

CHILD MALTREATMENT AND POOR SLEEP OUTCOMES

Child Maltreatment and Poor Sleep Outcomes Among Canadian Adolescents: A Cross-Sectional Study

by

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Abstract

Background: Child maltreatment is experienced by many Canadians and is associated with a range of adverse health outcomes. Consequences of child maltreatment may be experienced during adolescence, which is a critical developmental period. While child maltreatment can contribute to poor outcomes, such as poor sleep, the presence of protective factors may mitigate the negative impacts on health. Conversely, electronic device use may exacerbate the relationship between child maltreatment and poor sleep.

Objectives: The objectives of the current study were to: 1) examine associations between child maltreatment (i.e., physical abuse, sexual abuse, physical neglect, emotional abuse, exposure to physical IPV, and exposure to emotional IPV) and poor sleep outcomes (i.e., prolonged sleep latency, frequent nocturnal awakenings, and inadequate sleep duration) among Canadian adolescents (15- to 17- year-olds); 2) examine whether protective factors (i.e., physical activity, participation in organized sports/clubs, perceived social support, meaningful leisure time, physical activity with peers, and family meals) moderate (i.e., mitigate) the association between child maltreatment and poor sleep outcomes; 3) examine whether electronic device use moderates the association between child maltreatment and poor sleep outcomes; and 4) examine whether the association of child maltreatment and poor sleep outcomes differs according to sex.

Methods: Data were drawn from the 2023 Canadian Health Survey on Children and Youth (CHSCY). Logistic regression models were conducted to examine the associations between child maltreatment types and sleep outcomes. Interaction terms were included to evaluate whether protective factors, electronic device use, or sex modified these associations.

Results: Each type of child maltreatment was significantly associated with an increased likelihood of prolonged sleep latency, frequent nocturnal awakenings, and inadequate sleep

duration. Frequent family meals and having relationships where the adolescent's skill and competence are recognized, as protective factors mitigated (i.e., lessened) the association between any child maltreatment and prolonged sleep latency. Frequent family meals and having someone to talk to about important life decisions, as protective factors mitigated (i.e., lessened) the association between any child maltreatment and inadequate sleep duration. Additionally, good perceived social support (composite score and individual items) and frequent family meals were each associated with a decreased likelihood of each poor sleep outcome. Participation in organized sports or clubs was associated with a decreased likelihood of prolonged sleep latency and frequent nocturnal awakenings. Engagement in physical activity with peers was associated with a decreased likelihood of prolonged sleep latency and inadequate sleep durations. High daily electronic device use significantly moderated the association between any child maltreatment and frequent nocturnal awakenings. More specifically, using an electronic device for online social networking may moderate the association between any child maltreatment and prolonged sleep latency, and any child maltreatment and inadequate sleep duration. Using an electronic device in the bedroom prior to falling asleep and high daily electronic device use were associated with an increased likelihood of prolonged sleep latency and inadequate sleep durations. Using an electronic device for online social networking and online messaging were associated with an increased likelihood of frequent nocturnal awakenings and inadequate sleep duration. In addition, sex was identified as a significant moderator of the association between sexual abuse and prolonged sleep latency, and exposure to physical IPV and frequent nocturnal awakenings, whereby each association was stronger for males compared to females.

Conclusions: These findings indicate that child maltreatment is associated with poor sleep outcomes among adolescents. Identifying protective factors, forms of electronic device use, and sex as moderators highlights key targets for intervention and prevention efforts.

Introduction

At least one form of child maltreatment (physical abuse, sexual abuse, emotional abuse, physical neglect and/or exposure to intimate partner violence) is reported by approximately 60.9% of Canadians before 18 years old (Afifi et al., 2026) and is associated with poor short-term and long-term mental and physical health outcomes (Afifi et al., 2014, 2016; Boullier & Blair, 2018; Cecil et al., 2017; McPhie et al., 2014). Research has indicated that child maltreatment is related to poor sleep outcomes such as short sleep durations, difficulty falling asleep, or difficulty staying asleep (Baddam et al., 2019; Brown et al., 2022; Javakhishvili & Spatz Widom, 2021; McPhie et al., 2014; Turner et al., 2020; Zarchev et al., 2024), which are important components of overall health. Sleep is essential for cardiovascular health, weight control, immune responses, injury prevention, adequate brain function for critical processes and skills, academic success, and emotional regulation (Gruber et al., 2014). Youth benefit mentally and physically from physical activity, social interactions, and shared activities (Gunn & Eberhardt, 2019; Palagini et al., 2018), however, the potential for these factors to mitigate child maltreatment and sleep outcomes has not been extensively studied. Given their known benefits, it is important to investigate the potential of protective factors to lessen the impact of child maltreatment on poor sleep outcomes.

Recent research suggests that the use of electronic devices may have a negative impact on the mental and physical health of youth (Gomes & Goldman, 2024; Hale et al., 2018; Marciano & Camerini, 2021; Priftis & Panagiotakos, 2023; Santos et al., 2023; Twenge et al., 2019; Twenge & Campbell, 2018a). A recent rise in screen time among youth has been detected (Cammack et al., 2020; Oliveira et al., 2022; Saunders & Vallance, 2017), which underscores the

importance of examining its impact on health and developmental outcomes, such as adolescent sleep.

Sleep deprivation and sleep disorders are commonly identified among Canadian youth, and these sleep issues are often under-reported, underdiagnosed, and left untreated (Gruber et al., 2014). Adequate sleep is essential for understanding overall health as it is crucial for longevity and overall life satisfaction (Dai et al., 2020; Gruber et al., 2014; Itani et al., 2017; Jike et al., 2018; Medic et al., 2017). The majority of existing literature examining the association between child maltreatment and poor sleep outcomes primarily focuses on these outcomes in adulthood (McPhie et al., 2014). While Canadian studies have investigated the association between child maltreatment and sleep outcomes among adolescents, these studies focus on adolescent populations in Ontario (McPhie et al., 2014; Turner et al., 2020). Expanding the scope of the literature to encompass adolescents across all Canadian provinces would make a significant contribution to the existing knowledge base. The purpose of the current study was to examine the associations between child maltreatment and poor sleep outcomes (i.e., prolonged sleep latency, frequent nocturnal awakenings, and inadequate sleep duration) among Canadian adolescents while assessing whether protective factors, including physical activity, perceived social support, and shared activities, moderate (i.e., weaken) the association between child maltreatment and poor sleep outcomes. In addition, the current study examined whether electronic device use is a potential risk factor that moderates (i.e., strengthens) the association between child maltreatment and sleep outcomes of adolescents. Finally, sex differences in the associations between child maltreatment and individual poor sleep outcomes were examined.

Review of the Literature

Child Maltreatment

Child maltreatment includes abuse and neglect that occurs among youth under 18 years old (World Health Organization, 2022). There are five types of child maltreatment: physical abuse, sexual abuse, neglect, emotional abuse, and exposure to intimate partner violence (IPV). All child maltreatment types have been found to be associated with an increased likelihood of poor mental health outcomes, including depression, anxiety, attention deficit hyperactivity disorder (ADHD), substance abuse, and suicide ideation or risk later in life (Afifi et al., 2014; Binks et al., 2025; Cecil et al., 2017; Langevin et al., 2023; Scholtes & Cederbaum, 2024; World Health Organization, 2024). Child maltreatment is also associated with poor physical health outcomes such as increased risk of chronic diseases, obesity, back problems, and chronic fatigue syndrome (Afifi et al., 2016; Boullier & Blair, 2018; Felitti et al., 1998; Springer et al., 2003). In 2022, data from a nationally representative study indicated that 34.4% of Canadian adults retrospectively reported experiencing one or more forms of child abuse (i.e., physical abuse sexual abuse, and/or exposure to IPV) during childhood, which is a statistically significant increase from the prevalence of 32.1% reported in 2012 (Afifi et al., 2014, 2025). These estimates focus specifically on child abuse instead of child maltreatment, which also includes neglect and emotional abuse. The rising prevalence of child abuse between 2012 and 2022 underscores the continued need for more research and to include all child maltreatment types, as child abuse is a large component of child maltreatment. As such, a recent population-based Canadian study indicates that 60.9% of adults aged 18-49 years retrospectively report experiencing at least one form of child maltreatment before the age of 18 years (Afifi et al.,

2026). The notable rise in the prevalence of child abuse from 2012 to 2022 alongside recent child maltreatment prevalence updates support the continued need for child maltreatment research.

Recent Canadian child maltreatment data are reported by adults while the maltreatment occurred during childhood (Afifi et al., 2025, 2026). Conversely, Canadian data on adolescent reports of child maltreatment from the 2014 Ontario Child Health Study (OCHS) indicates 26.4% of adolescents aged 14-17 years experienced at least one type of child maltreatment (Salmon et al., 2022). Notably, these adolescent reports are much lower compared to adults retrospectively reporting child maltreatment experiences. Existing data indicates that only approximately 10% of child maltreatment reports are from adolescents over 15 years old (Guastafiero & Shipe, 2023). This suggests that the large discrepancy between adult and adolescent reports cannot be accounted for by suggesting that experiencing maltreatment may occur for those between the ages of 15-17 years. The varying prevalence of child maltreatment reports from adults compared to adolescents, alongside the rising prevalence of child abuse reports between 2012 and 2022, reinforces the importance of studying these experiences during childhood or adolescence when consequences of child maltreatment continue to deepen and extend throughout the lifespan (Font & Cage, 2018; Fry et al., 2018; Miller et al., 2013).

Studying the associations between child maltreatment and poor health outcomes in adolescence is vital as it is a critical developmental period marked by cognitive and behavioural changes that can influence future mental and physical health trajectories (National Academies of Sciences, 2019a; Salam et al., 2016). Among adolescents, child maltreatment experiences are commonly associated with increased absence from school, reduced academic performance, and lower engagement in school activities (Font & Cage, 2018; Fry et al., 2018; Miller et al., 2013).

These educational impacts often occur alongside greater peer isolation, decreased academic achievement, and an elevated risk of substance use (Font & Cage, 2018; Fry et al., 2018).

Moreover, adolescents exposed to child maltreatment demonstrate a higher prevalence of adverse mental health outcomes, including depression, anxiety, anger, post-traumatic stress disorder (PTSD), and suicidal ideation (Binks et al., 2025; Calhoun et al., 2019; Cecil et al., 2017; Ford et al., 2009; Scholtes & Cederbaum, 2024; Statistics Canada, 2023a). Research suggests that examining child maltreatment in the context of positive or negative coping mechanisms can deepen the understanding of the health outcomes associated with child maltreatment (Cammack et al., 2020). Positive coping mechanisms can include exercise and positive relationships (Zhou et al., 2025), while some negative coping mechanisms identified include aggressive behaviours (Zhou et al., 2025), substance use (Zhou et al., 2025), and excessive screen time (Cammack et al., 2020). Accordingly, examining the moderating roles of common healthy and unhealthy coping mechanisms provides deeper insight into how child maltreatment experiences may influence adolescent sleep outcomes. Given the wide-ranging consequences of child maltreatment during adolescence, continued examination of its impact is essential to inform strategies that support healthy adolescent development and mitigate the detrimental and potentially lasting effects of early adversity. Taken together, the scholarship examined presents a notable gap in the Canadian literature specifically examining these associations during adolescence, highlighting the need for further research to inform relevant prevention and intervention strategies.

Sleep Outcomes

Current guidelines recommend that adolescents obtain 8-10 hours of sleep per night to support optimal health and functioning (Tremblay et al., 2016); however, 28% of Canadian

adolescents do not meet this recommendation (Chaput & Janssen, 2016). Research among Canadian adults found that sleep durations outside the recommended hours were associated with increased mortality rates, health-risk behaviours, worse psychological well-being, and a greater incidence of multiple health conditions (Itani et al., 2017; Jike et al., 2018; Medic et al., 2017). Sleep deprivation and disorders are multifactorial, with environmental elements and daily habits such as electronic media use, excessive evening light exposure, caffeine or stimulant intake, physical environment factors (e.g., temperature, noise or air quality), and low priority of sleep playing significant roles in affecting sleep quality and patterns (Gruber et al., 2014). It is essential to acknowledge that existing literature highlights the importance of quality sleep because the absence of quality sleep has the potential to harm cognitive function, socio-emotional regulation, quality of life, and health trajectories of adolescents (Brown et al., 2022; Forest et al., 2022; Gruber et al., 2014; Nelson et al., 2022; M. Ohayon et al., 2017; M. M. Ohayon, 2008). Components contributing to sleep quality include sleep latency, nocturnal awakenings, sleep efficiency, and total sleep duration (Brown et al., 2022; Nelson et al., 2022; M. Ohayon et al., 2017; M. M. Ohayon, 2008).

Sleep latency refers to the time it takes to transition from wakefulness to sleep (M. Ohayon et al., 2017). Among adolescents, sleep latency is considered normal at 30 minutes or less, whereas prolonged latency (i.e., exceeding 30 minutes) may reflect difficulty initiating sleep and is associated with poorer sleep quality (Jin et al., 2025; Nelson et al., 2022; M. Ohayon et al., 2017). Nocturnal awakenings are the number of wake-ups that occur after sleep onset (M. Ohayon et al., 2017; M. M. Ohayon, 2008). During adolescence, experiencing up to two nocturnal awakenings in one week is not detrimental to sleep quality, whereas three or more awakenings are associated with disrupted and poor-quality sleep (Hysing et al., 2013; Nelson et

al., 2022; M. M. Ohayon, 2008; Substance Abuse and Mental Health Services Administration, 2016). Sleep efficiency and sleep duration reflect the proportion of time spent asleep while in bed; where sleep efficiency is the ratio of time spent asleep to total time in bed, and sleep duration is only the time spent asleep (Nelson et al., 2022; M. Ohayon et al., 2017).

Focusing on sleep during adolescence is important because this period is a developmental stage marked by shifts in sleep patterns, such as sleep phase delay (Galván, 2020), which reflects a biological shift towards a preference for later bedtimes and wake-up times (Crowley et al., 2018; Gunn & Eberhardt, 2019). Compared to children (ages 6-13 years), adolescents report more sleep problems, shorter sleep durations, and greater tiredness during the day (Michaud & Chaput, 2016). These shifts in sleep quality underscore the broader biological and behavioural changes that impact adolescent sleep; such experiences of developmental disruption early on in a child's life can affect their adult health by embedding adversities during sensitive developmental periods (Gruber et al., 2014). Previous studies have found that individual child maltreatment types were associated with an increased likelihood of negative sleep outcomes in adolescence (Baddam et al., 2019; Brown et al., 2022; Javakhishvili & Spatz Widom, 2021; McPhie et al., 2014; Turner et al., 2020; Zarchev et al., 2024). These findings underscore the importance of advancing our understanding of the factors contributing to poor sleep outcomes and highlight the need for effective interventions that promote healthy sleep among adolescents. Considering the association between poor sleep and increased negative health outcomes later in life, and child maltreatment and detrimental health and social outcomes, expanding Canadian literature to examine the association between child maltreatment and sleep is crucial. The existing literature predominantly examines sleep outcomes among adults; however, a significant gap remains in research investigating sleep outcomes among adolescents.

Protective Factors

Protective factors are conditions, characteristics, or environments that buffer against risk or help manage adversity, thereby decreasing the likelihood or impact of abuse and neglect and promoting better outcomes (Austin et al., 2020; Centers for Disease Control and Prevention, 2024). Literature indicates that elements such as physical activity, positive social engagement, and shared activities such as sharing meals or involvement with community clubs or sports, may function as protective factors, alluding to their potential role in mitigating the adverse effects of child maltreatment. Physical activity has been studied broadly and with particular attention to participation in team sports or engaging in physical activities with peers, identifying its association with stress reduction and suggesting alleviation of mental health issues such as depression and anxiety (Hillman & Drobles, 2012; McPhie & Rawana, 2015; Pascoe & Parker, 2019; Sagatun et al., 2007). Additionally, physical activity has been shown to improve cognitive function and self-regulation, thereby enhancing decision-making abilities and academic performance (Hillman & Drobles, 2012). Current public health guidelines recommend that adolescents engage in at least 60 minutes of physical activity per day to promote optimal health and well-being (Tremblay et al., 2016).

Family and school connectedness during adolescence increases the likelihood of protective effects across a range of health outcomes, including reduced emotional distress, suicidal ideation, involvement in violence, risky sexual behaviours, and substance use (Austin et al., 2020; Blum et al., 2022; Ehsan et al., 2019; McGraw et al., 2008; Novak & Kawachi, 2015; Oldfield et al., 2016; Rauner, 2000; Steiner et al., 2019; Ungar, 2004). The frequency of shared family meals is an example of family connectedness identified as a specific protective factor, such that having at least three meals shared with family per week is inversely associated with

high-risk behaviours and poor mental health outcomes (Franko et al., 2008; Fulkerson et al., 2006; Hammons & Fiese, 2011; Harrison et al., 2015). Moreover, during adolescence, there is often a shift in social dynamics, with youth spending less time with their parents and more time with peers due to increased involvement in school, organized sports, clubs, and community activities (Blum et al., 2022; DeWalt et al., 2013; Iwasaki et al., 2018; Murphy et al., 2022; Oshri et al., 2017; Rauner, 2000).

While parental relationships remain important, peer relationships become a prominent influence during this developmental stage. Positive peer connectedness, such as feeling accepted by friends, sharing meaningful experiences, having supportive and trusting relationships, and identifying with similar values and interests, can have lasting positive effects on adolescent behaviours and mental health rendering it valuable to assess as a protective factor against adverse experiences (DeWalt et al., 2013; Ehsan et al., 2019; National Academies of Sciences, 2019a, 2019b; Novak & Kawachi, 2015; Oshri et al., 2017; Rauner, 2000). Participation in organized activities, such as sports teams or clubs, can further foster these connections by facilitating access to like-minded peers and reinforcing positive social interactions (Blum et al., 2022). While participation in organized activities and groups with peers may be protective, other leisure time activities, such as spending time on individual hobbies one enjoys including reading or arts and crafts, have similar positive influences on adolescent well-being (Iwasaki et al., 2018). Taken together, the literature suggests that physical activity engagement, connectedness and positive relationships with family and peers, participation in organized teams and clubs, and meaningful leisure time during adolescence increase the likelihood of positive health trajectories. As such, considering these items as protective factors is valuable in the examination of the association between child maltreatment and poor sleep outcomes among Canadian adolescents.

Electronic Device Use

An increasing proportion of youth spend their leisure time on electronic devices, and as the prevalence of screen time rises, research is increasingly finding associations between excessive electronic device use and poor health outcomes (Priftis & Panagiotakos, 2023; Saunders & Vallance, 2017; Twenge et al., 2019). Excessive screen time among children and adolescents is associated with poor mental and physical health outcomes, including decreased emotional regulation, difficulty forming friendships, depression, worsening eyesight, obesity, reduced physical activity, and poor sleep quality (Gomes & Goldman, 2024; Oliveira et al., 2022; Priftis & Panagiotakos, 2023; Santos et al., 2023; Saunders et al., 2014; Twenge & Campbell, 2018a). As electronic device use increases, it often displaces health-promoting behaviours such as physical activity, reading, and in-person social interactions (LeBourgeois et al., 2017). This reduction in the frequency of beneficial health-promoting activities can indirectly compromise overall well-being by limiting engagement in routines essential for physical, cognitive, and social development (Hale et al., 2018; LeBourgeois et al., 2017; Twenge et al., 2019). In particular, displacing healthy evening activities, such as exercise, reading, or family conversations (Hale et al., 2018), with electronic device use before bedtime can disrupt sleep by increasing cognitive and physiological arousal and delaying the circadian rhythm, which in turn postpones sleep onset and contributes to insufficient sleep durations and daytime tiredness (Gomes & Goldman, 2024; Hale et al., 2018; LeBourgeois et al., 2017; Nelson et al., 2022; Twenge et al., 2019; Twenge & Campbell, 2018a).

The type of content consumed, such as social media and gaming, can further impair sleep by increasing emotional and mental arousal during a time when the brain should be preparing for rest (Gomes & Goldman, 2024; Hale et al., 2018; LeBourgeois et al., 2017; Twenge et al., 2019).

To promote overall well-being, it is recommended that adolescents limit their recreational screen time to less than two hours per day, as excessive use has been linked to poorer psychological well-being and reduced academic performance (Marciano & Camerini, 2021; Santos et al., 2023; Twenge & Campbell, 2018b). Adults with a history of child maltreatment often report higher leisure electronic device use compared to those without such experiences, suggesting that electronic device use may moderate the association between child maltreatment and sleep outcomes (Cammack et al., 2020). While this potential moderation effect has not yet been examined among adolescents, the higher leisure device use among adults with child maltreatment histories suggests the assessment of electronic device use may be relevant for youth. The increasing use and integration of electronic devices into the daily lives of youth underscores the importance of examining how electronic device use may influence the association between child maltreatment and sleep outcomes, particularly as emerging literature associates increased screen time with adverse mental and physical health outcomes.

Sex Differences

Adolescence is a period of rapid biological, social, and behavioural development; and these differences often manifest differently for males and females (Díaz-Morales & Escribano, 2015; Dow-Edwards et al., 2019; Lenroot & Giedd, 2010; National Academies of Sciences, 2019a). Adolescent females tend to experience greater problems with depression, anxiety, and sleep disturbances, whereas males exhibit greater rates of aggression and risk-taking behaviours (Afifi et al., 2012; Lenroot & Giedd, 2010). Hormonal changes associated with puberty, differences in brain development, and evolving socialization patterns can contribute to these sex-specific trajectories (National Academies of Sciences, 2019a). In terms of sleep, the literature consistently indicates that adolescent females report poorer sleep quality than males, including

longer sleep latency (Galland et al., 2017; Hysing et al., 2013), shorter sleep durations (Forest et al., 2022; Li et al., 2021), and more frequent nocturnal awakenings (Li et al., 2021), which can lead to greater daytime sleepiness (Forest et al., 2022). Such sleep issues interfere more with daily functioning for adolescent females than males, including missing school or withdrawing from social activities (Forest et al., 2022; Galland et al., 2017). These disruptions are concerning given the developmental importance of education and peer relationships during adolescence (Dow-Edwards et al., 2019; National Academies of Sciences, 2019a; Salam et al., 2016). A potential mechanism underlying these differences is that changes in ovarian steroid hormones during puberty are associated with disrupted sleep, particularly through shifts in circadian timing and altered arousal regulation (Díaz-Morales & Escribano, 2015; Mong & Cusmano, 2016).

Females report more cases of child maltreatment compared to males, 63.0% and 56.3%, respectively (Statistics Canada, 2023a). More specifically, females tend to report more experiences of sexual abuse, emotional abuse, and neglect, compared to males reporting more experiences of physical abuse (Afifi et al., 2025; Bader & Frank, 2025; Statistics Canada, 2023a; Yue et al., 2023). Females with experiences of emotional abuse and exposure to physical IPV have a greater probability of mood and anxiety disorders compared to males experiencing these same forms of maltreatment (Bader & Frank, 2025). Taken together, the observed sex differences in child maltreatment and sleep outcomes underscore the importance of examining sex as a potential moderator in the current study to inform targeted and effective interventions.

Sociodemographic Characteristics

Prior research has identified sociodemographic characteristics associated with adolescent health and sleep outcomes such as age, sex, parental education, and family structure. The rapid development occurring during adolescence includes physical and mental health development

(Font & Cage, 2018), shifts in social circles, behavioural changes such as shifts towards risk taking behaviours (Dow-Edwards et al., 2019) and changes in sleep patterns (Crowley et al., 2007, 2018). Throughout adolescence, sleep duration tends to decrease with age, where younger adolescents typically sleep longer than their older peers (Crowley et al., 2007; Galván, 2020; Gariépy et al., 2020; Maslowsky & Ozer, 2014). Additionally, prior research shows that sleep times from early to late adolescence tend to shift towards later sleep times and later wake-up times with this behaviour peaking at age 16 years (Galván, 2020; Gunn & Eberhardt, 2019; Randler et al., 2017). This tendency reflects a sleep phase delay, a biologically driven experience in adolescence (Crowley et al., 2018; Galván, 2020). Recent literature also found that sex differences among adolescents occur greatest at 16 years old and remain during early adulthood (Randler et al., 2017).

Sex is important developmental factor as adolescent females are more likely than males to report poor sleep quality (Forest et al., 2022; Galland et al., 2017), and greater rates of mental health issues such as anxiety and depression (Bader & Frank, 2025; Kessler et al., 2005; Lenroot & Giedd, 2010). Differences in male and female health and outcomes may be associated with biological changes during puberty (Blakemore, 2019; Laureys et al., 2021; National Academies of Sciences, 2019a; Rauner, 2000) as well as social and environmental stressors that differ by sex (Blum et al., 2022; Ehsan et al., 2019; National Academies of Sciences, 2019a; Rauner, 2000). Parental education also has a strong influence on adolescent development and health and education outcomes such that compared to lower parental education levels, higher parental education levels are associated with adolescents exhibiting improved academic achievement (Dubow et al., 2009), lower risk of depression (Xiang et al., 2024), and greater longevity (Huebener, 2019). In relation to sleep, adolescents whose parents have higher educational

attainment tend to report longer sleep durations, better sleep quality, and more consistent sleep routines (Bagley et al., 2015; Cameron et al., 2022).

Family structure refers to the adolescent's household composition, specifically, whether they live with two biological parents, a single biological parent, a step-parent, adoptive or foster parents, a guardian, or no parent/guardian at all. According to 2021 Canadian Census data, 71.1% of Canadian children live in two-parent (biological or adoptive) family (Government of Canada, 2022). Adolescents not living with two biological parents are more likely to experience adverse outcomes such as lower academic achievement, increased substance use, and greater mental and physical health issues (Park & Lee, 2020), and behavioural difficulties (Hveem et al., 2022; Yang & Jiang, 2023). Additionally, adolescents in foster care or under guardian care have reported significantly worse psychological well-being, more mental health concerns, and lower levels of resilience compared to adolescents in more stable family environments (Dubois-Comtois et al., 2021; Greeno et al., 2018).

Mental Health

Mental health struggles continue to be an ongoing challenge for adolescents. Depression, anxiety, and behavioural disorders are some of the leading causes of disability and illness among adolescents globally (World Health Organization, 2025). It is estimated that 1.2 million Canadian children and youth are affected by mental illness and approximately 70% of those living with mental illness report their earliest symptoms occurring prior to 18 years old (Mental Health Commission of Canada, n.d.). Accordingly, recent surveillance data shows that the prevalence of Canadian youth between ages 12 to 17 years reporting very good or excellent mental health has steadily declined between 2016 and 2024 from 75.4% to 58.1% (Public Health Agency of Canada, 2024). Having poor mental health is associated with lower educational

attainment (Wickersham et al., 2021; World Health Organization, 2025), worse sleep (Public Health Agency of Canada, 2022), low peer and family connectedness (Randler et al., 2017), lower life satisfaction (Schlack et al., 2021), and worse overall physical health (Cherkasova et al., 2022; Schlack et al., 2021). As adolescence is a critical developmental period, the impact of helpful social and emotional habits is vital (World Health Organization, 2025). Research indicates that adolescents who had problems with anxiety, rejection, shyness, attention, restlessness, and/or peer problems often exhibited poorer overall mental health in adulthood, such as more depressive episodes, eating disorders, lower physical and psychological quality of life, and overall lower life satisfaction (Randler et al., 2017; Schlack et al., 2021; Yonemoto & Kawashima, 2023).

Research examining the relationship between child maltreatment and mental health demonstrates that adolescents with histories of maltreatment exhibit higher levels of psychological distress, poorer physical and behavioural symptoms, and increased reports of diagnosed mental health disorders compared to their non-maltreated peers (Balistreri & Alvira-Hammond, 2016; Bielas et al., 2016; Binks et al., 2025; Cecil et al., 2017; Humphreys et al., 2020; Scholtes & Cederbaum, 2024; D. Wang et al., 2021; World Health Organization, 2022). Child maltreatment is recognized as a social determinant of mental illness and represents a modifiable target for intervention aimed at reducing the risk and burden of mental health disorders (Kirkbride et al., 2024). Adolescent mental health problems are also related to sleep disturbances. Research indicates that children and youth with adequate sleep quality consistently had better mental health outcomes than those with poor sleep quality (Public Health Agency of Canada, 2022). Sleep problems are associated with conduct disorder, ADHD, anxiety, depression (Calhoun et al., 2019), and psychological distress (Wang et al., 2021).

The established associations between child maltreatment and mental health, as well as between sleep outcomes and mental health, support the examination of mental health as a confounding factor between child maltreatment and poor sleep outcomes. Since mental health is likely independently associated with both the exposure and the outcome of the current study, failure to account for it may bias estimates of the association between child maltreatment and poor sleep outcomes. Accordingly, diagnosed conditions such as anxiety, mood disorder (depression, bipolar disorder, mania, or dysthymia), attention deficit disorder (ADD), and autism spectrum disorder (ASD) are included alongside the distress scale to comprehensively control for the mental health of Canadian adolescents in the assessment of child maltreatment and poor sleep outcomes.

Theoretical Frameworks

Resilience Theory

Although child maltreatment is often associated with poor health outcomes across the lifespan, not all individuals who experience maltreatment go on to develop these poor outcomes. Norman Garmezy defined resilience as the capacity to recover and maintain adaptive behaviours despite stressful or adverse circumstances, known as the Resilience Theory (Haggerty, 1996). The Resilience Theory suggests that children who experience maltreatment may gain skills such as problem-solving or interpersonal abilities that act as protective factors or foster resilience, which mitigate the poor health outcomes associated with maltreatment over their lifespan (Haggerty, 1996). Research suggests that resilience is not fixed but rather a dynamic process influenced by the interaction of individual, relational, and environmental factors (Haggerty, 1996). David Fergusson and colleagues contributed to this theory by finding that the combination of several resiliency factors, rather than a single resiliency factor, is associated with reduced risk

of mental health and behavioural problems in adolescents with high-risk backgrounds (Fergusson & Horwood, 2003; Fergusson & Lynskey, 1996). Fergusson and Lynskey stated that adolescents showing greater resilience typically experienced lower family adversity scores, higher IQ, avoided delinquent peers, and had lower novelty seeking behaviours (Fergusson & Lynskey, 1996). When considered alongside the work of Garmezy, Fergusson's findings support the understanding of resilience as a dynamic and multifactorial process in which the combination of several factors aids in the development of resilience to act as protective factors against adversity, such as child maltreatment, and risky environments.

Given the existing literature linking various forms of physical activity with improvements in mental health and sleep, it is valuable to investigate how physical activity may contribute to enhanced resilience or serve as a protective factor against the negative consequences of child maltreatment among adolescents. Research has also examined how positive relationships with parents, trusted adults, and peers can influence psychophysiological responses, which in turn promote sleep quality. As such, the resilience theory suggests that these positive experiences (i.e., protective factors) may promote adaptive functioning in the face of adversity (Haggerty, 1996). Thus, examining the interpersonal relationships and leisure activities of adolescents who have experienced child maltreatment may offer a deeper understanding of how these aspects of daily life may mitigate poor sleep outcomes associated with child maltreatment.

Ecological Systems Theory

To further contextualize the influence of adolescents' relationships and environments, Urie Bronfenbrenner's Ecological Systems Theory suggests that individuals are shaped by multiple, nested environmental systems (Bronfenbrenner, 1977). Adolescence is a period of heightened sensitivity and responsiveness to environmental influences, which can significantly

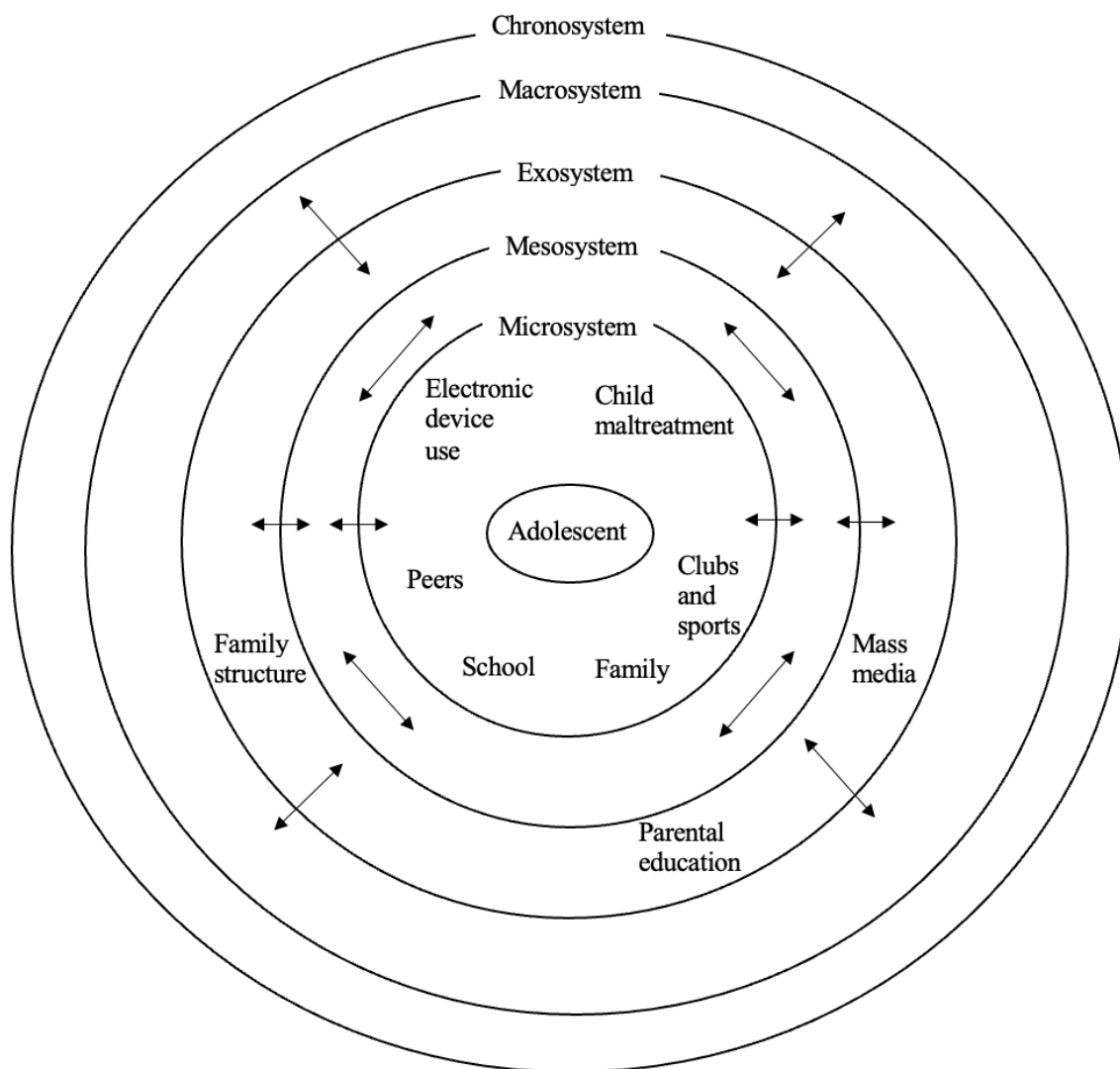
shape developmental trajectories (National Academies of Sciences, 2019a, 2019b). This underscores the importance of examining adolescents' surrounding environments to better understand how they may impact development. This theory provides a useful framework for understanding child maltreatment as it emphasizes the interplay between personal experiences and broader social contexts. The Ecological Systems Theory is composed of five interrelated systems: the microsystem, mesosystem, exosystem, macrosystem, and chronosystem. The microsystem refers to immediate environments, such as the home or school, where the adolescent engages in direct interaction and holds specific roles, such as child, student, or friend (Bronfenbrenner, 1977). The mesosystem is considered a "system of microsystems," representing the interconnections between multiple settings the adolescent participates in and reflects how experiences in one setting may influence outcomes in another (Bronfenbrenner, 1977). The exosystem and macrosystem refer to broader environmental and societal influences that the adolescent does not directly interact with but are impacted by. The exosystem includes mass media, local governments, familial socioeconomic status, and their family structure. The macrosystem refers to societal and cultural norms that shape how the adolescents may understand the world such as gender norms or societal expectations. Lastly, the chronosystem refers to the role of time on an adolescent's life such as puberty or the COVID-19 pandemic occurring during their adolescent phase and how that may influence their life trajectory.

Specific to this study, child maltreatment experiences typically occur within the microsystem, where direct interactions occur between the youth and their family. The microsystem encompasses direct and face-to-face interactions such as family and peer relationships, experiences at school and in extracurricular sports and clubs, and electronic device use. These individual components directly influence adolescents and how they learn and interact

with the world around them. The different experiences that a child has at home or with their peers will interact with one another within the mesosystem. Positive connections with family and peers, such as being physically active and engagement in structured programs, encompass microsystem-level protective factors that may buffer the negative effects of child maltreatment (Austin et al., 2020; Blum et al., 2022; Ehsan et al., 2019; Gordon et al., 2019; Gunn & Eberhardt, 2019; Hillman & Drobles, 2012; McPhie & Rawana, 2015; Novak & Kawachi, 2015; Oldfield et al., 2016; Pascoe & Parker, 2019; Steiner et al., 2019). Positive experiences, such as those with non-perpetrating family and peers, may mitigate the negative impacts of child maltreatment, aligning with the Resilience Theory (Bronfenbrenner, 1977; Haggerty, 1996; Mrazek & Mrazek, 1987). Interactions across systems, such as schools, families, and communities promoting healthy routines for adolescents, further reinforce resilience through the mesosystem (Badura et al., 2016; DeWalt et al., 2013; Fulkerson et al., 2006; Murphy et al., 2022; Oldfield et al., 2016; Rauner, 2000).

While some aspects of adolescents' environments may offer protection, others may contribute to risk. Electronic device use represents a component of the microsystem, as it often occurs in personal spaces such as bedrooms. This can directly influence adolescents' daily routines and sleep quality through delayed bedtimes, cognitive stimulation, and increased physiological arousal (Bronfenbrenner, 1977; Gomes & Goldman, 2024; Hale et al., 2018; LeBourgeois et al., 2017). Electronic device use can extend beyond the microsystem, as it occurs not only in isolation but may also be influenced by family, peers, community, mass media, and societal norms (Langdon et al., 2025). Excessive electronic device use may interfere with protective factors that may buffer against the effects of maltreatment, making it an important factor to examine. The Ecological Systems Theory suggests development is shaped by dynamic

interactions between systems, which highlights the importance of examining how various protective factors and electronic device use individually interact with child maltreatment to influence sleep outcomes of adolescents. The interactions of protective factors and child maltreatment also complement the Resiliency Theory as it suggests that certain elements of an adolescent's life may foster resilience to mitigate the adverse effects associated with maltreatment. Figure 1 presents the theoretical framework of the current study. This model illustrates the interacting components influencing the adolescent. The microsystem level contains several protective factors that may foster resilience among adolescents who have experienced child maltreatment within the same system. However, the microsystem also contains possible harmful factors such as electronic device use, which may also interact with child maltreatment. The exosystem can influence the adolescent through broader contextual factors, such as the influence of mass media and family structure. This conceptual framework contributed to the development and understanding of the current study and continues to guide the interpretation of the many influences on an adolescent's experiences and outcomes.

Figure 1. *A conceptual framework of the Resilience Theory with the Ecological Systems Theory*

Study Objectives

The objectives of the current study were: 1) to examine the association between child maltreatment (i.e., physical abuse, sexual abuse, physical neglect, emotional abuse, exposure to physical IPV, and exposure to emotional IPV) and poor sleep outcomes (i.e., prolonged sleep latency, frequent nocturnal awakenings, and inadequate sleep duration) among Canadian adolescents (15- to 17- year-olds); 2) to examine whether protective factors (i.e., physical

activity engagement, participation in organized sports and clubs, perceived social support, meaningful leisure time, physical activity with peers, and family meals) moderate (i.e., weaken) the association between child maltreatment and poor sleep outcomes; 3) to examine whether electronic device use moderates (i.e., strengthens) the association between child maltreatment and poor sleep outcomes; and 4) to examine whether the association of child maltreatment and poor sleep outcomes differs according to sex.

Research Questions and Hypotheses

Research Question 1

Is child maltreatment (any and individual types) associated with an increased: a) likelihood of prolonged sleep latency, b) likelihood of frequent nocturnal awakenings, and c) likelihood of inadequate sleep durations, among Canadian adolescents after adjusting for covariates (i.e., sex, age, parental education, family structure, and mental health)?

Hypothesis

It is hypothesized that Canadian adolescents who have experienced child maltreatment (i.e., any and individual types) compared to those without a child maltreatment history will more likely report poor sleep outcomes including prolonged sleep latency, frequent nocturnal awakenings, and/or increased inadequate sleep duration after adjusting for covariates.

Research Question 2

Does physical activity engagement, participation in organized sports and clubs, good perceived social support, meaningful leisure time, physical activity with peers, and frequent family meals act as protective factors in mitigating the negative impact of child maltreatment on poor sleep outcomes among Canadian adolescents after adjusting for covariates (i.e., sex, age, parental education, family structure, and mental health)?

Hypothesis

It is hypothesized that physical activity engagement, participation in organized sports and clubs, good perceived social support, meaningful leisure time, physical activity with peers, and/or frequent family meals will serve as protective factors and weaken the association between child maltreatment and poor sleep outcome among Canadian adolescents after adjusting for covariates.

Research Question 3

Does electronic device use moderate (i.e., strengthen) the association of child maltreatment on poor sleep outcomes among Canadian adolescents after adjusting for covariates (i.e., sex, age, parental education, family structure, and mental health)?

Hypothesis

It is hypothesized that high electronic device use (i.e., electronic device use in the bedroom prior to falling asleep, high daily electronic device use, and electronic device use for online social networking, messaging, and gaming) will strengthen the association between child maltreatment and poor sleep outcomes among Canadian adolescents after adjusting for covariates.

Research Question 4

Does the association between child maltreatment (any and individual types) and sleep outcomes, specifically prolonged sleep latency, frequent nocturnal awakenings, and inadequate sleep duration differ by sex among Canadian adolescents after adjusting for covariates (i.e., age, parental education, family structure, and mental health)?

Hypothesis

It is hypothesized that the strength of the association between child maltreatment (i.e., any and individual types) and poor sleep outcomes will differ between males and females whereby Canadian female adolescents a child maltreatment history report more poor sleep outcomes (i.e., prolonged sleep latency, frequent nocturnal awakenings, and inadequate sleep duration) compared to poor sleep outcome reports of Canadian male adolescents with a child maltreatment history after adjusting for covariates.

Methods

Data and Sample

The current study utilized data from the 2023 Canadian Health Survey on Children and Youth (CHSCY), collected by Statistics Canada. The questionnaire developed by Statistics Canada was made in collaboration with McMaster's Offord Centre for Child Studies, the Public Health Agency of Canada, and Health Canada (Statistics Canada, 2024a). This collaboration aimed to utilize relevant content for programs and policies that address youth-related gaps in the data. The 2023 CHSCY is a voluntary cross-sectional survey sampling children and youth representing 1-17-year-old Canadians across the provinces sampled from the Canada Child Benefit file which covers 98% of the Canadian population in this age group, excluding Canadian territories, First Nations reserves and institutional settings (Statistics Canada, 2024a). With a response rate of 54.2%, the survey yielded 22,739 total cases. A key objective of the 2023 CHSCY was to assess changes in the health and circumstances of children and youth in Canada, including the impact of the COVID-19 pandemic (Statistics Canada, 2023b). This included a longitudinal follow-up of respondents from the 2019 CHSCY, focusing on individuals aged 1 to 22 years (Statistics Canada, 2023b). Additionally, a cross-sectional sample was incorporated into

the final CHSCY dataset to represent Canadian children and youth in 2023. Participants in this dataset were randomly sampled from a list of youth that did not participate in the 2019 CHSCY (Statistics Canada, 2023b). Child maltreatment was only measured at the second wave.

The current study examined individuals aged 15 to 17 years from the cross-sectional component as this age range aligns with the development stage of adolescence and represents the group for whom all child maltreatment measures were administered. Data were collected through two online questionnaires, one completed by the adolescent and one by the person most knowledgeable (PMK) who was a birth, step or foster parent 98% of the time (Government of Canada, 2024; Statistics Canada, 2023b). Data collection occurred in two waves, from March to June 2023 and September to December 2023 using a different sample in each wave (Statistics Canada, 2023b). This split in data collection was made to reflect the school year due to the summer season often reflecting a period of routine change for youth (Statistics Canada, 2023b). Two sets of survey weights were produced, such that one set of weights accounts for the partial submissions from the youth, where the PMK completed portions of the questionnaire that the youth did not (Statistics Canada, 2024a). The other set of weights accounts for the new content that was only asked during the second wave of data collection (Statistics Canada, 2024a). For the current study, only responses from the youth were used. Prior to participation, selected individuals received invitation letters with details about the survey, ensuring informed consent from parents or legal guardians and the youth (Statistics Canada, 2023b). The response rate youth aged 12-17 years old was 38.1%, yielding approximately 7600 responses for adolescents 15-17 years old.

Measures

Child Maltreatment

Six types of child maltreatment were assessed in the 2023 CHSCY: physical abuse, sexual abuse, emotional abuse, physical neglect, exposure to physical IPV, and exposure to emotional IPV. Physical abuse, sexual abuse, exposure to physical IPV, and emotional IPV items were assessed using items from the Childhood Experiences of Violence Questionnaire (CEVQ), a valid and reliable tool developed to assess youth victimization (Walsh et al., 2008). Emotional abuse, and physical neglect were assessed using items adapted from the National Longitudinal Study of Adolescent to Adult Health (Harris et al., 2019), which have also been incorporated in other Statistics Canada surveys (Afifi et al., 2014; Turner et al., 2020). Each child maltreatment variable was coded in accordance with the respective questionnaire they were derived from.

Physical abuse was measured by three items in the survey. Physical abuse was assessed by asking individuals 15 to 17 years old to report on, “how many times did an adult”: a) “slap you on the face, head or ears or hit or spank you with something hard to hurt you?”, b) “push, grab, shove or throw something at you to hurt you?”, and c) “kick, bite, punch, choke, burn you, or physically attack you in some way?”. Physical abuse was coded as present if either of the first two items occurred three or more times or if the third item occurred one or more times. Sexual abuse was measured with two items asking “how many times did an adult”: a) “force you or attempt to force you into any unwanted sexual activity, by threatening you, holding you down or hurting you in some way?”, and b) “touch you against your will in any sexual way, such as anything from unwanted touching or grabbing, to kissing or fondling?”. Sexual abuse was coded as present if either of the items occurred one or more times. Emotional abuse was assessed by one item asking, “How many times did any one of your parents, step-parents or guardians say things that really hurt your feelings or made you feel like you were not wanted or loved?”. Emotional abuse was coded as present if this item occurred six or more times. Physical neglect

was assessed by one item asking, “How many times did your parents, step-parents or guardians not take care of your basic needs, such as keeping you clean or providing food or clothing?”.

Physical neglect was coded as present if this item occurred one or more times. Exposure to physical IPV was measured using one item asking, “how many times did you see or hear any one of your parents, step-parents or guardians hit each other or another adult in your home?”.

Exposure to physical IPV was coded as present if it occurred three or more times. Exposure to emotional IPV was measured by using one item asking, “how many times did you see or hear any one of your parents or caregivers say hurtful or mean things to each other or to another adult in your home?”. Exposure to emotional IPV was coded as present if it occurred six or more times. Any child maltreatment was coded as present if the respondent reported experiencing at least one type of individual child maltreatment item, and coded as absent if the respondent indicated no child maltreatment experiences across relevant items.

Poor Sleep Outcomes

Adolescents were asked about three types of sleep experiences: (1) sleep latency (i.e., how long to fall asleep), (2) frequency of nocturnal awakenings, and (3) sleep duration. Sleep latency was assessed by asking participants, “how long does it usually take [this child/you] to fall asleep at night?”. Sleep latency was coded dichotomously as “normal” (falling asleep in 30 minutes or less) and “prolonged” (falling asleep in more than 30 minutes). The frequency of nocturnal awakenings was assessed by asking, “after [this child/you] [has/have] gone to sleep at night, how often [does/do] [this child/you] usually wake up during the night?”. The frequency of nocturnal awakenings was coded dichotomously as “infrequent” (twice a week or less), and “frequent” (three times a week or more). Lastly, sleep duration was assessed by averaging the number of hours slept per night over 7 days. Sleep duration was coded dichotomously as

“inadequate” (less than 8 hours or more than 10 hours on average per night), and “adequate” (8 to 10 hours on average per night) (Chaput & Janssen, 2016).

Protective Factors

Physical activity was measured in total minutes per day that the participant engaged in physical activity over seven days; it was coded dichotomously as “inadequate” (less than 60 minutes) and “adequate” (60 minutes or more). Participation in organized sports and clubs was measured through three “yes” or “no” questions regarding participation in the past 12 months in (1) sport or activity with a coach or instructor, (2) music, drama or art clubs or lessons, and (3) other types of organized clubs or community. Participation in organized sports and clubs was coded dichotomously as “yes” (if the respondent answered “yes” to at least one question), and “no” (if they answered “no” to all). Perceived social support was measured using the social provisions 5-item scale score, derived from the Social Provisions Scale (SPS) (W. H. Jones & Perlman, 1987; Orpana et al., 2019) with scores ranging from 5-20 derived from four questions asking respondents about (1) having a sense of emotional security from close relationships, (2) having someone to talk to about important decisions, (3) having relationships where competence and skill are recognized, and (4) being part of a group with shared attitudes and beliefs. Individuals answered on a scale ranging from strongly agree (coded as 1) to strongly disagree (coded as 4) (see questionnaire in Appendix A). In accordance with the cutoffs provided from the SPS-5 validation, scores were dichotomized as “good perceived social support” (5-9 points) and “poor perceived social support” (10 or more points) (Orpana et al., 2019). Meaningful leisure time was measured by two questions asking about time spent over seven days engaging in a) outdoor physical activities in free time, and b) reading books/stories/articles for enjoyment. In accordance with the recommendation for a child to have at least one hour per day engaging in

meaningful leisure time (Iwasaki et al., 2018), the responses were coded as “adequate” if the seven hours or more were spent between both types of leisure activity questions, and “inadequate” if there was less than seven hours between both activities. Next, participants were asked, “thinking about your close friends, how many of these friends play sports or are involved in physical activity on a regular basis?”, which was dichotomized as “low peer activity” (if respondent answers “none of them” or “some of them”), and “high peer activity” (if respondent answered “most of them” or “all of them”). Lastly, participants were asked, “In the past 7 days, how many days did [this child/you] eat the evening meal with [his/your] family sitting at the dinner table?”, where answers were dichotomized in accordance with guidelines from previous literature into “frequent” (≥ 3 times), and “infrequent” (< 3 times) (Franko et al., 2008; Fulkerson et al., 2006; Hammons & Fiese, 2011; Harrison et al., 2015).

Electronic Device Use

The CHSCY 2023 measured electronic device use with five items, in which respondents were asked to report their use of electronic devices in their free time. Item one asked “In the past 7 days, did you use an electronic device in your bedroom before falling asleep?” coded as “yes” or “no”. Item two asked “On a typical day, how much time in total do you spend using any electronic device such as a mobile device, computer, tablet, video game console or television while you are sitting or lying down?” which was dichotomized as “low use” (0-2 hours), and “high use” (3 or more hours). Items three to five asked how often the individual would go online for: (3) “social networking e.g., Instagram, TikTok, Facebook or Twitter”, (4) “video or instant messaging e.g., Messenger, Snapchat, FaceTime or WhatsApp”, and (5) “online gaming e.g., League of Legends, Minecraft or World of Warcraft”. Such items were each dichotomized as “high use” (constantly, and several times a day), and “low use” (once a day, weekly, less than

weekly and never). Items were coded in accordance to past literature guidelines on electronic device use (Marciano & Camerini, 2021; Santos et al., 2023; Twenge & Campbell, 2018b).

Sociodemographic Characteristics

The sociodemographic characteristics included in the current study were the adolescents' sex (male or female), age (15, 16, or 17 years old), parent education (high school diploma or less; certificate or diploma below the bachelor's level; bachelor's degree, certificate, and diploma; or degree above the bachelor's) and family structure. Family structure was assessed by asking the respondent with whom the child lives with. Family structure was categorized a priori and remains consistent with existing literature. The final categorization comprised two groups: a) two biological parents, and b) other family structures (a biological parent with a step/adoptive-parent or unrelated spouse; two adoptive, foster or step-parents; lone-parent household; related or unrelated guardian care; and no parent or guardian household).

Mental Health Covariates

The 2023 CHSCY measured diagnosed mental health conditions and psychological distress. The diagnosed mental health conditions were measured through four items that asked, "have you been diagnosed with any of the following long-term health conditions?": a) "an anxiety disorder, such as a phobia, obsessive-compulsive disorder or a panic disorder", b) "a mood disorder such as depression, bipolar disorder, mania or dysthymia", c) "attention deficit disorder or attention deficit hyperactivity disorder, also known as ADD or ADHD", and d) "autism spectrum disorder, also known as autism, autistic disorder, Asperger's disorder or pervasive developmental disorder". Diagnosed mental health conditions was coded as "yes" (if respondent answered "yes" to at least one mental health condition item), and "no" (if respondent answered "no" to all mental health condition items). To measure psychological distress, the

Kessler 6-item (K6) Psychological Distress Scale was developed and is widely used to measure feelings of anxiety, depression, worthlessness, hopelessness, and nervousness (Kessler et al., 2002, 2003). This scale was originally developed for the US National Health Interview Survey (NHIS) (Kessler et al., 2002, 2003) and provides a comprehensive measurement of psychological distress. Using the K6 Psychological Distress Scale, scores ranged from 0-24. The six questions asked respondents, “during the past month, about how often did you feel the following?”: (1) “nervous”, (2) “hopeless”, (3) “restless or fidgety”, (4) “so depressed that nothing could cheer you up”, (5) “that everything was an effort”, and (6) “worthless”. Respondents answered on a scale ranging from “all the time” (coded as 1) to “none of the time” (coded as 5). The sum of the six items was calculated by the 2023 CHSCY questionnaire and coded by Statistics Canada in accordance with the cut-offs provided by the K6 Psychological Distress Scale (Kessler et al., 2002, 2003), and scores were dichotomized as “not distressed” (12 or fewer points), and “distressed” (13 or more points).

Data Analysis

Data analyses were conducted using STATA. Preliminary data analyses were conducted to examine data distributions, evaluate the assumptions of multivariable and univariable logistic regression, and assess the proportion and pattern of missing data. The key assumptions included independence of observations, absence of multicollinearity among predictors, absence of influential outliers, and adequate sample size (Tabachnick & Fidell, 2013b). The assumption of independence of observations is met if each response comes from a different case (Tabachnick & Fidell, 2013b). In the current study, independence of observations was met as each adolescent in the 2023 CHSCY dataset represents a unique, unrelated respondent. Polychoric correlations and Variance Inflation Factors (VIF) were examined to assess the assumption of absence of

multicollinearity. Polychoric correlation coefficients examined were each ≤ 0.80 . Additionally, VIF factors were between 1.02-1.38. Together, correlation coefficients ≤ 0.80 and VIF values of approximately 1 indicate minimal correlation among predictor variables, thereby supporting the assumption of independence among the child maltreatment and moderating variable (Tabachnick & Fidell, 2013b, 2013a). The assumption of the absence of influential outliers was assessed using SPSS, and no influential outliers were identified. The assumption of sufficient sample size was met given the large and representative sample provided by the 2023 CHSCY. Individual child maltreatment types had adequate power and met Statistics Canada vetting rule; thus, where indicated, individual child maltreatment types were assessed. Descriptive statistics were used to report frequencies and proportions to summarize the prevalence of child maltreatment (individual and any), sleep outcomes, protective factors, electronic device use, sociodemographic characteristics, and mental health variables.

Univariable and multivariable logistic regression were used to examine the association between child maltreatment types (i.e., individual types and any maltreatment) and poor sleep outcomes (i.e., prolonged sleep latency, frequent nocturnal awakenings, and inadequate sleep duration). Unadjusted (OR) and adjusted models were estimated, with adjustments made for sociodemographic characteristics including age, sex, parental education, and family structure (AOR1) and additionally adjusted for mental health variables including the K6 Psychological Distress Scale and diagnosed anxiety, mood disorder, ADD, and autism (AOR2) (research question 1). To address potential moderation effects, multivariable logistic regression models included interaction terms between any child maltreatment and each protective factor (engagement in physical activity, participation in organized sports and clubs, perceived social support, time spent active with peers, leisure time spent outside and/or reading, and frequency of

family meals) in individual models to determine whether these factors modified the association between any child maltreatment and individual poor sleep outcomes. The interaction terms were included in the logistic regression models alongside the main effects. Statistical significance of the interaction terms were assessed at $p \leq 0.10$. Unadjusted (OR) and adjusted models were estimated, with adjustments made for sociodemographic characteristics including age, sex, parental education, and family structure (AOR1) and additionally adjusted for mental health variables including the K6 Psychological Distress Scale and diagnosed anxiety, mood disorder, ADD, and autism (AOR2) (research question 2). Methodological research has demonstrated that observational research tests for interaction effects often have lower statistical power relative to main effects (Aiken et al., 1991; Fairchild & McQuillin, 2010; Shieh, 2018). This increased likelihood of Type II errors with interaction effects supports moderation analyses to be considered significant at a 90% confidence interval (Aiken et al., 1991; McClelland & Judd, 1993). However, conducting moderation analyses using 90% confidence intervals may increase the probability of Type I error; thus, the results were interpreted cautiously.

In addition to the main model, two sensitivity analyses were conducted. The first sensitivity analysis was conducted to examine the moderating effects of each SPS-5 item on the association between any child maltreatment and individual poor sleep outcomes. To assess this, multivariable logistic regression models included interaction terms between any child maltreatment and each SPS-5 item (see Appendix A for SPS-5 questionnaire) in individual models. Unadjusted (OR) and adjusted models were estimated, with adjustments made for sociodemographic characteristics including age, sex, parental education, and family structure (AOR1) and additionally adjusted for mental health variables including the K6 Psychological Distress Scale and diagnosed anxiety, mood disorder, ADD, and autism (AOR2). The second

sensitivity analysis was conducted to examine whether any protective factors were associated with any individual sleep outcomes. Univariable and multivariable logistic models were used to examine the association between each protective factor (engagement in physical activity, participation in organized sports and clubs, perceived social support, individual SPS-5 items, time spent active with peers, leisure time spent outside and/or reading, and frequency of family meals) and individual poor sleep outcomes. Unadjusted (OR) and adjusted models were estimated, with adjustments made for sociodemographic characteristics including age, sex, parental education, and family structure (AOR1) and additionally adjusted for mental health variables including the K6 Psychological Distress Scale and diagnosed anxiety, mood disorder, ADD, and autism (AOR2).

Moderation analyses were conducted to examine the moderation effects of electronic device use on the association between any child maltreatment and individual poor sleep outcomes. Multivariable logistic regression models included interaction terms between any child maltreatment and each type of electronic device use (electronic device use in the bedroom prior to falling asleep, high daily electronic device use, and electronic device use for online social networking, messaging, and gaming) in individual models to determine whether these factors modified the association between any maltreatment and individual sleep outcomes. The interaction terms were included in the logistic regression models alongside the main effects. The statistical significance of the interaction terms were assessed at $p \leq 0.10$. Unadjusted (OR) and adjusted models were estimated, with adjustments made for sociodemographic characteristics including age, sex, parental education, and family structure (AOR1) and additionally adjusted for mental health variables including the K6 Psychological Distress Scale and diagnosed anxiety, mood disorder, ADD, and autism (AOR2) (research question 3). A sensitivity analysis was

conducted to examine whether any type of electronic device use was associated with any individual sleep outcomes. Univariable and multivariable logistic models were used to examine the association between each type of electronic device use and individual poor sleep outcomes. Unadjusted (OR) and adjusted models were estimated, with adjustments made for sociodemographic characteristics including age, sex, parental education, and family structure (AOR1) and additionally adjusted for mental health variables including the K6 Psychological Distress Scale and diagnosed anxiety, mood disorder, ADD, and autism (AOR2).

To address sex differences (research question 4), multivariable logistic models were conducted to examine associations of child maltreatment types (i.e., individual and any child maltreatment) with individual poor sleep outcomes that differ between males and females. The statistical significance of the interaction terms were assessed at $p \leq 0.10$. Interaction terms between sex and child maltreatment were included in both unadjusted (OR) and adjusted models, with adjustments made for sociodemographic characteristics including age, parental education, and family structure (AOR1) and additionally adjusted for mental health variables including the K6 Psychological Distress Scale and diagnosed anxiety, mood disorder, ADD, and autism (AOR2).

Survey sampling weights containing only the youth's responses were applied to the analysis to ensure an accurate representation of the Canadian youth aged 15- to 17-year-olds. Additionally, bootstrapping variance estimates were employed to calculate variance estimates. By incorporating bootstrap replicate weights alongside the survey sampling weights, the analysis ensured valid estimation of odds ratios, 95% and 90% confidence intervals, and p -values that are representative of the target population. A p -value of ≤ 0.05 in main effect models and a p -value of ≤ 0.10 in the interaction effect models were used to determine statistical significance. The

main effect models were assessed for significance in unadjusted and adjusted models (AOR1 and AOR2). For moderation models, significance was only assessed in models adjusted for sociodemographic characteristics and mental health variables (AOR2).

Ethical Considerations

Ethics approval for the current study was granted by RITHIM Harmony and access to the 2023 CHSCY dataset was granted through the Research Data Centre (RDC). Statistics Canada ensures confidentiality by removing direct identifiers from the data and respondents' information is anonymized and represented as numbers in the database. As the current study used secondary data, additional consent was not required. Statistics Canada previously obtained informed consent under the Statistics Canada Act, and there was no direct contact with respondents or access to identifying information (Statistics Canada, 2023c). Privacy and confidentiality were addressed by collecting two separate questionnaires: one completed by the parent or legal guardian and the other by the youth (Statistics Canada, 2023b). Both questionnaires were administered independently to allow for the separate submission of their responses (Statistics Canada, 2023b). Respondents were informed about the survey's purpose, topics, and voluntary nature through their invitation, reminder letters, and in the introductory pages of the questionnaire (Statistics Canada, 2023b). This transparency enabled respondents to make informed decisions about their participation, including adolescents for whom parental consent was required (Statistics Canada, 2023b). A risk in participating in the 2023 CHSCY is possible emotional distress related to sensitive topics such as child maltreatment. However, the survey includes features such as a "leave page quickly" button on the questionnaire and access to mental health resources to mitigate these risks (Statistics Canada, 2023b). Furthermore, the use of anonymized data and the secondary nature of the analysis minimize any potential risks to

participants, as only existing data is being analyzed and there is no further communication with respondents. Benefits of participation include contributing to important research aimed at improving the health and well-being of Canadian adolescents, as well as access to health resources offered during the survey.

Results

Assessment of Missing Data

The proportion and pattern of missing data were assessed in STATA and SPSS for all variables. Missing data of approximately 5% or less is deemed acceptable and does not pose a serious problem (Tabachnick & Fidell, 2013a). As shown in Table 1, missing data greater than 5% were examined among each child maltreatment type and physical activity engagement variable. To assess potential bias, variables with greater than 5% missing data were examined using logistic regression models to determine if missingness was associated with individual poor sleep outcomes and sociodemographic characteristics (i.e., age, sex, parental education status, and family structure). The missingness of each child maltreatment variable was significantly associated with each poor sleep outcome. The missingness of the physical activity engagement variable was significantly associated with inadequate sleep duration. This pattern of missing data observed suggests the data were missing not at random (MNAR). Given the moderate proportion of missingness, analyses were conducted using complete case analysis.

Table 1. *Missing data $\geq 5\%$*

Variable	Missing (%)
Physical abuse	9.84
Sexual abuse	9.70
Emotional abuse	10.46
Physical neglect	9.32
Exposure to physical IPV	9.77
Exposure to emotional IPV	9.72

Variable	Missing (%)
Any child maltreatment	11.30
Physical activity in the past seven days	15.50

Descriptive Analysis

Table 2 exhibits the sociodemographic characteristics of the total sample. The study sample was evenly distributed among age and sex. The distribution of the highest level of parental education varied, with a bachelor's degree (31.32%) being most reported. Majority of adolescents in this study came from a household with two biological parents (73.40%) compared to other family structures (26.6%).

Table 2. *Sample characteristics*

Characteristic	Total Sample % (95% CI)
Sex	
Male	50.67 (49.58-51.76)
Female	49.33 (48.24-50.42)
Age, years	
15	35.82 (34.26-37.42)
16	33.77 (32.37-35.20)
17	30.41 (28.94-31.91)
Parental education	
High school diploma or less	16.03 (14.90-17.22)
Certificate or diploma below the bachelor's level	34.04 (32.57-35.54)
Bachelor's degree	31.32 (29.80-32.88)
Certificate, diploma, degree above the bachelor's	18.61 (17.38-19.92)
Family structure	
Two biological parents	73.40 (72.07-74.69)
Other	26.60 (25.31-27.93)
Diagnosed mental health condition	
Yes (anxiety, mood disorder, ADD, and/or autism)	21.49 (20.26-22.77)
No	78.51 (77.23-79.74)
Kessler 6-item Psychological Distress Scale	
Psychologically distressed	5.77 (5.13-6.47)
Not psychologically distressed	94.23 (93.53-94.87)

Abbreviation: *CI* confidence interval.

Table 3 describes the distribution of the total sample with and without child maltreatment experiences stratified by sociodemographic characteristics. The overall prevalence of child maltreatment was 29.0%. The most frequently reported child maltreatment type among the sample of the current study was emotional abuse (15.77%) followed by exposure to emotional IPV (14.95%), physical abuse (11.41%), sexual abuse (5.97%), physical neglect (5.1%), and exposure to physical IPV (2.87%). Among female adolescents, 35.01% reported any child maltreatment experiences, while 23.13% of males reported any child maltreatment experiences. The prevalence of 15-, 16-, and 17-year-old adolescents experiencing any child maltreatment was 26.32%, 29.56%, and 31.49%, respectively. Similar prevalence estimates of any child maltreatment were reported among adolescents of parents whose highest level of education is a high school diploma or less (27.98%), a diploma or degree greater than high school but less than a bachelor's (29.45%), a bachelor's degree (30.29%), and greater than a bachelor's degree (26.78%). Among adolescents living with two biological parents, 24.99% reported experiencing any child maltreatment, and of the adolescents who have a different family structure (i.e., step/adoptive-parent, foster parent, lone-parent, or no parent or guardian household) 39.95% reported experiencing any child maltreatment. Among adolescents with at least one diagnosed mental health condition (i.e., anxiety, mood disorder, ADD, and/or autism) and adolescents indicating psychological distress, 40.55% and 37.32% (respectively) reported experiencing at least one form of child maltreatment.

Table 3. *Weighted prevalence of child maltreatment types stratified by study characteristics*

	Physical abuse		Sexual abuse		Emotional abuse		Physical neglect		Exposure to physical IPV		Exposure to emotional IPV		Any child maltreatment	
	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)
Sex														
Male	10.22 (8.76-11.90)	89.78 (88.10-91.24)	2.21 (1.53-3.18)	97.79 (96.82-98.47)	10.58 (9.11-12.25)	89.42 (87.75-90.89)	4.08 (3.38-4.92)	95.92 (95.08-96.62)	2.27 (1.62-3.18)	97.73 (96.82-98.38)	11.51 (9.98-13.23)	88.49 (86.77-90.02)	23.13 (21.04-25.36)	76.87 (74.64-78.96)
Female	12.60 (11.05-14.32)	87.40 (85.68-88.95)	9.23 (7.98-10.64)	90.77 (89.36-92.02)	21.04 (19.32-23.08)	78.86 (76.92-80.68)	6.15 (5.23-7.21)	93.85 (92.79-94.77)	3.45 (2.76-4.30)	96.55 (95.70-97.24)	18.48 (16.75-20.35)	81.52 (79.65-83.25)	35.01 (32.85-37.22)	64.99 (62.78-67.15)
Age, years														
15	11.35 (9.46-13.56)	88.85 (86.44-90.54)	4.59 (3.63-5.80)	95.41 (94.20-96.37)	12.79 (11.12-14.67)	87.21 (85.33-88.88)	4.72 (3.85-5.78)	95.28 (94.22-96.15)	2.24 (1.66-3.02)	97.76 (96.98-98.34)	13.04 (84.85-88.82)	86.96 (84.85-88.82)	26.32 (23.88-28.91)	73.68 (71.09-76.12)
16	10.30 (8.83-11.99)	89.7 (88.01-91.17)	5.46 (4.47-6.66)	94.54 (93.34-95.53)	15.91 (13.99-18.04)	84.09 (81.96-86.01)	4.74 (3.84-5.82)	95.26 (94.18-96.16)	3.06 (2.26-4.13)	96.94 (95.87-97.74)	14.97 (13.10-17.05)	85.03 (82.95-86.90)	29.56 (27.10-32.15)	70.44 (67.85-72.90)
17	12.67 (10.65-15.02)	87.33 (84.98-89.35)	7.18 (5.60-9.15)	92.82 (90.85-94.40)	19.08 (16.79-21.61)	80.98 (78.39-83.21)	5.94 (4.69-7.49)	94.06 (92.51-95.31)	3.38 (2.38-4.79)	96.62 (95.21-97.62)	17.17 (14.94-19.66)	82.83 (80.34-85.06)	31.49 (28.61-34.51)	68.51 (65.49-71.39)
Parental education														
High school diploma or less	12.36 (9.85-15.39)	87.64 (84.61-90.15)	6.26 (4.50-8.65)	93.74 (91.35-95.50)	13.13 (10.86-15.78)	86.87 (84.22-89.14)	5.31 (4.03-6.97)	94.69 (93.03-95.97)	3.97 (2.52-6.19)	96.03 (93.81-97.48)	15.02 (11.98-18.67)	84.98 (81.33-88.02)	27.98 (24.28-32.01)	72.02 (67.99-75.72)
More than high school, less than bachelor's	12.13 (10.31-14.23)	87.87 (85.77-89.69)	6.04 (4.83-7.54)	93.96 (92.46-95.17)	16.28 (14.38-18.37)	83.72 (81.63-85.62)	5.70 (4.76-6.81)	94.30 (93.19-95.24)	3.28 (2.53-4.23)	96.72 (95.77-97.47)	14.67 (12.85-16.69)	85.33 (83.31-87.15)	29.45 (26.97-32.07)	70.55 (67.93-73.03)
Bachelor's degree	11.36 (9.39-13.69)	88.64 (86.31-90.61)	5.96 (4.63-7.64)	94.04 (92.36-95.37)	16.57 (14.34-19.07)	83.43 (80.93-85.66)	4.38 (3.25-5.90)	95.62 (94.10-96.75)	2.10 (1.44-3.05)	97.90 (96.95-98.56)	15.74 (13.48-18.31)	84.26 (81.69-86.52)	30.29 (27.42-33.33)	69.71 (66.67-72.58)

	Physical abuse		Sexual abuse		Emotional abuse		Physical neglect		Exposure to physical IPV		Exposure to emotional IPV		Any child maltreatment	
	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)
Certificate, diploma, or degree above the bachelor's	9.41 (7.36-11.97)	90.59 (88.03-92.64)	4.08 (2.92-5.69)	95.92 (94.31-97.08)	15.58 (12.77-18.86)	84.42 (81.14-87.23)	4.49 (3.41-5.90)	95.51 (94.10-96.59)	2.31 (1.15-4.59)	97.69 (95.41-98.85)	13.78 (11.30-16.71)	86.22 (83.29-88.70)	26.78 (23.45-30.40)	73.22 (69.60-76.55)
Family structure														
Two biological parents	9.36 (8.18-10.68)	90.64 (89.32-91.82)	5.11 (4.30-6.07)	94.89 (93.93-95.70)	13.32 (12.02-14.73)	86.68 (85.27-87.98)	3.30 (2.74-3.97)	96.70 (96.03-97.26)	1.79 (1.30-2.45)	98.21 (97.55-98.70)	11.68 (10.37-13.12)	88.32 (86.88-89.63)	24.99 (23.22-26.84)	75.01 (73.16-76.78)
Other	16.94 (14.62-19.54)	83.06 (80.46-85.38)	7.28 (5.88-8.98)	92.72 (91.02-94.12)	22.31 (19.92-24.91)	77.69 (75.09-80.08)	10.01 (8.55-11.68)	89.99 (88.32-91.45)	5.99 (4.77-7.51)	94.01 (92.49-95.23)	24.25 (21.67-27.02)	75.75 (72.98-78.33)	39.95 (37.11-42.86)	60.05 (57.14-62.89)
Diagnosed mental health condition														
Yes (anxiety, mood disorder, ADD, and/or autism)	16.24 (13.73-19.11)	83.76 (80.89-86.27)	11.53 (9.35-14.14)	88.47 (85.86-90.65)	24.26 (21.44-27.32)	75.74 (72.68-78.56)	9.31 (7.62-11.33)	90.69 (88.67-92.38)	4.17 (3.29-5.26)	95.83 (94.74-96.71)	21.56 (18.70-24.72)	78.44 (75.28-81.30)	40.55 (37.13-44.05)	59.45 (55.95-62.87)
No	10.21 (9.05-11.51)	89.79 (88.49-90.95)	4.15 (3.47-4.94)	95.85 (95.06-96.53)	13.62 (12.35-15.00)	86.38 (85.00-87.65)	4.01 (3.45-4.67)	95.99 (95.33-96.55)	2.55 (1.99-3.27)	97.45 (96.73-98.01)	13.31 (12.03-14.72)	86.69 (85.28-87.97)	26.14 (24.47-27.88)	73.86 (72.12-75.53)
Kessler 6-item Psychological Distress Scale														
Psychologically distressed	14.13 (10.31-19.06)	85.87 (80.94-89.69)	7.22 (4.75-10.83)	92.78 (89.17-95.25)	20.26 (16.06-25.24)	79.74 (74.76-83.94)	8.51 (6.04-11.87)	91.49 (88.13-93.96)	5.48 (3.57-8.32)	94.52 (91.68-96.43)	18.86 (15.06-23.36)	81.14 (76.64-84.94)	37.32 (31.75-43.26)	62.68 (56.74-68.25)
Not psychologically distressed	11.24 (10.12-12.46)	88.76 (87.54-89.88)	5.58 (4.84-6.43)	94.42 (93.57-95.16)	15.47 (14.26-16.77)	84.53 (83.23-85.74)	4.77 (4.18-5.45)	95.23 (94.55-95.82)	2.65 (2.14-3.29)	97.35 (96.71-97.86)	14.69 (13.45-16.02)	85.31 (83.98-86.55)	28.53 (26.95-30.16)	71.47 (69.84-73.05)
Total sample	11.41 (10.33-12.58)	88.59 (87.54-89.64)	5.67 (4.96-6.48)	94.33 (93.52-95.04)	15.77 (14.60-17.02)	84.23 (82.98-85.40)	5.10 (4.51-5.77)	94.9 (94.23-95.49)	2.87 (2.37-3.46)	97.13 (96.54-97.63)	14.95 (13.77-16.22)	85.05 (83.78-86.23)	29.00 (27.48-30.57)	71.00 (69.43-72.52)

Table 4 presents the distribution of the total sample with and without poor sleep outcomes stratified by sociodemographic characteristics. Overall, 56.47% of adolescents reported at least one poor sleep outcome. Among the adolescents in the current study, 38.36% reported inadequate sleep duration, 19.68% reported prolonged sleep latency, and 17.70% reported frequent nocturnal awakenings. Table 5 provides the prevalence of poor sleep outcomes by child maltreatment experiences within the total sample. Among adolescents experiencing any child maltreatment, 42.52% reported experiencing prolonged sleep latency, 41.37% reported frequent nocturnal awakenings, and 35.55% reported inadequate sleep durations.

Table 4. *Weighted prevalence of individual poor sleep outcomes stratified by sociodemographic characteristics*

	Prolonged sleep latency		Frequent nocturnal awakenings		Inadequate sleep duration	
	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)
Sex						
Male	16.71 (15.02-18.55)	83.29 (81.45-84.98)	13.85 (12.33-15.53)	86.15 (84.47-87.67)	36.94 (34.61-39.34)	63.06 (60.66-65.39)
Female	22.71 (20.98-24.54)	77.29 (75.46-79.0)	21.66 (20.09-23.31)	78.34 (76.69-79.91)	39.94 (37.66-41.97)	60.21 (58.03-62.34)
Age, years						
15	19.29 (17.21-21.55)	80.71 (78.45-82.79)	16.79 (15.02-18.71)	83.21 (81.29-84.98)	31.65 (29.17-34.24)	68.35 (65.76-70.83)
16	20.00 (18.02-22.13)	80.00 (77.87-81.98)	17.51 (15.71-19.47)	82.49 (80.53-84.29)	41.66 (38.98-44.40)	58.34 (55.60-61.02)
17	19.79 (17.67-22.09)	80.21 (77.91-82.33)	18.97 (16.82-21.32)	81.03 (78.68-83.18)	42.72 (39.74-45.75)	57.28 (54.25-60.26)
Parental education						
High school diploma or less	20.69 (17.69-24.04)	79.31 (75.96-82.31)	18.22 (15.88-20.82)	81.78 (79.18-84.12)	41.27 (37.35-45.30)	58.73 (54.70-62.65)
More than high school, less than bachelor's	22.23 (20.10-24.52)	77.77 (75.48-79.90)	20.22 (18.21-22.38)	79.78 (77.62-81.79)	36.94 (34.46-39.49)	63.06 (60.51-65.54)
Bachelor's degree	19.36 (17.07-21.87)	80.64 (78.13-82.93)	16.00 (14.00-18.23)	84.00 (81.77-86.00)	38.91 (36.03-41.87)	61.09 (58.13-63.97)
University certificate, diploma or degree above the bachelor's	15.06 (12.77-17.66)	84.94 (82.34-87.23)	15.52 (12.92-18.53)	84.48 (81.47-87.08)	38.57 (34.78-42.49)	61.43 (57.51-65.22)
Family structure						
Two biological parents	18.60 (17.16-20.13)	81.40 (79.87-82.84)	16.68 (15.37-18.08)	83.32 (81.92-84.63)	37.33 (35.40-39.29)	62.67 (60.71-64.60)
Other	22.76 (20.50-25.19)	77.24 (74.81-79.50)	20.19 (18.15-22.40)	79.81 (77.60-81.85)	40.93 (37.98-43.94)	59.07 (56.06-62.02)
Diagnosed mental						

	Prolonged sleep latency		Frequent nocturnal awakenings		Inadequate sleep duration	
	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)
health condition						
Yes	31.86 (28.95-34.91)	68.14 (65.09-71.05)	24.11 (21.61-26.80)	75.89 (73.20-78.39)	39.85 (36.59-43.20)	60.15 (56.80-63.41)
No	16.44 (15.18-17.78)	83.56 (82.22-84.82)	15.95 (14.73-17.26)	84.05 (82.74-85.27)	37.91 (36.10-39.76)	62.09 (60.24-63.90)
Kessler 6-item Psychological Distress Scale						
Psychologically distressed	27.68 (22.21-33.91)	72.32 (66.09-77.79)	23.56 (19.04-28.76)	76.44 (71.24-80.96)	43.20 (37.39-49.21)	56.80 (50.79-62.61)
Not psychologically distressed	19.27 (18.02-20.58)	80.73 (79.42-81.98)	17.38 (16.23-18.59)	82.62 (81.41-83.77)	38.21 (36.53-39.91)	61.79 (60.09-63.47)
Total sample	19.68 (18.48-20.94)	80.32 (79.06-81.52)	17.70 (16.59-18.86)	82.3 (81.14-83.41)	38.36 (36.77-39.98)	61.64 (60.02-63.23)

Table 5. *Weighted prevalence of child maltreatment experiences and individual poor sleep outcomes*

	Prolonged sleep latency		Frequent nocturnal awakenings		Inadequate sleep duration	
	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)
Child maltreatment						
Physical abuse						
Yes	18.35 (15.51-21.57)	9.72 (8.63-10.93)	17.91 (15.25-20.91)	10.01 (8.88-11.28)	14.63 (12.85-16.61)	8.66 (89.95-92.56)
No	81.65 (78.43-84.49)	90.28 (89.07-91.37)	82.09 (79.09-84.75)	89.99 (88.72-91.12)	85.37 (83.39-87.15)	91.34 (89.95-92.56)
Sexual abuse						
Yes	10.34 (8.18-12.98)	4.53 (3.82-5.36)	11.83 (9.70-14.35)	4.36 (3.65-5.20)	7.02 (5.78-8.50)	4.27 (3.48-5.24)
No	89.66 (87.02-91.82)	95.47 (94.64-96.18)	88.17 (85.65-90.30)	95.64 (94.80-96.35)	92.98 (91.50-94.22)	95.73 (94.76-96.52)

	Prolonged sleep latency		Frequent nocturnal awakenings		Inadequate sleep duration	
Child maltreatment	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)
Emotional abuse						
Yes	24.02 (21.13-27.17)	13.79 (12.52-15.18)	25.98 (22.89-29.31)	13.55 (12.30-14.90)	20.85 (18.76-23.11)	12.13 (10.85-13.54)
No	75.98 (72.83-78.87)	86.21 (84.82-87.48)	74.02 (70.69-77.11)	85.45 (85.10-87.70)	79.15 (76.89-81.24)	87.87 (86.46-89.15)
Physical neglect						
Yes	8.73 (7.30-10.40)	4.21 (3.57-4.95)	8.68 (7.03-10.67)	4.34 (3.73-5.04)	6.66 (5.50-8.05)	3.95 (3.36-4.63)
No	91.27 (89.60-92.70)	95.79 (95.05-96.43)	91.32 (89.33-92.97)	95.66 (94.96-96.27)	93.34 (91.95-94.50)	96.05 (95.37-96.64)
Exposure to physical IPV						
Yes	4.91 (3.54-6.79)	2.36 (1.86-2.99)	5.57 (3.91-7.86)	2.29 (1.82-2.87)	4.02 (3.17-5.10)	1.82 (1.37-2.42)
No	95.09 (93.21-96.46)	97.64 (97.01-98.14)	94.43 (92.14-96.09)	97.71 (97.13-98.18)	95.98 (94.90-96.83)	98.18 (97.58-98.63)
Exposure to emotional IPV						
Yes	22.32 (19.32-25.63)	13.15 (11.92-14.48)	23.26 (20.20-26.63)	13.14 (11.86-14.54)	18.19 (16.09-20.50)	12.38 (11.09-13.80)
No	77.68 (74.37-80.68)	86.85 (85.52-88.08)	76.74 (73.37-79.80)	86.86 (85.46-88.14)	81.81 (79.50-83.91)	87.62 (86.20-88.91)
Any child maltreatment						
Yes	42.52 (38.91-46.22)	25.77 (24.15-27.45)	41.37 (37.93-44.89)	26.31 (24.62-28.07)	35.55 (32.96-38.22)	24.04 (22.24-25.94)
No	57.48 (53.78-61.09)	74.23 (72.55-75.85)	58.63 (55.11-62.07)	73.69 (71.93-75.38)	64.45 (61.78-67.04)	75.96 (74.06-77.76)

Table 6 presents the prevalence of the protective factors among the sample. The most reported protective factor was participation in organized sports or clubs (75.76%), with similar reports of frequent family meals (74.33%), and good perceived social support (69.48%). Notably, the least commonly reported protective factor among adolescents is meaningful leisure time (17.82%). Table 7 presents the prevalence of electronic device use among the sample. This distribution indicates that adolescents most commonly use their electronic device in their bedroom prior to falling asleep (87.08%) with similar reports of high daily use of an electronic device (85.73%). The least common use for an electronic device is for online games (20.43%).

Table 6. *Prevalence of protective factors among the sample*

Protective factors	Yes (%)	No (%)
Participation in sports/clubs	75.76	24.24
Family meals	74.33	25.67
Perceived social support	69.48	30.52
Physical activity with peers	46.68	53.32
Physical activity	32.43	67.57
Meaningful leisure time	17.82	82.18

Table 7. *Prevalence of electronic device use among the sample*

Electronic device use	Yes (%)	No (%)
Electronic device use in bedroom prior to falling asleep	87.08	12.92
High daily electronic device use	85.73	14.27
Online social networking	76.60	23.40
Online messaging	70.08	29.92
Online games	20.43	79.57

Logistic Regression Models

Associations between child maltreatment and poor sleep outcomes

Univariable and multivariable logistic regression models were estimated to examine associations between individual and any child maltreatment types and individual poor sleep outcomes in unadjusted models, models adjusted for sociodemographic characteristics (AOR1), and models adjusted for sociodemographic characteristics and mental health variables (AOR2) (Table 8). In the unadjusted models, individual and any child maltreatment types were significantly associated with prolonged sleep latency (OR ranging from 1.90-2.43), frequent nocturnal awakenings (OR ranging from 1.96-2.94), and inadequate sleep durations (OR ranging from 1.57-2.26). These associations remained statistically significant after these models were adjusted for the sociodemographic characteristics (AOR1 ranging from 1.48-2.61) and further adjusted for mental health (AOR2 ranging from 1.48-2.36). These results indicate that individuals who experience any individual type of child maltreatment have an increased likelihood of having poor sleep outcomes in adolescence. Compared to adolescents without child maltreatment experiences, adolescents with any child maltreatment experience are more likely to have prolonged sleep latency (AOR2 = 1.88, 95% CI 1.57-2.27) frequent nocturnal awakenings (AOR2 = 1.72, 95% CI = 1.43-2.08), and inadequate sleep duration (AOR2 = 1.67, 95% CI = 1.42-1.97).

Table 8. Associations of child maltreatment and poor sleep outcomes; unadjusted and adjusted for sociodemographic characteristics and mental health variables

Child maltreatment	Prolonged sleep latency			Frequent nocturnal awakenings			Inadequate sleep duration		
	OR (95% CI)	AOR1 (95% CI)	AOR2 (95% CI)	OR (95% CI)	AOR1 (95% CI)	AOR2 (95% CI)	OR (95% CI)	AOR1 (95% CI)	AOR2 (95% CI)
Physical abuse	2.09 (1.65-2.94)***	2.00 (1.57-2.56)***	1.89 (1.47-2.43)***	1.96 (1.56-2.47)***	1.85 (1.45-2.36)***	1.76 (1.37-2.26)***	1.81 (1.45-2.25)***	1.69 (1.35-2.12)***	1.71 (1.36-2.14)***
Sexual abuse	2.43 (1.76-3.36)***	2.23 (1.59-3.11)***	1.86 (1.32-2.62)***	2.94 (2.20-3.93)***	2.61 (1.94-3.53)***	2.36 (1.75-3.19)***	1.69 (1.25-2.29)***	1.56 (1.13-2.15)**	1.54 (1.11-2.14)**
Emotional abuse	1.98 (1.61-2.42)***	1.85 (1.51-2.28)***	1.67 (1.35-2.07)***	2.24 (1.83-2.74)***	1.99 (1.61-2.47)***	1.88 (1.51-2.33)***	1.91 (1.60-2.28)***	1.81 (1.50-2.18)***	1.80 (1.49-2.18)***
Physical neglect	2.18 (1.68-2.82)***	1.99 (1.51-2.62)***	1.72 (1.29-2.29)***	2.10 (1.58-2.77)***	1.90 (1.43-2.53)***	1.73 (1.29-2.32)***	1.74 (1.33-2.27)***	1.61 (1.21-2.13)***	1.59 (1.20-2.11)***
Exposure to physical IPV	2.14 (1.38-3.32)***	1.92 (1.24-2.95)**	1.84 (1.16-2.91)**	2.51 (1.60-3.94)***	2.33 (1.40-3.87)***	2.27 (1.36-3.81)**	2.26 (1.54-3.33)***	2.10 (1.41-3.12)***	2.12 (1.42-3.16)***
Exposure to emotional IPV	1.90 (1.54-2.34)***	1.79 (1.43-2.23)***	1.66 (1.32-2.09)***	2.00 (1.61-2.49)***	1.87 (1.47-2.37)***	1.79 (1.40-2.28)***	1.57 (1.30-1.90)***	1.48 (1.21-1.80)***	1.48 (1.21-1.81)***
Any child maltreatment	2.13 (1.79-2.53)***	2.04 (1.71-2.45)***	1.88 (1.57-2.27)***	1.98 (1.67-2.34)***	1.81 (1.51-2.18)***	1.72 (1.43-2.08)***	1.74 (1.50-2.03)***	1.66 (1.42-1.95)***	1.67 (1.42-1.97)***

Abbreviations: *OR* unadjusted odds ratio; *AOR1* odds ratio adjusted for sociodemographic characteristics (age, sex, parental education, and family structure); *AOR2* odds ratio adjusted for sociodemographic characteristics and mental health variables; *CI* confidence interval.

* $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$

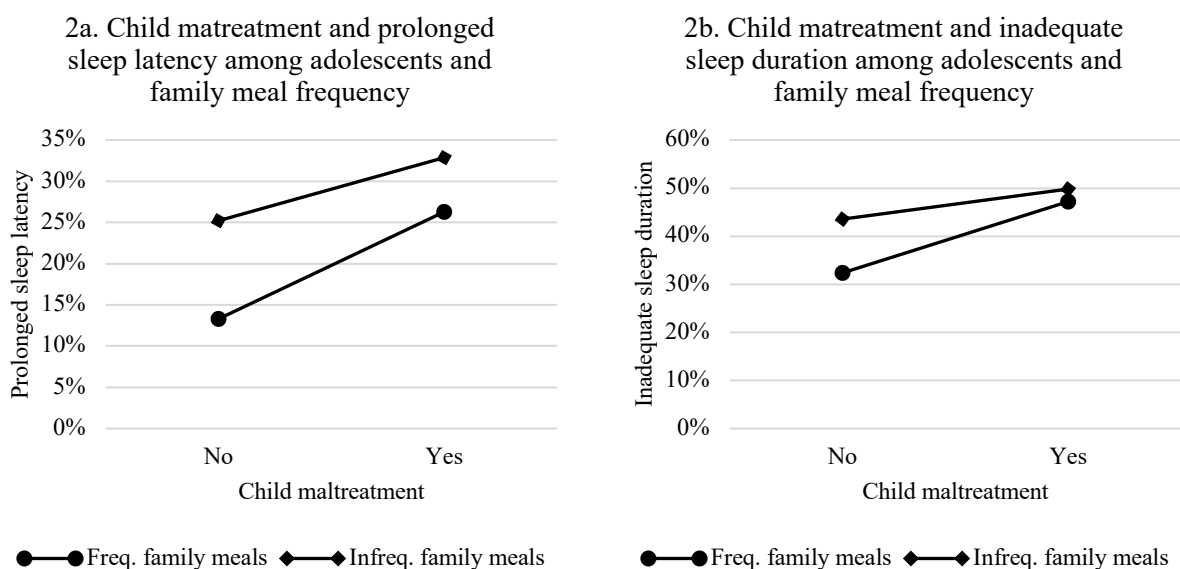
Moderating effects of protective factors on the association between child maltreatment and poor sleep outcomes

Multivariable logistic regression models were computed to examine if individual protective factors (i.e., physical activity engagement, participation in organized sports and clubs, perceived social support, meaningful leisure time, physical activity with peers, or frequent family meals) moderated the association between any child maltreatment and individual poor sleep outcomes. Results indicated that among the six protective factors examined, only frequent family meals significantly moderated the association between any child maltreatment and prolonged sleep latency, and any child maltreatment and inadequate sleep duration.

Interaction plots were generated to interpret the trends observed among the significant moderation effects of frequent family meals and the two poor sleep outcomes (see Figure 2). Figure 2a indicates that among adolescents with and without child maltreatment histories, those who have frequent family meals (i.e., three or more meals per week with their family) report a lower prevalence of prolonged sleep latency compared to adolescents without frequent family meals. However, while protective, prolonged sleep latency is higher among those with a child maltreatment history and frequent family meals compared to those without a child maltreatment history and frequent family meals. This indicates that having frequent family meals is protective for prolonged sleep latency among those with and without a child maltreatment history. The plots also indicate that for adolescents with child maltreatment histories and frequent family meals, the prevalence of prolonged sleep latency is similar to that of adolescents without child maltreatment histories and infrequent family meals, further demonstrating the protective nature. Those with a child maltreatment history and without frequent family meals have the highest sleep latency. Figure 2b indicates that the adolescents without child maltreatment histories and

with frequent family meals report the lowest inadequate sleep durations. Those with a child maltreatment history and frequent family meals have slightly lower inadequate sleep durations compared to those without frequent family meals and are comparable to those without a child maltreatment history and infrequent family meals. These results indicate significant interaction effects for child maltreatment and frequent family meals for sleep outcomes. More specifically, having frequent family meals is protective against the association between child maltreatment and prolonged sleep latency for adolescents with a child maltreatment history and is also protective for those without child maltreatment histories. Additionally, frequent family meals reduce the prevalence of inadequate sleep duration for those without a child maltreatment history but did not indicate a large difference for those with a child maltreatment history. The remaining protective factors (i.e., good perceived social support, physical activity engagement, participation in organized sports and clubs, meaningful leisure time, and physical activity with peers) did not demonstrate significant moderation effects.

Figure 2. *Prevalence of poor sleep outcomes among adolescents with and without child maltreatment histories stratified by family meal frequency*



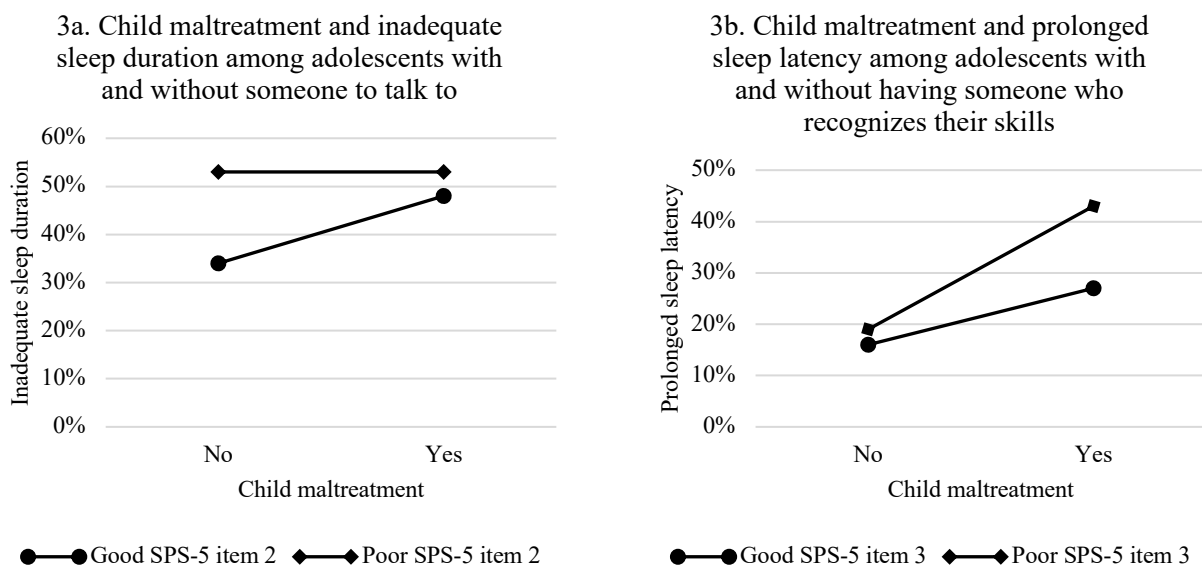
Sensitivity analysis

To ensure that the non-significant moderation effects were not due to a Type II error, two sensitivity analyses were conducted. The first sensitivity analysis was conducted for the item measuring perceived social support. Perceived social support was measured using the SPS-5. The 2023 CHSCY included each question from the SPS-5 questionnaire and allowed for the creation of a derived variable with a total score for each respondent; see Appendix A for the SPS-5 questionnaire. While the derived item using total scores did not significantly moderate the association between any child maltreatment and individual poor sleep outcomes, a sensitivity analysis was conducted using the individual SPS-5 items to assess whether any of the five individual items significantly moderated the association between any child maltreatment and individual poor sleep outcomes. The results indicated that, item two of the SPS-5 (i.e., having someone they can talk to about important life decisions) significantly moderated the association between any child maltreatment and inadequate sleep duration, and item three (i.e., having relationships where their competence and skill are recognized) significantly moderated the association between any child maltreatment and prolonged sleep latency. Items 1 (i.e., having close relationships that provide emotional security), 4 (i.e., being part of a group with shared attitudes and beliefs), and 5 (i.e., having people to count on in an emergency) of the SPS-5 did not significantly moderate the association between any child maltreatment and individual poor sleep outcomes.

Interaction plots were generated to interpret the trends observed in the significant moderation effects of SPS-5 items 2 and 3 (Figure 3). The plot in Figure 3a indicates that among adolescents without child maltreatment histories, those who have someone to talk to about important decisions in their life report a lower prevalence of inadequate sleep durations

compared to those who do not have someone to talk to about important decisions. Similarly, among adolescents with child maltreatment histories, those who have someone to talk to about important decisions still indicate a lower prevalence of inadequate sleep durations compared to those who do not have someone to talk to about important decisions. However, the difference in the prevalence of inadequate sleep durations is much smaller between adolescents with child maltreatment histories who have someone to talk to about important decisions and those who do not compared to the two groups without child maltreatment histories. Next, Figure 3b indicates that among adolescents without child maltreatment histories, adolescents who have someone in their life who recognizes their skills and competence and those who do not, have similar prevalences of prolonged sleep latency. However, among adolescents with child maltreatment histories, those who have someone in their life that recognizes their skills and competence report a lower prevalence of prolonged sleep latency compared to those who do not have someone in their life who recognizes their skills and competence. This suggests that having someone in their life that recognizes their skills and competence is protective for prolonged sleep latency among adolescents with child maltreatment histories.

Figure 3. *Prevalence of poor sleep outcomes among adolescents with and without child maltreatment histories stratified by SPS-5 items*



The second sensitivity analysis was conducted to examine whether physical activity engagement, participation in organized sports and clubs, perceived social support, meaningful leisure time, physical activity with peers, or frequent family meals affected poor sleep outcomes among adolescents regardless of child maltreatment histories. The sensitivity analysis examined whether individual protective factors were independently associated with poor sleep outcomes when modelled as the main exposure in logistic regression, irrespective of their roles as effect modifiers of the association between child maltreatment and poor sleep outcomes. Each protective factor was treated as the independent variable to assess associations with prolonged sleep latency, frequent nocturnal awakenings, and inadequate sleep duration in unadjusted models, models adjusted for sociodemographic characteristics (AOR1), and models adjusted for sociodemographic characteristics and mental health variables (AOR2) (Table 9). Perceived social support was examined as the derived SPS-5 total score and individual items.

The results of the sensitivity analysis indicate that participation in sports or clubs, good perceived social support, physical activity with peers, and frequent family meals are each associated with a decreased likelihood of prolonged sleep latency. Good perceived social support and frequent family meals remained significantly associated with prolonged sleep latency across unadjusted and adjusted models (AOR1 and AOR2). Participation in organized sports or clubs and physical activity with peers were significantly associated with prolonged sleep latency in unadjusted models and models adjusting for sociodemographic characteristics (AOR1), but no longer significant in models adjusting for sociodemographic characteristics and mental health variables (AOR2). Participation in sports or clubs, good perceived social support, and frequent family meals were each associated with a decreased likelihood of frequent nocturnal awakenings. Good perceived social support and frequent family meals remained significantly associated with frequent nocturnal awakenings across unadjusted and adjusted models (AOR1 and AOR2). Unexpectedly, engagement in physical activity was significantly associated with an increased likelihood of frequent nocturnal awakenings in the adjusted models (AOR1 and AOR2). Participation in organized sports or clubs was significantly associated with frequent nocturnal awakenings in unadjusted models and models adjusting for sociodemographic characteristics (AOR1), but no longer significant when adjusted for sociodemographic characteristics and mental health variables (AOR2). In addition, good perceived social support, physical activity with peers, and frequent family meals were associated with a decreased likelihood of inadequate sleep duration. Physical activity with peers was only significantly associated with inadequate sleep duration in the unadjusted models. Good perceived social support and frequent family meals were significantly associated with inadequate sleep duration in unadjusted and adjusted models (AOR1 and AOR2). Meaningful leisure time was not significantly associated with any of

the measured poor sleep outcomes. While only frequent family meals were identified as a protective factor between child maltreatment and prolonged sleep latency, and child maltreatment and inadequate sleep duration, the sensitivity analysis indicated that engagement in physical activity, participation in sports or clubs, good perceived social support, and physical activity with peers were associated with a decreased likelihood of poor sleep outcomes.

Within this sensitivity analysis, the individual perceived social support items were also examined as independent variables with each poor sleep outcome to assess how each measured social support variable may be associated with sleep alongside the composite SPS-5 score. Each SPS-5 item was treated as the independent variable to assess associations with prolonged sleep latency, frequent nocturnal awakenings, and inadequate sleep duration in unadjusted models, models adjusted for sociodemographic characteristics (AOR1), and models adjusted for sociodemographic characteristics and mental health variables. SPS-5 items 1, 2, and 3 were significantly associated with a decreased likelihood of prolonged sleep latency, frequent nocturnal awakenings, and inadequate sleep duration in unadjusted and adjusted models (AOR1 and AOR2). SPS-5 items 4 and 5 were significantly associated with a decreased likelihood of prolonged sleep latency and frequent nocturnal awakenings in unadjusted and adjusted models (AOR1 and AOR2). However, SPS-5 items 4 and 5 were each associated with a decreased likelihood of inadequate sleep durations only in the unadjusted models.

Table 9. Associations between each protective factor and poor sleep outcomes; unadjusted and adjusted for sociodemographic characteristics and mental health variables

Protective Factors	Prolonged sleep latency			Frequent nocturnal awakenings			Inadequate sleep duration		
	OR (95% CI)	AOR1 (95% CI)	AOR2 (95% CI)	OR (95% CI)	AOR1 (95% CI)	AOR2 (95% CI)	OR (95% CI)	AOR1 (95% CI)	AOR2 (95% CI)
Physical activity	0.86 (0.72-1.03)	0.92 (0.76-1.11)	0.96 (0.80-1.16)	1.15 (0.97-1.37)	1.30 (1.08-1.56)**	1.35 (1.12-1.63)**	0.92 (0.79-1.06)	0.93 (0.80-1.08)	0.94 (0.81-1.10)
Participation in sports/clubs	0.78 (0.65-0.93)**	0.80 (0.66-0.97)*	0.87 (0.71-1.05)	0.81 (0.68-0.96)*	0.81 (0.68-0.97)*	0.86 (0.72-1.03)	0.90 (0.77-1.06)	0.95 (0.80-1.12)	0.94 (0.80-1.12)
Perceived social support	0.53 (0.45-0.62)**	0.55 (0.46-0.65)**	0.56 (0.47-0.66)**	0.67 (0.57-0.80)**	0.68 (0.57-0.81)**	0.69 (0.58-0.83)**	0.78 (0.68-0.90)**	0.81 (0.69-0.94)**	0.81 (0.70-0.94)**
Meaningful leisure time	1.05 (0.86-1.28)	1.09 (0.89-1.34)	1.12 (0.91-1.38)	0.92 (0.74-1.14)	0.97 (0.78-1.22)	0.99 (0.79-1.25)	1.01 (0.84-1.20)	1.03 (0.86-1.23)	1.03 (0.85-1.23)
Physical activity with peers	0.72 (0.62-0.84)**	0.80 (0.68-0.95)**	0.86 (0.72-1.02)	0.96 (0.82-1.12)	1.09 (0.92-1.28)	1.14 (0.96-1.25)	0.83 (0.72-0.95)**	0.88 (0.77-1.02)	0.90 (0.77-1.04)
Family meals	0.51 (0.43-0.60)**	0.53 (0.44-0.63)**	0.57 (0.47-0.68)**	0.62 (0.52-0.72)**	0.67 (0.57-0.79)**	0.70 (0.59-0.83)**	0.66 (0.57-0.76)**	0.71 (0.60-0.83)**	0.72 (0.61-0.84)**
SPS-5									
Item 1 (emotional security)	0.40 (0.30-0.54)**	0.38 (0.28-0.50)**	0.40 (0.30-0.55)**	0.52 (0.39-0.69)**	0.52 (0.39-0.69)**	0.54 (0.41-0.72)**	0.55 (0.42-0.72)**	0.58 (0.44-0.76)**	0.58 (0.44-0.77)**
Item 2 (someone to talk to)	0.51 (0.36-0.71)**	0.52 (0.37-0.74)**	0.52 (0.36-0.75)**	0.60 (0.44-0.83)**	0.66 (0.48-0.91)*	0.66 (0.48-0.91)*	0.57 (0.42-0.77)**	0.57 (0.41-0.78)**	0.56 (0.41-0.77)**
Item 3 (skills are recognized)	0.56 (0.43-0.72)**	0.59 (0.45-0.76)**	0.62 (0.48-0.80)**	0.47 (0.36-0.61)**	0.48 (0.36-0.63)**	0.49 (0.37-0.66)**	0.64 (0.50-0.81)**	0.64 (0.50-0.81)**	0.65 (0.50-0.83)**
Item 4 (shared beliefs)	0.53 (0.42-0.66)**	0.54 (0.42-0.69)**	0.60 (0.46-0.76)**	0.41 (0.32-0.52)**	0.42 (0.32-0.54)**	0.44 (0.34-0.57)**	0.77 (0.62-0.94)*	0.81 (0.66-1.01)	0.81 (0.65-1.00)
Item 5 (rely on in emergency)	0.55 (0.36-0.85)**	0.52 (0.34-0.80)**	0.55 (0.36-0.83)**	0.53 (0.34-0.81)**	0.55 (0.36-0.86)**	0.57 (0.36-0.89)*	0.62 (0.43-0.91)**	0.71 (0.48-1.05)	0.71 (0.48-1.06)

Abbreviations: *OR* unadjusted odds ratio; *AOR1* odds ratio adjusted for sociodemographic characteristics (age, sex, parental education, and family structure); *AOR2* odds ratio adjusted for sociodemographic characteristics and mental health variables; (*CI* confidence interval).

* $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$

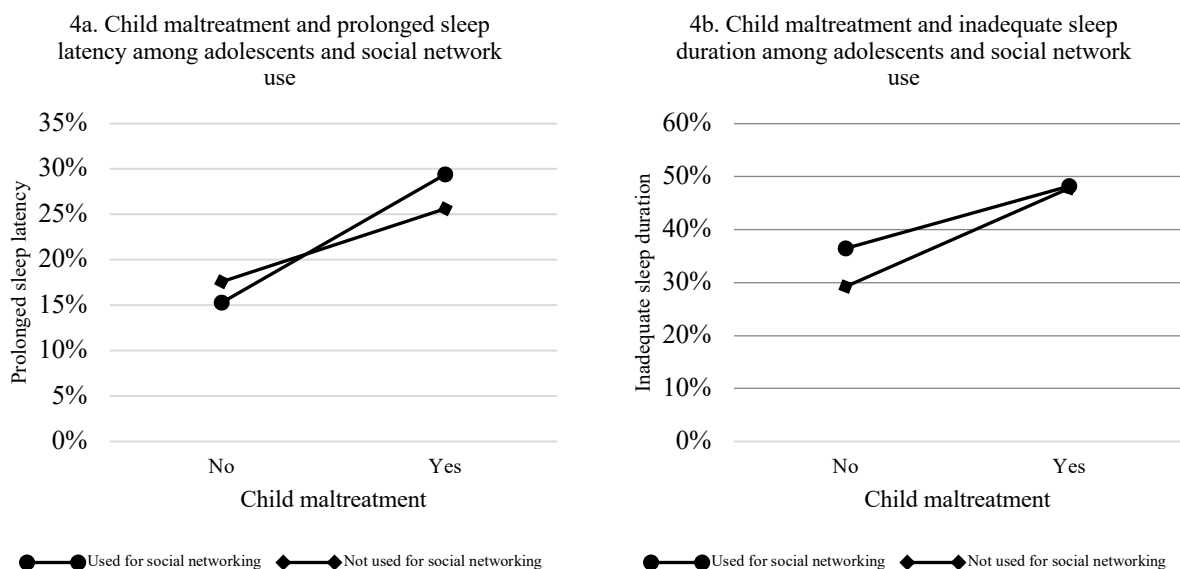
Moderating effects of child maltreatment and electronic device use on poor sleep outcomes

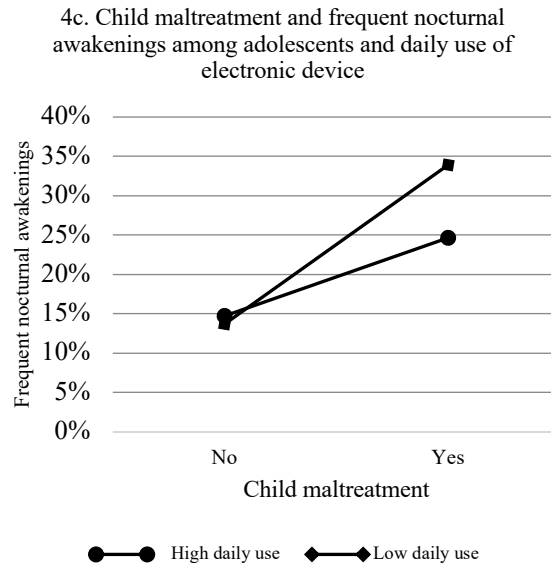
Multivariable logistic regression models were computed to examine if excessive electronic device use (i.e., electronic device use in the bedroom prior to falling asleep, daily electronic device use, and electronic device use for online social networking, messaging, and gaming) moderates the association between any child maltreatment and individual poor sleep outcomes. Interaction terms between each electronic device use item and any child maltreatment were created and included in the logistic regression models alongside the main effects. Statistical significance was assessed at $p \leq 0.10$. Electronic device use for online social networking (e.g., Instagram, TikTok, Facebook or Twitter) significantly moderated the association between any child maltreatment and prolonged sleep latency. Using an electronic device for online social networking also significantly moderated the association between any child maltreatment and inadequate sleep duration. Additionally, high daily use of an electronic device significantly moderated the association between any child maltreatment and frequent nocturnal awakenings.

Interaction plots were generated to interpret the trends observed in the significant moderation effects (see Figure 4). The plots in Figure 4a indicate that among adolescents without child maltreatment histories, prolonged sleep latency was similar for those who used an electronic device for social networking compared to those not using an electronic device for social networking. However, among adolescents with child maltreatment histories those who did not report using an electronic device for social networking had a lower prevalence of prolonged sleep latency compared to those who did use an electronic device for social networking. Figure 4b plots indicate that among adolescents without child maltreatment histories, those who used an electronic device for social networking reported a higher prevalence of inadequate sleep durations compared to those who did not use an electronic device for social networking.

However, among those with child maltreatment histories, adolescents reported a similar prevalence of inadequate sleep duration regardless of online social networking. Lastly, the plots in Figure 4c indicate that the prevalence of frequent nocturnal awakenings among adolescents without child maltreatment histories did not vary depending on daily electronic device usage. However, among adolescents who experienced child maltreatment, those with a high daily use of an electronic device reported a lower prevalence of frequent nocturnal awakenings compared to those who reported a low daily use of an electronic device. Additionally, frequent nocturnal awakenings were higher among those with a child maltreatment history compared to those without regardless of daily device use.

Figure 4. *Prevalence of poor sleep outcomes among adolescents with and without child maltreatment histories stratified by electronic device use*





Sensitivity analysis

Sensitivity analyses were conducted to examine if electronic device use in the bedroom prior to falling asleep, high daily electronic device use, or electronic device use for online social networking, messaging, or gaming were associated with individual poor sleep outcomes. This allowed for an examination of the direct associations between electronic device use and poor sleep outcomes independent of the interaction effects of electronic device use on the association between child maltreatment and poor sleep outcomes. Each electronic device item was treated as an independent variable to examine whether they were associated with poor sleep outcomes when modelled as the main exposure in logistic regression, irrespective of its roles as an effect modifiers in the association between child maltreatment and poor sleep outcomes. Logistic regression was conducted for each electronic device use variable with prolonged sleep latency, frequent nocturnal awakenings, and inadequate sleep duration in unadjusted models, models adjusted for sociodemographic characteristics (AOR1), and models adjusted for sociodemographic characteristics and mental health variables (Table 10). Results indicated that using an electronic device in the bedroom prior to falling asleep was associated with an increased

likelihood of prolonged sleep latency and inadequate sleep durations. These associations remained significant across unadjusted and adjusted models (AOR1 and AOR2). Using an electronic device for social networking was significantly associated with an increased likelihood of frequent nocturnal awakenings and inadequate sleep duration. These associations remained significant across unadjusted and adjusted models (AOR1 and AOR2). Using an electronic device for messaging was associated with an increased likelihood of frequent nocturnal awakenings only in unadjusted models. Additionally, using an electronic device for messaging was associated with an increased likelihood of inadequate sleep duration in unadjusted and adjusted models (AOR1 and AOR2). Lastly, using an electronic device for gaming was significantly associated with a reduced likelihood of frequent nocturnal awakenings, but only in the unadjusted model. Additionally, these variables were identified as significantly associated with poor sleep outcomes, along with using an electronic device for online messaging and for online gaming.

Table 10. *Associations between each type of electronic device use and individual poor sleep outcomes in models unadjusted and adjusted for sociodemographic characteristics and mental health variables*

Electronic device use	Prolonged sleep latency			Frequent nocturnal awakenings			Inadequate sleep duration		
	OR (95% CI)	AOR1 (95% CI)	AOR2 (95% CI)	OR (95% CI)	AOR1 (95% CI)	AOR2 (95% CI)	OR (95% CI)	AOR1 (95% CI)	AOR2 (95% CI)
In the bedroom prior to falling asleep	1.60 (1.27- 2.00)***	1.53 (1.21- 1.93)***	1.50 (1.15- 1.84)**	1.16 (0.90- 1.51)	1.11 (0.85- 1.45)	1.07 (0.82- 1.40)	2.02 (1.64- 2.49)** *	1.94 (1.58- 2.40)** *	1.94 (1.57- 2.39)** *
High daily use	1.58 (1.26- 1.99)***	1.49 (1.18- 1.89)***	1.41 (1.11- 1.79)**	1.07 (0.84- 1.37)	1.03 (0.79- 1.33)	0.97 (0.75- 1.26)	1.34 (1.10- 1.63)**	1.30 (1.06- 1.60)*	1.28 (1.04- 1.57)*
Online social networking	1.00 (0.84- 1.20)	0.90 (0.75- 1.08)	0.93 (0.78- 1.12)	1.45 (1.22- 1.73)***	1.30 (1.08- 1.56)**	1.33 (1.11- 1.61)**	1.35 (1.15- 1.58)** *	1.30 (1.10- 1.53)**	1.34 (1.14- 1.59)** *
Online messaging	1.09 (0.92- 1.29)	1.08 (0.91- 1.29)	1.10 (0.92- 1.32)	1.15 (0.98- 1.35)***	1.07 (0.91- 1.27)	1.09 (0.92- 1.29)	1.19 (1.03- 1.37)*	1.17 (1.01- 1.35)*	1.18 (1.02- 1.36)*

Electronic device use	Prolonged sleep latency			Frequent nocturnal awakenings			Inadequate sleep duration		
	OR (95% CI)	AOR1 (95% CI)	AOR2 (95% CI)	OR (95% CI)	AOR1 (95% CI)	AOR2 (95% CI)	OR (95% CI)	AOR1 (95% CI)	AOR2 (95% CI)
Online games	1.13 (0.94- 1.36)	1.22 (0.99- 1.51)	1.13 (0.92- 1.40)	0.73 (0.60- 0.90)**	0.85 (0.68- 1.05)	0.80 (0.64- 1.00)	1.07 (0.90- 1.27)	1.13 (0.95- 1.35)	1.11 (0.93- 1.33)

Abbreviations: *OR* unadjusted odds ratio; *AOR1* odds ratio adjusted for sociodemographic characteristics (age, sex, parental education, and family structure); *AOR2* odds ratio adjusted for sociodemographic characteristics and mental health variables; *CI* confidence interval.

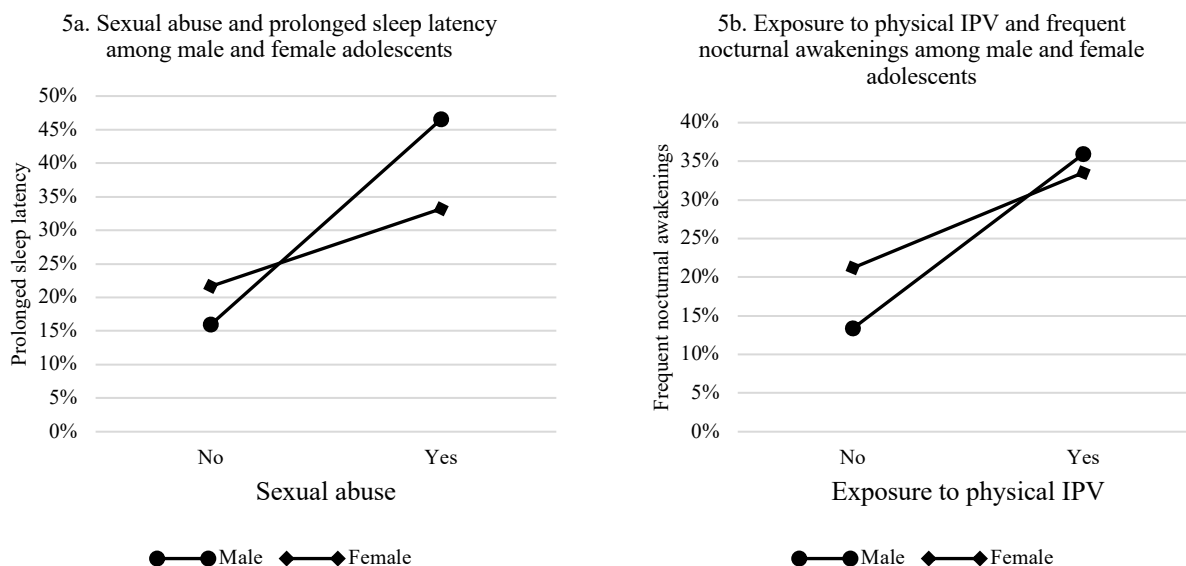
* $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$

Moderating effects of child maltreatment and sex on poor sleep outcomes

To examine if sex moderated the association between child maltreatment and poor sleep outcomes, interaction terms between sex and individual and any child maltreatment types were created and included in multivariable logistic regression models alongside the main effects. Statistical significance was assessed at $p \leq 0.10$. Sex significantly moderated the association between sexual abuse and prolonged sleep latency, and exposure to physical IPV and frequent nocturnal awakenings. The remaining interaction terms were not statistically significant.

Interaction plots were generated to interpret the trends observed in the significant moderation effects (see Figure 5). The plots in Figure 5a indicate that among adolescents without sexual abuse histories, males reported less prolonged sleep latency than females. However, among adolescents with sexual abuse histories, males reported more prolonged sleep latency experiences than females. Figure 5b indicates that among adolescents without reports of exposure to physical IPV, males report fewer experiences of frequent nocturnal awakenings compared to females. However, among adolescents with exposure to physical IPV, despite a smaller difference compared to previous plots, males report slightly more frequent nocturnal awakenings than females. Overall, the plots indicate that the associations between sexual abuse and prolonged sleep latency, and exposure to physical IPV and frequent nocturnal awakenings were stronger for male adolescents compared to females.

Figure 5. *Prevalence of poor sleep outcomes among adolescents with and without child maltreatment histories stratified by sex*



Discussion

The aim of the current study was to examine the associations between child maltreatment and poor sleep outcomes among Canadian adolescents. Additionally, the current study also assessed the moderating roles of protective factors, electronic device use, and sex differences. The current study identified that individual and any child maltreatment types (i.e., physical abuse, sexual abuse, emotional abuse, physical neglect, exposure to physical IPV, and exposure to emotional IPV) were each significantly associated with an increased likelihood of prolonged sleep latency, frequent nocturnal awakenings, and inadequate sleep duration among Canadian adolescents.

The moderation analysis only identified frequent family meals as a statistically significant protective factor between any child maltreatment and prolonged sleep latency, and any child maltreatment and inadequate sleep durations. However, the sensitivity analysis additionally indicated that adolescents with relationships where their skills and competence are recognized is protective between any child maltreatment and prolonged sleep latency, and

adolescents with relationships where they have someone to talk to about important life decisions is protective between any child maltreatment and inadequate sleep duration. In addition to the significant moderation effects, various measured protective factors indicated better sleep outcomes irrespective of child maltreatment histories. Furthermore, good perceived social support, frequent family meals, and each individual perceived social support item where adolescents have: 1) a sense of emotional security, 2) someone to talk to about important life decisions, 3) relationships where their competence and skill are recognized, 4) a group with shared attitudes and beliefs, and 5) someone to count on in an emergency, were each associated with a decreased likelihood of each poor sleep outcome. Perceived social support items 4 and 5, were only significantly associated with a decreased likelihood of inadequate sleep durations in unadjusted models, however each remaining variable was significantly associated with each poor sleep outcome across unadjusted and adjusted models. Participation in organized sports or clubs was associated with a decreased likelihood of prolonged sleep latency and frequent nocturnal awakenings in the unadjusted models and models adjusted for sociodemographic characteristics; however, these associations became non-significant in models that additionally adjusted for mental health variables. Engagement in physical activity with peers was associated with a decreased likelihood of prolonged sleep latency in adjusted models and models adjusted for sociodemographic characteristics but were no longer significant when additionally adjusted for mental health variables. Engagement in physical activity with peers was also associated with a decreased likelihood of inadequate sleep durations, but only in unadjusted models. Unexpectedly, engagement in physical activity was significantly associated with an increased likelihood of frequent nocturnal awakenings in both adjusted models but was not significant in the unadjusted model.

The associations between any child maltreatment and prolonged sleep latency, and any child maltreatment and inadequate sleep durations were stronger for adolescents who used an electronic device for online social networking (e.g., Instagram, TikTok, Facebook or Twitter). Unexpectedly, the association between any child maltreatment and frequent nocturnal awakenings was weaker for adolescents with high daily electronic device use (i.e., greater than two hours daily during their free time). In addition to the moderation effects, the study found that using an electronic device in the bedroom prior to falling asleep and high daily electronic device use were associated with an increased likelihood of prolonged sleep latency and inadequate sleep durations in unadjusted and adjusted models. Similarly, using an electronic device for online social networking was associated with an increased likelihood of frequent nocturnal awakenings and inadequate sleep duration across unadjusted and adjusted models. Using an electronic device for online messaging was associated with an increased likelihood of frequent nocturnal awakenings only in unadjusted models, and inadequate sleep duration in unadjusted and adjusted models. Unexpectedly, using an electronic device for online gaming was associated with a decreased likelihood of frequent nocturnal awakenings in the unadjusted model. Sex was identified as a significant moderator between sexual abuse and prolonged sleep latency, and exposure to physical IPV and frequent nocturnal awakenings, wherein these associations were stronger for male adolescents compared to females.

The current study contributes to the literature by providing recent prevalence estimates on child maltreatment experiences reported by adolescents, indicating that 29.0% of Canadian adolescents aged 15-17 years experienced at least one type of child maltreatment. In contrast, 26.4% of adolescents (aged 14 to 17 years) in Ontario indicated experiencing at least one type of child maltreatment (Salmon et al., 2022). While the Ontario child maltreatment prevalence

reported by adolescents is similar to the Canadian child maltreatment prevalence from the current study, both studies vary from the reports of Canadian adults aged 18-49 years retrospectively disclosing child maltreatment where approximately 60.9% indicated experiencing at least one type of child maltreatment under 18 years old (Afifi et al., 2026). The discrepancy between the adolescent and adult reports of child maltreatment may reflect the retrospective advantage adults possess to reinterpret their childhood experiences with greater cognitive maturity and emotional clarity (Naicker et al., 2017). Conversely, adolescents still embedded within their home environment may not recognize certain experiences as abuse nor feel safe enough for disclosure (Baldwin et al., 2019; Coleman et al., 2024), whereas adults are removed from the unsafe environment and may be able to more easily identify and safely disclose such behaviours as maltreatment (Coleman et al., 2024). The current study also provides updated prevalence estimates of Canadian adolescent sleep outcomes, indicating that 38.4% of adolescents do not sleep an adequate duration at night, 19.7% have prolonged sleep latency, and 17.7% have frequent nocturnal awakenings. Comparatively, Canadian literature previously indicated that 28% of adolescents sleep within the recommended 8-10 hours per night (Chaput & Janssen, 2016) and 42% of adolescents reported having difficulty falling asleep or staying asleep (Michaud & Chaput, 2016). Recent Canadian literature has not examined sleep latency and nocturnal awakenings separately.

Associations of child maltreatment and poor sleep outcome

It was hypothesized that physical abuse, sexual abuse, emotional abuse, physical neglect, exposure to physical IPV, and exposure to emotional IPV were each associated with prolonged sleep latency, frequent nocturnal awakenings, and inadequate sleep duration among Canadian adolescents. The data confirmed this hypothesis as individual and any child maltreatment types

were significantly associated with the individual poor sleep outcomes in unadjusted models, in models adjusting for sociodemographic characteristics (i.e., age, sex, parental education, and family structure), and in models further adjusted for sociodemographic characteristics, diagnosed mental health conditions and K6 Psychological Distress Scale scores. These findings are consistent with literature that suggests child maltreatment is associated with poor sleep outcomes (Baddam et al., 2019; Javakhishvili & Spatz Widom, 2021; McPhie et al., 2014; Turner et al., 2020), however the current study sought to examine this association among Canadian adolescents.

These results can be interpreted using the Ecological Systems Theory. Urie Bronfenbrenner's Ecological Systems Theory discusses how direct and indirect interactions between multiple nested environment systems influence an individual's development (Bronfenbrenner, 1977). Interpreting the current results within the Ecological Systems Theory depicts of how the micro-level influences can interact with one another to influence the adolescent. The influence of the maltreatment within the family-level microsystem may heighten psychological and physiological arousal (Sinha, 2016), dysregulate stress-response systems, and create environments that are not conducive to quality sleep (Brown et al., 2022).

A study found that early childhood adversities, such as child maltreatment, predict occurrences in sleep problems such as poor sleep quality, prolonged sleep duration, and irregular sleep times (Brown et al., 2022). These findings may be due to the brain's stress or fear responses to trauma which evoke hyperactivation of mental arousal centres and increase neurobiological and physiological arousal, thus interfering with sleep (Sinha, 2016). As child maltreatment is considered a traumatic experience, it is plausible that similar processes may contribute to the findings of the current study. Literature suggests that early maltreatment

experiences can increase physiological stress responses by altering hypothalamic-pituitary-adrenal (HPA) axis and immune systems which increase arousal and sleeplessness or negatively impact circadian modulation during sleep (Brown et al., 2022). While this mechanism has not been directly examined among adolescents with child maltreatment experiences, is it possible that similar physiological responses contribute to poor sleep outcomes among adolescent population in the current study (Baddam et al., 2019).

Prior research has shown that physical abuse and sexual abuse are associated with more nighttime activity, longer sleep latency, and lower sleep efficiency (Kajeeepeta et al., 2015). Consistent with this, the current study found physical abuse and sexual abuse associated with prolonged sleep latency, frequent nocturnal awakenings, and inadequate sleep durations, reflecting the sleep disruption identified in the literature. Specifically, sexual abuse often occurs in a place similar to where the individual sleeps; as such it may increase sleep-related hyperarousal and therefore cause sleep disturbances (O'Connor et al., 2025). These sleep disturbances associated with sexual abuse are often due to higher levels of distress and a high frequency of nightmares (Belleville et al., 2019). Emotional abuse has also been associated with frequent nightmares (Kajeeepeta et al., 2015), which interrupt sleep and contribute to poorer sleep quality, prolonged sleep latency, and daytime sleepiness (Paul et al., 2015). These sleep disturbances associated with emotional abuse identified in the literature are in line with the findings of the current study which indicate emotional abuse is significantly associated with prolonged sleep latency, frequent nocturnal awakenings, and inadequate sleep durations.

Physical neglect was found to be associated with each poor sleep outcome; research suggests this is likely due to increased perceived stress that underlies this association (O'Connor et al., 2025). Evidence indicates that positive parent-child relationships are consistently

associated with better adolescent sleep, likely due to a warmer home environment, greater comfort, and more consistent parental monitoring of sleep (Gunn & Eberhardt, 2019). The relationship between child maltreatment and sleep is complex, involving familial and environmental influences and stress, along with psychological and physiological arousal. While these mechanisms could not be examined in the current study, they offer plausible explanation and support for the findings in this study.

Protective factor moderation effects on child maltreatment and poor sleep outcomes

It was hypothesized that each protective factor (i.e., physical activity, participation in organized sports and clubs, perceived social support, time spent active with peers, meaningful leisure time, and frequency of family meals) would weaken the associations between any child maltreatment and individual poor sleep outcomes examined in the study. The research hypothesis was not supported for the other protective factors; only frequent family meals were observed to be a significant moderator. Frequent family meals were identified as a statistically significant protective factor for association between any child maltreatment and prolonged sleep latency, and any child maltreatment and inadequate sleep duration among Canadian adolescents. The results from the moderation analysis indicate that family meals are protective for prolonged sleep latency among adolescents with and without child maltreatment histories, and protective for inadequate sleep durations among adolescents without child maltreatment histories. Protective factors are conditions and characteristics that buffer against risk associated with exposure or help manage adversity (Austin et al., 2020; Centers for Disease Control and Prevention, 2024). Despite the lack of significant moderation, it is likely that each measured protective factor remains beneficial to adolescents. Furthermore, as the missing data is likely MNAR, conducting complete-case analysis may have produced biased estimates of the moderation effects. The

missing data may have reduced power in moderation analyses due to the cumulative missingness in the adjusted (AOR2) models, and this reduction in power is notable especially given that interaction effects are typically more difficult to detect than main effects (Aiken et al., 1991; McClelland & Judd, 1993; Shieh, 2018). The combination of reduced statistical power and potential bias under MNAR may have reduced the precision of the moderation analysis and attenuated the observed significant interactions (Desai et al., 2011; White & Carlin, 2010). Consequently, the observed significant moderation effects may represent conservative estimates compared to the true interactions.

These protective factor moderation results can be interpreted by both the Resilience Theory and Ecological Systems Theory. The Resilience Theory from Norman Garmezy and David Fergusson suggests that children who experience maltreatment may gain skills or experiences that mitigate adverse health outcomes (Fergusson & Lynskey, 1996; Haggerty, 1996). The mechanism by which the resilience in the context of adversity is developed cannot be established from the current study; however, literature indicates that a high frequency of family meals is associated with better emotional and behavioural outcomes, and a greater emotional well-being (B. L. Jones, 2018; Utter et al., 2017). From the perspective of the Resilience Theory and Ecological Systems Theory, the results suggest that protective and harmful processes can coexist within the same relational context. Maltreatment is often episodic rather than constant (Bryce et al., 2023), therefore periods of relative stability, such as three or more family meals per week, may provide opportunities for connection and support for building resilience. These moments may contribute to the development of resilience by offering adolescents brief, but meaningful, exposure to supportive microsystem experiences. In turn, this highlights how interactions within

the family system are not uniformly detrimental but instead reflect a complex interplay of risk and protection that can shape adolescents' capacity to cope with adversity.

To ensure that the non-significant moderation effects were not due to a Type II error, sensitivity analyses were conducted to examine moderation of the individual SPS-5 items rather than only the composite score. Examining the individual SPS-5 items alongside the total score provides a better understanding of each component of perceived social support. While the composite score did not demonstrate significant moderation, examining individual SPS-5 items indicated that two individual components which contribute to good perceived social support independently moderated the association between any child maltreatment and poor sleep outcomes. The results indicated that having someone to talk to was protective against inadequate sleep durations for adolescents with and without child maltreatment histories. Additionally, having someone who recognizes their skills and competence was protective against prolonged sleep latency among adolescents with child maltreatment histories. These results are supported by prior literature indicating that positive peer connectedness, such as feeling accepted by friends, sharing meaningful experiences, having supportive and trusting relationships, and identifying with similar values and interests, has been identified to positively impact adolescent behaviours and outcome (DeWalt et al., 2013; Ehsan et al., 2019; National Academies of Sciences, 2019a, 2019b; Novak & Kawachi, 2015; Oshri et al., 2017; Rauner, 2000). These two perceived social support items indicating significant moderation suggests who having someone to talk to about life decisions and having someone that recognizes their skills and competence are more relevant at buffering the impact of child maltreatment on inadequate sleep duration and prolonged sleep latency (respectively) than overall perceived social support.

The remaining protective factors (i.e., physical activity, participation in organized sports and clubs, perceived social support, time spent active with peers, and meaningful leisure time) did not significantly modify the association between any child maltreatment and any individual poor sleep outcome. A second sensitivity analysis was conducted to examine if individual protective factors were associated with individual poor sleep outcomes. This allowed for a better understanding of how each protective factor impacted poor sleep outcomes among adolescents irrespective of child maltreatment histories. The results indicated that good perceived social support and frequent family meals were each associated with a decreased likelihood of each poor sleep outcome in unadjusted and adjusted models. Participation in organized sports or clubs was associated with a decreased likelihood of prolonged sleep latency and frequent nocturnal awakenings in the unadjusted models and models adjusted for sociodemographic characteristics; however, these associations became non-significant in models that additionally adjusted for mental health variables. Engagement in physical activity with peers was associated with a decreased likelihood of prolonged sleep latency in adjusted models and models adjusted for sociodemographic characteristics but were no longer significant when additionally adjusted for mental health variables. Engagement in physical activity with peers was also associated with a decreased likelihood of inadequate sleep durations, but only in unadjusted models.

The lack of significance in adjusted models may be explained by the mental health variables, such that consistently among literature, physical activity is closely related to mental health such that poorer mental health is often associated with less physical activity engagement (Cherkasova et al., 2022; Schlack et al., 2021b). Additionally, adolescents who have poor mental health also exhibit greater difficulty with sleep quality and sleep durations (Akpoveta et al., 2025; Calhoun et al., 2019; Public Health Agency of Canada, 2022). Together, this existing literature provides

support for the loss of statistical significance in the adjusted models. Family and peer connectedness, such as positive relationships, participation in activities together, sharing values and interests, and spending meaningful time together during adolescence, reduces the likelihood of poor mental health and physical health outcomes (Austin et al., 2020; Blum et al., 2022; Ehsan et al., 2019; Harrison et al., 2015; Novak & Kawachi, 2015; Oldfield et al., 2016; Steiner et al., 2019). This points to participation in sports or clubs, good perceived social support, physical activity with peers, and frequent family meals as general protective influences even if they did not emerge as specific buffers of child maltreatment effects on sleep outcomes. The Resilience Theory indicates resilience is a dynamic process influenced by the interaction of individual, relational, and environmental factors where positive experiences, such as the measured protective factors in the current study, may promote adaptive functioning when faced with adversity (Haggerty, 1996). This aligns with the Ecological Systems Theory where these measured protective factors interact within the mesosystem and positively impact the adolescent's sleep.

Unexpectedly, engagement in physical activity (i.e., 60 minutes or more per day), was associated with an increased likelihood of frequent nocturnal awakenings. As such, this finding is inconsistent with existing literature which indicates that physical activity is associated with improved sleep quality (Alnawwar et al., 2023; Kredlow et al., 2015; Statistics Canada, 2022). A possible explanation may be related to the operationalization of physical activity engagement in the past seven days. Respondents were first asked if they participated in moderate intensity physical activity. If a respondent indicated “no” to engaging in moderate intensity exercise (i.e., “sweating at least a little or breathing harder”) in the past seven days, they were not presented any further questions regarding physical activity. Consequently, engagement in physical activity

variable contained 15.5% missing data. Taken together, the operationalization and missingness of engagement in physical activity likely impacted the observed associations between physical activity and frequent nocturnal awakenings and not fully captured the variation in physical activity behaviours across the adolescents.

The individual SPS-5 items were examined in similar models. The SPS-5 measures the support an individual receives from their social relationships, which is valuable for assessing how the individual manages stress and maintains a positive well-being (Orpana et al., 2019). Therefore, a sensitivity analysis on each of the SPS-5 questions provides an understanding of how each component contributing to good perceived social support impacts the sleep of adolescents (see Appendix A for questionnaire). The results indicated that items 1 (emotional security), 2 (has someone to talk to), and 3 (skills are recognized) were significantly associated with a decreased likelihood of each poor sleep outcome in unadjusted and adjusted models. Items 4 (shared beliefs) and 5 (someone to count on) were significantly associated with a decreased likelihood of prolonged sleep latency and frequent nocturnal awakenings in unadjusted and adjusted models. However, items 4 and 5 were associated with a decreased likelihood of inadequate sleep durations only in the unadjusted models. These two perceived social support items may be related to sociodemographic characteristics or mental health variables which explain the associations with inadequate sleep durations and therefore resulting in a lack of statistical significance when controlled for. Specifically, as adolescents grow older, they often experience a sleep phase delay wherein, due to their biological changes, they begin to sleep later (Crowley et al., 2018; Galván, 2020). This impacts their sleep durations as they sleep later but school start times remain the same. It is possible that controlling for age may explain the lack of significance in the adjusted models. Furthermore, literature indicates that poor mental health is

associated with lower family and peer connectedness (Randler et al., 2017), which may further explain the lack of significance between social supports items 4 and 5 in adjusted models. These findings are somewhat consistent with the prior sensitivity analysis, in which the total score of the SPS-5 was significantly associated with each of the poor sleep outcomes. Notably, while the former sensitivity analysis identified significant moderation only for SPS-5 items 2 and 3 between child maltreatment and inadequate sleep duration and prolonged sleep latency (respectively), the latter sensitivity analysis demonstrated that each SPS-5 item, as well as overall perceived social support, was independently associated with at least one poor sleep outcome. These findings suggest that although multiple dimensions of perceived social support may influence sleep outcomes, only specific forms of perceived social support appear to buffer the association between child maltreatment and sleep duration and sleep latency.

The findings from both sensitivity analyses suggest that participation in sports or clubs, good perceived social support, physical activity with peers, and frequent family meals positively influence sleep overall. While significant interaction effects were not found between child maltreatment and poor sleep outcomes, the direct effect model indicates that these variables remain important for understanding sleep outcomes among adolescents. However, given that sleep is consistently identified as an important factor for positive short- and long-term mental and physical health outcomes (Brown et al., 2022; Forest et al., 2022; Gruber et al., 2014; Medic et al., 2017; Nelson et al., 2022; M. Ohayon et al., 2017; M. M. Ohayon, 2008), the associations found between the protective factors and poor sleep outcomes should be considered impactful. The findings from the sensitivity analysis indicate that although each protective factor did not significantly moderate the associations between child maltreatment and poor sleep outcomes,

they may independently contribute to reducing the likelihood of poor sleep outcomes among adolescents.

These findings can be interpreted through the Resilience Theory which posits that factors which contribute to resilience are equally beneficial for those with and without adverse childhood experiences (Fergusson & Horwood, 2003). This is observed in the sensitivity analysis where variables which were not identified as protective against child maltreatment in the moderation analysis were still associated with a decreased likelihood of poor sleep outcomes in the sensitivity analysis; suggesting these variables still have a protective influence on Canadian adolescents. Furthermore, each of these protective factors operates within the microsystem as described by the Ecological Systems Theory. Within this framework, these factors do not function in isolation but interact with one another in the adolescent's immediate environment to benefit development (Fergusson & Lynskey, 1996). In line with the Resilience Theory, the combined impact of multiple protective factors is more beneficial than any protective factor alone (Fergusson & Horwood, 2003; Fergusson & Lynskey, 1996). This interplay between the Resilience Theory and Ecological Systems Theory guides the interpretation of the results, where the impact of child maltreatment on sleep may limit the ability of individual factors to modify this relationship. However, despite identifying only one statistically significant moderator, the identification of multiple factors associated with less poor sleep outcomes remains an important finding of the current study.

Moderation effects of electronic device use on child maltreatment and poor sleep outcomes

The third research question examined the moderation of electronic device use variables among the associations between any child maltreatment and individual poor sleep outcomes. It was hypothesized that each electronic device use variable (i.e., electronic device use in the

bedroom prior to falling asleep, high daily electronic device use, and electronic device use for online social networking, messaging, and gaming) would strengthen the association between any child maltreatment and each poor sleep outcome. This hypothesis was partially supported. Significant moderation effects were detected with using an electronic device for online social networking, and high daily electronic device use. However, the trends observed in the significant interaction effects plotted demonstrated varying patterns of moderation across groups. Using an electronic device for online social networking strengthened the association between child maltreatment and prolonged sleep latency. However, only among adolescents without child maltreatment histories, those who used a device for online social networking indicated more inadequate sleep durations compared to those who did not use a device for online social networking. Additionally, high daily electronic device use weakened the association between child maltreatment and frequent nocturnal awakenings.

In addition to the moderation analysis, a sensitivity analysis was conducted to examine the independent effects between each electronic device use variables and prolonged sleep latency, frequent nocturnal awakenings, and inadequate sleep durations. While significant moderation may not have been identified for each electronic device use variable, the sensitivity analysis allowed an understanding of how electronic device use may still be associated with poor sleep outcomes, independent of moderation effects. All but two of the significant associations remained significant across unadjusted and adjusted models. Using an electronic device for online messaging was significantly associated with an increased likelihood of frequent nocturnal awakenings. Secondly, and unexpectedly, using an electronic device for online gaming was significantly associated with a decreased likelihood of frequent nocturnal awakenings. Neither of these associations remained significant in models adjusting for sociodemographic characteristics

and further adjusting for mental health variables. As such, these observed associations may be influenced by underlying cofounders that were controlled for in adjusted models. Previous literature indicates that sleep outcomes among adolescents vary by age, sex, parental education levels, family structure, and mental health. Older adolescents (i.e., greater than 16 years old) often experience a biologically driven sleep phase delay which impacts their sleep times compared to younger adolescents (i.e., less than 16 years old) (Galván, 2020; Gunn & Eberhardt, 2019; Randler et al., 2017). Moreover, female adolescents report poorer sleep quality than males (Forest et al., 2022; Galland et al., 2017). Additionally, higher parental education levels have been associated with better sleep quality and sleep routines for adolescents (Bagley et al., 2015; Cameron et al., 2022), and adolescents living without two biological parents are more likely to experience mental and physical health issues, which in turn impact their sleep (Park & Lee, 2020). Since 2016, the prevalence of Canadian youth indicating good mental health has been steadily declining (Public Health Agency of Canada, 2024), and poor mental health is commonly associated with worse sleep (Public Health Agency of Canada, 2022). This suggests that adolescents with poor mental health are more likely to have poor sleep outcomes compared to those with good mental health. Taken together, adjusting for sociodemographic characteristics and mental health variables likely attenuated these associations observed in the unadjusted models.

The association between online messaging and frequent nocturnal awakenings is consistent with existing literature which suggests that socially interactive forms of electronic device use can increase arousal and interfere with sleep quality (Cammack et al., 2020; Nagata et al., 2023). Using an electronic device for online gaming is often associated with worse sleep among adolescents (Hamre et al., 2022). However, the literature indicates that internet use is an

avoidance coping mechanism that may foster resilience to stressors (McNicol & Thorsteinsson, 2017; Vasconcellos et al., 2025). While internet use is not considered to be a healthy coping mechanism, this may provide a possible explanation for the association with online gaming and a decreased likelihood of frequent nocturnal awakenings as online gaming may provide temporary relief and relaxation prior to sleeping. Studies suggest that when adolescents game, they may see their gaming characters as extensions of themselves and unintentionally attempt to compensate their real-life unmet needs through their gaming characters (Choi et al., 2018). While this may offer temporary mental relief and relaxation, replacing real interactions and activities in this manner poses a risk to their socioemotional well-being (Green et al., 2020). Another possibility for this finding is the difference in the prevalence of adolescents using electronic devices for gaming compared with other electronic device variables. Among the study sample, 20.43% of adolescents reported using an electronic device for online gaming, whereas 70.08% to 87.08% reported electronic device use for the remaining variables. The substantially lower prevalence of adolescents using an electronic device for gaming, compared with the other electronic device variables, may contribute to the differing result.

Within the context of the Ecological Systems Theory, electronic device use is part of the microsystem as it often occurs in the adolescent's immediate environment, such as in their bedrooms or in place of in-person social interactions or other activities. However, exposure and interactions with online mass media and social media via electronic devices reflect the exosystem as its influences occur more indirectly. The interaction of these different systems can influence an adolescent's routines and behaviours by interfering with healthy sleep hygiene, as the use of electronic devices can increase physiological and cognitive arousal, especially when harmful content is consumed. This supports the findings from this sensitivity analysis, which

indicated that electronic device use in the bedroom prior to falling asleep, high daily use of an electronic device, using an electronic device for online social networking, and online messaging were associated with an increased likelihood of at least one poor sleep outcome.

From the perspective of the Ecological Systems Theory, as also indicated by the sensitivity analysis, the study results reveal microsystem interactions occurring with child maltreatment experiences and electronic device use and how they impact an adolescent's sleep outcomes. For example, the use of electronic devices can impact sleep by displacing opportunities for good sleep hygiene such as reading or family time (Hale et al., 2018), thus increasing cognitive and physiological arousal, and interrupting the circadian rhythm, which can postpone sleep onset (Gomes & Goldman, 2024; Hale et al., 2018; LeBourgeois et al., 2017; Nelson et al., 2022). Furthermore, the use of an electronic device can also occur within the exosystem, illustrating how multiple layers of an adolescent's environment can shape outcomes in different ways. For example, the electronic device use may take place in the home environment (i.e., the microsystem), while the content accessed, such as social or mass media, reside in the exosystem. The type of content consumed can interrupt sleep by heightening emotional and mental activation when the brain should be preparing for rest (Gomes & Goldman, 2024; Hale et al., 2018; LeBourgeois et al., 2017; Twenge et al., 2019) as adolescents who use social media may have a more difficult time de-arousing following a negative or harmful online interaction (Cammack et al., 2020). This inability to de-arouse is likely to prolong the time it takes the adolescent to fall asleep (Cammack et al., 2020). However, the current study did not measure the type of content consumed by the adolescent, nor de-arousal, thereby posing a limitation which is discussed in the strengths and limitations section.

The moderation results of high daily electronic device use indicate that it may operate as a coping mechanism within the adolescent's microsystem and attenuate the effects of child maltreatment on frequent nocturnal awakenings as these systems interact within the mesosystem. Literature commonly examines substance use or binge drinking as coping mechanisms in adulthood (Afifi et al., 2012, 2020; Shin et al., 2018), however, recent studies are recognizing that the same pathway for coping is being manifested through screen time (Cammack et al., 2020; McNicol & Thorsteinsson, 2017). Specifically, screen time is being used as an avoidance coping mechanism to escape from negative emotions whereby individuals are using electronic devices in place of learning resilience skills from their parents or practicing healthy coping mechanisms such as physical activity or fostering positive peer relationships (Vasconcellos et al., 2025). While this mechanism has not been examined among adolescents, its presence in adults suggests adolescents in the current study may be practicing avoidance coping through electronic device use. Moreover, although adolescents reported their frequency of daily device use, this measure did not capture how devices were used. While other study variables assessed how adolescents used electronic devices, no measure linked the frequency of use with the type of device used; thus, the observed moderation with high daily electronic device use is ambiguous and is interpreted cautiously.

Moderation effects of sex on child maltreatment and poor sleep outcomes

It was hypothesized that sex would moderate the association between individual and any child maltreatment types and poor sleep outcomes, wherein female adolescents report more poor sleep outcomes compared to males. This hypothesis was not supported. The results indicated that the associations between sexual abuse and prolonged sleep latency, and exposure to physical IPV and frequent nocturnal awakenings were both stronger for male adolescents compared to

females. These results contradict existing studies which indicate that the association between child maltreatment and sleep disturbances is stronger for female adolescents compared to males (Oh et al., 2022; Xiao et al., 2020). In the absence of moderation, literature indicates that females report greater prolonged sleep latency and have a higher prevalence of sexual abuse reports compared to males (Afifi et al., 2025). Given the lower likelihood of males reporting sexual abuse experiences, it is possible that males in the current study who reported sexual abuse experiences were subjected to more severe sexual abuse than the females (Manay & Collin-Vézina, 2021); which may have influenced the findings. If this is the case, greater severity of sexual abuse experiences may disproportionately impact sleep latency as the trauma-related stress may sustain heightened physiological and psychological arousal, thereby delaying sleep onset (Baddam et al., 2019; Brown et al., 2022; McPhie et al., 2014; Sinha, 2016). Sexual abuse can occur in a location similar to where the adolescent sleeps and may contribute to the increased hyperarousal interfering with sleep latency (O'Connor et al., 2025). Exposure to physical IPV is associated with worse social, emotional, psychological, and behavioural problems (Bader & Frank, 2025; Berg et al., 2021; Oberheim et al., 2024; Wathen & MacMillan, 2013). However, the differences between male and female sleep outcomes based upon exposure to physical IPV remain understudied.

Within the Ecological Systems Theory, the macrosystem includes societal and cultural norms which influence the development of the adolescent. The macrolevel influences alongside the microsystem influences of child maltreatment may interact with one another to impact the adolescent's outcomes. Societal pressures of masculinity often begin in adolescence for males, whereas adolescent females often attribute societal expectations of femininity to adults (Solbes-Canales et al., 2020). Internalizing negative emotions is associated with poorer sleep outcomes

(Mombelli et al., 2025; Sesso et al., 2024), and the macrosystem-level societal pressures surrounding masculinity may discourage adolescent males from disclosing maltreatment, thus potentially promoting emotional suppression (Mokhwelepa & Sumbane, 2025) and contributing to poorer sleep. Additionally, macrosystem influences such as gender norms, may discourage males from disclosing abuse experiences, possibly due to pressure to conform to masculine traits. This may reflect social desirability bias, a potential limitation of the current study discussed in the strengths and limitations section below.

While the observed trends of the moderation analysis did not support the study hypothesis, they remain noteworthy as Canadian literature has not examined sex differences among the sleep outcomes of adolescents with child maltreatment experiences. The results indicate that both male and female adolescents with sexual abuse and exposure to physical IPV histories have poor sleep outcomes, but males indicate greater poor sleep outcomes compared to females. As per the moderate amount of missingness of each child maltreatment variable previously outlined, the findings of the current study should be interpreted with caution. Existing literature suggests that males are less likely than females to disclose experiences of abuse (Manay & Collin-Vézina, 2021), report distress (Camacho-Ruiz et al., 2026), or seek help (Liddle et al., 2021), suggesting that there may be more missingness among the adolescent males compared to females. As such, it is possible that the estimated interactions effects are attenuated for the male adolescents compared to the females.

Conceptual framework

The current study was guided by the Resilience Theory and the Ecological Systems Theory. The Resilience Theory suggests that children who experience maltreatment may gain skills or experiences that act as protective factors or build resilience, which mitigate the poor

health outcomes associated with adverse experiences in their lifespan (Haggerty, 1996). Furthermore, the combination of several resilience factors, rather than a single resilience factor, is associated with better outcomes and stronger resilience (Fergusson & Lynskey, 1996). Urie Bronfenbrenner's Ecological Systems Theory discusses how direct and indirect interactions among multiple nested environmental systems influence an individual's development (Bronfenbrenner, 1977). The current study identified frequent family meals as a protective factor between any child maltreatment and prolonged sleep latency, and any child maltreatment and inadequate sleep duration. As per the Resilience Theory, it is likely that a higher frequency of family meals aids mental and emotional resilience required to mitigate the effects of child maltreatment (Haggerty, 1996). Frequent family meals emerged as a noteworthy moderator, given that the same caregivers who may perpetrate maltreatment are often with whom meals are shared with. Maltreatment and family meals both occur in the adolescent's microsystem, such that their interactions (i.e., the mesosystem) influence the adolescent's outcomes. The Resilience Theory and Ecological Systems Theory align to demonstrate how frequent family meals can function as a meaningful buffer against the poor sleep outcomes associated with childhood maltreatment among Canadian adolescents.

The adolescent's microsystem includes their immediate environment and face-to-face interactions (Bronfenbrenner, 1977) which encompasses child maltreatment experiences, relationships with peers, participation in activities, and electronic device use. The results of the current study show how such factors within the microsystem can influence an adolescent's sleep outcomes. Maltreatment perpetrated by caregivers alters the adolescent's sense of safety and predictability in their home (i.e., the microsystem) (Sinha, 2016). The influence of the maltreatment within the microsystem may heighten psychological and physiological arousal

(Sinha, 2016), dysregulate stress-response systems, and create environments that are not conducive to quality sleep (Brown et al., 2022). The current study indicated that if an adolescent experienced physical abuse, sexual abuse, emotional abuse, physical neglect, exposure to physical IPV, and/or exposure to emotional IPV, they are more likely to have prolonged sleep latency, frequent nocturnal awakenings, and inadequate sleep duration. Additionally, the Ecological Systems Theory illustrates how multi-level system influences of electronic device may interact with microsystem-level child maltreatment experiences. Electronic device use occurs within the adolescent's microsystem, mesosystem, and exosystem, whereby interactions across multiple ecological levels may collectively influence an adolescent's sleep outcomes. The present study also revealed that the associations between sexual abuse and prolonged sleep latency, and exposure to physical IPV and frequent nocturnal awakenings were stronger for males than females. The micro-level influences of males and females may vary, thereby differentially shaping the effects of maltreatment on their sleep outcomes. Adolescent males are less likely to seek support or disclose experiences of abuse, which may accumulate greater physiological arousal and interrupt sleep (Mokhwelepa & Sumbane, 2025; Mombelli et al., 2025; Sesso et al., 2024). The conceptual framework combining the Resilience Theory and Ecological Systems Theory aids the conceptualization of how different positive or negative influences interact with child maltreatment experiences to influence sleep outcomes in adolescence.

Strengths and Limitations

The current study has many strengths. A primary strength of this study is the use of the 2023 CHSCY, as it provides a representative sample of Canadian youth in 2023. Currently, Canadian research examining child maltreatment and adolescent sleep outcomes is limited to the Ontario population, therefore the current study contributes to the literature by enhancing the

generalizability of the findings to the broader Canadian provincial youth population. The inclusion of multiple sleep outcomes enables a more comprehensive evaluation of sleep health, thereby strengthening the assessment of sleep quality. Additionally, examining protective factors, electronic device use, and sex as potential modifiers represents a notable strength of the current study as it allows for identification of variables that may influence the strength of the association between child maltreatment and poor sleep outcomes among adolescents. The inclusion of these moderation analyses contributes to the existing child maltreatment and sleep literature, as such potential modifiers have not been considered despite their prominent influence on adolescents' lives. The additional adjustment for mental health among the association between child maltreatment and poor sleep outcomes presents another strength of this study. Mental health was considered a potential covariate between child maltreatment and poor sleep; accordingly, adjusting for this factor allowed a more precise estimation of the examined associations.

Another strength of the 2023 CHSCY is the decreased likelihood of recall bias due to the shorter time between experiencing child maltreatment and answering the questionnaire as an adolescent compared to studies involving adults recalling experiences from childhood. Although the relatively short recall period for adolescents may mitigate potential recall bias, it does not eliminate the issue entirely, as inaccuracies in self-reported data may still occur, which is a limitation of the study. Recall bias may also occur when respondents report on sleep experiences or social media use, as these are commonly routine behaviours that go unnoticed, thus increasing susceptibility to recall bias when asked specific details. Another limitation may be social desirability bias as the respondents may be hesitant to admit to experiences of child

maltreatment due to fear of judgment or social stigma, which may lead to underreporting of the five types of child maltreatment.

The use of secondary data eliminated control over which items were measured and how key variables are operationalized, which influenced the depth and precision of the analysis and interpretation of the findings. A prominent example from the current study was the use of parental education as a proxy for household income. While parental education provides valuable contextual information regarding the adolescent's socioeconomic environment, the inclusion of household income would have provided a more comprehensive measurement of socioeconomic status. This variable operationalization limitation extends to the measurement for meaningful leisure time, as respondents were only asked about time spent engaging in physical activity outdoors and reading books, stories, or articles for enjoyment. Measuring meaningful leisure time using only these two questions may have failed to capture the other ways adolescents spend their leisure time, such as time spent with friends and family or engaging in creative activities including playing an instrument, drawing, painting, or cooking. As a result, the operationalization used in the current study may not accurately reflect the amount of time Canadian adolescents spend engaging in meaningful leisure time.

The operationalization of the electronic device use variables represents another limitation. Questions regarding the use of an electronic device in the bedroom prior to falling asleep and the frequency of electronic device use within a day did not specify what type of device was being used or how it was being used. Information on how the electronic device was used would be valuable, as it may influence the adolescent's mental and physiological arousal. For example, if the adolescent consumed inappropriate or harmful online content, or received negative messages from peers, it may negatively impact their ability to decompress and prepare

for sleep. Conversely, if the adolescent used their device for positive interactions with friends, engaged in enjoyable online gaming, or listened to soothing music, it may aid relaxation prior to sleeping. The exclusion of these details poses a limitation in the current study as it removes the ability to understand the specific manner adolescents are using electronic devices which limits the understanding of how it may impact their sleep. Misclassification bias is another limitation, as it may have occurred during the measurement of using an electronic device in the bedroom prior to falling asleep. The vague wording of this question may have led to different interpretations among respondents, thereby incorrectly classifying the adolescents.

Additionally, the current study could only examine adolescents aged 15-17 years due to the 2023 CHSCY only administering child maltreatment questions to this age range. This measurement limitation extends to the application of the Ecological Systems Theory, as the study included only variables at the microsystem and mesosystem levels, excluding the exosystem, macrosystem, and chronosystem. The exclusion of higher-level influences such as neighbourhood context and developmental transitions constrains the ability to fully capture the multilevel processes that shape sleep outcomes among adolescents. Another limitation of the current study is the relatively low response rate of the 2023 CHSCY. Among 12- to 17-year-olds, the response rate was 38.1%; however, a separate response rate for 15- 17-year-old adolescents was not available (Public Health Agency of Canada, 2026). The low response rate may have introduced a non-response bias if the adolescents who answered the questionnaire differed systematically from those who did not participate; thus, potentially limiting the generalizability of the current study. Additionally, the response rate of the study's sample was unavailable, and therefore the extent to which the non-response bias may have impacted the current study remains unknown. A further limitation is the proportion of missing data for each child maltreatment

variable (ranging from 9.32 to 10.46%) and the physical activity moderator (15.50%). Despite the missing data likely being MNAR, complete case analysis was conducted, which may have introduced selection bias if the participants excluded from the analysis were systematically different than those who were included. Cumulative missingness from covariate adjustments further limited the effective sample size, which may have altered the composition of the retained sample and reduced the precision of the observed results. As the direction and magnitude of the bias is unknown, the findings of the current study should be interpreted with caution.

Another concern is the possibility of Type II error. Moderation analyses often exhibit reduced statistical power (Aiken et al., 1991; Fairchild & McQuillin, 2010; Shieh, 2018); therefore, the associations from the moderation analyses were interpreted at $p \leq 0.10$ rather than $p \leq 0.05$. Another limitation may be the imbalanced distributions among some of the examined moderators. For example, only 12.92% of adolescents reported no use of electronic devices before going to sleep. This limited variability within the moderator may have reduced the precision of moderation estimates. Additionally, adolescents who do not use their electronic device prior to sleeping may differ systematically from those who did, potentially reflecting unmeasured factors such as differing socioeconomic status or access to technology, which were not captured in the 2023 CHSCY dataset. A further limitation of the current study is the exclusion of youth living in First Nations reserves, institutional settings, or foster care, as this limits the generalizability of the findings to these communities. The exclusion of the Canadian territories also limits generalizability to only those residing in the Canadian provinces. Lastly, due to the cross-sectional design of this study, causality cannot be established between child maltreatment, protective factors, electronic device use, and sleep outcomes.

Implications

The current study contributes to the growing literature on child maltreatment, providing deeper insights into its lasting impacts. Identifying the associations between individual and any child maltreatment and poor sleep outcomes highlights the potential utility of prolonged sleep latency, frequent nocturnal awakenings, and/or inadequate sleep durations as indicators of child maltreatment. Incorporating sleep screening into child maltreatment assessments, alongside current screening methods, may aid in identification of at-risk adolescents. Furthermore, informing educators of these findings may help identify potential signs of maltreatment. Additionally, identifying frequent family meals as an effect modifier provides a target for intervention where promotion of these factors may help mitigate the impact child maltreatment has on poor sleep outcomes among adolescents.

The current study also indicates that having relationships where their skills and competence are recognized and where they have someone to talk to about important life decisions are protective between child maltreatment and prolonged sleep latency and inadequate sleep durations (respectively). These findings highlight the importance for adults, such as teachers, coaches, mentors, or parents of the adolescent's friends, to create comfortable environments and relationships where the adolescent feels recognized and free to talk about important decisions. These findings emphasize how such relationships can buffer the negative impacts of child maltreatment on the adolescent's sleep. While other protective factors were not identified as statistically significant modifiers, participation in sports or clubs, good overall and individual perceived social support items, engagement in physical activity with peers, and frequent family meals were identified as being significantly associated with a lower likelihood of poor sleep outcomes. The study findings support the promoting these variables to be impactful

towards a lower likelihood of poor sleep outcomes among Canadian adolescents regardless of maltreatment histories.

The current study supports the importance of adolescents lessening device use in the bedroom prior to falling asleep, lowering their daily use of electronic devices, and lowering their use of an electronic device for social networking, and messaging. These findings support encouraging parents to maintain consistent and structured bedtime routines into adolescence, as parental regulation of these routines typically declines during this phase of development compared to younger childhood (Bauducco et al., 2024; Short et al., 2011). Encouraging educators, clinicians, and mentors to observe or inquire about how often or in which ways adolescents use electronic devices may be valuable for supporting healthy adolescent sleep outcomes.

Furthermore, the identification of sex as a significant moderator suggests awareness of these differences may assist practitioners in considering sex-specific vulnerabilities when assessing adolescents with sleep-related concerns. While these negative associations exist for males and females, data indicate that male adolescents compared to females may have worse sleep outcomes when experiencing sexual abuse and exposure to physical IPV histories. Literature repeatedly indicates that, among individuals with child maltreatment histories, compared to males, females generally indicate worse health outcomes, including worse sleep outcomes (Bader & Frank, 2025; Oh et al., 2022; Xiao et al., 2020). The current study expands this body of literature by demonstrating that the associations of sexual abuse and exposure to physical IPV with poor sleep outcomes were stronger for male adolescents compared to females. These findings have valuable implications for clinical, educational, and community services as they underscore that male adolescents also have poor sleep outcomes in association with child

maltreatment; and they highlight the importance of addressing the needs of both male and female adolescents. The current study highlights how frequent family meals, electronic device use, and sex can influence the poor sleep outcomes of adolescents with child maltreatment histories.

While most current literature focuses on the associations between child maltreatment and sleep outcomes among adults, the current study contributes to the field by specifically examining sleep outcomes in adolescents and additionally observing the moderating roles of protective factors, electronic device use, and sex. Table 11 presents a summary of findings from the current study, alongside the relevant implications.

Table 11. *Summary of Findings.*

Analysis	Findings	Implications
Main effects: child maltreatment (individual types and any child maltreatment) and poor sleep outcomes (prolonged sleep latency, frequent nocturnal awakenings, and inadequate sleep durations).	All individual and any types of child maltreatment were significantly associated with an increased likelihood of each poor sleep outcome.	Incorporation of prolonged sleep latency, frequent nocturnal awakenings, and inadequate sleep duration into child maltreatment assessments. Recognition of poor sleep among adolescents as a potential indicator for child maltreatment in clinical, educational, and community settings. Encouragement for parents to maintain consistent and structured bedtime routines into adolescence.

Analysis	Findings	Implications
Moderation by protective factors between any child maltreatment and individual poor sleep outcomes.	Frequent family meals, relationships where skills and competence are recognized, and relationships where there is someone to talk to about important life decisions were identified as significant moderators between any child maltreatment and poor sleep outcomes. Frequent family meals weakened the associations between: - Any child maltreatment and prolonged sleep latency - Any child maltreatment and inadequate sleep duration Frequent family meals (≥ 3 meals weekly with family) are protective for prolonged sleep latency among adolescents with and without child maltreatments histories. Frequent family meals are protective for inadequate sleep durations among adolescents without child maltreatment histories.	Frequent family meals indicated protection regardless of child maltreatment histories. Therefore, families are encouraged to have three or more meals together weekly to promote better sleep outcome among adolescents. Encouragement for parents, teachers, coaches, and mentors to acknowledge adolescents' developing skills and recognizing their competence as protection for prolonged sleep latency among adolescents with child maltreatment histories.

Analysis	Findings	Implications
	Having relationships where competence and skill is recognized weakened the association between any child maltreatment and prolonged sleep latency. Having someone to talk to about important life decisions weakened the association between any child maltreatment and inadequate sleep duration. Decreased likelihood of each poor sleep outcome with: - Good perceived social support - Frequent family meals - Having relationships with: 1) a sense of emotional security, 2) someone to talk to about important life decisions, 3) recognition of competence and skills, 4) shared attitudes and beliefs, and 5) someone to count on in an emergency	

Analysis	Findings	Implications
	Participation in organized sports or clubs was associated with a decreased likelihood of prolonged sleep latency and frequent nocturnal awakenings. Engagement in physical activity with peers was associated with a decreased likelihood of prolonged sleep latency and inadequate sleep durations.	
Moderation by electronic device use between any child maltreatment and individual poor sleep outcomes.	Significant moderation was identified with two electronic device use variables: - Electronic device use for online social networking moderated (i.e., strengthened) the association between any child maltreatment and prolonged sleep latency - Among adolescents without child maltreatment histories, using an electronic device use for online social networking increased inadequate sleep durations - High daily electronic device use moderated (i.e.,	Promotion to reduce online social networking to aid in better sleep outcomes among adolescents. However, high daily electronic device use may be a negative coping behaviour of child maltreatment. Therefore, increasing alertness for adolescents with more than two hours of daily recreational electronic device use may be valuable for navigating healthy sleep outcomes among Canadian adolescents.

Analysis	Findings	Implications
	weakened) the association between child maltreatment and frequent nocturnal awakenings Increased likelihood of prolonged sleep latency with: - Electronic device use in the bedroom prior to falling asleep - High daily electronic device use Increased likelihood of frequent nocturnal awakenings with: - Online social networking - Online messaging Increased likelihood of inadequate sleep durations with: - Electronic device use in the bedroom prior to falling asleep - High daily electronic device use - Online social networking - Online messaging	Overall, electronic device use in the bedroom prior to falling asleep, high daily use, and online social networking and messaging should be limited due to their associations with poor sleep outcomes. It is encouraged that parents continue to monitor electronic device use throughout adolescence. While online gaming is associated with decreased likelihood of frequent nocturnal awakenings, this should not be encouraged among adolescents, but instead prompt future research to understand online gaming behaviours of adolescents.

Analysis	Findings	Implications
	Decreased likelihood of frequent nocturnal awakenings with: - Online gaming	
Moderation by sex between child maltreatment (individual types and any) and individual poor sleep outcomes.	Significant moderation was identified between two associations such that each was stronger for males compared to females: - Sexual abuse and prolonged sleep latency - Exposure to physical IPV and frequent nocturnal awakenings	While negative impacts for males and females, the findings highlight that there are differential impacts of sexual abuse and exposure to physical IPV on male and female adolescent sleep outcomes. This may be valuable in identifying child maltreatment in clinical, educational, and community settings.

Knowledge Translation

These findings will be disseminated through academic and community-focused channels to maximize impact and accessibility. Publishing in an open-access peer-reviewed journal will broaden its accessibility to researchers, practitioners, policymakers, and the public. Sharing visually engaging infographics on social media platforms will help reach a wider audience, including community organizations and more of the public. These infographics will summarize key findings, present insights on promoting protective factors, and include links or QR codes that direct audiences to additional resources, conference presentations, or publications.

Future Directions and Conclusion

The current study was the first to examine the association between individual and any child maltreatment and poor sleep outcomes among Canadian adolescents and additionally assess the moderating roles of protective factors, electronic device use, and sex differences. One of the main findings of the current study was that physical abuse, sexual abuse, emotional abuse, physical neglect, exposure to physical IPV, and exposure to emotional IPV are each associated with prolonged sleep latency, frequency of nocturnal awakenings, and inadequate sleep duration among Canadian adolescents. The current study also identified that frequent family meals and having relationships where competence and skill are recognized mitigate the impact of any child maltreatment on prolonged sleep latency. Similarly, frequent family meals and relationships where there is someone to talk to about important life decisions mitigate the impact of any child maltreatment on inadequate sleep duration. Among the measured protective factors, good perceived social support, frequent family meals, and each perceived social support item where adolescents have relationships with: a) a sense of emotional security, b) someone to talk to about important life decisions, c) recognition of their competence and skills, d) shared attitudes and beliefs, and e) someone to count on in an emergency, were each associated with a decreased likelihood of each poor sleep outcome. Participation in organized sports or clubs was associated with a decreased likelihood of prolonged sleep latency and frequent nocturnal awakenings. Engagement in physical activity with peers was associated with a decreased likelihood of prolonged sleep latency and inadequate sleep durations.

Other significant moderation observed indicated that online social networking strengthened the association between child maltreatment and prolonged sleep latency, and child maltreatment and inadequate sleep durations. Unexpectedly, high daily electronic device use

weakened the association between child maltreatment and frequent nocturnal awakenings. In addition to the moderation effects, using an electronic device in the bedroom prior to falling asleep and high daily electronic device use were associated with an increased likelihood of prolonged sleep latency and inadequate sleep durations. Similarly, using an electronic device for online social networking was associated with an increased likelihood of frequent nocturnal awakenings and inadequate sleep duration. Using an electronic device for online messaging was associated with an increased likelihood of frequent nocturnal awakenings and inadequate sleep durations. Unexpectedly, using an electronic device for online gaming was associated with a decreased likelihood of frequent nocturnal awakenings. Sex differences were identified among the associations between sexual abuse and prolonged sleep latency, and exposure to physical IPV and frequent nocturnal awakenings, such that each association was stronger for male adolescents compared to females.

The current study was unable to measure the larger systems of the Ecological Systems Theory. Future studies should aim to understand the broader societal and cultural aspects that may contribute to the association between child maltreatment and poor sleep outcomes such as social norms regarding electronic device use or cultural norms regarding time spent with family and friends. Furthermore, broader ecological systems, such as the chronosystem, which encompass changes that occur over time, including developmental changes in sleep patterns and the increasing importance adolescents give to their peer relationships compared to childhood, would provide valuable insights into the association between child maltreatment and poor sleep outcomes. This could not be examined due to the cross-sectional design of the current study. A longitudinal study design would deepen the understanding of the relationships between child maltreatment and poor sleep outcomes. Additionally, future studies are encouraged to examine

the content adolescents consume on their devices as different types of content may have varying effects on their sleep outcomes. Differences by sex at birth were examined in the current study, but the incorporation of gender in future studies may provide additional insight into the associations between child maltreatment and poor sleep outcomes. Finally, the current study only examined the Canadian provincial population; however, inclusion of youth living in foster homes, the Canadian territories, First Nations reserves, and other Indigenous settlements would enhance the generalizability of the findings and provide a deeper understanding of sleep outcomes among Canadian youth.

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Appendix A

The Social Provisions Scale (SPS) was developed as a self-report measure of social support. The Social Provisions 5-Item Scale (SPS-5) (Orpana et al., 2019) questionnaire is derived from the original SPS-24 scale (Cutrona & Russell, 1983) to reduce respondent burden. SPS-5 is a validated measure of social support.

Please indicate to what extent each statement describes your current relationships with other people.

(1) Strongly agree, (2) agree, (3) disagree, and (4) strongly disagree.

1. I have close relationships that provide me with a sense of emotional security and well-being.
2. There is someone I could talk to about important decisions in my life.
3. I have relationships where my competence and skill are recognized.
4. I feel part of a group of people who share my attitudes and beliefs.
5. There are people I can count on in an emergency.