2.2 and 2.3). Less well-known are factors that may moderate or mediate the association between chronic physical illness and mental illness. In the limited research that does exist, the severity of the chronic physical illness and related pain have both been found to mediate and moderate the relationship between chronic physical illness and mental illness (Eiser et al., 1992; Ferro, 2016; Merikangas et al., 2015; Qadeer et al., 2017). Child sex has also been found to act as a moderator (Ferro, 2016; Pless et al., 1993). Only one Canadian epidemiological study of children aged 10 to 15 years was found that examined mediation (Ferro & Boyle, 2015). Childhood mental illness in children living with chronic physical illness was mediated by increased maternal depression and family dysfunction which were associated with higher symptoms of anxiety and depression in these children. Clarifying which factors act as moderators and exploring mediating factors in a sample of young children is necessary to better understand potential causal mechanisms and to identify at-risk children to reduce incidence of multimorbidity.

3.2.1 Study 2 Objectives and Hypotheses

The objectives of Study 2 included: 1) quantifying adjusted associations between chronic physical illness and mental illness; 2) investigating potential moderating roles of child age, sex, health functioning, mental health service contact, and household income on these associations; and 3) exploring the potential mediating effect of family functioning in the development of physical-mental multimorbidity.

Regarding Objective 1, it was hypothesized that chronic physical illness would not be associated with mental illness after adjusting for health functioning (i.e., health utility). Health

functioning would moderate the association between physical and mental illness, such that children with physical illness resulting in poor health functioning would have increased odds of mental illnesses vs. their healthy peers. An additional hypothesis included child sex would moderate associations between physical illness and internalized mental illnesses such that females would have a higher likelihood of these disorders and males would have a higher likelihood of externalized disorders. Other hypotheses included older children would have higher odds of mood disorder, household income would not act as a moderator in physical-mental multimorbidity, and mental health service would attenuate these associations. Regarding exploratory mediation, family functioning would mediate physical-mental multimorbidity associations for internalized mental disorder outcomes.

3.3 Study 3

Understanding the extent of mental health service contact based on child health status is vital to improving the quality, access, and integration of physical and mental health services for children. While Canadian research indicates young adults living with multiple diagnoses (e.g., physical illness, mental illness, substance use disorders, and/or learning disabilities) have more mental health service contact and less unmet mental health needs than peers with a single diagnosis (Findlay & Sunderland, 2014; Reaume et al., 2021), there is a paucity of Canadian population-based research examining mental health service access and use across childhood, and how mental health service contact differs based on child health status. Clarifying where children and families seek help and the predisposing, enabling, and need factors affecting mental health service access will help make services more equitable with proper resource allocation. Despite calls for integrated health and mental health services, these two systems often remain siloed.

Information disseminated from this study will help prioritize investments through system integrations and efficiencies.

3.3.1 Study 3 Objectives and Hypotheses

Objective 1 of Study 3 was to estimate the prevalence of mental health service contact based on child health status (healthy, chronic physical illness only, mental illness only, multimorbid). Additional objectives included, 2) quantifying the adjusted association between health status and types of mental health service contact; and 3) quantifying the association between health status and the number of different types of mental health service contacts.

Regarding Objective 1, it was hypothesized that the overall prevalence of mental health service contact would be approximately 30% and a dose-response would be supported such that physically ill children would have more mental health service contact than their healthy peers, children with mental illness only would have a higher prevalence of contact than physical illness only children, and multimorbid children would have the highest prevalence of mental health service contact. It was also predicted that healthy children and children with mental illness only would have more contact with school-based mental health services than in other settings. Children with physical illness only and multimorbid children would have higher contact with medical-based settings and providers than other types of contact.

Chapter 4: Methodologies and Analytic Approaches

4.1 The 2014 Ontario Child Health Study

This dissertation conducted secondary analysis on the 2014 OCHS, an epidemiological, cross-sectional survey, completed by Statistics Canada on behalf of the Offord Centre for Child Studies (Patten, 2019; Statistics Canada, 2017). Clustered and random sampling, stratified by income, was used for sample selection (Boyle, Georgiades, Duncan, Comeau et al., 2019). A three-stage sampling plan was used, with neighbourhoods selected at the first stage, census tracts and dissemination areas selected at the second stage, and households selected at the third stage (Statistics Canada, 2017). Bootstrap procedures and sampling weights offset the complex sampling design (Patten, 2019). The survey questions covered numerous content areas, including neighbourhood characteristics, school environment, academic achievement, family composition and functioning, bullying and victimization, physical and mental illness, and mental health service utilization. Information related to some neighbourhood characteristics, including socioeconomic factors, and familiar demographics were obtained from the 2011 Canadian Census (Boyle, Georgiades, Duncan, Comeau et al., 2019).

4.1.1 Participants and Procedure

The target population included all private households in Ontario in which children aged 4 to 17 resided. Excluded were children living in collective dwellings (e.g., children in welfare and justice systems) as well as those living on Indigenous reserves (Boyle, Georgiades, Duncan, Comeau et al., 2019; Statistics Canada, 2017). The household response rate was 50.8% (Patten, 2019). The 2014 OCHS collected physical and mental health data from 10,802 children living in 6,537 household across 240 neighbourhoods in Ontario (Boyle, Georgiades, Duncan, Comeau et al., 2019; Patten, 2019; Statistics Canada, 2017). Due to vetting requirements from Statistics

Canada and the SouthWestern Ontario Research Data Centre, weighted samples are used for analyses in this dissertation.

Data collection occurred between October 2014 and September 2015 with in-person visits, using computer-assisted interviews as well as self-complete paper questionnaires (Boyle, Georgiades, Duncan, Comeau et al., 2019; Statistics Canada, 2017). The person most knowledgeable (PMK), 88.3% being mothers, was asked to complete surveys for up to four children living in the household, with one of the four children being deemed the ‘selected child’ (Boyle, Georgiades, Duncan, Comeau et al., 2019). Partners also completed a survey regarding the selected child, and if aged 12 to 17, the selected child also completed self-reports (Statistics Canada, 2017). A full description of the study methods can be found at ontariochildhealthstudy.ca/ochs/ and read in Boyle, Georgiades, Duncan, Comeau, et al. (2019). The 2014 OCHS received ethical approval from the Hamilton Integrated Research Ethics Board (13-140).

4.2 Study Measures

All questionnaires are available from ontariochildhealthstudy.ca/ochs/research-2/study-documentation/. Some of the same measures from the original 1983 OCHS were used in the 2014 OCHS to allow for comparison (Patten, 2019). A pilot study of 180 households, including 280 children, tested and retested reliability of all measures (Boyle, Georgiades, Duncan, Comeau et al., 2019).

4.2.1 Chronic Physical Illness

Chronic physical illness was measured using a standard checklist of physical illnesses, diagnosed by health professionals, that had lasted or was expected to last six months or longer (Boyle, Georgiades, Duncan, Comeau et al., 2019). The PMK checked ‘yes’ or ‘no’ to the

checklist which included: food or digestive allergies, respiratory allergies such as hay fever, any other allergies, asthma, bronchitis, cerebral palsy, diabetes, eczema, epilepsy, heart condition or disease, kidney condition or disease, and any other long-term conditions. A binary variable was created such that endorsement of at least one illness indicated the presence of chronic physical illness. Binary responses to a standard checklist are often used to examine chronic physical illness from a non-categorical approach as it is the consequences of physical illness, rather than diagnostic label, that impacts mental health (Ferro, 2016; Ferro et al., 2022). An ordinal variable, based on the number of physical illnesses endorsed (0, 1, 2, or ≥ 3), assessed the cumulative impact of physical illnesses on mental illness. There was no missing data for chronic physical illness.

4.2.2 Mental Illness

The OCHS Emotional Behavioural Scales (OCHS-EBS), a 52-item checklist, was reported by the PMK to assess symptoms of mental illness in the previous six months (Boyle, Duncan et al., 2019; Boyle, Georgiades, Duncan, Wang et al., 2019; Georgiades et al., 2019). The OCHS-EBS took approximately eight to ten minutes to complete. Based on DSM-5 criteria, the following seven mental illnesses were reported on: conduct disorder (CD), opposition defiant disorder (ODD), attention deficit hyperactivity disorder (ADHD), major depressive disorder (MDD), generalized anxiety disorder (GAD), separation anxiety disorder (SAD), and social phobia (SOP). Each item was scored on a 3-point frequency scale of (0) ‘never or not true’; (1) ‘sometimes or somewhat true’; and (2) ‘often or very true’. Scale scores were tallied for both externalizing (CD, ODD, ADHD) and internalizing (MDD, GAD, SAD, and SOP) disorders and a total symptoms scale score was summed for all seven illnesses (Georgiades et al., 2019). To indicate the presence or absence of mental illness, weighted prevalence estimates from

Georgiades et al. (2019) were averaged amongst the age groups and used for threshold scores. These threshold scores were also used to create binary variables for mood disorder (MDD), anxiety disorder (GAD, SAD, and SOP), behaviour disorder (CD and ODD), and neurodevelopmental disorder (ADHD). An ordinal variable was also created such that children were grouped into having 0, 1, 2, or ≥ 3 mental illnesses. Whether used as a dimensional or categorical measure, the OCHS-EBS demonstrates sound psychometric properties with satisfactory reliability and validity (Boyle, Duncan et al., 2019; Duncan, Georgiades, Wang et al., 2019). The OCHS-EBS has an average one-to-two-week test-retest reliability of $k=0.67$ and an average beta coefficient for convergent validity of 0.69 (Boyle, Duncan et al., 2019). Proration was used for scales missing less than one third of their items.

4.2.3. Health Status Categories

Studies utilized the binary chronic physical illness and mental illness variables, creating child health status categorizes of ‘healthy’ (no physical and no mental illness), ‘chronic physical illness only’, ‘mental illness only’, and ‘multimorbid’ (at least one physical illness and at least one mental illness). These health status categories were used in all study descriptive analyses and in Study 3 regression models, with healthy children being the reference category.

4.2.4 Health Utility

The 31-item Health Utilities Index Mark III (HUI) assesses children’s day-to-day overall health functioning for eight health attributes: vision, hearing, speech, ambulation, dexterity, emotion, cognition, and pain (Feeny et al., 1995; Furlong et al., 2001; Horsman et al., 2003). Responses were binary, with further ordinal questions asked if respondents endorsed ‘yes’ to health attribute items. If ‘yes’ was endorsed, functional limitations, severity of impairment, and reliance on aids was assessed on a 5 to 6-point scale, indicating an unrestricted to highly disabled

state (Feeny et al., 1995; Furlong et al., 2001). Using multiplicative, multi-attribute utility functions, the HUI describes 972,000 unique health states (i.e., different combinations and levels of disabled states; Horsman et al., 2003). An overall health score from -0.34 (worse than death) to 1 (perfect health) was calculated, with 0 representing a death state (Horsman et al., 2003). Validity and reliability of the HUI have been well evidenced in hundreds of studies globally and across various patient groups and with a variety of illnesses (Horsman et al., 2003; Feng et al., 2009). In the 2014 OCHS sample, 192 of 10,802 children had missing HUI data. Cases with missing data were removed for all studies as these cases represented 1.77% of missing HUI data. More information about the HUI can be found at <http://www.healthutilities.com>.

4.2.5 Family Functioning

The PMK completed the 12-item General Family Functioning subscale of the McMaster Family Assessment Device, which provides an overall assessment of how well families work together to complete everyday tasks (Byles et al., 1988). Response options include (1) strongly agree, (2) agree, (3) disagree, and (4) strongly disagree (Byles et al., 1988). An overall score of 12 to 48 was summed across item responses, where higher scores indicate greater dysfunction (Byles et al., 1988) and a cut point of 26.04 indicates pathological family functioning (2014 OCHS Derived Scales Documentation; Miller et al., 1985). The one-week test-retest reliability of the General Family Functioning subscale is 0.71 (Byles et al., 1988; Miller et al., 1985). Reliability, when using Chronbach's test of internal consistency is 0.86, and when using the Gutman split-half correlation is 0.83 (Byles et al., 1988). Statistics Canada used proration for responses missing less than one third of their items. Prorated cases were not identified by Statistics Canada. Approximately 9.2% of data was missing for mediation analyses, with missing data described in section 4.3.1.

4.2.6 Mental Health Service Contact

Considerable information regarding mental health service utilization, including but not limited to type of provider, location of services, and helpfulness of services was reported on by the PMK. Mental health-related service contacts made in the last six months were assessed by asking the PMK about mental health providers and settings that they discussed their child's mental health concerns with or that they knew their child discussed mental health related concerns with. Responses were aggregated and binary variables were created to indicate type of mental health service contact, which included any, general medicine (family doctor, pediatrician, nurse, other type of medical specialist), specialized mental health (psychiatrist, psychologist, social worker, counsellor, general therapist, mental health or addictions agency), school-based (school or guidance counsellor, teacher, or trusted adult at school), alternative (helpline, crisis line, naturopath, herbalist, religious or spiritual leader), and urgent medicine (walk in clinic, urgent care, emergency departments) (Georgiades et al., 2019). An overall binary variable was also created such that children either did or did not have any mental health service contact. An ordinal variable indicated that children could have 0, 1, 2, or ≥ 3 different types of mental health-related service contacts. Information regarding perceived helpfulness of services was only collected for general health and specialized mental health contacts and was thus excluded in study analyses. Sample characteristics for urgent and alternative mental health-related service contacts did not meet Statistics Canada vetting requirements and were thus excluded from the current study. Similarly, models for urgent mental-health service contact could not be presented.

4.2.7 Sociodemographic Covariates

Child-level sociodemographic measures include age (4-17 years) and sex at birth (male/female). Household sociodemographic measures include income and ethnicity. Household

income was recorded as low ($<20^{\text{th}}$ percentile of the sample median), medium (between low and high percentiles) and high ($\geq 80^{\text{th}}$ percentile). Ethnicity referred to the ethnicity of the PMK and was reduced from the OCHS's original 14 categories due to small cell counts. Categories of ethnicity include: White (e.g., European decent); south Asian (e.g., East Indian, Pakistani, Sri Lankan, Vietnamese, Cambodian, Malaysian, and Laotian); other Asian (e.g., Chinese, Filipino, Korean, Japanese, Iranian, Afghan, and Arab); Black; Indigenous; and other (e.g., other and Latin American).

4.3 Statistical Analyses

Specific analytic approaches to each study are described in detail in Chapters 3, 4, and 5. Briefly, an overview of data management and approaches that span the entire dissertation are outlined in this section. Pearson correlation coefficients for continuous variables (age), and chi-square for categorical variables (sex, health utility index, physical illness and mental illness, income, family functioning, ethnicity) were used to assess for basic descriptives. For univariate analyses, measures of central tendency are reported in frequency tables. Binary variables are presented with prevalence estimates. For categorical variables, frequencies and percentages are reported. For continuous variables, means, standard deviations, and ranges are presented. Cross-tabulations were used to present bivariate analyses, using chi-squares and Pearson correlations.

Logistic and ordinal regressions were used to model the associations between chronic physical illness and mental illness, while controlling for child age, sex, household income, ethnicity, and severity of functional limitations. The original HUI score was factored by 10 in all the regression models to facilitate interpretation of odds ratios, such that a unit difference on the transformed HUI score corresponds to a 0.10 difference on the original HUI score (Lima &

Kopec, 2005; Miller et al., 2012). Positive and negative directionality and magnitude of effect sizes are reported with odds ratios.

Variables included in product-term interaction analyses were grand-mean centred. Interactions were deemed statistically significant at the 0.05 level. Chapter 6 examined family functioning as a potential mediator in the association between chronic physical illness and mental illness using the product of coefficients method (MacKinnon, 2008). Mediation analyses presented in Chapter 6 are strictly exploratory due to the cross-sectional data.

Due to the complex survey design, including correlated responses amongst siblings in the same household, the balanced repeated replication variance estimation method was used with the generalized bootstrap weights and Fay adjustment to generate accurate standard errors. Weights were calculated by Statistics Canada to maintain representativeness with the Ontario child population. All analyses were conducted in SAS Studio statistical software (SAS version 9.4, SAS Institute Inc., Cary, NC, USA), using survey procedures and the combined child and sibling weight.

4.3.1 Study Samples and Missing Data

Study 1: For this study, the entire 2014 OCHS (n=10,802) sample was eligible for inclusion. However, 4.6% of youth had missing mental disorder data. Using logistic regression, with mental illness missingness as the outcome and covariates as the exposure, children with better health functioning (higher HUI scores) were more likely to have missing mental disorder data (OR=1.14 [1.04, 1.26]). No other covariates were associated with missing data. Complete case analysis was used. The total sample size for Study 1 was 10,303 children, representing 1,976,819 Ontario children aged 4 to 17 years in 2014. The weighted sample (N=1,976,819) was used for analyses.

Study 2: For this study, index children (n=6,537) were eligible for inclusion. For moderation analyses, 4.6% of youth had missing data on the outcome variable (mental illness). Using logistic regression, with mental illness missingness as the outcome and covariates as the exposure, children with higher HUI scores were more likely to have missing mental disorder data (OR=1.14 [1.04, 1.26]). Completed case analysis was used for moderation analysis (n=6,242). For mediation analysis, examining family functioning as a mediator between chronic physical illness and mental illness, approximately 9.2% of data was missing. Statistics Canada prorated scores with less than one third of missing items. It is unknown which cases were prorated. Missing data for family functioning and any mental illness in mediation analyses was more likely among Other Asian (vs. White) children (OR=1.54 [0.30, 0.96]), children from low-income households (vs. middle income) (OR=1.47 [1.02, 2.11]), and children with higher HUI scores (OR=1.20 [1.12, 1.27]). Completed case analysis was also used for mediation models (n=5,935). The weighted sample (N=1,223,047) was used for analysis.

Study 3: Index children (n=6,537) were eligible for inclusion in Study 3. 4.6% of children had missing data in at least one covariate. Missing data for any mental health service contact was associated with higher functional health scores (OR=1.60 [1.37, 1.88]), female children (OR=7.72 [2.54, 23.51]) and being from a lone parent household (OR=5.42 [1.66, 17.71]). Complete case analysis (n=6,242) was used with the weighted sample, representing 1,223,047 children aged 4 to 17 years in Ontario in 2014.

Chapter 5: Manuscript 1

An epidemiological study of physical-mental multimorbidity in youth.

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Abstract

Objective: This epidemiological study estimated lifetime prevalence of chronic physical illness (i.e., an illness that lasted or was expected to last ≥ 6 months) and six-month prevalence of mental disorder and multimorbidity (i.e., ≥ 1 physical illness and ≥ 1 mental disorder) in youth.

Associations between physical illness and mental disorder were quantified, including the number of illnesses. Secondary objectives examined factors associated with mental disorder, after controlling for physical illness.

Methods: Data come from 10,303 youth aged 4-17 years in the 2014 Ontario Child Health Study (OCHS). Physical illness was measured using a list of chronic conditions developed by Statistics Canada. Mental disorders were measured using the OCHS Emotional Behavioural Scales. The Health Utility Index Mark III assessed overall functional health.

Results: Weighted prevalence estimates showed 550,090 (27.8%) youth had physical illness, 291,986 (14.8%) had mental disorder, and 108,435 (5.4%) had multimorbidity. Physical illness was not associated with mental disorder. However, youth with two physical illnesses, as compared to no physical illnesses, had increased odds of having any mental (OR=1.75 [1.08, 2.85]), mood (OR=2.50 [1.39, 4.48]) and anxiety disorders (OR=2.40 [1.33, 4.31]). Mean functional health scores demonstrated a dose-response association across health status categories, with highest scores among healthy youth and lowest scores among multimorbid youth (all $p < .05$).

Conclusion: Chronic physical illness and mental disorder are prevalent in youth. Youth with two physical illnesses have higher likelihood for mental disorder. Higher functional health scores protected against all mental disorders. Mental health interventions for youth should promote strong overall functional health.

Keywords: youth; chronic physical illness; mental disorder; multimorbidity; population health; secondary analysis

Introduction

Youth with chronic physical illnesses (i.e., those conditions that are expected to last at least six months), endure psychosocial and emotional challenges, predisposing them to an increased risk of mental disorder.¹⁻⁶ Evidence suggests the risk of mental disorder is similar across different physical illnesses^{1,7,8} and increases with additional physical diagnoses^{9,10} and severity of functional limitations.^{4,11} Other biological and psychosocial risk factors of mental disorders include sex,^{8,12,13} age,^{8,12,14} lower socioeconomic status,¹⁵ and Indigenous status.¹⁶ The co-occurrence of at least one physical illness and at least one mental disorder (herein, *multimorbidity*), is common in youth.¹ Prevalence of youth multimorbidity is estimated at 38% to 55% in Ontario-based clinical samples^{1,17} and 15% to 30% in Canadian and American epidemiological samples.^{7,18} Multimorbidity has negative impacts on quality of life,^{9,18-20} physical and mental health functioning,^{18,21} self-esteem,²⁰⁻²³ academic achievement,^{24,25} and suicidality.²⁶ Because chronic physical illness and mental disorder are both chronic in nature, with at least 90% of youth with physical illness becoming adults with physical illness,²⁷ and because the mental health impact of childhood physical illness persists across adolescence and into adulthood,^{4,6} an urgent public health response is needed to address the long-term consequences of youth multimorbidity.

Despite the chronicity of physical illness and mental disorder risk, there is a paucity of research that examines multimorbidity early in life. Evidence that does exist focuses on emerging adult, not youth, populations.^{7,15,18,28} Including children and adolescents in youth samples is critical for advancing the current state of knowledge about youth mental health and preventing mental disorder in this population. Unfortunately, estimates generated using non-standardized mental disorder diagnostic criteria¹⁵ make incidence and prevalence comparisons unreliable and

assessments of burden difficult. Instead, using measures aligned with standardized diagnostic criteria (e.g., Diagnostic and Statistical Manual of Mental Disorders) is critical to public health prevention and surveillance efforts. Youth multimorbidity research often has outdated epidemiological samples,^{18,28} with contemporary samples needed to assess a broad spectrum of multimorbidity. Samples obtained from hospital registers²¹ limits generalizability to clinical populations, making population-level health recommendations difficult. Addressing these gaps in knowledge and methodology will produce evidence-based findings that can inform policy, prevention, and intervention efforts aimed at reducing mental disorder among youth with and without chronic physical illness.

The current study addresses these gaps in youth multimorbidity research by using contemporary epidemiological data that aligns with standard diagnostic criteria, from a sample of youth that is inclusive of children and adolescents. Data from the 2014 Ontario Child Health Study (OCHS) are used primarily to: 1) estimate the lifetime prevalence of chronic physical illness and six-month prevalence of mental disorder and multimorbidity, in a sample of youth; and 2) quantify associations between chronic physical illness and mental disorder, including the number of physical and mental morbidities. Secondary objectives include examining risk factors for mental disorder after controlling for the effect of chronic physical illness. Results will contribute to youth multimorbidity surveillance research and inform best practices for targeted youth mental health interventions.

Methods

Source

Analyses were conducted using the 2014 OCHS, a cross-sectional, epidemiological study implemented by Statistics Canada, that consisted of 10,802 youth from 6,587 households across

240 neighbourhoods.²⁹ Multistage sampling, stratified by income, were used for sample selection, such that neighbourhoods were selected at the first stage, followed by census tracts and dissemination areas, and households selected at the third stage.²⁹ The target population included all private households in Ontario in which youth aged 4 to 17 years resided. Excluded were youth living in collective dwellings (e.g., youth in welfare and justice systems) as well as those living on Indigenous reserves (due to data sovereignty).²⁹ The household response rate was 50.8%.^{29,30} In-person data collection occurred between October 2014 and September 2015, using computer-assisted interviews and self-completed paper questionnaires.²⁹ The person most knowledgeable (PMK), 88.3% being mothers, was asked to complete surveys for up to four youth living in the household. The 2014 OCHS received ethical approval from the Hamilton Integrated Research Ethics Board (13-140).

Measures

Responding to a list of chronic physical illnesses used in Statistics Canada surveys, the PMK reported if youth ever had physical illnesses diagnosed by a health professional that had lasted or were expected to last at least six months.²⁹ Physical illnesses included: food or digestive allergies, respiratory allergies such as hay fever, any other allergies, asthma, bronchitis, cerebral palsy, diabetes, eczema, epilepsy, heart condition or disease, kidney condition or disease, and any other long-term conditions. A binary variable was created such that endorsement of at least one illness indicated the presence of chronic physical illness. Binary responses to a standard checklist are often used to examine chronic physical illness from a non-categorical approach as it is the consequences of physical illness, rather than diagnostic label, that impacts mental health.^{7,8} An ordinal variable, based on the number of physical illnesses endorsed (0, 1, 2, or ≥ 3), assessed the cumulative impact of physical illnesses on mental disorder. Psychometric properties of this

checklist are not reported by Statistics Canada; however, similar checklists show negligible misclassification bias.³¹

Mental disorder was measured using the PMK-reported OCHS Emotional Behavioural Scales (OCHS-EBS), a 52-item checklist, assessing symptoms of mental disorder in the previous six months.^{30,32,33} Based on DSM-5 criteria, the following mental disorders were assessed: major depressive, generalized anxiety, separation anxiety, social phobia, conduct, oppositional defiant, and attention deficit hyperactivity disorder (ADHD). Each item was scored on a 3-point scale of (0) ‘never or not true’; (1) ‘sometimes or somewhat true’; and (2) ‘often or very true’. A total symptoms scale score was summed for all seven disorders.³⁰ Binary variables for any mental, mood (major depressive), anxiety (generalized, separation, and social phobia), behavioural (conduct and oppositional defiant), and neurodevelopmental disorders (ADHD) were created by establishing cut-points that resulted in closely matched disorder prevalence estimates reported in Georgiades, Duncan, Wang et al. (2019). An ordinal variable was also created such that youth were grouped into having 0, 1, 2, or ≥ 3 mental disorders. The OCHS-EBS has an average test-retest reliability (based on κ) of 0.67 and indicators of convergent validity (i.e., β coefficients) averaged 0.69.³³

Overall functional health was measured using the Health Utilities Index Mark III (HUI). The HUI is a PMK-reported measure that assessed daily overall health and functioning across eight health attributes: vision, hearing, speech, ambulation, dexterity, emotion, cognition, and pain.²⁹ The HUI accounts for impairment, functional limitations, and reliance on aids (e.g., glasses) and mechanical equipment (e.g., mobility and speech devices).³⁴ A total score ranging from -0.34 (worse than death) to 1 (perfect health) was calculated, with 0 representing a death

state.³⁴ The HUI has been extensively validated across varying chronic illnesses and for youth population samples.^{34,35}

Sociodemographic covariates were included in the analyses based on published evidence supporting their inclusion as risk factors for mental illness in youth with or without chronic physical illness and as potential confounders in the association between physical and mental illness.^{8,12-16} Covariates included age, sex, household income (low: <20th percentile of the sample median, mid: between low and high percentiles, and high: $\geq$ 80th percentile), and ethnicity of the PMK (Black, Indigenous, other, Other Asian, South Asian, and White).

Analysis

Descriptive and bivariable statistics were used to compare sociodemographic characteristics of youth based on health status ('healthy', 'physical illness only', 'mental disorder only', and 'multimorbid'). Cross-tabulations were used to calculate the lifetime prevalence of chronic physical illness and six-month prevalence of mental disorders and multimorbidity (objective 1). Rao-Scott Chi-square tests compared sex-specific differences in prevalence rates of chronic physical illness and mental disorders. Prevalence estimates are presented as weighted percentages and frequencies. Using t-tests, overall functional health scores were compared amongst youth with and without physical illness and mental disorder. Logistic regression models were computed to quantify associations between chronic physical illness and mental disorder (objective 2a). Ordinal regression models quantified associations between chronic physical illness and number of mental disorders (objective 2b). Sociodemographic and health covariates were simultaneously included in all regression models and adjusted results are reported with odds ratios (ORs) and 95% confidence intervals (CIs). Raw functional health scores were scaled by a factor of 10 to facilitate the interpretation of odds ratios.^{36,37} Due to the complex survey

design and correlated responses amongst siblings from the same household, the balanced repeated replication variance estimation method was used with the generalized bootstrap weights and Fay adjustment to generate accurate standard errors. Weights were calculated by Statistics Canada to maintain representativeness with the Ontario youth population. Analyses were conducted in SAS 9.4.

Missing Data

A total of 499 (4.6%) of youth had missing data in at least one covariate. Missing data for any mental disorder was associated with higher overall functional health scores (OR=1.14 [1.04, 1.26]). Given the low level of missing data, complete case analysis was used,³⁸ with a total sample of 6,242 households consisting of 10,303 youth- representing 1,976,819 Ontario youth.

Results

Sample Characteristics

The sex distribution of youth was nearly equal (1,018,635; 51.5% males), the mean age was 10.6 years (0.07), and the mean overall functional health score was 0.92 (0.002). Most youth came from two-parent households (1,594,563; 80.8%), 1,236,916 (62.6%) were White, and 810,905 (41.0%) were immigrants. Almost half of PMKs (896,717; 46.1%) had at least a bachelor degree and over half (1,131,886; 57.2%) of households reported a mid-level annual income. A dose-response association was observed for overall functional health scores, such that scores significantly decreased from ‘healthy’ youth to ‘chronic physical illness only’ to ‘mental disorder only’ to ‘multimorbid’ youth ($p < 0.05$ for all). As the number of physical illnesses and mental disorders cumulated, mean overall functional health scores decreased, with lowest scores among youth with three or more physical illnesses (0.80, 0.01) and three or more mental disorders (0.60, 0.01). Detailed sample characteristics are shown in Table 1.

Prevalence of Chronic Physical Illness and Mental Disorders

From PMK reports, 62.9% (1,243,177) of youth were healthy (no physical illness or mental disorder), lifetime prevalence of chronic physical illness was 27.8% (550,090), six-month prevalence of mental disorder was 14.8% (291,986), and six-month multimorbidity was 5.4% (108,435). Specific mental disorder prevalence estimates were 3.9% (76,725) for mood, 6.3% (124,814) for anxiety, 6.1% (121,280) for behavior, and 7.9% (155,261) for neurodevelopmental. Prevalences of each physical illness and mental disorder are shown in Supplementary Figures 1 and 2.

Association between Chronic Physical Illness and Mental Disorder

Logistic regression models were computed to examine the association between having a chronic physical illness and mental disorder (Table 2). Across all adjusted models, chronic physical illness was not associated with mental disorder. Consistent across models, better overall functional health was associated with lower adjusted odds of mental disorder (OR range: 0.56-0.69). Age was associated with increased adjusted odds for mood (OR=1.16 [1.10, 1.22]) and behaviour disorders (OR=1.04 [1.01, 1.09]) and lower adjusted odds for neurodevelopmental disorder (OR=0.91 [0.89, 0.95]). Female youth had lower adjusted odds for any mental (OR=0.67 [0.54, 0.82]), behavior (OR=0.64 [0.49, 0.85]), and neurodevelopmental disorders (OR=0.44 [0.34, 0.58]).

As compared to White youth, Black (OR=0.50, [0.27, 0.94]), Other Asian (OR=0.52 [0.34, 0.78]), and South Asian youth (OR=0.39 [0.25, 0.61]) had lower adjusted odds of any mental disorder. Black (OR=0.07 [0.03, 0.14]) and South Asian youth (OR=0.08 [0.02, 0.25]) had lower adjusted odds of mood disorder compared to White youth. For anxiety disorder, Black (OR=0.43 [0.20, 0.92]) and South Asian youth (OR=0.39 [0.20, 0.76]) had lower adjusted odds

than White youth. For behavior disorder, youth with ‘other ethnicity’ (OR=0.42 [0.23, 0.74]) and South Asian youth (OR=0.37 [0.18, 0.74]) had lower adjusted odds compared to White youth. Youth categorized as Other Asian (OR=0.49 [0.28, 0.83]) and South Asian (OR=0.40 [0.19, 0.84]) had lower adjusted odds for neurodevelopmental disorder than White youth. Compared to White youth, Indigenous youth had higher adjusted odds for any mental (OR=1.84 [1.12, 3.02]), mood (OR=4.35 [2.41, 7.84]), and neurodevelopmental disorders (OR=2.19 [1.33, 3.60]).

Association of Number of Chronic Physical Illnesses and Mental Disorder

As shown in Table 3, having two chronic physical illnesses, as compared to no illness, was significantly associated with higher adjusted odds of having any mental (OR=1.75 [1.08, 2.85]), mood (OR=2.50 [1.39, 4.48]), and anxiety disorders (OR=2.40 [1.33, 4.31]). There were no significant mental disorder outcomes for youth with one or three or more chronic physical illnesses. The effects of age, sex, income, ethnicity, and overall functional health on mental disorder were similar to those found for models of chronic physical illness and mental disorder.

Number of Physical and Mental Morbidities

Ordinal regression models were computed to quantify the associations between the presence of chronic physical illness and the number of mental disorders (Table 4), and between the number of chronic physical illnesses and the number of mental disorders (Table 5). Results were robust across different analytic models, with the effects of chronic physical illness, age, sex, income, ethnicity, and health utility similar in Tables 2 and 3. As shown in Table 5, having two chronic physical illnesses increased the adjusted odds of the number of mental disorders (OR=1.90 [1.20, 2.99]). There were no significant associations with number of mental disorders for youth with one or three or more chronic physical illnesses.

Discussion

Summary of Findings

Using data from a large epidemiological study of Ontario youth, this study 1) estimated lifetime prevalence of chronic physical illness, and six-month prevalence of mental disorder and multimorbidity; 2) quantified associations between chronic physical illness and mental disorder, including the number of physical-mental morbidities; and secondary objectives examined risk factors of mental disorder after controlling for physical illness. Regarding Objective 1, over one-quarter of youth in the current sample reported chronic physical illness, aligning with contemporary epidemiological prevalence estimates.^{39,40} Compared to the seminal 1983 OCHS, chronic physical illness increased from 18.0%⁴¹ to 27.8%. The prevalence of youth screening positive for mental disorder (15%) was lower than estimates in epidemiological studies that report one in five youth living with mental disorder.^{7,18,32} In addition, youth multimorbidity decreased from 8.0%⁴¹ in the 1983 OCHS to 5.4% in the current study. Differences in mental disorder and multimorbidity estimates can be attributed to methodological differences in duration of illness (higher prevalence in longer study time periods), measurement of mental health (higher prevalence in studies that exclude impairment), structured diagnostic interviews vs. symptom checklist (prevalence differences based on type of disorder),³² number of mental disorders assessed, informant (higher rates in adolescent vs. parent reports),³² and respondent age (prevalence of different disorders fluctuate throughout development).⁴²

Contrary to research suggesting a cumulative effect of number of chronic physical illnesses on mental disorder risk,^{9-11, 43} the current study found that youth with two chronic physical illnesses had increased odds of any, mood, and anxiety disorders as well as having increased odds of having a higher number of mental disorders (Objective 2b). Notably, there were no significant associations with mental disorder outcomes for youth with one and three or

more chronic physical illnesses. This finding may signal that youth in the general population living with one chronic physical illness may have relatively mild illness. With learned coping strategies, a single physical illness may be managed well by children and families, thus avoiding declines in mental health. Going from one to two chronic physical illnesses may result in more serious impairments, increasing burden on youth and families, and thus increase odds of mental disorder. Youth with three or more chronic physical illnesses may have additional medical complexities, requiring routine follow-ups with health professionals- where in the context of holistic models of care- their mental health needs are adequately addressed.⁴⁴ Alternatively, the mental health of medically complex youth maybe overshadowed by their physical health needs. In addition, the mental health of medically complex youth maybe difficult to assess due to substantial impairment or a lack of validated instruments for this specific population. These inferences are speculative; additional research to understand the nuances of physical-mental multimorbidity in youth is needed.

Overall functional health was a robust and consistent factor associated with mental disorder across different analytic models (secondary objectives). This finding supports the non-categorical approach to understanding youth multimorbidity.^{7,8} Rather than the presence or type of chronic physical illness, it is impairment and functional limitations (e.g., restrictions in dressing, walking, expressing thoughts independently)^{35,45} that conditions risk for mental disorder. As HUI score differences of 0.03 are clinically significant and the HUI responds to health changes over time³⁴ it has been used to examine various treatment therapies in numerous cost-utility studies.³⁴ Therapeutic interventions such as psychological counselling, physical and occupational therapy,³⁴ medication adjustments,³⁵ and use of aids (e.g., mobility and communication devices) can target functional limitations by addressing the barriers that reduces

participation in developmentally-appropriate activities. Future clinical research that incorporates the HUI as a measure of overall functional health, should examine modifiable functional limitations that are specific to physically and/or mentally ill youth. This study generated findings that were representative across the youth population and supports public health interventions targeting functional limitations, which aligns with the non-categorical approach to understanding multimorbidity in youth and young adult populations.^{7,28,46}

The effects of age, sex, and ethnicity on mental disorder were generally consistent with current literature.^{28,32,47,48} Older age was associated with mood and behaviour disorders while younger age was associated with neurodevelopmental disorder. Females vs. males had lower odds for having behavior and neurodevelopmental disorders. Whereas some studies report higher prevalences of internalizing disorders in females vs. males,^{49,50} the current study is consistent with other 2014 OCHS studies that did not find sex differences.^{32,42} Notably, Indigenous youth were disproportionately represented across mental disorders and multimorbidity. Compared to White youth, Indigenous youth were four times more likely to have a mood disorder and two times more likely to have a neurodevelopmental disorder. Given the current study excluded Indigenous youth living on reserve (about 37% of the Indigenous youth population)²⁹ where mental disorder rates are approximately twice that than in non-Indigenous communities,⁵¹ the current estimates are likely underestimated.⁵²

Implications

Findings support broad mental health screening across pediatric settings, regardless of diagnosis, for youth with a chronic physical and/or mental disorder. Vigilant screening efforts are needed for youth with two physical illnesses. Strategies should involve routine monitoring of physical and mental health, impairment, and functioning. Interventions should target the

prevention of functional health declines, which would promote favorable health outcomes over the life course. These strategies would address continued recommendations to integrate physical and mental health care.^{8,53} Given the higher odds of mental disorder among Indigenous youth, integrated health care and mental health interventions must be culturally appropriate. Future research should examine the nuances in the association between the number of physical illnesses and mental disorder outcomes, including potential mediating and moderating effects. Future clinical research should examine interventions to prevent functional health declines, and the impact that income, age, sex, and ethnicity may have on accessing therapeutic interventions.

Strengths and Limitations

The current study contributes to youth multimorbidity research, an emerging field of study. As a large-population based study, findings can be broadly applied to the spectrum of youth, inclusive of children and adolescents. There are significant implications for health policy, supporting youth with and without chronic physical illness. Modifiable impairments and functional limitations can be targeted to improve mental health outcomes in youth with physical and/or mental illnesses. Potential biases associated with cross-sectional data (e.g. recall and misclassification biases) are minimized by using health professional-diagnosed conditions and standardized mental health measures that align with DSM-5 criteria.

There are limitations warranting consideration when interpreting findings from this study. First, data were collected prior to the COVID-19 pandemic; thus, the current burden of chronic physical illness, mental disorder, and multimorbidity may be underestimated.¹⁷ Second, because the parent version of the OCHS-EBS was used, reported prevalence of internalizing mental disorders and thus multimorbidity may be underestimated.^{32,54,55} Future research should include youth self-reports and where possible, other informants (e.g., teacher, health professional). Third,

prevalence estimates may be under or overestimated due to racial and cultural biases in assessments and reporting of mental disorder. For instance, assessments may overestimate externalizing disorders for Black youth while estimates for Asian youth may be under reported.^{47,48} Last, the 2014 OCHS is cross-sectional and causation cannot be inferred.

Conclusion

Chronic physical illness and mental disorders are prevalent in youth. While the presence of chronic physical illness was not associated with mental disorder, the number of chronic physical illnesses was important in examining mental health outcomes. Youth with two chronic physical illnesses have increased odds of mental disorder. Indigenous youth were consistently more likely to report mental disorder, providing evidence for the importance of culturally-sensitive health care. Even after adjusting for relevant health factors, better overall functional health was robustly associated with better mental health outcomes across various analytical models. A dose-response was observed, such that overall daily health functioning scores significantly declined from ‘physical illness only’ to ‘mental disorder only’ to ‘multimorbidity’. Future clinical research should examine targeted interventions aimed at preventing functional health declines, supporting a mental health research strategy for youth with and without chronic physical illness.

Data Access

Data access is available through Statistics Canada Research Data Centres.

Conflicts of Interest

The authors declare no conflicts of interest.

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Table 1

Sample characteristics

	Morbidity Status				
	Total	Healthy	CPI Only	MD Only	MM
Weighted N	1,976,819	1,243,177	441,655	183,552	108,435
% of Total Weighted Sample (95% CI)	100	62.89 (61.19-64.58)	22.34 (20.84-23.83)	9.29 (8.33-10.23)	5.49 (4.64-6.32)
Age (Mean, 95% CI)	10.59 (10.45-10.74)	10.27 (10.17-10.36)	11.21 (11.05-11.38)*	10.57 (10.32-10.82)	11.90 (11.56-12.23)
Health Utility (Mean, 95% CI)	0.92 (0.91-0.92)	0.96 (0.96-0.96)*	0.92 (0.91-0.93)*	0.78 (0.77-0.80)*	0.73 (0.71-0.76)*
Male	51.52 (49.80-53.26)	31.22 (29.62-32.82)	11.28 (10.16-12.40)	5.60 (4.83-6.36)*	3.42 (2.74-4.10)*
Ethnicity:					
Black	5.30 (4.61-5.99)	3.43 (2.90-3.97)	1.38 (0.98-1.79)	0.26 (0.10-0.41)	0.21 (0.08-0.36)
Indigenous	2.50 (1.99-3.01)	1.15 (0.86-1.44)	0.59 (0.28-0.90)	0.49 (0.26-0.72)	0.27 (0.09-0.44)
Other	6.09 (5.23-6.94)	4.07 (3.38-4.76)	1.34 (0.92-1.77)	0.47 (0.22-0.72)	0.20 (0-0.40)
Other Asian	11.64 (10.53-12.76)	8.14 (7.20-9.09)	2.47 (1.92-3.01)	0.78 (0.52-1.03)	0.24 (0.03-0.46)
South Asian	11.89 (10.71-13.07)	8.84 (7.82-9.87)	2.23 (1.68-2.79)	0.54 (0.23-0.84)	0.27 (0.08-0.47)
White	62.57 (60.89-64.25)	37.23 (35.57-38.90)	14.31 (13.05-15.58)	6.74 (5.93-7.54)	4.28 (3.53-5.02)
Lone parent household	19.19 (17.88-20.50)	11.55 (10.49-12.61)	3.92 (3.32-4.51)	2.12 (1.67-2.58)	1.59 (1.11-2.07)
Immigrant	41.02 (39.31-42.72)	28.66 (27.11-30.20)	8.74 (7.71-9.77)	2.49 (1.97-3.00)	1.12 (0.76-1.50)
Parent Education:					
Did not complete secondary school	3.03 (2.54-3.52)	1.91 (1.52-2.30)	0.54 (0.33-0.74)	0.41 (0.21-0.62)	0.16 (0.06-0.26)
Secondary school completed	9.32 (8.39-10.24)	6.08 (5.30-6.84)	1.84 (1.43-2.24)	0.96 (0.65-1.28)	0.43 (0.25-0.62)
College, trade or university below bachelor	41.54 (39.78-43.30)	24.79 (23.23-26.34)	9.80 (8.66-10.96)	4.05 (3.38-4.72)	2.89 (2.20-3.57)
Bachelor degree or higher	46.1 (44.37-47.84)	30.09 (28.51-31.66)	10.19 (9.11-11.27)	3.81 (3.20-4.41)	2.01 (1.52-2.51)
Income:					
Low	20.70 (19.60-21.81)	12.83 (11.98-13.69)	4.38 (3.84-4.90)	2.24 (1.88-2.60)	1.25 (0.97-1.53)
Mid	57.26 (55.65-58.87)	35.98 (34.20-37.76)	12.88 (11.50-14.25)	5.14 (4.30-5.98)	3.26 (2.48-4.02)
High	22.03 (20.86-23.21)	14.07 (13.13-15.01)	5.09 (4.48-5.70)	1.90 (1.56-2.23)	0.97 (0.74-1.20)
Chronic physical illness:					
Any CPI	27.82 (26.22-29.43)	~	22.34 (20.85-23.83)	~	5.49 (4.64-6.32)
1 CPI	19.47 (18.08-20.86)	~	16.17 (14.87-17.47)	~	3.30 (2.70-3.90)

2 CPI's	5.68 (4.80-6.56)	~	4.17 (3.41-4.92)	~	1.51 (1.03-1.99)
3≥ CPI's	2.67 (2.00-3.36)	~	2.00 (1.44-2.57)	~	0.67 (0.27-1.07)
Mental disorder:					
Any MD	14.77 (13.54-15.99)	~	~	9.28 (8.33-10.23)	5.49 (4.64-6.32)
1 MD	7.87 (6.96-8.78)	~	~	5.41 (4.68-6.16)	2.44 (1.89-3.00)
2 MD's	3.36 (2.71-4.00)	~	~	1.84 (1.44-2.25)	1.51 (1.00-2.02)
3≥ MD's	3.54 (2.90-4.18)	~	~	2.01 (1.52-2.50)	1.52 (1.10-1.94)
Mood disorder	3.90 (3.20-4.59)	~	~	1.96 (1.50-2.42)	1.93 (1.40-2.47)
Anxiety disorder	6.33 (5.47-7.20)	~	~	3.72 (3.07-4.37)	2.61 (2.01-3.21)
Behavior disorder	6.14 (5.31-6.96)	~	~	3.79 (3.18-4.40)	2.35 (1.78-2.92)
Neurodevelopment disorder (ADHD)	7.88 (7.02-8.73)	~	~	5.14 (4.45-5.84)	2.73 (2.21-3.26)
Data are frequency (95% CI) unless noted otherwise.					
CPI= chronic physical illness; MD= mental disorder; MM= multimorbid; CI= confidence interval.					
*Denotes difference with all other health status groups is statistically significant at $p < 0.05$.					

Table 2

Association of Chronic Physical Illness and Mental Disorder

	Mental Disorder				
	Any MD	Mood	Anxiety	Behavior	Neurodevelopmental
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
CPI					
Present vs. Not present (ref)	1.17 (0.94-1.45)	1.50 (0.95-2.34)	1.37 (0.96-1.96)	1.13 (0.81-1.57)	0.94 (0.71-1.25)
Demographics					
Age	0.99 (0.97-1.01)	1.16 (1.10-1.22)	1.00 (0.97-1.04)	1.04 (1.01-1.09)	0.91 (0.89-0.95)
Sex: Female vs. Male (ref)	0.67 (0.54-0.82)	0.82 (0.53-1.26)	1.17 (0.88-1.56)	0.64 (0.49-0.85)	0.44 (0.34-0.58)
Income:					
High vs. Medium (ref)	0.95 (0.74-1.22)	0.68 (0.41-1.12)	0.77 (0.54-1.08)	0.71 (0.50-1.00)	1.10 (0.84-1.46)
Low vs. Medium (ref)	1.12 (0.88-1.44)	1.02 (0.61-1.72)	1.01 (0.69-1.51)	1.10 (0.79-1.56)	1.24 (0.95-1.61)
Ethnicity:					
Black vs. White (ref)	0.50 (0.27-0.94)	0.07 (0.03-0.14)	0.43 (0.20-0.92)	0.40 (0.16-1.00)	0.70 (0.36-1.38)
Indigenous vs. White (ref)	1.84 (1.12-3.02)	4.35 (2.41-7.84)	1.77 (0.78-4.02)	1.88 (0.90-3.88)	2.19 (1.33-3.60)
Other vs. White (ref)	0.59 (0.35-1.00)	0.41 (0.17-1.03)	1.19 (0.58-2.46)	0.42 (0.23-0.74)	0.59 (0.35-1.00)
Other Asian vs. White (ref)	0.52 (0.34-0.78)	0.56 (0.23-1.33)	0.79 (0.43-1.44)	0.65 (0.41-1.01)	0.49 (0.28-0.83)
South Asian vs. White (ref)	0.39 (0.25-0.61)	0.08 (0.02-0.25)	0.39 (0.20-0.76)	0.37 (0.18-0.74)	0.40 (0.19-0.84)
Clinical Functioning					
Health Utility Index	0.56 (0.51-0.60)	0.58 (0.53-0.64)	0.64 (0.60-0.70)	0.69 (0.64-0.72)	0.57 (0.52-0.60)
C-Statistic	0.78	0.88	0.77	0.77	0.82
CPI= chronic physical illness; MD= mental disorder; OR= odds ratio; CI= confidence interval.					
Results are reported as adjusted ORs and 95% CIs. Statistically significant findings are shown in bold.					

Table 3

Association of Number of Chronic Physical Illnesses (3+) and Mental Disorder

	Mental Disorder				
	Any MD	Mood	Anxiety	Behavior	Neurodevelopmental
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Number of CPI's					
1 CPI vs. No CPI (ref)	1.06 (0.84-1.33)	1.31 (0.77-2.24)	1.20 (0.81-1.76)	1.16 (0.82-1.62)	0.93 (0.68-1.29)
2 CPIs vs. No CPI (ref)	1.75 (1.08-2.85)	2.50 (1.39-4.48)	2.40 (1.33-4.31)	1.49 (0.82-2.69)	1.39 (0.82-2.32)
3 ≥ CPIs vs. No CPI (ref)	0.89 (0.33-2.34)	0.98 (0.27-3.52)	0.76 (0.14-4.08)	0.47 (0.12-1.78)	0.35 (0.10-1.26)
Demographics					
Age	0.99 (0.97-1.01)	1.17 (1.10-1.23)	1.01 (0.97-1.04)	1.05 (1.01-1.09)	0.92 (0.89-0.95)
Sex: Female vs. Male (ref)	0.67 (0.54-0.82)	0.83 (0.55-1.26)	1.18 (0.89-1.57)	0.64 (0.49-0.84)	0.44 (0.34-0.57)
Income:					
High vs. Medium (ref)	0.94 (0.73-1.21)	0.68 (0.41-1.10)	0.77 (0.54-1.07)	0.71 (0.50-1.00)	1.10 (0.84-1.44)
Low vs. Medium (ref)	1.13 (0.88-1.45)	1.04 (0.62-1.74)	1.03 (0.69-1.52)	1.11 (0.80-1.56)	1.25 (0.97-1.62)
Ethnicity:					
Black vs. White (ref)	0.50 (0.27-0.94)	0.07 (0.03-0.14)	0.42 (0.20-0.90)	0.40 (0.16-1.00)	0.69 (0.35-1.37)
Indigenous vs. White (ref)	1.74 (1.04-2.89)	3.88 (2.04-7.36)	1.55 (0.67-3.61)	1.73 (0.81-3.70)	2.00 (1.21-3.31)
Other vs. White (ref)	0.59 (0.35-0.99)	0.41 (0.17-1.02)	1.17 (0.58-2.38)	0.41 (0.23-0.73)	0.58 (0.34-0.98)
Other Asian vs. White (ref)	0.52 (0.35-0.78)	0.56 (0.23-1.33)	0.80 (0.43-1.46)	0.65 (0.41-1.01)	0.49 (0.29-0.83)
South Asian vs. White(ref)	0.39 (0.25-0.60)	0.08 (0.02-0.23)	0.38 (0.19-0.76)	0.36 (0.18-0.72)	0.39 (0.18-0.82)
Clinical Functioning					
Health Utility Index	0.56 (0.51-0.60)	0.58 (0.52-0.63)	0.64 (0.59-0.69)	0.68 (0.64-0.72)	0.56 (0.52-0.60)
C-Statistic	0.78	0.88	0.77	0.77	0.82
CPI= chronic physical illness; OR= odds ratio; CI= confidence interval. Results are reported as adjusted ORs and 95% CIs. Statistically significant findings are shown in bold.					

Table 4

Association of Any Chronic Physical Illness and Number of Mental Disorders (3+)

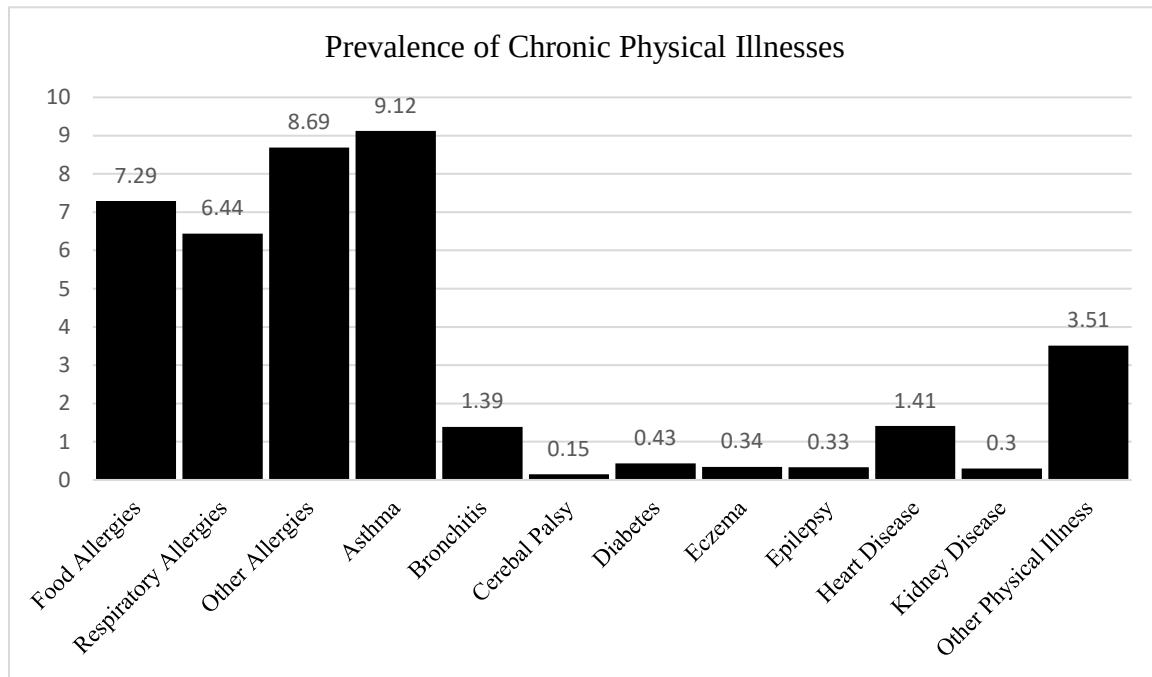
	Number of Mental Disorders
	OR (95% CI)
CPI	
Present vs. Not Present (ref)	1.22 (0.99-1.51)
Demographics	
Age	1.00 (0.97-1.01)
Sex: Female vs. Male (ref)	0.67 (0.54-0.81)
Income:	
High vs. Medium (ref)	0.91 (0.71-1.17)
Low vs. Medium (ref)	1.08 (0.85-1.38)
Ethnicity:	
Black vs. White (ref)	0.49 (0.26-0.90)
Indigenous vs. White (ref)	1.93 (1.21-3.08)
Other vs. White (ref)	0.59 (0.34-0.99)
Other Asian vs. White (ref)	0.54 (0.37-0.80)
South Asian vs. White (ref)	0.40 (0.26-0.60)
Clinical Functioning	
Health Utility Index	0.60 (0.56-0.63)
C-Statistic	0.77
CPI= chronic physical illness; OR= odds ratio; CI= confidence interval.	
Results are reported as adjusted ORs and 95% CIs.	
Statistically significant findings are shown in bold.	

Table 5

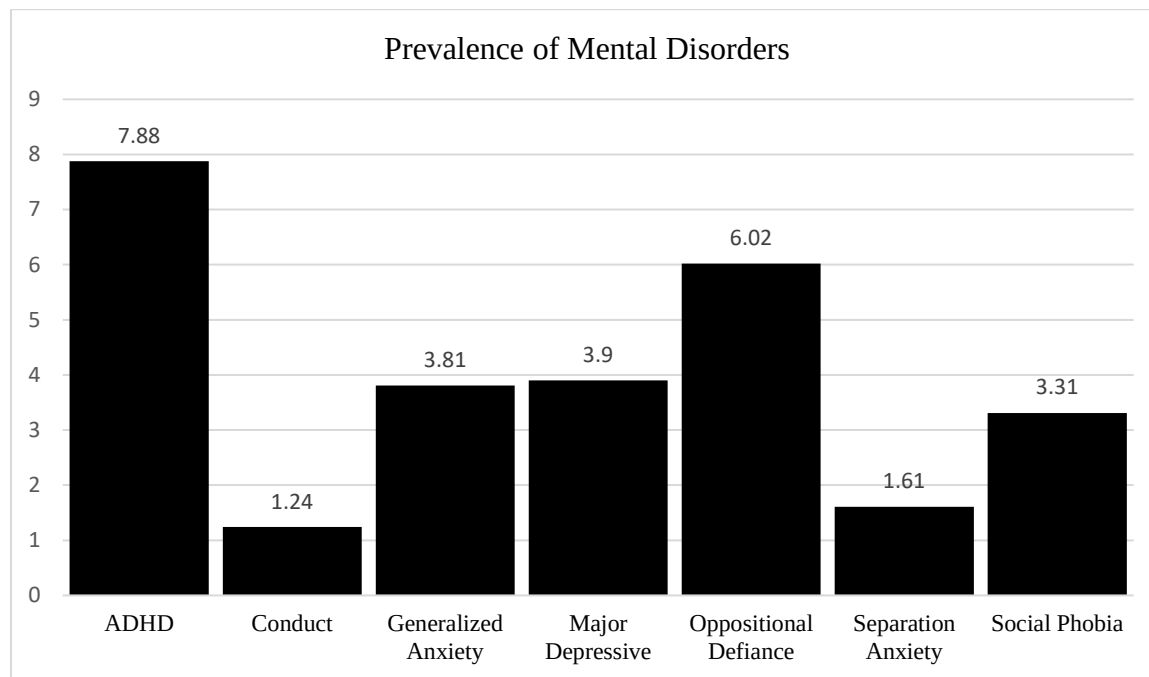
Association of Number of Chronic Physical Illnesses and
Number of Mental Disorders (3+)

	Number of Mental Disorders
	OR (95% CI)
Number of CPI's	
1 CPI vs. No CPI (ref)	1.09 (0.86-1.37)
2 CPIs vs. No CPI (ref)	1.90 (1.20-2.99)
3 ≥ CPIs vs. No CPI (ref)	0.98 (0.42-2.29)
Demographics	
Age	1.00 (0.97-1.02)
Sex: Female vs. Male (ref)	0.67 (0.55-0.81)
Income:	
High vs. Medium (ref)	0.90 (0.71-1.16)
Low vs. Medium (ref)	1.09 (0.86-1.38)
Ethnicity:	
Black vs. White (ref)	0.49 (0.26-0.90)
Indigenous vs. White (ref)	1.79 (1.11-2.88)
Other vs. White (ref)	0.59 (0.35-0.98)
Other Asian vs. White (ref)	0.55 (0.37-0.81)
South Asian vs. White (ref)	0.39 (0.26-0.60)
Clinical Functioning	
Health Utility Index	0.60 (0.56-0.63)
C-Statistic	0.77
CPI= chronic physical illness; OR= odds ratio; CI= confidence interval.	
Results are reported as adjusted ORs and 95% CIs. Statistically significant findings are shown in bold.	

Supplementary Figure 1.
Prevalence of Chronic Physical Illnesses.



Supplementary Figure 2.
Prevalence of Mental Disorders.



Chapter 6: Manuscript 2

Health functioning moderates the association between physical and mental illness in childhood.

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Abstract

Objectives: To quantify associations between chronic physical illness and mental illness; investigate potential moderating effects of child age, sex, health functioning, mental health service contact, and household income on these associations; and explore the potential mediating effect of family functioning.

Methods: Data come from 6,242 children aged 4-17 years in the Ontario Child Health Study (OCHS). Physical illness was measured using a list of chronic conditions developed by Statistics Canada. The Emotional Behavioural Scales assessed mental illness. The Health Utility Index Mark III measured health functioning. Logistic regression models quantified associations between physical and mental illness. Product-term interactions identified moderating effects. The product of coefficients method was used to explore mediating effects.

Results: Physical illness was associated with mood disorder [OR=2.25 (95% CI: 1.36-3.74)]. Health functioning moderated the association between physical and any mental illness [OR=1.33 (1.13,1.57)], anxiety disorder [OR=1.24 (1.04, 1.47)], and attention-deficit hyperactivity disorder [OR=1.23 (1.03, 1.47)], suggesting that children with chronic physical illness with better health functioning had higher odds of these mental illness outcomes vs. children without physical illness. No other moderating effects were found. Family functioning did not mediate any associations between physical illness and mental illness outcomes.

Conclusion: The association between physical and mental illness in children is nuanced, with health functioning moderating this association for any mental illness, anxiety disorders, and attention-deficit hyperactivity disorder, specifically. Mental health screening programs should ensure children with chronic physical illness with better health functioning are routinely assessed and upstream interventions initiated early to reduce the incidence of physical-mental multimorbidity.

Keywords: children, health functioning, chronic physical illness, mental illness, multimorbidity, population health, secondary analysis

Key Messages:

- Approximately 28% of children have a chronic physical illness; they are twice as likely than their healthy peers to screen positive for a mood disorder.
- Children with physical illnesses with better health functioning have higher odds of any mental illness, anxiety disorders, and attention-deficit hyperactivity disorder than their peers without physical illness.
- Early mental health screening and monitoring is needed for children newly diagnosed with a chronic physical illness.

Health functioning moderates the association between physical and mental illness in childhood

Chronic physical illnesses, conditions that are expected to last ≥ 6 months (e.g., diabetes and epilepsy), and mental illness are highly comorbid in children (Holland et al., 2023; Merikangas et al., 2015). Co-occurring physical and mental illness, herein *multimorbidity*, has adverse outcomes throughout life, including lower quality of life (Lee et al., 2013; Tegethoff et al., 2015), lower academic achievement (Crump et al., 2013; Forrest et al., 2011), and higher suicidality (Romano et al., 2021). Children with multimorbidity have higher odds of emergency department visits, inpatient hospitalizations (Holland et al., 2023), and utilize more mental health care compared to children with mental illness only (Reaume et al., 2021). Prevalence of child multimorbidity is estimated at 15% to 30% in American and Canadian epidemiological samples (Ferro, 2016; Tegethoff et al., 2015). Given the prevalence and pervasive consequences of multimorbidity, the public health and clinical care implications are substantial.

Child age, sex, and socioeconomic status are robust risk factors for childhood mental illness (Costello et al., 2003; Ferro et al., 2022; Helseth et al., 2016; Merikangas et al., 2010; Roberts et al., 2007). In children with physical illness, cumulative diagnoses (Waters et al., 2008; Wolock et al., 2020) and functional limitations (Adams et al., 2019; Ferro et al., 2024b) are consistent predictors of mental illness. However, there is a paucity of research that examines factors that may moderate or mediate physical-mental multimorbidity. One study showed that the presence of a musculoskeletal condition among young adults increases risk of bipolar disorder for females compared to males, while risk of bipolar disorder was higher in males compared to females without musculoskeletal conditions (Ferro, 2016). Other research shows that family functioning mediates the association between maternal and adolescent depressive symptoms,

with larger mediating effects in adolescents with physical illness vs. those without (Ferro, 2015; Ferro & Boyle, 2015). Examining moderating and mediating factors in children is needed for targeted screening and appropriate resource allocation for at-risk children which can reduce the incidence of multimorbidity. These efforts would address calls for better integrated physical and mental health care for children (Ferro et al., 2022; Malla et al., 2018; Reaume & Ferro, 2019).

Given that age, sex, functional limitations, and low socioeconomic status are risk factors for mental illness, they may moderate physical-mental illness relationships, such that associations may be stronger in older children, females, children with poor health functioning, and children with low socioeconomic status, while associations may be attenuated for children who use mental health services. The objectives of this study were to: 1-quantify adjusted associations between chronic physical illness and mental illness; 2-investigate potential moderating roles of child age, sex, health functioning, mental health service contact, and household income on these associations; and, 3-explore the potential mediating effect of family functioning in physical-mental multimorbidity.

Methods

These analyses used epidemiological data from the 2014 Ontario Child Health Study (OCHS). The OCHS, a representative study conducted by Statistics Canada, consists of 10,802 children from 6,587 households across 240 neighbourhoods (Boyle et al., 2019b). Multistage sampling, stratified by household income, was used for sample selection, such that neighbourhoods were selected at the first stage, followed by census tract and dissemination areas, and households at the third stage (Boyle et al., 2019b). The target population included all private households in the province of Ontario in which children aged 4-17 years resided. Excluded were children living in collective dwellings (e.g., children in welfare or justice

systems) and on Indigenous reserves (due to data sovereignty). The household response rate was 50.8% (Boyle et al., 2019b). In-person data collection occurred between October 2014 and September 2015, using computer-assisted interviews and self-completed questionnaires. The person most knowledgeable (PMK), 88.3% being mothers, was asked to complete surveys for up to four children living in the household, one of which was randomly selected to be the index child (n=6,587). The sample represents 1,223,047 children in the province. The OCHS received ethical approval from the Hamilton Integrated Research Ethics Board (13-140). Data were deidentified; thus, ethical approval was waived for these analyses.

Chronic Physical Illness

The PMK reported on child chronic physical illness using a standard checklist of health professional-diagnosed conditions, that had lasted or was expected to last ≥ 6 months (Boyle et al., 2019b). Physical illnesses were those commonly found in children (Cortes et al., 2020; Miller et al., 2016): food or digestive allergies, respiratory allergies such as hay fever, any other allergies, asthma, bronchitis, cerebral palsy, diabetes, eczema, epilepsy, heart condition or disease, kidney condition or disease, and any other long-term condition. Endorsement of ≥ 1 condition indicated the presence of physical illness. Binary responses to a standard checklist are often used to examine conditions using a non-categorical lens (Stein & Silver, 1999) as evidence shows it is the consequences of physical illness, rather than the diagnostic label, that impacts mental health (Ferro, 2016; Ferro et al., 2022). Psychometric properties of this checklist are not reported by Statistics Canada; however, similar checklists show negligible misclassification bias (Baumeister et al., 2010).

Mental Illness

Mental illness was measured using the PMK-reported Emotional Behavioural Scales (EBS), a 52-item checklist, assessing symptoms of mental illness in the previous six months

(Boyle et al., 2019a; 2019c; Georgiades et al., 2019). Based on DSM-5 criteria, common childhood disorders were assessed (Barican et al., 2022; Polanczyk et al., 2015): major depressive, generalized anxiety, separation anxiety, social phobia, conduct, oppositional defiant, and attention-deficit hyperactivity disorder (ADHD). Each item was scored on a 3-point scale of (0) ‘never or not true’; (1) ‘sometimes or somewhat true’; and (2) ‘often or very true’. A total symptom score was summed for all seven illnesses (Boyle et al., 2019a; 2019c). Matching prevalence estimates from Georgiades et al. (2019), threshold scores on the EBS were used to dichotomize presence/absence of any mental illness, mood disorder (major depressive), anxiety disorder (generalized, separation, social phobia), behaviour disorder (conduct, oppositional defiant), and ADHD. The EBS has sound psychometric properties (Boyle et al., 2019a; Duncan et al., 2019), including in samples of children with physical illness (Sajobi et al., 2023).

Health Functioning

Health functioning was measured using the Health Utilities Index Mark III (HUI). The HUI is a PMK-reported measure that assessed daily overall health and functioning across eight attributes: vision, hearing, speech, ambulation, dexterity, emotion, cognition, and pain (Horsman et al., 2003). The HUI accounts for disability, functional limitations, reliance on aids (e.g., glasses), and mechanical equipment (e.g., mobility and speech devices) (Horsman, 2003). A total score ranging from -0.34 (worse than death) to 1 (perfect health) was calculated, with 0 representing a death state (Horsman, 2003). Lower HUI scores indicate poorer health functioning. The HUI has been extensively validated across varying chronic illnesses, and in child clinical and population samples (Furlong et al., 2001; Horsman, 2003; Molina et al., 2023).

Mental Health Service Contact

Mental health service contact was assessed for type of provider and service setting in which the PMK discussed or knew the child discussed mental health concerns in the past six months. Types of mental health providers included general care providers (family doctor, pediatrician, nurse, other type of medical specialist), mental care providers (psychiatrist, psychologist, social worker), complementary/alternative providers (naturopath, religious leader), and helplines (crisis hotline). Service settings included specialized mental health or addiction agencies, urgent or emergency care, and school-based services. Endorsing ≥ 1 mental health provider or mental health setting indicated mental health service contact (Georgiades et al., 2019).

Family Functioning

The PMK completed the 12-item General Functioning subscale of the McMaster Family Assessment Device (FAD), which provided an overall assessment of how well families work together to complete everyday tasks (Byles et al., 1988). Response options include (1) strongly agree, (2) agree, (3) disagree, and (4) strongly disagree (Byles et al., 1988). Items were summed (range: 12 to 48), where higher scores indicated greater dysfunction (Byles et al., 1988) and a score >26 indicated pathological family functioning (Miller et al., 1985; Statistics Canada, 2017). Psychometric properties of this subscale are good (Byles et al., 1988; Oltean et al., 2020).

Sociodemographic Covariates

Sociodemographic covariates were included in the analyses to control for potential confounding effects (Costello et al., 2003; Ferro et al., 2022; Helseth et al., 2016; Merikangas et al., 2010; Owais et al., 2022; Roberts et al., 2007). These were age, sex, household income (low: <20 th percentile of the sample median, mid: between low and high percentiles, and high: ≥ 80 th

percentile), and ethnicity of the PMK (Black, Indigenous, South Asian, Other Asian, White, and other).

Analysis

Analyses were conducted in SAS 9.4, using sampling weights calculated by Statistics Canada to maintain representativeness with the Ontario population. Due to the complex survey design, the balanced repeated replication variance estimation method was used with generalized bootstrap weights and the Fay adjustment to produce accurate standard errors (Beaumont & Patak, 2012). Descriptive and bivariate statistics were used to compare sociodemographic characteristics of children based on health status ('healthy', 'physical illness only', 'mental illness only', and 'multimorbid'). Cross-tabulations were used to calculate the lifetimes prevalence of chronic physical illness and six-month prevalences of mental illness, multimorbidity, and mental health service contact. Prevalence estimates are presented with weighted percentages and frequencies.

Logistic regression models quantified adjusted associations between physical and mental illness. Results are reported with adjusted odds ratios (ORs) and 95% confidence intervals (CIs). Raw HUI scores were scaled by a factor of 10 to facilitate interpretations of ORs (Lima & Kopec, 2005; Miller et al., 2012). Product-term interactions between physical illness and child age, sex, health functioning, mental health service contact, and household income were included in logistic regression models to examine potential moderating effects. The product of coefficients method was used to explore if family functioning mediated associations between physical and mental illness (MacKinnon, 2008).

Missing Data

In total, 4.6% of children had missing data. Missing data for any mental illness was associated with higher health functioning (OR=1.14 [1.04, 1.26]). Given the low level of missing data, complete case analysis (n=6,242) was used for main effects and moderation analyses (Madley-Dowd et al., 2019). For exploratory mediation analyses, 9.2% of children had missing data and missing data was more likely among Other Asian (vs. White) children (OR=1.54 [0.30, 0.96]), children from low-income households (vs. middle income) (OR=1.47 [1.02, 2.11]), and children with higher health functioning (OR=1.20 [1.12, 1.27]). Completed case analysis was also used for mediation models (n=5,935).

Results

Sample Characteristics

In the sample, the sex distribution was nearly equal (629,528; 51.4% males), the mean age was 10.6 years (SE=0.09), and the mean health functioning score was 0.92 (SE=0.001). One-fifth of children (261,739; 21.4%) had mental health service contact. Over half (712,312; 58.2%) of households reported a mid-level annual income. The mean FAD score was 19.0 (SE=0.07) and most households reported healthy family functioning (1,048,557; 90.8%).

Overall, 62.8% (767,668) of children were healthy (no physical or mental illness), 28.3% (347,165) had ≥ 1 chronic physical illness, 14.9% (182,190) screened positive for ≥ 1 mental illness, and 6.0% had multimorbidity. Prevalence estimates were 3.9% (48,033) for mood, 6.7% (81,185) for anxiety, 6.2% (75,804) for behaviour, and 7.8% (94,960) for ADHD. Detailed sample characteristics are shown in Table 1.

Main Effects

Physical illness was associated with increased odds of mood disorder (Table 2; OR=2.25 [1.36, 3.74]) but was not associated with other mental illnesses. The main effects of the

moderators showed older age increased the odds of mood disorder (OR=1.17 [1.09, 1.25]) and lowered the odds of ADHD (OR=0.91 [0.88-0.95]). Female children had lower odds for any mental illness (OR=0.68 [0.50, 0.91]) and ADHD (OR=0.43 [0.31, 0.61]). Higher health functioning scores were associated with lower odds of mental illness across all models (OR range: 0.63-0.77). Mental health service contact was associated with higher odds of mental illness across all models (OR range: 3.71-7.47). No associations were found for household income.

Moderating Effects

Health functioning moderated the association between physical and any mental illness (Table 3; OR=1.33 [1.13, 1.57]), anxiety disorder [OR=1.24 (1.04, 1.47)], and ADHD [OR=1.23 (1.03, 1.47)]. This suggests for higher health functioning, children with physical illness have higher odds of any mental illness, anxiety disorder, and ADHD versus children with no physical illness. However, in the presence of lower health functioning, where there are more functional limitations, the effect of physical illness is negated. No other moderating effects were found.

Mediating Effects

While physical illness was not associated with family functioning (Table 4; path α : B= -0.20, CI: 0.61-1.07), family functioning was associated with all mental illness outcomes (β paths). Family functioning did not mediate any associations between physical and mental illness.

Discussion

Summary of Findings

In this representative epidemiological sample, children with physical illness were more than twice as likely than children without physical illness to report mood disorder. This is consistent with previous reports of increased rates of major depressive disorder among emerging

adults with chronic conditions (Butwicka et al., 2015; Ferro, 2016). Across all adjusted main effect models, health functioning was associated with mental illness. This finding is consistent with research using high-risk samples of children with physical illness (Ferro et al., 2022; 2024b). A dose-response was also observed, such that health functioning scores decreased from ‘healthy’ to ‘chronic physical illness only’ to ‘mental illness only’ to ‘multimorbid’ children. Health functioning can be targeted to potentially reduce the incidence of multimorbidity—limitations such as restrictions in walking, dressing, and expressing thoughts independently (Feng et al., 2009; Furlong et al., 2001) are potentially modifiable with therapeutic interventions like pain management, mobility aids, and communication devices (Furlong et al., 2001; Horman et al., 2003; Solmi et al., 2023). Improved functioning may assist children in participating more meaningfully in their families, schools, and communities (Lollar et al., 2012; Solmi et al., 2023). Efforts to reduce barriers (e.g., poor service reach and long wait times) for accessing these therapeutic interventions, allowing for early interventions and improved mental health outcomes, should be prioritized (Arakeylan et al., 2020; Waddell et al., 2019). Further research is needed to develop evidence-based therapeutic interventions for addressing limitations specific to childhood-onset multimorbidity.

Health functioning also moderated the association between physical and mental illness, suggesting children with physical illnesses with better health functioning have a higher likelihood of any mental illness, anxiety disorders, and ADHD. Social development experiences differ for children with physical illness, such that children with better health functioning have more frequent participation in structured and unstructured activities compared to children with poorer health functioning (Arakeylan et al., 2020). However, these experiences can be associated with intentional and unintentional victimization due to disability-related issues (e.g., low

stamina; Pinquart, 2017) and lower levels of belonging (Ferro et al., 2024a), hindering the psychosocial development of children with better health functioning. Higher rates of depression and anxiety have been reported in children with chronic physical illnesses versus children with life-limiting illnesses (Barker et al., 2023), suggesting the mental health of children with poorer health may be less impacted than children with better health (Ferro et al., 2021a). Combined, these findings suggest that children with poorer health functioning may adapt to the limitations that their physical illnesses impose on their lives (Fayed et al., 2020) and thus may be more resilient to declines to their mental health. Alternatively, the mental health of children with poorer health functioning may be overshadowed by their physical health needs. Mental health assessments may also be difficult, with a higher prevalence of intellectual disorders amongst children with poorer health functioning, resulting in an underreporting of mental illnesses (Barker et al., 2023). These inferences are speculative; longitudinal research is needed to understand the pervasive role of health functioning in the development of childhood multimorbidity.

Mediation analyses, which were exploratory, suggested family functioning did not mediate any associations between physical and mental illness. Given health functioning moderated the presence of multimorbidity, the mediating role of family functioning maybe more nuanced; resembling processes of mediated-moderation (i.e., the magnitude of the mediating effect of family functioning differs for children with vs. without physical illness) or moderated-mediation (i.e., the mediating process is hypothesized to be different for children with vs. without physical illness) (Ferro, 2015). Additional research to elucidate mediating factors in child multimorbidity is needed.

In the context of integrated care, the health, mental health, and education system must collaborate to support the complex needs of children with physical illness and reduce the incidence of multimorbidity (Ferro et al., 2021b). Policies and programs supporting the participation of children with physical illness and multimorbidity in structured and unstructured activities and curriculums targeting social skills (Arakeylan et al., 2020; Bedard et al., 2022) can be offered in schools and communities. Further, the EBS can be used as part of routine mental health screening (Halladay et al., 2023) and can ensure timely referrals and access to supportive resources. Structured care plans with clear communication and information sharing supports the coordination of services and reduces duplication of services (King et al., 2024). Integrated care can improve mental health treatment completion, contributing to better psychosocial outcomes (Burkhart et al., 2020).

Limitations

There are limitations to this study. First, the OCHS is cross-sectional; thus, causation cannot be inferred, and mediation analyses are exploratory. Second, data were collected prior to the COVID-19 pandemic; the current burden of physical-mental multimorbidity may be underestimated. Third, the OCHS excluded potentially high-risk populations (Waddell et al., 2019). While they represent a small fraction of the child population, findings cannot be generalized to those groups.

Conclusion

Chronic physical illness in children is common and these children are more than twice as likely as their healthy peers to have a mood disorder. The relationship between physical and mental illness is further nuanced by the moderating effect of health functioning. Specifically, children with physical illness with better health functioning have increased odds of any mental

illness, anxiety disorders, and attention-deficit hyperactivity disorder compared to their peers without physical illness. An integrated health care strategy that addresses health functioning may be useful in preventing multimorbidity in children. Future research is needed to identify evidence-based interventions to address the holistic needs of children with physical illness.

Data Access

Data access is available through Statistics Canada Research Data Centres.

Conflicts of Interest

Dr. Ferro is an Associate Editor for Child: Care, Health and Development. The authors declare no other conflicts of interest.

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Table 1. Sample Characteristics

	Total	Morbidity Status			
		Healthy	Physical Illness Only	Mental Illness Only	Multimorbid Only
Weighted N	1,223,047	767,668	273,189	108,214	73,976
% of Total Sample, N=6,242 (95% CI)	100	62.77 (60.60-64.93)	22.33 (20.46-24.21)	8.84 (7.68-10.01)	6.04 (4.88-7.21)
Age (Mean, 95% CI)	10.60 (10.40-10.79)	10.30 (10.60-10.55)	11.08 (10.69-11.47)	10.61 (10.03-11.19)	11.86 (11.05-12.67)
Health functioning (Mean, 95% CI)	0.92 (0.91-0.92)	0.96 (0.95-0.96)*	0.91 (0.90-0.93)*	0.80 (0.76-0.82)*	0.75 (0.70-0.80)*
Male	51.47 (49.24-53.70)	49.56 (46.76-52.35)	50.56 (45.76-55.36)	60.02 (53.41-66.62)	62.22 (52.40-72.05)
Ethnicity:					
Black	5.14 (4.27-6.02)	5.36 (4.30-6.42)	6.37 (3.93-8.80)	2.00 (0.93-3.06)	2.99 (0.90-5.09)
Indigenous	2.59 (1.92-3.25)	2.00 (1.36-2.66)	2.42 (0.79-4.06)	6.03 (2.50-9.58)	4.15 (0.87-7.44)
Other	5.94 (4.91-6.98)	6.46 (5.10-7.81)	5.45 (3.42-7.48)	4.71 (2.53-6.90)	4.24 (0-9.54)
Other Asian	12.19 (10.71-13.67)	13.83 (11.83-15.83)	11.38 (8.46-14.30)	6.59 (3.86-9.32)	6.33 (0.82-11.84)
South Asian	11.79 (10.29-13.28)	14.03 (12.02-16.05)	10.52 (7.40-13.64)	3.70 (1.41-5.98)	4.94 (0.54-9.35)
White	62.33 (60.18-64.50)	58.30 (55.53-61.05)	63.84 (59.21-68.48)	76.96 (71.71-82.20)	77.32 (68.67-85.97)
Lone parent household	20.41 (18.69-22.14)	20.01 (17.82-22.21)	17.81 (14.73-20.90)	23.39 (17.94-28.84)	29.91 (20.27-39.54)
Immigrant	37.19 (35.06-39.32)	42.68 (39.92-45.42)	34.44 (29.83-39.06)	19.26 (14.81-23.70)	16.68 (9.54-23.81)
Parent education:					
Did not complete secondary school	3.12 (2.48-3.76)	3.27 (2.48-4.06)	1.84 (0.86-2.84)	5.64 (2.14-9.16)	2.65 (0.41-4.90)
Secondary school completed	9.70 (8.49-10.91)	9.86 (8.29-11.43)	9.22 (6.91-11.63)	10.90 (6.50-15.31)	8.09 (4.00-12.17)
College, trade, or university below bachelor	41.00 (38.74-43.23)	39.06 (36.25-41.86)	42.08 (37.25-46.90)	44.51 (37.53-51.49)	51.86 (41.74-61.97)
Bachelor degree or higher	46.18 (43.94-48.42)	47.80 (44.99-50.62)	46.84 (42.01-51.67)	38.92 (32.52-45.32)	37.40 (27.66-47.14)
Household income:					
Low	20.46 (19.06-21.86)	19.51 (17.83-21.20)	20.49 (17.40-23.58)	24.84 (19.87-29.81)	23.67 (16.78-30.56)
Medium	58.24 (56.20-60.29)	58.98 (56.44-61.51)	56.83 (52.31-61.34)	56.24 (49.76-62.72)	58.70 (49.59-67.81)
High	21.30 (19.79-22.81)	21.50 (19.61-23.39)	22.68 (19.17-26.20)	18.91 (14.47-23.35)	17.63 (11.93-23.32)
Family functioning (healthy)	90.76 (89.50-92.01)	92.67 (91.30-94.03)	90.91 (87.92-93.90)	84.27 (79.57-88.96)	79.44 (71.60-87.29)
Chronic physical illness (any)	28.39 (26.32-30.44)	~	100%	~	100%
Mental illness:					
Any	14.90 (13.31-16.48)	~	~	100%	100%
Mood	3.94 (3.04-4.85)	~	~	19.18 (13.83-24.52)	36.87 (27.01-46.73)
Anxiety	6.67 (5.51-7.82)	~	~	41.76 (34.88-48.63)	48.80 (38.70-58.91)

Behaviour	6.20 (5.16-7.24)	~	~	41.47 (34.80-48.13)	41.80 (31.87-51.74)
Attention-Deficit Hyperactivity Disorder	7.80 (6.69-8.90)	~	~	53.11 (46.22-60.00)	50.74 (40.61-60.88)
Mental health service contact (any)	21.40 (19.59-23.21)	13.03 (11.26-14.81)	19.88 (15.87-23.90)	54.74 (47.83-61.66)	65.01 (55.47-74.55)

Data are weighted percentages (95% confidence interval) unless noted otherwise.

*Denotes difference with all other health status groups is statistically significant at $p < 0.05$.

Table 2. Association between Chronic Physical Illness and Mental Illness

	Mental Illness				
	Any Mental Illness	Mood	Anxiety	Behavior	ADHD
CPI (present) vs. Not present (ref)	1.24 (0.93-1.67)	2.25 (1.36-3.74)	1.41 (0.90-2.22)	1.13 (0.75-1.70)	1.07 (0.74-1.53)
Demographics					
Age	1.00 (0.97-1.02)	1.17 (1.09-1.25)	1.02 (0.98-1.07)	1.04 (0.99-1.09)	0.91 (0.88-0.95)
Sex: Female vs. Male (ref)	0.68 (0.50-0.91)	0.79 (0.46-1.37)	1.17 (0.79-1.73)	0.69 (0.47-1.00)	0.43 (0.31-0.61)
Income:					
High vs. Medium (ref)	0.89 (0.66-1.18)	0.75 (0.42-1.32)	0.71 (0.46-1.11)	0.76 (0.49-1.18)	1.00 (0.67-1.50)
Low vs. Medium (ref)	1.10 (0.84-1.42)	0.96 (0.54-1.70)	0.88 (0.60-1.30)	0.97 (0.67-1.40)	1.22 (0.87-1.72)
Ethnicity:					
Black vs. White (ref)	0.41 (0.26-0.65)	0.13 (0.06-0.31)	0.48 (0.23-0.97)	0.43 (0.20-0.90)	0.45 (0.21-0.96)
Indigenous vs. White (ref)	1.57 (0.83-2.94)	4.77 (2.10-10.80)	2.33 (1.10-4.95)	2.19 (1.18-4.07)	2.31 (1.24-4.29)
Other vs. White (ref)	0.79 (0.42-1.48)	0.76 (0.23-2.47)	1.54 (0.70-3.38)	0.68 (0.33-1.37)	0.50 (0.24-1.00)
Other Asian vs. White (ref)	0.48 (0.28-0.82)	0.73 (0.19-2.78)	0.66 (0.29-1.52)	0.78 (0.41-1.43)	0.46 (0.22-0.97)
South Asian vs. White (ref)	0.31 (0.17-0.62)	0.06 (0.01-0.24)	0.29 (0.14-0.61)	0.27 (0.06-1.28)	0.39 (0.13-1.16)
Clinical functioning					
Health functioning	0.66 (0.60-0.72)	0.69 (0.62-0.76)	0.72 (0.66-0.80)	0.77 (0.70-0.84)	0.63 (0.58-0.70)
Mental health service contact	4.56 (3.31-6.26)	7.47 (4.06-13.74)	3.90 (2.54-5.96)	5.60 (3.60-8.70)	3.71 (2.61-5.28)
C-Statistic	0.81	0.90	0.80	0.80	0.84

CPI = chronic physical illness; ADHD = Attention-Deficit Hyperactivity Disorder.

Results are reported as adjusted odds ratios (95% confidence intervals). Statistically significant estimates are shown in bold.

Table 3. Moderating Effects of Age, Sex, Household Income, Health Functioning, and Mental Health Service Contact on Mental Illness

	Mental Illness				
	Any Mental Illness	Mood	Anxiety	Behavior	ADHD
Age	1.05 (0.99-1.12)	0.99 (0.84-1.16)	1.02 (0.92-1.13)	1.05 (0.94-1.18)	1.03 (0.94-1.14)
Sex: Female vs. Male (ref)	0.80 (0.46-1.40)	0.43 (0.14-1.33)	0.70 (0.32-1.52)	1.37 (0.70-2.61)	0.78 (0.42-1.43)
Income:					
High vs. Medium (ref)	0.81 (0.39-1.71)	0.78 (0.24-2.44)	1.02 (0.45-2.32)	0.69 (0.26-1.85)	1.38 (0.55-3.44)
Low vs. Medium (ref)	0.68 (0.34-1.36)	0.53 (0.17-1.68)	0.69 (0.28-1.69)	0.39 (0.14-1.01)	1.20 (0.57-2.52)
Health functioning	1.33 (1.13-1.57)	0.91 (0.76-1.10)	1.24 (1.04-1.47)	1.07 (0.88-1.29)	1.23 (1.03-1.47)
Mental health service contact	1.18 (0.63-2.23)	0.97 (0.27-3.47)	1.62 (0.64-4.06)	1.39 (0.56-3.41)	0.70 (0.31-1.54)

ADHD = Attention-Deficit Hyperactivity Disorder.

Results are reported as adjusted odds ratios (95% confidence intervals) and those in bold are statistically significant. Healthy children (no physical or mental illness) was the reference group. Product-term interactions between having a physical illness and child age, sex, household income, health functioning, and mental health service contact were included in the adjusted logistic regression models.

Table 4. Mediating Effect of Family Functioning

	α Path	β Path	c' Path	$\alpha\beta$
Any Mental Illness		0.72 (1.36-3.11)	0.22 (0.93-1.67)	-0.14 (0.72-1.03)
Mood Disorder		0.92 (1.34-4.73)	0.81 (1.36-3.73)	-0.18 (0.67-1.03)
Anxiety Disorder	-0.20 (0.61-1.07)	0.97 (1.72-4.00)	0.34 (0.90-2.22)	-0.19 (0.64-1.07)
Behavioural Disorder		0.80 (1.37-3.68)	0.12 (0.75-1.70)	-0.16 (0.70-1.04)
Attention-Deficit Hyperactivity Disorder		0.52 (1.01-2.81)	0.07 (0.74-1.53)	-0.1 (0.81-1.00)

Results are reported as regression coefficients and 95% confidence intervals. Statistically significant associations are bolded. Analyses adjusted for child age, sex, health functioning, PMK ethnicity, household income, and mental health service contact.

Chapter 7: Manuscript 3

Mental health service contact in children with and without physical-mental multimorbidity.

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Abstract

Purpose: To estimate six-month prevalence of child mental health service contacts and quantify associations between child health status and mental health service contacts, including number of types of contacts.

Methods: Data come from 6,242 children aged 4-17 years in the Ontario Child Health Study. A list of chronic conditions developed by Statistics Canada measured physical illness. The Emotional Behavioural Scales assessed mental illness. Child health status was categorized as healthy, physical illness only, mental illness only, and multimorbid (≥ 1 physical and ≥ 1 mental illness). Mental health service contact was aggregated to general medicine, urgent medicine, specialized mental health, school-based, alternative, and any contact (≥ 1 of the aforementioned contacts). Regression models quantified associations between health status and type of mental health contact, including number of types of contacts.

Results: Weighted prevalence estimates showed 261,739 (21.4%) children had mental health-related service contact, with school-based services being the most common contact amongst all children, regardless of health status. Children with multimorbidity had higher odds for every mental health contact than healthy controls (OR range: 4.00-6.70). A dose-response was observed, such that the number of contacts increased from physical illness only (OR = 1.49, CI: 1.10-1.99) to mental illness only (OR = 3.39, CI: 2.59-4.44) to multimorbidity (OR = 4.13, CI: 2.78-6.15).

Conclusion: Over one-fifth of children had mental health-related service contact and contacts were highest among children with multimorbidity. Types of mental health contacts for children with multimorbidity are diverse, with further research needed to elucidate the barriers and facilitators of mental health use.

Keywords: children, mental health care service research, chronic physical illness, mental illness, multimorbidity

Mental health service contact in children with and without physical-mental multimorbidity

Due to medical and public health advancements, childhood mortality has significantly decreased in the past century while childhood chronic physical illnesses and disability have increased [1]. Approximately 28% of Canadian children have a chronic physical illness [2] and estimates suggest that children with a chronic physical illness account for a disproportionate amount of pediatric healthcare costs [3]. Children with chronic physical illness endure biopsychosocial challenges, such as high illness management needs, low self-esteem, and functional and school limitations [4-8]. Challenges associated with chronic physical illness predisposes these children to an increased risk of mental illness, a risk that is common across different physical illnesses [8-10], and a risk that ultimately affects upwards of 58% of children living with physical illness [8].

Physical-mental comorbidity, defined as having ≥ 1 physical and ≥ 1 mental illness, can have detrimental consequences for children across their lifespan including negative impacts on quality of life [11-13], physical and mental health functioning [13-14], self-esteem [7, 14], academic achievement [15-16], and suicidality [17]. If unaddressed, mental health challenges are also associated with higher medical speciality clinic drop-outs, medication non-compliance, and subsequent deterioration with physical illnesses [18]. Like chronic physical illness [19], mental illness experienced early life often continues into adulthood [20-23], placing considerable strain on children, families, and health and social systems. Thus, addressing the mental health of children living with chronic physical illness is an urgent public health concern.

Despite recognized mental health need in children living with chronic physical illness [5, 18, 24-25], there is a dearth of research examining the influence of child health status (e.g., physical illness only, mental illness only, and physical-mental multimorbidity) on mental health-

related service contact. Andersen's Behavioral Model of Health Service Use outlines three determinants that affect individual use of services: predisposing characteristics (e.g. sociodemographics), enabling resources (e.g., finances and availability of personnel to provide services), and need-related factors (e.g., perceived and assessed need, including health status) [26]. A large systematic review showed need-related factors, rather than predisposing or enabling, have driven mental health service utilization for adults with mental disorder [27]. Specific to physical illness, Canadian research shows 60% of youth aged 15 to 24 years with multimorbidity discussed mental health concerns with health professionals compared to 12% with physical illness only and 34% with mental illness only [28]. Similarly, another Canadian study found young adults aged 15 to 29 years with multimorbidity, versus singular diagnoses, were more likely to perceive a need for mental health care, use more types of mental health care, and report less unmet mental health need [29]. In an American adolescent sample, multimorbid adolescents had higher odds of emergency department visits and inpatient hospitalizations [30]. Combined, these findings suggest that the mental health need of young adults with physical-mental multimorbidity are treated upstream.

However, health status as a need-based factor, has yet to be examined in an epidemiological sample inclusive of young children, where early intervention can have the most impact [4-5]. As the effect of health status on mental health service use is unknown in young children, and whether a potential increase in mental health services is driven by physical or mental health illnesses, recommendations for resource allocation are challenging. Understanding how children with multimorbidity navigate the mental health system will elucidate patterns of service use and identify the multiple sectors and ministries needed to implement system integration.

This retrospective study addresses the gap in mental health service research by examining child health status as a mental health service need-based factor in a population sample inclusive of young children and of settings and providers that children utilize. Data from the 2014 Ontario Child Health Study (OCHS) are used to 1) estimate the six-month prevalence of health status and types of mental health service contact; 2) quantify adjusted associations between health status and type of mental health service contact; and 3) quantify adjusted associations between health status and number of different types of mental health service contacts. Findings can be used to inform health policy, such that early interventions can be provided efficiently to children and families in need of mental health services.

Methods

The 2014 Ontario Child Health Study (OCHS), a representative, epidemiological study conducted by Statistics Canada, consisted of 10,802 children from 6,587 households across 240 neighbourhoods [31]. Multistage sampling, stratified by household income, was used for sample selection. The target population included all private households in the province of Ontario in which children ages 4 to 17 years resided. Excluded were youth living in collective dwellings (e.g., children in welfare and justice systems) and on Indigenous reserves. The household response rate was 50.8% [31]. In-person data collection occurred between October 2014 and September 2015, using computer-assisted interviews and self-completed questionnaires. The person most knowledgeable (PMK), 88.3% being mothers, was asked to complete surveys for up to four children living in the household, one of which was randomly selected to be the index child (n=6,587). The PMK completed mental health-related service contact questions for the index child only. The sample of 6,537 children represents 1,223,047 children in the province. The OCHS received ethical approval from the Hamilton Integrated Research Ethics Board (13-140).

Chronic Physical Illness

The PMK reported on child chronic physical illness using a standard checklist of health professional-diagnosed conditions, that had lasted or were expected to last at least six months [31]. Physical illnesses included: food or digestive allergies, respiratory allergies such as hay fever, any other allergies, asthma, bronchitis, cerebral palsy, diabetes, eczema, epilepsy, heart condition or disease, kidney condition or disease, and any other long-term conditions. A binary variable was created such that endorsement of at least one condition indicated the presence of physical illness. Binary responses to a standard checklist are often used to examine conditions from a non-categorical approach as it is the consequences of physical illness, rather than the diagnostic label, that impacts mental health [9-10]. An ordinal variable was also created, indicating the presence of 0, 1, or ≥ 2 physical illnesses. Psychometric properties of this checklist are not reported by Statistics Canada; however, similar checklists show negligible misclassification bias [32].

Mental Illness

Mental illness was measured using the PMK-reported Emotional Behavioural Scales (EBS), a 52-item checklist, assessing symptoms of mental illness in the previous six months [33-35]. Based on DSM-5 criteria, the following disorders were assessed: major depressive, generalized anxiety, separation anxiety, social phobia, conduct, oppositional defiant, and attention-deficit hyperactivity. Each item was scored on a 3-point scale of (0) 'never or not true'; (1) 'sometimes or somewhat true'; and (2) 'often or very true'. Matching prevalence estimates from Georgiades et al. (2019), threshold scores on the EBS were used to dichotomize the presence of any mental illness. An ordinal variable was also created, indicating the presence of 0, 1, or ≥ 2 mental illnesses. The EBS has sound psychometric properties [34, 36], including in samples of children with physical illness [37]. Used as a categorical measure, the EBS average

test-retest reliability (based on k) is 0.67 and indicators of convergent validity (i.e., β coefficients) averaged 0.69 [34].

Health Status Categories

Using the binary chronic physical illness and mental illness variables, child health status was categorized as ‘healthy’ (no physical and no mental illness), ‘chronic physical illness only’, ‘mental illness only’, and ‘multimorbid’ (at least one physical illness and at least one mental illness). These health status categories were used in all analyses and regression models, with healthy children being the reference category.

Mental Health Service Contact

Mental health-related service contacts made in the last six months were assessed by asking the PMK about mental health providers and settings in which they discussed the mental health concerns of their child or in which they knew their child discussed mental health-related concerns. Responses were aggregated and binary variables were created to indicate type of mental health service contact, which included general medicine (family doctor, pediatrician, nurse, other type of medical specialist), urgent medicine (walk in clinic, urgent care, emergency departments), specialized mental health (psychiatrist, psychologist, social worker, counsellor, general therapist, mental health or addictions agency), school-based (school or guidance counsellor, teacher, or trusted adult at school), alternative (helpline, crisis line, naturopath, herbalist, religious or spiritual leader), and any contact (a binary variable indicating having had ≥ 1 of the aforementioned types of contact) [35]. An ordinal variable was also created to indicate the number of different types of mental health-related service contacts (0, 1, 2, or ≥ 3). Sample characteristics for urgent and alternative mental health-related service contacts did not meet

Statistics Canada data vetting requirements and were thus excluded from the current study. Similarly, models for urgent mental-health service contact could not be reported.

Sociodemographic Covariates

Sociodemographic covariates were included in the analyses to adjust for potential confounding effects on associations between health status and mental health service contact [29, 35, 38-39]. These were age, sex (female vs. male), overall functional health (as measured by the Health Utility Index Mark 3; 40), household income (low: <20th percentile of the sample median, mid: between low and high percentiles, and high: $\geq$ 80th percentile), ethnicity of the PMK (Black, Indigenous, other, Other Asian, South Asian, and White), PMK immigrant status (yes vs. no), and PMK educational attainment (did not complete secondary school, completed secondary school, college or trade certificate below a bachelor degree, and bachelor degree). Family functioning (functional vs. dysfunctional as measured by the McMaster Family Assessment Device; 41) and lone parent household status (1 parent vs. $\geq$ 2 parents) were reported for descriptive statistics only.

Analysis

Descriptive and bivariable statistics were used to compare sociodemographic characteristics of children across health status. Cross-tabulations were used to calculate the lifetime's prevalence of chronic physical illness, and six-month prevalences of mental illness, multimorbidity, and mental health service contact. Prevalence estimates are presented with weighted percentages and frequencies. Logistic regression models quantified adjusted associations between health status categories and type of mental health-related service contacts. An ordinal logistic regression examined the association between health status and number of different types of mental health service contacts. Results are reported with adjusted odds ratios

(ORs) and 95% confidence intervals (CIs). Raw overall functional health scores (Health Utilities Mark 3) were scaled by a factor of 10 to facilitate interpretations of ORs [42-43]. Analyses were conducted in SAS 9.4, using sampling weights calculated by Statistics Canada to maintain representativeness with the Ontario population. Due to the complex survey design, the balanced repeated replication variance estimation method was used with generalized bootstrap weights and the Fay adjustment to generate accurate standard errors.

Missing Data

In total, 4.6% of children had missing data in at least one covariate. Missing data for any mental health service contact was associated with higher functional health scores (OR=1.60 [1.37, 1.88]), female children (OR=7.72 [2.54, 23.51]) and being from a lone parent household (OR=5.42 [1.66, 17.71]). Given the low level of missingness, complete case analysis (n=6,242) was used [44].

Results

Sample Characteristics

The sex distribution was nearly equal (629,528; 51.4% males), the mean age was 10.6 years (SE=0.09), and the mean overall functional health score was 0.92 (SE=0.001). Most children came from two-parent households (971,050; 79.6%), 762,429 (62.3%) were White, and 517,260 (37.1%) were immigrants. Almost half of PMKs (556,115; 46.1%) had at least a bachelor degree, over half (712,312; 58.2%) of households reported a mid-level annual income, and most households reported healthy family functioning (1,048,557; 90.8%). Overall, 62.8% (767,668) of children were healthy (no physical or mental illness), 28.3% (347,165) had at least one chronic physical illness, 14.9% (182,190) screened positive for at least one mental illness, and 6.0% (73,976) reported multimorbidity. Regarding specific health status categories, 22.3%

(273,189) had chronic physical illness only and 8.8% (108,214) had mental illness only. One-fifth of children (261,739; 21.4%) had mental health service contact. Mental-health-related service contacts included: 10.5% (129,044) for general medicine, 1.1% (13,555) for urgent medicine, 10.7% (130,461) for specialized mental health, 14.0% (170,797) for school-based, and 2.9% (35,510) for alternative care contact. Detailed sample characteristics are listed in Table 1.

Prevalence of Different Types of Mental Health-Related Service Contacts

As shown in Table 2, the distribution in the prevalence of mental health-related service contacts in the last six months differed significantly across health status (X^2 range: 94.0 to 287.6; $p < 0.001$ for all). A dose-response was observed: healthy children had the lowest prevalence of service contact (13.0%), followed by chronic physical illness only (19.9%), mental illness only (54.7%), and children with multimorbidity had the highest prevalence (65.0%). Across all health status groups, school-based mental health-service related contact was the most common type of contact.

Adjusted associations between health status and six-month mental health-related service contacts were examined with logistic regressions (Table 3). Like unadjusted analyses, dose-response associations were found for all but one outcome (alternative service contacts); in reference to healthy controls, odds of mental health-related service contacts increased across health status groups. Children with a chronic physical illness only were not more likely than healthy controls to report general, specialized, or alternative mental health-related service contacts. For all service contacts, magnitudes of association were significantly larger for mental illness only and multimorbid compared to chronic physical illness only.

Health Status and Number of Types of Mental Health Service Contacts

An ordinal regression model was computed to quantify the association between child health status and number of different types of mental health-related service contacts (Table 4). Each health status category, as compared to healthy children, was associated with a higher number of different types of mental health-related service contacts in a dose-response manner. Having a chronic physical illness only (OR=1.49, CI: 1.10-1.99), a mental illness only (OR=3.39, CI: 2.59-4.44), and multimorbidity (OR=4.13, CI: 2.78-6.15) was associated with higher odds of having more types of mental health-related service contacts. Again, magnitudes of associations for mental illness only and multimorbidity were significantly larger than for chronic physical illness only. Odds ratios for mental illness only and multimorbidity were not significantly different from each other.

Discussion

Summary of Findings

In this epidemiological sample, one in five children reported mental health service contact in the prior six months before being surveyed, with school-based mental health service contact being the most common contact amongst general medicine, urgent medicine, specialized mental health, and alternative providers and settings. Given children in this sample were all school aged for elementary and secondary education in Ontario, this finding is not surprising and aligns with literature using OCHS data [35]. The Ministry of Education has an important role in child mental health planning and service provision. School-based universal and targeted mental health interventions are effective and promote mental health help-seeking behaviour [45]. Continued investments to support children's mental health in schools is warranted.

School-based mental health contact was also the most common contact across all health categories, including for children with chronic physical illness only and multimorbidity. This

finding is surprising because children with physical illness have higher school absenteeism [15-16] and they may have opportunities to discuss their mental health concerns with medical professionals overseeing their physical health condition. In addition, primary health care for children living in Ontario is provided in primary care settings with general medicine providers, not in school-based settings. Mental health care for children is accessed in numerous ways (e.g., community-based mental health agencies, physician offices, crisis support services, youth wellness hubs), not necessarily only in school-based settings. Mental health initiatives aimed at addressing the mental health of individuals with chronic physical illness has uniquely positioned physicians to provide patient training on physical health conditions, screen for mental illness, and provide appropriate mental health referrals when necessary [46]. One study showed parents of children with mental illness only had lower mental health literacy and fewer mental health professionals to contact than parents of children with complex medical conditions [47]. Thus, proactive mental health discussions during clinic appointments reflect upstream prevention of mental illness for children with physical illness, reducing the need for mental health contact in other settings.

However, as results from this study show children with physical illness have more mental health-related service contact in school versus medical settings, these children may have similar treatment needs as their peers, which may be adequately addressed in schools. Alternatively, their preference for accessing mental health services may be in school settings, where regular attendance would decrease barriers to care and health promotion initiatives reduce mental health stigma. Further, teachers or guidance counsellors in schools may also be initiating mental health conversations with students and families based on behavioural concerns [48]. These inferences are speculative; additional research is needed to elucidate the preferences of different types of

mental health service contact and uptake of mental health services (location, duration, treatment). Early interventions should ideally be delivered in a way that incorporates schools and general practitioners [49].

The burden of mental illness was evidenced across multiple models. A dose-response association between health status and type of mental health service category was found in unadjusted and adjusted analyses. The odds of discussing mental-health related concerns with a general medicine, specialized mental health, school-based, and any service contact significantly increased from children with physical illness only to mental illness only to multimorbid children. As odds of mental health service contact for children with mental illness only vs. multimorbidity did not significantly differ from each other, the importance of primary mental illness prevention efforts is crucial. Evidence suggests that mental illness has a more profound impact than physical illness on children and their families [47], costs Canadians \$64 billion annually [50] and is the leading cause of childhood disability worldwide [51]. Schools are well positioned to offer primary interventions and support students with mild mental health needs [52].

This study also investigated the association between health status and the number of different types of mental health service contacts. A dose-response, with the number of contacts increasing from physical illness only to mental illness only to multimorbidity was found. A similar dose-response was found in research examining professional mental health service use in young Canadians aged 15 to 24 years, which also showed a cumulative effect of multiple needs (e.g., mental and physical health needs and childhood trauma needs) on the number of contacts [28]. In the context of chronic physical illness, strong rapport between children and physicians they see routinely may prompt mental health conversations, screenings, and referrals [53]. These findings draw attention to the importance of mental health knowledge not only for school

providers but for health professionals, and the need for coordination of care between medical, mental health, and school systems. A lack of integrated care across these settings complicates system navigation, burdening children and families [54]. Fragmented funding models for these systems contribute to siloed services, perpetuating barriers to mental health care [54]. Innovative programs, such as the Extensive Needs Integrated Pathway program [55] provides coordinated care across these systems for children with multiple needs, decreasing burden parents often have and reducing duplication in services.

Strengths

Strengths of the study include using OCHS data, a large and representative sample of children and their families, which supports the generalizability of findings, with significant contributions to and implications for health policy. Alignment between mental health service contact and the multiple domains in which children live was robust, encompassing health and school settings. Chronic physical illness, a need factor in accessing mental health care, is often overlooked in mental health research [56]. The current examination of mental health care pathways based on health status is novel in a sample of young children, with most research focusing on older adolescent and young adult populations [28-29], allowing for an examination of the critical role schools have as mental health care providers. The design of the OCHS allows findings from this study to contribute to youth mental health research, providing recommendations for resource allocation across multiple domains, and identifying the government ministries needed for youth mental health service planning and delivery. Future research can examine how services across school and general medicine settings can optimize collaboration and integrated mental health services for children with physical illness.

Limitations

There are limitations to the current study and its interpretations which warrant consideration. First, having mental health service contact does not equate to the receipt of mental health treatment. Current study data was not linked with Ontario health agency data repositories to validate mental health care use. Similarly, the PMK was only asked to rate their satisfaction of the helpfulness of general medicine and specialized mental health care providers addressing mental health concerns, eliminating the possibility of examining perceived helpfulness and perceived need being met across types of mental health care providers and settings. Likewise, due to Statistics Canada minimum weighting requirements, results for urgent care settings could not be reported, limiting the generalizability of findings to general medicine, specialized mental health, school-based, and alternative-based contacts. Second, the current study used parent proxies for reporting mental health service contact. Informant discrepancies exist between adolescents and parents, with parents reporting higher rates of mental health contact [35]. Third, the current study did not examine if more mental health service contact resulted in better mental health outcomes. Outcomes related to treatment effectiveness are necessary for physical and mental health system integration recommendations. Future longitudinal research that examines the temporality of physical and mental illness, changes in pathways to care based on health status, and perceived barriers to accessing care is needed. Similarly, research examining the interaction of childhood trauma and health status (including physical-mental-substance use multimorbidity) is needed to determine how perceived need and access to mental health care differ in children and adolescents [28-29]. Fifth, as children in the welfare and justice systems and on Indigenous reserves were excluded, results cannot be generalized to these high-risk children. Lastly, data from the OCHS was collected from 2014 to 2015. More contemporary and innovative modes of accessing mental health services, including e-health, could influence access

to care. While virtual care can increase access to and engagement with mental health services, including specialized services, and reduce delivery costs, efforts are needed to address privacy concerns, improve access for marginalized children, and address safety concerns for children with high psychopathology [57].

Conclusions

Regardless of health status, children and their caregivers are most likely to have discussions regarding concerns about mental health in school-based settings. Children with physical-mental multimorbidity have a high likelihood of having mental health service contact and have the highest number of contacts. Prevention of mental illness in children with physical illness is needed to decrease burden on families and the health and education systems. Schools are well-positioned to promote mental wellness and provide primary and secondary interventions. Integrated and coordinated care across health, mental health, and education systems is needed to support children with multimorbidity and reduce system inefficiencies. Research investigating mental health outcomes and whether care and treatment effectively addresses mental health need in medical and education systems would inform mental health strategies for children at risk of mental illness.

Data Access

Data access is available through Statistics Canada Research Data Centres.

Conflicts of Interest

The authors declare no conflicts of interest.

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Table 1. Sample characteristics

Characteristic, % (95% CI)	Type of mental health service contact					
	Total	General medicine	Specialized mental health	School-based	Alternative	Any
Weighted N	1,223,047	129,044	130,461	170,797	35,510	261,739
% of Total Sample, N = 6,242 (95% CI)	100	10.5 (9.2-11.9)	10.6 (9.3-12.0)	13.9 (12.4-15.5)	2.9 (2.2-3.6)	21.4 (19.5-23.2)
Age (Mean, 95% CI)	10.6 (10.4-10.7)	11.0 (10.4-11.5)	11.4 (10.9-12.0)	10.2 (9.7-10.6)	11.5 (10.5-12.5)	10.7 (10.3-11.1)
Health utility (Mean, 95% CI)	0.9 (0.9-0.9)	0.7 (0.7-0.8)	0.7 (0.7-0.8)	0.8 (0.7-0.8)	0.7 (0.6-0.8)	0.8 (0.8-0.8)
Male	51.4 (49.2-53.7)	63.0 (56.6-69.3)	58.2 (51.6-64.7)	57.7 (51.8-63.7)	56.9 (44.8-68.9)	56.8 (52.0-61.5)
Ethnicity:						
Black	5.1 (4.2-6.0)	1.5 (0.7-2.4)	2.8 (1.4-4.3)	2.5 (1.1-3.9)	*	2.6 (1.5-3.8)
Indigenous	2.5 (1.9-3.2)	4.4 (1.7-7.1)	5.2 (2.3-8.1)	4.8 (2.2-7.4)	*	4.5 (2.6-6.4)
Other	5.9 (4.9-6.9)	3.5 (1.6-5.4)	3.1 (1.6-4.7)	3.2 (1.9-4.6)	*	3.7 (2.4-5.0)
Other Asian	12.1 (10.7-13.6)	9.2 (4.9-13.6)	6.9 (3.3-10.6)	6.9 (4.0-9.9)	*	8.1 (5.5-10.7)
South Asian	11.7 (10.2-13.2)	2.7 (1.0-4.3)	3.8 (1.1-6.6)	2.4 (1.0-3.7)	*	3.5 (1.9-5.1)
White	62.3 (60.1-64.5)	78.4 (73.0-83.8)	77.8 (72.5-83.2)	80.0 (75.6-84.3)	*	77.2 (73.5-80.9)
Lone parent household	20.4 (18.6-22.1)	27.8 (21.6-33.9)	34.6 (28.3-40.8)	26.4 (21.3-31.5)	28.8 (18.1-39.6)	28.6 (24.2-32.9)
Immigrant	37.1 (35.0-39.3)	18.3 (13.8-22.8)	19.9 (14.8-25.0)	16.2 (12.7-19.8)	16.2 (9.0-23.3)	20.17 (16.7-23.6)
Parent Education:						
Did not complete secondary school	3.1 (2.4-3.7)	2.0 (0.6-3.4)	3.3 (1.5-5.0)	1.3 (0.5-2.0)	*	2.6 (1.5-3.8)
Secondary school completed	9.7 (8.4-10.9)	8.5 (5.4-11.6)	7.4 (4.6-10.2)	8.0 (5.4-10.5)	*	8.0 (6.0-10.1)
College, trade, or below bachelor	41.0 (38.7-43.2)	50.7 (43.9-57.5)	45.1 (38.3-51.9)	47.0 (40.9-53.1)	*	46.3 (41.4-51.2)
Bachelor degree or higher	46.1 (43.9-48.4)	38.6 (32.3-44.9)	44.0 (37.3-50.7)	43.6 (37.7-49.5)	*	42.8 (38.1-47.5)
Household income:						
Low	20.4 (19.0-21.8)	23.7 (18.9-28.6)	27.0 (22.0-32.0)	22.2 (18.2-26.2)	25.3 (15.5-35.0)	23.0 (19.8-26.2)
Medium	58.2 (56.2-60.2)	55.4 (49.0-61.8)	52.6 (46.1-59.0)	56.2 (50.7-61.8)	57.0 (45.4-68.5)	55.5 (51.0-60.0)
High	21.3 (19.7-22.8)	20.7 (16.5-25.3)	20.3 (15.7-24.9)	21.4 (17.7-25.1)	17.6 (11.1-24.2)	21.4 (18.3-24.5)
Family functioning (healthy)	90.7 (89.5-92.0)	85.9 (81.4-90.4)	83.9 (79.0-88.8)	87.3 (83.7-90.9)	84.1 (75.7-92.6)	87.4 (84.4-90.3)
Chronic physical illness (CPI):						
Any	28.3 (26.3-30.4)	40.8 (33.9-47.7)	41.5 (34.8-48.2)	41.4 (35.8-47.5)	36.5 (23.8-49.1)	39.1 (34.2-43.9)
0 CPIs	71.6 (69.5-73.6)	59.1 (52.2-66.0)	58.4 (51.7-65.1)	58.5 (52.4-64.7)	63.5 (50.8-76.1)**	60.8 (56.0-65.1)
1 CPI	19.6 (17.8-21.3)	18.9 (14.4-23.4)	24.8 (19.0-30.5)	23.9 (18.6-29.1)	18.3 (10.5-26.0)**	23.5 (19.4-27.6)

≥2 CPIs	8.7 (7.4-10.1)	21.8 (14.8-28.8)	16.7 (11.0-22.4)	17.5 (12.0-22.9)	18.1 (5.3-31.0)**	15.6 (11.4-19.7)
Mental illness (MI):						
Any	14.9 (13.3-16.4)	53.6 (46.8-60.3)	51.1 (44.5-57.7)	45.7 (39.8-51.7)	56.3 (44.5-68.1)	41.0 (36.3-45.7)
0 MIs	85.1 (83.5-86.6)	46.4 (39.6-53.1)	48.8 (42.2-55.4)	54.2 (48.3-60.1)	43.6 (31.8-55.5)**	58.9 (54.3-63.6)
1 MI	7.8 (6.6-9.0)	17.9 (12.5-23.3)	16.4 (11.8-21.1)	15.2 (11.6-18.8)	13.8 (5.0-22.6)**	15.4 (12.1-18.7)
≥ 2 MIs	7.0 (5.9-8.2)	35.6 (29.2-42.0)	34.6 (28.1-41.1)	30.5 (24.9-36.2)	42.4 (30.0-54.9)	25.5 (21.3-29.8)

CI = confidence interval.

*Characteristic not released by Statistic Canada due to small cell count.

**Characteristic rounded to base 50 due to Statistic Canada vetting rules.

Table 2. Prevalence of health status categories and types of mental health service contacts

Health status	Total sample (n=1,223,047)	Type of mental health service contact					
		General medicine (n=129,044)	Urgent medicine (n=13,555)	Specialized mental health (n=130,461)	School-based (n=170,797)	Alternative (n=35,510)	Any (n=261,739)
Healthy	62.7 (60.6-64.9)	4.9 (3.8-6.0)	0.3 (0.0-0.6)	5.1 (3.9-6.2)	7.5 (6.2-8.9)	1.4 (0.8-2.0)	13.0 (11.2-14.8)
CPI only	22.3 (20.4-24.2)	7.9 (5.2-10.6)	0.1 (0.0-0.2)	8.9 (6.1-11.7)	12.6 (8.9-16.2)	1.6 (0.7-2.4)	19.8 (15.8-23.9)
MI only	8.8 (7.6-10.0)	35.2 (28.8-41.7)	4.7 (1.8-7.6)	34.1 (27.6-40.6)	38.7 (32.2-45.3)	10.6 (6.7-14.5)	54.7 (47.8-61.6)
Multimorbid	6.0 (4.8-7.2)	41.9 (31.9-51.8)	6.9 (2.1-11.8)	40.2 (30.4-49.9)	49.0 (38.9-59.1)	11.5 (4.5-18.5)	65.0 (55.4-74.5)
χ^2		270.9	103.1	250.3	232.5	94	287.6
<i>p</i> value		<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

CPI = chronic physical illness; MI = mental illness.

Table 3. Association between health status and type of mental health service contact

Health Status	Type of mental health service contact				
	General medicine OR (95% CI)	Specialized mental health OR (95% CI)	School-based OR (95 % CI)	Alternative OR (95% CI)	Any OR (95% CI)
Healthy (ref)	1	1	1	1	1
CPI only	1.37 (0.83-2.24)	1.47 (0.98-2.20)	1.49 (1.03-2.13)	0.88 (0.43-1.76)	1.37 (1.02-1.84)
MI only	5.96 (3.96-8.97)^a	5.57 (3.87-8.00)^a	4.49 (3.27-6.17)^a	4.32 (2.13-8.75)^a	4.50 (3.27-6.22)^a
Multimorbid	6.70 (4.02-11.18)^a	5.97 (3.47-10.29)^a	6.53 (3.64-11.72)^a	4.00 (2.06-7.79)^a	6.57 (3.97-10.87)^a

OR = odds ratio; CI = confidence interval; CPI = chronic physical illness; MI = mental illness.

Results are reported as adjusted ORs and 95% CIs. Adjusted for child age, sex, overall functional health, PMK ethnicity, household income, PMK immigrant status, and PMK educational attainment.

Statistically significant findings are shown in bold.

^aStatistically significantly different from ORs of CPI only.

Table 4. Health status and number of different types of mental health service contacts

Health Status	Number of different types of mental health care contacts				OR (95% CI) ^a
	0	1	2	≥3	
Healthy (ref)	86.96 (85.18-88.73)	8.78 (7.20-10.32)	2.73 (2.00-3.46)	1.53 (0.94-2.12)	1
CPI only	80.11 (76.10-84.13)	11.46 (8.49-14.42)	6.07 (3.14-9.00)	2.35 (1.16-3.55)	1.49 (1.10-1.99)
MI only	45.25 (38.34-52.16)	15.90 (10.90-20.89)	15.40 (11.08-19.71)	23.44 (17.62-29.27)	3.39 (2.59-4.44)^b
Multimorbid	34.99 (25.44-44.53)	20.21 (11.14-29.28)	15.90 (10.29-21.52)	28.89 (19.47-38.30)	4.13 (2.78-6.15)^b

Data are % (95% CI).

OR = odds ratio; CI = confidence interval; CPI = chronic physical illness; MI = mental illness.

^aMultivariable ordinal regression of number of types of mental health service contacts, adjusting for child age, sex, overall health functioning, PMK ethnicity, household income, PMK immigrant status, and PMK educational attainment.

Statistically significant ORs are bolded.

^bStatistically significantly different from OR of CPI only.

Chapter 8: General Discussion

8.1 Overview

Chronic physical illness is a determinant of childhood mental illness (Butler et al., 2018; Ferro, 2016, Patalay & Fitzsimons, 2016) but is often omitted in mental health literature (Ferro, 2016; Merikangas et al., 2009). The co-occurrence of physical illness and mental illness (multimorbidity) is common as approximately 50% of children living with chronic physical illness are additionally diagnosed with a mental illness (Butler et al., 2018). Child multimorbidity can have detrimental consequences for children across their lifespan (Chen et al., 2006), burdens families (Ferro & Boyle, 2015; Piquart, 2018), health, social, and educational systems (Brady et al., 2021; Chen et al., 2006; Schwartz & Feudtner, 2019), and accounts for a disproportionate amount of pediatric healthcare costs (Newacheck and Kim, 2005). Disrupting the sequelae of child multimorbidity is crucial for improving these outcomes. Childhood is a critical developmental period for addressing biopsychosocial needs (Butler et al., 2018; Chen et al., 2006; Romano et al, 2018). Research is needed to guide prevention and early intervention efforts during childhood. Findings from the research presented in this dissertation will help inform interventions to address child multimorbidity and improve child well-being.

The objectives of this dissertation were to: 1) estimate the prevalence of chronic physical illness, mental illness, and physical-mental multimorbidity among children; 2) quantify associations between physical and mental illness, including the number of physical and mental morbidities; 3) identify risk factors of mental illness after controlling for chronic physical illness; 4) investigate moderating effects of child age, sex, health functioning, mental health service contact, and household income on physical and mental illness associations; 5) explore the mediating effect of family functioning on physical-mental illness associations; 6) estimate the prevalence of children's mental health service contact based on health status; and, 7) quantify

associations between child health status and mental health service contacts, including number of types of contacts.

Given the negative effects and burden of child multimorbidity throughout life, this dissertation addressed key knowledge gaps of estimating the prevalence of multimorbidity in Ontario, identifying risk factors for mental illness, and examining mental health-related service contact based on child health status. Broad mental health screening across pediatric settings, regardless of physical diagnosis, and targeted screening with early intervention for children at highest risk of mental illness (i.e., those with two physical illnesses) are upstream strategies to reduce the incidence of multimorbidity. Knowledge generated from this research illustrated nuances are important to consider when developing and implementing clinical interventions for children with physical illness. Examining mental health service contact based on child health status created new knowledge for policymakers to consider when allocating resources based on service setting. By using a population-based sample, inclusive of young children and older adolescents, this dissertation offers critical knowledge that can be broadly applied to support integrated health and mental health services recommendations.

The following sections of this chapter summarize key findings for each manuscript in this dissertation (Section 8.2), discusses integrated findings from this body of research (Section 8.3), outlines implications for practice, policy, and future research (Section 8.4), considers strengths and limitations (Section 8.5), and offers overall conclusions (Section 8.6).

8.2 Summary of Key Findings

Study 1 (Chapter 5) estimated that over one-in-four Ontario children aged 4-17 years had physical illness, over one-in-ten had mental illness, and one-in-twenty had physical-mental multimorbidity. A dose-response association between overall functional health scores and health status was supported, with healthy children having highest scores and multimorbid children

having lowest scores. Adjusted analyses suggested that physical illness was not associated with mental disorder. Rather, the number of physical illnesses was associated with mental disorder. Children with two physical illnesses had increased odds of having any, mood, and anxiety disorders – a novel finding from previous research documenting a cumulative effect of illnesses on mental disorder risk (Ireys et al., 1994; Read et al., 2017; Waters et al., 2008; Wolock et al., 2020). This study suggests that at a population-level, children with one physical illness may have mild and manageable illnesses while children with three illnesses may have more complex needs requiring tertiary and holistic care. Children with two physical illnesses may fall between these subgroups, not severe enough to be followed by tertiary care, but not so complex that their mental health is overshadowed by their physical health needs. This finding demonstrates the need for targeted and routine mental health screening in children with two physical illnesses. Preventative mental health interventions should focus on preventing declines in overall functional health and improving modifiable functional limitations.

Study 2 (Chapter 6) used the subgroup of household index children and quantified associations between chronic physical illness and mental disorder and explored moderating and mediating effects in this association. Children with physical illness were twice as likely as their healthy peers to have a mood disorder. Notably, this study found that the risk of mental illness in children with physical illness is nuanced and depends on health functioning. Children with physical illness with better health functioning had higher odds of having any mental disorder, anxiety disorder, and attention-deficit hyperactivity disorder versus children without physical illness. Child age, sex, mental health service contact and household income did not moderate physical-mental illness associations and family functioning did not mediate these associations. The differential effects of physical illness on mental health of children suggests targeted mental

health screening for children living with chronic physical illnesses with better health functioning is needed.

Study 3 (Chapter 7) also used the subsample of household index children to estimate the six-month prevalence of mental health service contact. Regression modeling quantified associations between child health status and mental health service contacts, including the number of types of contact. Results indicated over one-fifth of children had mental health-related service contact and a dose-response in number of contacts was observed such that contacts were lowest in healthy children and increased from physical illness only, to mental illness only, to multimorbid children. Regardless of health status, school-based mental health service contact was the most common type of contact amongst children. This study provides novel information about mental health care for young children with multimorbid-related needs in Ontario. These results have broad implications for informing integrated health and mental health care. Specifically, integrated models of care should be adopted for children with multimorbidity-and policies that support early interventions should incorporate the health and education systems.

8.3 Integrated Findings

Findings from this dissertation suggested that approximately 28% of children aged 4 to 17 years live with at least one chronic physical illness, which is an increase from 18% in the 1983 seminal OCHS (Cadman et al., 1987). Approximately 15% of children have a mental illness while 6% have multimorbidity. This estimate was lower than other epidemiological studies that reported one in five children living with mental illness (Ferro et al., 2016; Tegethoff et al., 2015; Georgiades et al., 2019), contributing to the lower prevalence estimate for multimorbidity (decreased from 8% in 1983) (Cadman et al., 1987). Methodological differences, including use of parent-reports versus adolescent reports, may underestimate estimates of mental illness (Georgiades et al., 2019). Despite these differences in estimates, there remains a pressing

need to address the mental health of children living with physical illness. A public health intervention to reduce the incidence and pervasiveness of multimorbidity is required.

Mental health screening, using the OCHS-EBS, can be used as a public health strategy for early identification of mental health concerns. As a screening measure for categorical classifications of mental disorders, the EBS has similar psychometric properties to standardized structured diagnostic interviews (Boyle, Duncan et al., 2019). Offering an alternative to burdensome and expensive interviews, the EBS is appealing for triaging patients and allocating mental health resources (Boyle, Duncan et al., 2019). The EBS can also be used as a tertiary strategy to guide clinical directions and treatment decisions (Boyle, Duncan et al., 2019; Halladay et al., 2023). Specifically, Halladay et al. (2023) suggested high EBS scores on externalizing mental disorders could guide clinical treatment plans for impulse-related issues. Given the ability of the EBS to efficiently and effectively identify children in need of mental health services, the EBS can be used by researchers, administrators, and clinicians to support a public health strategy for child mental health.

Second, a dose-response was supported across all studies. Mean functional health scores (e.g., health utility scores) demonstrated titrated associations across health status categories, with scores decreasing from ‘healthy’ to ‘chronic physical illness only’ to ‘mental illness only’ to ‘multimorbid’ children. The burden of multimorbidity is also evident in mental health-related service contacts. A similar dose-response was observed in Study 3, with the number of mental health-related service contacts increasing from physical illness to mental illness to multimorbid children. These dose-response associations highlight a need to focus on impairment and functional limitations to reduce incidence of mental illness and multimorbidity. Clinical interventions, including psychological counselling, occupational therapy, physiotherapy, and

medical interventions can target limitations resulting from chronic physical illnesses (Feng et al., 2009; Furlong et al., 2001; Horsman et al., 2003). As the Health Utility Index (HUI) was a robust predictive factor of mental illness and because differences of 0.03 indicate clinical significance, clinical researchers can use the HUI to examine the effects of interventions over time (Horsman et al., 2003). Specifically, the HUI has been used to measure changes in mental wellness and quality of life in samples of children with asthma (Feeny et al., 2009), as a tool for evaluating hearing aids in hearing-impaired children (de Wolf et al., 2011) and is used for cost-analysis for child mental health service planning (Petrrou et al., 2010). The broad application of the HUI in child health and psychiatry can be adopted by both researchers and clinicians.

Despite the robust power of the HUI to predict mental health outcomes, Study 2 highlighted how this association changes when the interaction between health functioning and physical illness is examined. Health functioning moderated the association between physical and mental illness, suggesting children with physical illnesses with better health functioning have a higher likelihood of any mental illness, anxiety disorders, and ADHD. Social experiences differ for children with physical illness, such that children with better health functioning as compared to children with poorer functioning, have more frequent participation in structured and unstructured activities (Arakeylan et al., 2020). However, victimization during these activities is often experienced due to disability-related issues (Pinquart, 2017), hindering the psychosocial development of children with better health functioning. Higher rates of internalized mental disorders have been reported in children with chronic physical illnesses compared to children with more severe life-limiting illnesses (Barker et al., 2023), suggesting the mental health of children with poorer health functioning may be less impacted than children with better health functioning. COVID-19 research also suggests that children with poorer health functioning have

adapted to the limitations their illnesses impose and are resilient to declines in their mental health (Fayed et al., 2020). Alternatively, measures for mental illness need to be validated in populations of more severely disabled children, where the prevalence of intellectual disorders is higher than in children with better health functioning (Barker et al., 2023). Future research that includes collaboration with clinicians and children and families with lived experience with chronic physical illness is needed to elucidate the nuances of health functioning and mental health.

Moreover, findings showed household income did not predict mental illness outcomes and family functioning did not mediate associations between physical illness and mental illness. Although not statistically significant in this dissertation, future research should continue to examine the intersectionality of household income, family functioning, and physical-mental multimorbidity. Family dysfunction and living in poverty are adverse childhood experiences that influence mental illness (Chen et al., 2006; Cheung et al., 2017; Dey et al., 2015) while childhood physical illness influences the family ecosystem, including maternal mental health (Ferro & Boyle, 2015; Ferro, Meyer, et al., 2021) and sibling well-being (Giallo et al., 2014). Continued efforts to understand the intersectionality of these factors could assist with lowering disadvantages in accessing resources and creating equitable pathways for treatment. Future disability research should also consider inquiring PMKs about government child-disability financial support programs (e.g., Special Services at Home) as these can increase annual household income and access to mental health and allied-health services. Furthermore, given health functioning moderated physical and mental illness associations, the mediating role of family functioning may also be more nuanced. Future research should examine mediated-moderation (i.e., the magnitude of the mediating effect of family functioning differs for children

with vs. without physical illness or amongst children with different health functioning) and moderated-mediation (i.e., the mediating process is hypothesized to be different for children with vs. without physical illness or amongst children with different health functioning) (Ferro, 2015; Muller et al., 2005).

Studies 1 and 2 provided evidence of children of PMK's with Indigenous ethnicity being over two to four times more likely to have mental illnesses than children of PMK's with White ethnicity. Given high rates of mental illness on Indigenous reserves and the exclusion of on-reserve children from the OCHS, these estimates are likely underestimated (Kirmayer et al., 2000; Waddell et al., 2019). With these higher odds indicating need for service, use of mental health services should be higher. However, findings from Study 3 did not support this. Mental health services may not be reaching children most at need or may not be tailored for this specific population. Researchers must work with Indigenous communities and be inclusive of their unique practices and needs. Future research should seek to understand the needs of Indigenous children and their distinctive pathways to mental health care. Mental health service planning and interventions must be culturally appropriate.

Study 3 provided insight into how children use mental health services based on their health status. Findings illustrated school-based services have the most mental health related contacts with children, regardless of child health status. This finding was surprising for children living with physical illnesses as they may be routinely followed by a physician. Mental health training initiatives have uniquely positioned physicians to provide mental health care to children with chronic physical illnesses (Prince et al., 2007), reducing the need for contact in other settings. The preference of children with physical illness to receive school-based mental health care (Courtwright et al., 2023; Duong et al., 2021) suggests their mental health needs may be

similar to healthy peers and regular school attendance may make school mental health services more accessible. However, children with physical illness may endure additional challenges in accessing school-based mental health services that appropriately meet their complex needs (Courtright et al., 2023; Ferro, Qureshi et al., 2021). School-based services may focus solely on academic accommodations, may only reach a small percentage of students in need of service, and school interventions may not be based on clinical evidence (Ferro, Qureshi et al., 2021). Additional challenges include the perceptions of the role and scope of school nurses amongst secondary students with and without physical illness which did not include mental health support (Courtright et al., 2023). In addition, adolescents most in need of mental health services often have a low perceived need of support (Patte, Battista et al., 2024). School-connectedness and belonging are also associated with mental help-seeking behaviour in school-based settings, and these factors are lower among disadvantaged children and children with physical illness and multimorbidity (Ferro, Qureshi et al., 2021; Kirpatrick, 2020; Patte, Gohari et al., 2024).

The barriers for children with physical illness and multimorbidity in accessing appropriate school-based mental health services can be addressed with public health strategies. First, providing mental health literacy amongst school staff on recognizing student mental health distress and providing appropriate treatment or referrals can reduce multimorbidity (Ferro, Qureshi et al., 2021). Similarly, embedding mental health literacy in curriculum can assist children and youth in recognizing the need for mental health support and how to access mental health services (Courtright et al., 2023). Collaboration with community-based mental health services and the health system can help target the complex needs of children with physical illness and multimorbidity and help meet the demand for services. Moreover, improving school connectedness and belonging by improving school climates, resources, and inclusion would

assist children with forming positive relationships with trusted adults at school, whom they can turn to for mental health support (Patte, Gohari et al., 2024). Thus, continued investments in school-based mental health services and in mental health literacy programs in the Ontario education curriculum is warranted.

8.4 Implications for Policy, Practice, and Future Research

The studies contained in this dissertation have implications for policy, practice, and future research as they pertain to reducing the incidence of childhood multimorbidity and improving the mental health of children. First, integrated health and mental health care is a critical public health strategy needed for addressing child multimorbidity. With mental health screenings occurring in multiple settings, coordinated efforts between health care professionals, mental health specialists, and schools is needed (Fazel et al., 2021). As school-based services was the most common mental health service contact amongst all children (Study 3) and because school-based interventions are effective at reducing symptoms of mental disorders (Wasserman et al., 2023), continued school-based mental health investments are important. Structured care plans with clear communication, information sharing, and collaboration between health, mental health, and education systems is a step closer to implementing calls for integrated care (Fazel et al., 2021; King, Shafran et al., 2024). Heightened collaboration is needed to support the multifaceted biopsychosocial needs of children living with multimorbidity and the specialized accommodations and treatment they may require in school settings (Ferro, Qureshi et al., 2021). Clear mental health referral pathways with shared care plans also ensures coordination of services, receipt of services, and reduces duplication of services (King, Shafran et al., 2024). An integrated care model is a promising mode of care delivery that can assist in treating symptoms of mental illness early and improve mental health outcomes for children with physical illness (Fazel et al., 2021; King, Shafran et al., 2024).

Second, there are implications for clinical practice and public health. Evidenced-based interventions such as cognitive behavioural therapy for children with chronic physical illness and family-based interventions such as parent training for problem-solving skills (King, Hui et al., 2024; Zhou et al., 2024) can help increase coping skills and address various disease-related challenges (Zhou et al., 2024). These interventions can be prioritized for high-risk children (e.g., those with two physical illnesses or those with better health functioning) and their families. On a broader scale, school-based programming that includes building trait resiliency can protect against depressive symptoms in children with adverse childhood experiences (Watters et al., 2023). Low-intensity psychotherapies, such as offering guided self-help or peer-support for older adolescents is a pragmatic mental health strategy that can address mild symptoms of mental illness (Roach et al., 2024). Moreover, physical-activity interventions that have a peer support and social competence component should target children with physical illness and multimorbidity (as these children are underactive) and can be offered in schools and communities (Bedard et al., 2022). Investing in these public health and clinical interventions can protect the mental health of children.

Third, the results from this dissertation highlight numerous opportunities for future child multimorbidity research. Across all the studies in this dissertation, results have been limited due to cross-sectional data. Longitudinal research could dissect temporality of chronic physical illness diagnosis and onset of mental disorder. Mental wellness strategies and early interventions could be more effectively applied by acutely identifying appropriate timing for initiating interventions. Mediation analyses, including potential processes resembling mediated-moderation or moderated-mediation, could also be further utilized and incorporate more individual-level and family-level factors involved in the development of physical-mental

multimorbidity. Moreover, as Study 1 was the first study to examine the effect of the number of physical illnesses on mental disorder risk in a sample of young children, future research needs to replicate findings. An in-depth examination of risk and resiliency factors in children with 1, 2, or 3 or more physical illnesses would produce intervention recommendations for children at-risk of mental illness. Validating the OCHS-EBS on a sample of children with diverse and more complex illnesses would provide a deeper understanding of the cumulative effect on mental disorder risk. Additionally, future research could explore mental health service use more fully by linking study data with Ontario health agency data repositories to validate mental health care use and mitigate biases associated with parent or child-reported service use. Future mental health service research can also explore effectiveness of mental health interventions adapted for children with physical illness.

Notably, child and family engagement are crucial for advancing the child multimorbidity research field, evaluating interventions, and improving physical and mental well-being. Ethically engaging children and families from research design to dissemination ensures research is meaningful and improves child outcomes, clinical interventions, and healthcare systems (Dunstan et al., 2023; Fusar-Poli et al., 2024). Incorporating child and family partners with lived experience with physical illness and mental illness in the research process could help identify facilitators of positive mental health and help shift disability research and dissemination to a more value-neutral or value-positive position. It is through the inclusion of families with lived experience that their stories highlight sources of resiliency and resources, bringing needed context and nuance to the phenomena being examined (Rosenbaum, 2020). Including the preferences of children and families into new integrated models of care also assists with building

responsive and effective integrated health systems (Fazel et al., 2021). Partnerships with researchers, clinicians, and children and families is critical to advancing child health research.

8.5 Strengths and Limitations

This dissertation conducted secondary data analyses on the 2014 OCHS, a large population-based study that collected data on children and their households. As such, findings from this dissertation are generalizable and broad. The burden of child multimorbidity, including prevalence estimates and mental health service use more accurately reflect the general child population of Ontario compared to studies that use high-risk clinical samples from hospital registers (Merikangas et al., 2015). Recommendations and implications for policy and practice are at the population-level, which have broad outreach to children and service providers. Whether children are healthy or followed for their illnesses by community-based care (e.g., family physician), or followed by tertiary-based care (e.g., hospital-based medical specialists), findings from this dissertation are applicable to improving child mental health.

The comprehensive mental health service questions asked in the OCHS align with the multiple domains in which children live (e.g., school, community, medical, spiritual), allowing for an in-depth examination of mental health service use based on child health status—an examination that has not been conducted at a population-based level with contemporary data. With these analyses, recommendations for mental health services resource allocations and integrated care were made to stakeholders. Moreover, prevalence estimates, intervention recommendations, and implications for policy, practice, and future research were based on a robust measure of child mental health—the OCHS-EBS—that aligns with DSM-5 criteria (Boyle, Duncan et al., 2019; Duncan, Georgiades, Wang et al., 2019). Therefore, potential biases associated with cross-sectional data (e.g., recall and misclassification biases) are minimized.

Lastly, despite chronic physical illness being a determinant of childhood mental illness (Butler et al., 2018; Ferro, 2016; Patalay & Fitzsimons, 2016) and physical illness being identified as a need factor in mental health service literature (Andersen, 2008), it is often overlooked in research (Romano et al., 2018). This dissertation makes significant contributions to filling these knowledge gaps and thus makes recommendations that are inclusive of children with chronic physical illness.

There are limitations that warrant consideration in interpreting findings. The cross-sectional data of the 2014 OCHS precludes causal inferences. Mediation analyses were also limited. Although the OCHS oversampled low-income households, it did not include some high-risk samples such as institutionalized children or children living on Indigenous reserves (Boyle, Georgiades, Duncan, Comeau et al., 2019). This exclusion represents a small fraction of the child population and findings cannot be generalized to these groups (Waddell, 2019). Further, this dissertation used the parent-reported OCHS-EBS, which has lower prevalences of internalizing mental illnesses than youth reports (Georgiades et al., 2019). Thus, mental illness and multimorbidity estimates may be underestimated and future research should include multiple informants. Similarly, this dissertation used parent proxies for reporting mental health service contact. Informant discrepancies exist between adolescents and parents, with parents reporting higher rates of mental health service contact (Georgiades et al., 2019). Therefore, service contact estimates may be overestimated. Linking parent and adolescent reports of mental health service contact to provincial health records would assist with assessing pathways to mental health care and confirming utilization of services. Lastly, because data was collected prior to the COVID-19 pandemic, the current burden of multimorbidity may be underestimated (Ferro, Lipman et al.,

2021) and new pathways to mental health services, such as e-health, could influence access to care and affect mental health service estimates.

8.6 Conclusions

This dissertation examined the burden, risk factors, and mental health service outcomes for children with physical-mental multimorbidity. Chronic physical illness is common in Ontario children, with one in four living with illnesses requiring long-term management. Approximately 15% of Ontario children live with mental disorder while 6% live with physical-mental multimorbidity. The findings demonstrated that nuances exist when examining risk factors for mental illness in children with physical illness. Rather than the mere presence of a physical illness being sufficient for increasing the risk of mental disorder, findings illustrated that the number of physical illnesses and health functioning must be considered. Children with two physical illnesses have a higher likelihood of mental illness. Better health functioning also conditions risk of mental disorder, highlighting the importance of examining moderating effects of health functioning in multimorbidity research and clinical care. Further, findings demonstrated mental health service contact was most common in school settings, regardless of child health status. However, children with multimorbidity have the highest mental health-related service contact, emphasizing the need for integrated medical, mental health, and school services. Combined, these findings highlight the burden of chronic physical illness in childhood and the need for upstream mental health interventions.

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Appendix A: 2014 OCHS Questionnaire-Chronic Physical Illness

13. Has a health professional diagnosed any of the following long-term conditions for ____:

	Yes	No
Food or digestive allergies?	01	02
Respiratory allergies such as hay fever?	01	02
Any other allergies?	01	02
Bronchitis?	01	02
Heart condition or disease?	01	02
Epilepsy?	01	02
Cerebral Palsy?	01	02
Kidney condition or disease?	01	02
Asthma?	01	02
Diabetes?	01	02
Any other long-term condition? Specify_____	01	02

Source: 2014 OCHS PMK Questionnaire, Part 1 – CAPI: About the Child, Page 2
https://ontariochildhealthstudy.s3.amazonaws.com/uploads/2014OCHS_PMK_July2014.pdf

Note: Question 13 is based on Statistics Canada’s National Longitudinal Survey of Children and Youth, Cycle 8 in which long-term conditions refer to conditions that have lasted or are expected to last six months or longer. Eczema was removed from the ‘other’ category and listed as its own condition once the Statistics Canada minimal cell count requirement was met.

Appendix B: OCHS-EBS



Ontario Child Health Study Emotional Behavioural Scales: Parent Version (of youth 4-17)

The statements below describe some of the feelings and behaviours of children and youth. For each statement, please select the response that best describes your child now or within the past 6 months. You may only select one response.

	Never or not true	Sometimes or somewhat true	Often or very true		Never or not true	Sometimes or somewhat true	Often or very true
Afraid of doing things in front of others	0	1	2	Has broken into someone else's house, building or car	0	1	2
Angry and resentful	0	1	2	Has difficulty awaiting turn in games or groups	0	1	2
Anxious or on edge	0	1	2	Has nightmares about being separated from loved ones	0	1	2
Argues a lot with adults	0	1	2	Has trouble enjoying self	0	1	2
Avoids school because of fear of separation from loved ones	0	1	2	Impulsive or acts without thinking	0	1	2
Avoids social situations	0	1	2	Is nervous with people he/she doesn't know	0	1	2
Blames others for own mistakes	0	1	2	Loses temper	0	1	2
Can't concentrate, can't pay attention for long	0	1	2	Makes careless mistakes	0	1	2
Can't stay seated when required to do so	0	1	2	Nervous, high-strung or tense	0	1	2
Changes in appetite	0	1	2	Overly upset when leaving loved ones	0	1	2
Complains of feeling sick before separating from loved ones	0	1	2	Overtired or lacks energy	0	1	2
Cruelty, bullying or meanness to others	0	1	2	Runs away from home	0	1	2
Deliberately harms self or attempts suicide	0	1	2	Scared to go to sleep without parents being near	0	1	2
Destroys things belonging to his/her family or other children	0	1	2	Sets fires	0	1	2
Distractible, has trouble sticking to any activity	0	1	2	Stays out at night despite being told not to	0	1	2
Doesn't like to be with people he/she doesn't know	0	1	2	Steals outside the home	0	1	2
Easily annoyed by others	0	1	2	Talks about killing self	0	1	2
Fails to finish things he/she starts	0	1	2	Too fearful or anxious	0	1	2
Feels worthless or inferior	0	1	2	Trouble sleeping	0	1	2
Fidgets	0	1	2	Truancy, skips school	0	1	2
Finds it hard to stop worrying	0	1	2	Unhappy, sad or depressed	0	1	2
Gets anxious about meeting new people	0	1	2	Uses weapons when fighting	0	1	2
Gets back at people	0	1	2	When anxious, his/her mind goes blank	0	1	2
Gets in many fights	0	1	2	Worries about doing better at things	0	1	2
Gets no pleasure from usual activities	0	1	2	Worries that bad things will happen to loved ones	0	1	2
Has been physically cruel to others	0	1	2	Worries that something bad will cause separation from loved ones	0	1	2

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OCHS-EBS Scoring Instructions

The items are scored as follow: Never or not true=0, Sometimes or somewhat true=1, Often or very true=2.

Individual disorder scale scores: Item scores can be summed together for the following item sets to generate scale scores for the following seven disorders.

Internalizing and Externalizing scale scores: All externalizing and internalizing item scores can be summed together to generate scale scores for these two disorder groupings.

Total scale score: All 52 items can be summed together to generate a total score.

Externalizing

Conduct Disorder (11 items)

Cruelty, bullying or meanness to others
Destroys things belonging to his/her family or other children
Gets in many fights
Has been physically cruel to others
Has broken into someone else's house, building or car
Runs away from home
Sets fires
Stays out at night despite being told not to
Steals outside the home
Truancy, skips school
Uses weapons when fighting

Opposition Defiant Disorder (6 items)

Angry and resentful
Argues a lot with adults
Blames others for own mistakes
Easily annoyed by others
Gets back at people
Loses temper

Attention Deficit Hyperactivity Disorder (8 items)

Can't concentrate, can't pay attention for long
Can't stay seated when required to do so
Distractible, has trouble sticking to any activity
Fails to finish things he/she starts
Fidgets
Has difficulty awaiting turn in games or groups
Impulsive or acts without thinking
Makes careless mistakes

Internalizing

Major Depressive Disorder (9 items)

Changes in appetite
Deliberately harms self or attempts suicide
Feels worthless or inferior
Gets no pleasure from usual activities
Has trouble enjoying self
Overtired or lacks energy
Talks about killing self
Trouble sleeping
Unhappy, sad or depressed

Generalized Anxiety Disorder (6 items)

Anxious or on edge
Finds it hard to stop worrying
Nervous, high-strung or tense
Too fearful or anxious
When anxious, his/her mind goes blank
Worries about doing better at things

Separation Anxiety Disorder (7 items)

Avoids school because of fear of separation from loved ones
Complains of feeling sick before separating from loved ones
Has nightmares about being separated from loved ones
Overly upset when leaving loved ones
Scared to go to sleep without parents being near
Worries that bad things will happen to loved ones
Worries that something bad will cause separation from loved ones

Social Phobia/Social Anxiety Disorder (5 items)

Afraid of doing things in front of others
Avoids social situations
Doesn't like to be with people he/she doesn't know
Gets anxious about meeting new people
Is nervous with people he/she doesn't know

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Source: https://ontariochildhealthstudy.s3.amazonaws.com/uploads/OCHS-EBS_Parent-1.pdf

Note: Permission granted from Dr. Laura Duncan to include the EBS in this dissertation.

Appendix C: OCHS-EBS Thresholds

Binary variables for mental disorders assessed in the EBS were created by establishing thresholds that resulted in closely matched prevalence estimates reported in Georgiades et al. (2019). The thresholds for the mental disorders are listed below, where 0 refers to having no disorder and 1 refers to having a disorder.

Conduct Disorder: if CKLSTCD<4.4 then CD=0; else CD=1;
Attention Deficit Hyperactivity Disorder: if CKLSTADHD<8 then ADHD=0; else ADHD=1;
Opposition Defiant Disorder: if CKLSTODD<6 then ODD=0; else ODD=1;
Separation Anxiety Disorder: if CKLSTSAD<8 then SAD=0; else SAD=1;
Major Depressive Disorder: if CKLSTDEP<7 then DEP=0; else DEP=1;
Generalized Anxiety Disorder: if CKLSTGAD<7 then ANX=0; else ANX=1;
Social Phobia: if CKLSTSP<6.25 then SP=0; else SP=1;

Citation: Georgiades, K., Duncan, L., Wang, L., Comeau, J., Boyle, M. H., & 2014 Ontario Child Health Study Team. (2019). Six-month prevalence of mental disorders and service contacts among children and youth in Ontario: Evidence from the 2014 Ontario Child Health Study. *The Canadian Journal of Psychiatry*, 64(4), 246-255. <https://doi.org/10.1177/0706743719830024>