

**ADHD SYMPTOMOLOGY AND SEVERITY IN  
CANADIAN CHILDREN AND ADOLESCENTS DURING  
THE COVID-19 PANDEMIC - A LIFE COURSE PERSPECTIVE**

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## Abstract

Little is known about the impact of the COVID-19 pandemic response on the development of children and adolescents with ADHD. According to the life course theory, a child's age and developmental stage at the onset of a stressful event may differentially impact their developmental trajectory. Our study explored changes in ADHD symptom severity during the pandemic for Canadian children and adolescents from kindergarten to grade 12 with clinical levels of ADHD. We focused on the period between the spring of 2021 and the fall of 2022, marked by school closures, remote learning, and the subsequent transition back to in-person education. We observed a general increase in ADHD symptom severity across all three presentations (hyperactive/impulsive, inattentive, and combined). Contrary to our predictions, we did not find children's age to be a predictive factor in the amount of symptom severity change. However, we did see a correlation between initial symptom severity and symptom change. Particularly, our findings revealed that individuals with milder symptoms at baseline experienced the greatest increases in severity over the study period. In contrast, those with more severe symptoms showed stability or even slight improvements in symptoms.

Understanding the pandemic's impact on children and adolescents with ADHD is the first step to providing tailored and effective support, prevention, and intervention. Findings from our study may aid in both practical and theoretical understanding of the COVID-19 pandemic and pandemic responses' impact on children and adolescents with ADHD.

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## Introduction

Attention-deficit/hyperactivity disorder (ADHD) is one of the most common neurodevelopmental disorders, affecting roughly 7.6% of school-aged children aged 3 to 12 years and 5.6% of teenagers worldwide (Salari et al., 2023). Over the past decade, the prevalence of ADHD diagnosis in Canada has increased by approximately 6.9–8.6% among 4- to 17-year-olds and 2.9% among adults (Espinet et al., 2022).

On January 30, 2020, the World Health Organization declared the COVID-19 outbreak a public health emergency of international concern. Since then, COVID-19 pandemic response measures have dramatically impacted the daily lives of children and adolescents worldwide. School closures were implemented in more than 190 countries, affecting over 1.5 billion children and adolescents, or 90% of all students worldwide (Aurini & Davies, 2021; UNESCO, 2020). By the spring of 2021, schools had already been closed for a full year for more than 168 million children globally (UNICEF, 2021). In Canada, most provinces closed schools by mid-March 2020 due to COVID-19-related public health concerns and implemented emergency remote learning alternatives. Schools remained closed until the end of the 2019 – 2020 school year. In the following school year, subsequent waves of increased COVID-19 cases prompted periodic school closures (Wong, 2020). Overall, it is estimated that 5.7 million Canadian elementary and secondary school students were impacted by school closures (Government of Canada, 2021).

Children and adolescents with ADHD were particularly vulnerable to the negative impacts of the COVID-19 pandemic. Emergency and public health measures disrupted the familiar rhythms of daily life for parents and children alike, influencing every domain of life (Cost et al., 2022; Vaillancourt et al., 2021). Disruptions to routines, remote learning difficulties, reduced access to support services, and mental health concerns were often named the major pandemic-related challenges for students with ADHD (Becker et al., 2020;

Winfield et al., 2023). On the global level, a meta-analysis by Rogers and MacLean (2023) found that children and adolescents with ADHD experienced a clinically small but statistically significant increase in ADHD symptoms in the year following the pandemic's onset. A narrative review by Davvody and colleagues (2022) yielded similar results, although localized findings varied. For example, a Finnish longitudinal study found that although ADHD diagnoses and prevalence significantly increased in Finland between 2020 and 2022. However, male participants aged 21 and younger were exceptions to this trend, whereas adolescent females experienced a three-fold increase in ADHD symptoms (Auro et al., 2024).

More research is needed to understand the impacts of COVID-19 public health measures on the mental health of Canadian children and adolescents with ADHD. There is little peer-reviewed literature on the long-term effects of the COVID-19 pandemic on child development, particularly regarding ADHD. Several reviews have stressed the need for longitudinal, Canadian-based research on these effects (Brooks et al., 2020; Meherali et al., 2021; Vaillancourt et al., 2021).

This study aims to address the current gaps in research on the impact of the COVID-19 pandemic on Canadian children and adolescents with ADHD. Specifically, we examined the following questions: (1) How did ADHD symptom severity change through the pandemic in Canadian children and adolescents? And (2) How does a child's developmental stage and initial ADHD symptoms at the onset of the pandemic impact changes in ADHD symptom severity throughout the pandemic? In asking these questions, we hope to understand whether (and how) ADHD symptom severity and age impact a child's vulnerability to negative effects of the pandemic. We also hope to clarify how ADHD symptom severity in Canadian children and adolescents changed during the COVID-19 pandemic.

## Literature Review

### **Pandemic-related challenges to children and adolescents with ADHD**

Children, especially children and adolescents with ADHD, thrive in predictable, structured, and secure environments (Harris et al., 2014; Livingstone et al., 2016). Accordingly, children and adolescents with ADHD are at a disadvantage in adapting to pandemic-induced changes, as they typically engage in less flexible coping mechanisms and more maladaptive behaviours during periods of chronic stress (Dvorsky et al., 2021). Thus, children and adolescents with ADHD experienced more severe mental health symptoms and conduct problems during the pandemic compared to their neurotypical peers, though both groups experienced a decline in mental health compared to a pre-COVID-19 sample (Cost et al., 2022; Dvorsky et al., 2021; Nonweiler et al., 2020). Moreover, the COVID-19 pandemic and related public health policies and restrictions amplified a sense of uncertainty, fear, and distress for both adults and children (Brooks et al., 2020; Imran et al., 2020). Notably, parents of children and adolescents with ADHD in Ontario, Canada, identified a lack of routine as one of the most significant barriers to maintaining optimal mental health, alongside the lack of social interaction and support, as well as pandemic-induced increases in uncertainty and fear (Winfield et al., 2023).

The impact of the COVID-19 pandemic on the mental health of children and adolescents with ADHD fluctuated throughout the pandemic, and much remains unclear within the literature. Notwithstanding this, most studies suggest a marked deterioration in mental health for most children and adolescents with ADHD during the initial lockdown of the COVID-19 pandemic (e.g., Breaux et al., 2021; Dvorsky et al., 2021). Canadian studies have observed similar trends (e.g., Cost et al., 2022; Swansburg et al., 2021). This observation is consistent with observations from past pandemics, where population-level mental health declined shortly after the initial pandemic event, with anxiety, depression, sleep

and appetite disturbances, and social interaction impairments being the most common concerns (Meherali et al., 2021).

### ***School closures and their impacts on ADHD***

Particularly noteworthy in the early stages of the pandemic were worldwide school closures that had detrimental effects on children and adolescents with ADHD (Saulle et al., 2022). While implemented globally as a public health measure to reduce the transmission of COVID-19, the effectiveness of school closures in reducing transmission remains debated (El Jaouhari et al., 2021; Hume et al., 2023; Walsh et al., 2021). For children and adolescents in Canada, remote learning has been associated with heightened levels of depression, anxiety, irritability, and inattention (Hai et al., 2021; Patte et al., 2023; Swansburg et al., 2021; Welch, 2021). School closures negatively impacted students' development in other domains apart from mental health. For instance, regarding academic achievement, researchers Hai and colleagues (2021) found that 78% of Canadian students spent up to 10 fewer hours on schoolwork per week during remote learning compared to pre-pandemic levels. These trends raise concerns about long-term academic achievement and psychosocial development for Canadian children (Vaillancourt et al., 2021).

When schools are closed, access to school-based mental health resources and interactions with peers and teachers are also restricted (Cortese et al., 2020). This can be remarkably troublesome for families who depend on school-based support for their children with ADHD. Further, with limited opportunities to socialize or nurture healthy peer relationships, students with ADHD face setbacks in social development and behavioral difficulties in addition to psychological and academic concerns (Korpa et al., 2021).

## **Additional vulnerabilities for children and adolescents with ADHD**

While children of different ages and symptom severities faced similar pandemic-related challenges, the impact of these stressors may differ (Benner & Mistry, 2020; Elder Jr., 1998). Apart from pandemic-specific factors previously outlined, several other biopsychosocial factors may also influence the vulnerability of children and adolescents with ADHD. These include comorbid mental health conditions, familial and environmental stressors, academic and peer difficulties, sleep problems, substance use, socioeconomic status, and access to treatment and support, among other factors (Lahey et al., 2016; Willcutt, 2012). Although these factors warrant a more in-depth discussion, this study focuses on the role of developmental age and initial symptom severity.

### ***Age and developmental stage***

**General trends.** ADHD symptoms tend to follow a predictable pattern as children grow and often manifest differently depending on the child's developmental age (National Institute of Mental Health, 2024). In early childhood, hyperactivity and impulsivity tend to be the most pronounced ADHD symptoms. Young children may struggle to follow routines, take turns, play with others, and manage transitions. Inattentiveness may also be present but less pronounced than hyperactivity and impulsivity symptoms. In middle childhood, children face more complex and longer tasks in elementary school. As a result, they may struggle with sustained attention, organization, and time management. With the right support, children with ADHD may begin to develop strategies to manage their symptoms and impulses better. Older children may also struggle with emotional regulation, risk-taking behaviors, and impulsive decisions during adolescence (Lahey et al., 2016; Willcutt, 2012).

Overall, ADHD symptoms typically decrease with age. However, researchers have also suggested that the diagnostic criteria may be insensitive to developmental changes in symptoms (Faraone et al., 2006). Hyperactivity and impulsivity tend to become less severe,

while inattention symptoms persist or decrease minimally. As inattention symptoms remain relatively stable across development and hyperactivity-impulsivity symptoms decline with age, many who initially meet the criteria for a combined presentation in early childhood may shift towards an inattentive presentation (Willcutt, 2012).

**Pandemic impacts.** During pre-pandemic times, we generally observed ADHD symptoms lessen with age, such that the overt signs of hyperactivity and impulsivity declined with increasing age, while symptoms of inattentiveness were more likely to persist (Willcutt, 2012). Some literature points to some pandemic-related changes to these trends. For instance, while hyperactive-impulsive symptoms typically decline more rapidly than inattentive symptoms as children age, the pandemic disruptions appear to have stalled or reversed this trend by exacerbating hyperactive and impulsive behaviors (Rogers & MacLean, 2023). Likewise, a longitudinal study from the Netherlands found that while externalizing behaviors decreased over time across development, the rate of decrease was slowed by the COVID-19 pandemic lockdowns (Achterberg et al., 2021). Conversely, the study found no significant influence of the COVID-19 lockdown on children's internalized behaviors from pre-pandemic trends.

The impacts of the pandemic on ADHD and mental health appear complex and varied based on the population. For example, an observational cross-sectional study in Italy by De Rossi and colleagues (2023) found significantly higher ADHD symptoms in younger children than in adolescents, consistent with pre-pandemic trends. However, the study also found an increase in general psychopathology in adolescents despite a reduction in ADHD symptoms. Conversely, a longitudinal USA study on adolescents with ADHD found no evidence of pandemic-related mitigation of ADHD severity (Sibley et al., 2021). Thus, it is still unclear how the pandemic has impacted the previously observed age-related trends in ADHD symptoms.

### ***Initial symptom severity***

The severity of ADHD symptoms in early childhood is often predictive of long-term outcomes. Children with more severe symptoms of inattention, oppositional, conduct disorder, and anxiety at a young age are more likely to exhibit greater future functional impairments into adolescence (Lahey et al., 2016). Accordingly, in the context of the pandemic, we might expect children with higher initial symptoms to show more significant increases in symptom severity throughout the pandemic due to their heightened vulnerability. Yet, the relationship between initial symptom severity and symptom change appears more complex and varied based on initial symptom severity. For example, an Italian study found that amongst children and adolescents with ADHD, those with high and moderate severity of ADHD symptoms before the pandemic showed more stability in their symptom severity during lockdown. Conversely, those with low symptom severity before the pandemic showed a significant worsening of symptoms during the pandemic (Melegari et al., 2021).

### **The Canadian context**

Across Canada, pandemic-related restrictions varied, along with their impact on ADHD symptoms and children's experiences of the pandemic. Common amongst the pandemic response measures across Canadian provinces and territories were sudden shifts to virtual learning, school closures, and disruptions to routine. These posed significant challenges to children with ADHD, who often rely on structured environments to manage their symptoms effectively. Research indicates increased behavioral problems, emotional dysregulation, and difficulties adapting to online learning for Canadian children and adolescents with ADHD (Becker et al., 2020; Breaux et al., 2021; Sibley et al., 2021). Further, parents and caregivers reported more significant difficulties managing their children's behaviors and noted the need for additional support (Winfield et al., 2023).

While some evidence indicates a global increase in children’s ADHD symptoms since the pandemic (Rogers & MacLean, 2023), there remain discrepancies within the Canadian context. Studies have shown that the pandemic has exacerbated mental health symptoms and lifestyle stressors for children and adolescents with ADHD in Canada, including anxiety, depression, disturbed sleep, strained social connections, and familial stress (Swansburg et al., 2021; Winfield et al., 2023). However, some evidence suggests that a minority of children and adolescents with ADHD experienced positive changes in mental health following the COVID-19 pandemic, despite increased risks for mental health concerns (Cost et al., 2022; Dvorsky et al., 2021). For instance, researchers in Toronto, Canada, found that 67–70% of their child participants (62% of whom had a pre-existing psychiatric diagnosis) experienced worsening in at least one mental health domain, while 19–31% of participants experienced improvements during the first wave of the pandemic (Cost et al., 2022). Thus, the existing Canadian literature point to a worsening of mental health for most children and an improvement in mental health for a minority. We did not find nationwide samples, studies situated outside of Ontario, nor ones that specifically focused on changes in ADHD symptoms.

### **Theoretical framework**

Two complementary theoretical frameworks guide this study. Both are based on the premise that children’s mental health cannot be decontextualized from larger, concurrent sociocultural events. First, the life course theory offers a useful guide to conceptualize the potential effects of the COVID-19 pandemic response measures on children’s developmental trajectories (Benner & Mistry, 2020; Elder Jr., 1998). This theory views development as a complex web of intertwined trajectories and sensitive critical periods. According to the life course theory, macro-level events such as the COVID-19 pandemic can introduce shocks to

development, acting as a transition point (see Figure A in the Appendix). Following this theory, we would expect children of different developmental stages to be differentially impacted by the pandemic (Benner & Mistry, 2020; Settersten et al., 2020).

Second, we utilize the diathesis-stress model, a biopsychosocial model of pathology, which posits that individuals with pre-existing vulnerabilities (i.e., diathesis) may be more susceptible to exacerbating symptoms when exposed to intensified environmental stressors (Hankin & Abela, 2005). In other words, individual differences in pre-existing genetic vulnerabilities can manifest in divergent symptom severities, even when subjected to the same set of stressors (see Figure B in the Appendix). In the context of the pandemic, the model suggests that pre-existing vulnerabilities to psychopathology increase in high-risk contexts, and those with greater pre-existing biological vulnerabilities would be more negatively influenced by pandemic disruptions. Applying this to our study, we would expect those with higher levels of ADHD to be more negatively impacted by pandemic stressors.

### **The current study**

Our study seeks to address gaps in the current literature by examining the effects of the pandemic on children and adolescents with ADHD in Canada. To date, few, if any, longitudinal studies have explored the question of ADHD symptom severity within the Canadian context. Of the handful of empirical studies focused on the mental health of Canadian children and adolescents with ADHD, most are situated in southern Ontario (Browne et al., 2021; Cost et al., 2022; Mactavish et al., 2021; Winfield et al., 2023), took a cross-sectional approach (Mactavish et al., 2021; Swansburg et al., 2021; Winfield et al., 2023), focused on the early periods of the pandemic, and utilized a relatively small sample of children and adolescents with ADHD (e.g., Cost et al., 2021). The complexity of the findings highlights a need for region-specific explorations on pandemic-related mental health trends,

which would aid in understanding the relationship between mental health trends and public health restrictions, such as school closures, which varied between provinces. More longitudinal designs are necessary to delineate the effects of the pandemic with more clarity. The importance of further exploration is also highlighted by trends from past pandemics, where long-term adverse consequences on children's and adolescents' mental health were observed (Meherali et al., 2021). Moreover, a nationwide sample can support a broader understanding of children's mental health within Canada.

Thus, we aim to address the following questions:

- (1) How did ADHD symptom severity change throughout the pandemic amongst children and adolescents in Canada?
- (2) How did a child's developmental stage and ADHD symptom severity impact changes in ADHD symptom severity during the pandemic?

We hypothesize that the ADHD severity increased for all age groups, as we have seen in the literature (Rogers & MacLean, 2023; Summerton et al., 2023). In our review of the literature, we did not find any studies examining age-related ADHD trends using between-group comparisons, nor strong evidence for age-specific differences in changes in ADHD symptom severity. Thus, we refrain from making specific predictions on the impact of age on ADHD symptom severity change. Next, we hypothesize that children and adolescents with higher initial symptoms will show a greater increase in symptom severity throughout the pandemic, as suggested by the diathesis-stress model.

In sum, the proposed study aims to address the current gaps in research on the impact of the COVID-19 pandemic on Canadian children and adolescents with ADHD. Together, we hope to understand how a child's developmental stage and initial symptom severity during the pandemic relates to the severity of ADHD over time.

## **Methods**

### **Study design**

The current study is part of a larger, Canada-wide, observational, longitudinal study. Specifically, the wider study aimed to examine the experiences of children and parents with and without ADHD during and after the COVID-19 pandemic, with four time points of data collection spanning 2021 to 2023. Ethics approval was granted by the University of Ottawa, Saint Paul University, and the Carleton University Research Ethics Board for the initial data collection in the spring of 2021 and subsequent data collection points.

### **Procedure**

The study used a convenience sampling approach to recruit participants. Convenience sampling was chosen due to its strengths in efficiency and practicality in accessing the desired participant population. Partnering with ADHD-affiliated institutions across Canada provided a convenient avenue for recruitment, as these institutions had established relationships and access to networks of individuals meeting the study criteria. This approach saved time and resources that would have been required for more complex sampling methods. Thus, participants were either self-referred or recruited through advertisement via ADHD associations (i.e., the Canadian ADHD Resource Alliance, the Centre for ADHD Awareness), university laboratories focused on ADHD research, and various social media platforms.

Given the challenges posed by pandemic-related travel restrictions and social distancing protocols, online recruitment methods were utilized. This allowed participants to join from across Canada and allowed for a broader outreach than possible via in-person means. Accordingly, the study reached a geographically diverse pool of potential participants, including scarcely populated parts of Canada. Recruitment materials were distributed electronically through partnerships with ADHD-affiliated institutions across Canada and

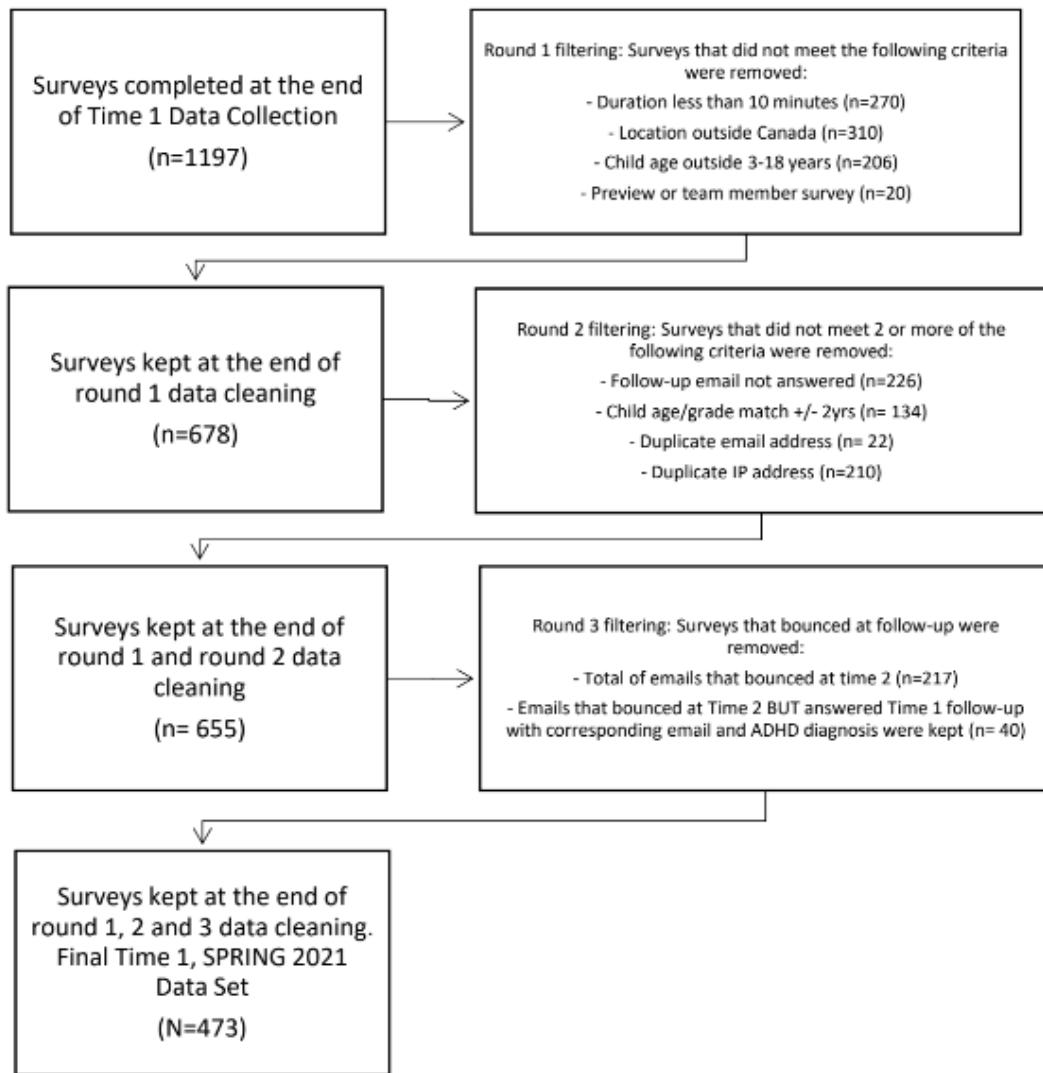
coordinated by the ADHD and Development Lab at the University of Ottawa and the Attention, Behaviour, and Cognitions Lab at Saint Paul University.

### **Data collection**

Data collection occurred online, administered via Qualtrics. At the end of the questionnaire, parents were prompted to provide their email addresses if they wished to be contacted for follow-up studies and to receive compensation for their participation. Participants who consented to be contacted for follow-up studies were invited in the spring of 2022 to complete a subsequent online questionnaire featuring a similar battery of measures. They were reminded to respond about the same child as in the initial time point. Recruitment for new parent respondents also occurred at T2. Additionally, parent respondents initially recruited at T1 and T2, who consented to future contact, were approached again for participation in follow-up studies at the T3 (Fall 2022) and T4 (Spring 2023) data collection. Participants were asked to report on the same child across all time points. Following the recruitment at T2, no new participants were acquired subsequently at Time 3 (Fall 2022) or Time 4 (Spring 2023); only participants from Time 1 and Time 2 were invited to participate in Time 3 and Time 4. For each time point, the complete questionnaire was estimated to take approximately 30 - 45 minutes to complete. \$20 CAD honorarium gift cards were given to participants at each time point.

Both parental and child experiences were captured via parent-report questionnaires. The questionnaire consisted of a request for consent, demographic inquiries, and a battery of mental health, lifestyle, and relational measures. For instance, these measures captured school-related questions such as achievement, attendance, parental involvement in school, and available school-based support. They also captured parent and child variables, encompassing mental health, lifestyle, pandemic-related experiences, parental beliefs about

child learning, and relationship quality. The content of the questionnaire varied slightly between time points to capture factors of interest to the researchers; some measures were excluded, and others were added.



**Figure 1.** Flowchart for data filtering at Time 1, Spring 2021

### ***Data cleaning and preparation***

Several measures were implemented during data collection to enhance the integrity of the data and minimize bot-generated responses. These measures included collecting IP addresses, a re-captcha bot screening question, and a numerical selection question. In addition to these precautionary measures, a stringent and multi-step filtering process was

implemented to maintain data integrity. This process was meticulously designed to uphold the validity of the collected data. Two rounds of filtering occurred at T1, and a third round of filtering occurred at the end of T2. Refer to Figure 1 for a flowchart of the data filtering process.

## **Measures**

### ***Child and adolescent symptom inventory–progress monitor–parent form***

To operationalize children’s ADHD symptom severity, we use the ADHD subscale of the Child & Adolescent Symptom Inventory-Progress Monitor-Parent Form (CASI-PM-P; Lavigne et al., 2009). See Table B in the Appendix for a full list of items. The CASI-PM-P is well-suited to measure symptom severity change as it was created to assess changes in clinical status and intervention responsiveness. Parents report on their child’s behaviours over the past month using a 4-point Likert scale (1 = “Never”, 4 = “Very Often”). The full scale includes 29 items that evaluate symptom change for commonly referred child and adolescent disorders, including ADHD. The ADHD subscale consists of eight questions, four assessing hyperactivity/impulsivity, and four assessing inattentiveness. Thus, CASI-PM-P’s ADHD subscale provides three ADHD ratings: (1) ADHD Sum, (2) ADHD hyperactivity/impulsivity, and (3) ADHD inattentiveness (Lavigne et al., 2009).

**Item selection and psychometrics.** The CASI-PM-P is a measure of behavioral change in clinical settings and has been used widely in peer-reviewed literature and demonstrates high levels of internal consistency (ADHD-I:  $a = .87$ ; ADHD-HI:  $a = .88$ ; ADHD-C:  $a = .89$ ), test-retest reliability (ADHD-I:  $r = .73$ ; ADHD-HI:  $r = .86$ ; ADHD-C:  $r = .83$ ), and was sensitive to change in a treated sample. The items in the Child and Adolescent Symptom Inventory-Progress Monitor Parent Checklist (CASI-PM-P) were derived from the parent versions of the Early Childhood Inventory (ECI-4), Child Symptom

Inventory-4 (CSI-4), and Adolescent Symptom Inventory-4 (ASI-4) (see Gadow & Sprafkin, 2009). Further, independent studies (Lavigne et al., 2009) have established the reliability and validity of the CASI-PM-P.

**Standardization.** The CASI-PM-P has been standardized for all age groups of children and has a common set of norms for both sexes. The CASI-PM-P is derived from the long form of the Symptom Inventories, which are DSM-IV–referenced, broadband instruments for assessing child and adolescent emotional and behavioral problems. The long form Symptom Inventories refers to three scales: the Early Childhood Inventory-4 (ECI-4) (Gadow and Sprafkin 1997b; Gadow and Sprafkin 2000) for 3–5 year olds in preschool programs, the Child Symptom Inventory-4 (CSI-4) (Gadow and Sprafkin 1994; Gadow and Sprafkin 2002) for 5–12 year old children in elementary school, and the Adolescent Symptom Inventory-4 (ASI-4) (Gadow and Sprafkin 1997a; Gadow and Sprafkin 1998) for 12–18 year old adolescents in middle or secondary schools. The standardization samples for these measures were included in the standardization of the CASI-PM (ECI-4: boys  $n = 268$ , girls  $n = 251$ ; CSI-4: boys  $n = 272$ , girls  $n = 279$ ; ASI-4: boys  $n = 389$ , girls  $n = 390$ ).

**Test-retest reliability.** In a one-month ( $M = 27.6$  days) retest, test-retest reliability in a small sample ( $n = 24$ ) of clinic patients, ages 3-18 years was high for the ADHD subscale (ADHD-I:  $r = .70$ ; ADHD-HI:  $r = .90$ ; ADHD-C:  $r = .84$ ). When assessed over a longer period in the larger sample ( $n = 178$ ), test-retest reliability remained high for the ADHD subscale (ADHD-I:  $r = .73$ ; ADHD-HI:  $r = .86$ ; ADHD-C:  $r = .83$ ) (Sprafkin et al., 2010).

### ***Operationalization***

**Three presentations of ADHD.** There are several compelling reasons for examining ADHD in terms of its various presentations: combined, hyperactive-impulsive, and inattentive. Different symptom clusters or presentations of ADHD are associated with distinct behaviors and comorbidities, which provide more insight into the association between ADHD

symptoms and variables of interest. For example, hyperactive-impulsive presentations appear more strongly linked to emotional dysregulation, behavioral issues, and externalizing comorbidities (e.g., oppositional defiant disorder and delinquency), while inattentive presentations relate more to attention difficulties (Katzman et al., 2017; McKinney et al., 2013). Research also indicated that inattentive and hyperactive-impulsive symptoms become more differentiated and less clustered with age, indicating a distinct developmental path of symptom change with an increase in age (Niina et al., 2022; Silk et al., 2019). Thus, examining ADHD presentations can shed light on the heterogeneity and variability of ADHD symptom clusters, underscoring the importance of considering specific symptom profiles.

Therefore, to address our research questions, we operationalized the outcome variable “ADHD severity” in three ways to reflect the three ADHD presentations of combined, hyperactive-impulsive, and inattentive. First, the CASI-PM-P ADHD sum score is operationalized as ADHD combined symptom severity. We divided the ADHD sum score by two (i.e., since it is the sum of the two subscales, hyperactivity/impulsivity and inattentive) to standardize for comparison purposes. Second, we operationalized the CASI-PM-P ADHD hyperactivity/impulsivity sum score as ADHD hyperactivity/impulsivity symptom severity. Third, we operationalized the CASI-PM-P ADHD inattentive sum score as ADHD inattentiveness symptom severity.

**Change in symptom severity.** To address change in symptom severity over time, we operationalized “ADHD symptom severity change” as the difference in symptom severity between two time points. We calculated the ADHD symptom severity change for all three outcome variables (i.e., overall ADHD severity, ADHD hyperactivity/impulsivity symptom severity, and ADHD inattentiveness symptom severity) between Spring 2021 and Fall 2022 to answer our second research question. We subtracted the earlier time point from the later

time point so that a negative result corresponds to a decrease in symptom severity over time, and a positive result corresponds to an increase in symptom severity.

## **Sample**

### ***ADHD as a continuum***

While the clinical need for diagnosis cannot be neglected, viewing ADHD as a continuum highlights ADHD's varied symptom presentations and allows for a more nuanced and strengths-based understanding of the condition. When considered as a continuous trait that exists in the general populations in addition to clinical populations, the continuum of symptom severity would range from "high" for the clinical population to "low" for those who exhibit fewer and milder symptoms. Taking a continuous, rather than categorical, view of ADHD has long been explored in the literature. In a systematic review, McLeannan (2016) found evidence from diverse fields of taxonomy, epidemiology, genetics, neurobiology, and neuropsychology that ADHD is most consistent with a dimensional or continuous conceptualization rather than a categorical one. Moreover, many individuals who experience some ADHD traits but do not meet the diagnostic criteria may still experience impairment and benefit from tailored ADHD interventions.

Accordingly, the clinically diagnosed sample was combined with the non-diagnosed sample whose symptom scores were above the clinical threshold. Specifically, we included the non-ADHD sample that met a threshold score based on their CASI-PM-P ADHD subscale score at either time points. This allows us to examine inattention and hyperactivity/impulsivity as continuous traits. As all participants completed both the inattentive and hyperactive/impulsive subscales; participants are included if either of their inattentive or hyperactive/impulsive scores falls above the non-clinical cut-off. Thus, we

included participants in our analysis who reported a CASI ADHD score above the non-clinical range at T1 (see Table C in the Appendix).

### ***Attrition***

We recruited 1197 participants at the initial data collection point (i.e., T1) from across Canada. The sample comprised parents of children between the ages of 6 and 11 years with and without ADHD (ADHD group  $n = 586$ , non-ADHD group  $n = 191$ ) who participated across the country. All parents or caretakers of a child in kindergarten to Grade 12 (i.e., ages 3 to 18) who resided within Canada were eligible to participate. Participants must be able to read English. Only one child per immediate family could be included in the study. That is, siblings and stepsiblings are excluded from participation in the study. For our analyses, T1 and T3 were utilized, with data collection in Spring 2021 and Fall 2022 respectively. We removed T2 and T4 for analysis to retain the maximum number of paired samples. After filtering, 540 data points remained (male  $n = 272$ ; female  $n = 201$ ). After selecting only participants who scored above the clinical threshold for ADHD at either of the time points and who had a formal diagnosis, 377 participants remained (male  $n = 210$ ; female  $n = 167$ ). Of the 377 participants, 133 responded during both T1 and T3 data collections points (male  $n = 68$ ; female  $n = 65$ ).

### ***Participant demographics***

Participant ages ranged from 3 to 16 ( $m = 10.06$ ). 115 children (86.5%) were formally diagnosed with ADHD at T1, and only 2 (1.5%) at T3. At T1, the vast majority were diagnosed by pediatricians ( $n = 56$ , 47.9%) or family physicians ( $n = 20$ , 17.1%). Diagnoses were also obtained from psychological associates ( $n = 7$ , 6.0%), and psychiatrists ( $n = 8$ , 6.8%), with the remaining participants reporting other means ( $n = 24$ , 20.5%). The remaining 16 participants were included based on elevated ADHD symptom scores for either inattention or hyperactive/impulsive symptoms that fell above the clinical cut-off.

Ethnically, most children were White or Caucasian (n = 104, 78.2%). Other ethnic categories include Aboriginal, First Nations, Metis, or Inuit (n = 15, 11.3%), Black (n = 4, 3%), with only one participant (n = 1, .8%) for each of the following ethnicities: South Asian, Japanese, and multi-ethnic. Participants from all provinces and territories were geographically represented except for the Yukon and Prince Edward Island. The most represented provinces were Ontario (n = 45, 33.8%), British Columbia (n = 34, 25.6%), Alberta (n = 21, 15.8%), and Nova Scotia (n = 8, 6%). Only 5 participants (3.8%) resided in Quebec. A full summary is provided in the Appendix (see Table D1).

**Table 1**

*Summary of Demographics – Child Characteristics*

Demographic Characteristic	<i>n</i>	%
<b>Child Age (in years)</b>		
3 to 7	32	24.0
8 to 12	78	58.6
13 to 16	23	17.4
<b>Child Sex</b>		
Male	68	51.1
Female	65	48.9
<b>Child Ethnicity</b>		
White/Caucasian	104	78.2
Aboriginal/First Nations/Métis/Inuit	15	11.3
Prefer not to answer	7	5.3
Other	7	5.4
<b>Diagnoses ADHD</b>		
Yes	115	86.5
No	18	13.5
<b>Number of Diagnosed Co-Morbid Disorders</b>		
0	7	5.3
1	38	28.6

2	60	45.1
3 or more	28	21.1
<hr/>		
Province/Territory		
Ontario	45	33.8
British Columbia	34	25.6
Alberta	21	15.8
Nova Scotia	8	6.0
Manitoba	5	3.8
Quebec	5	3.8
Northwest Territories	5	3.8
Newfoundland and Labrador	4	3.0
New Brunswick	2	1.5
Nunavut	2	1.5
Saskatchewan	1	0.8
Prince Edward Island	0	0.0
Missing	1	0.8
<hr/>		
<i>Note. N = 133 for TI</i>		

The parent-report survey was completed mostly by biological mothers (n = 84, 63.2%) and biological fathers (n = 42, 32.3%). Parental age ranged from 27 to 47. Respondents were mostly married (n = 124, 93.2%), working 21-39 hours per week (n = 67, 50.4%), and obtained a college diploma (n = 31, 23.3%) or a bachelor's degree (n = 60, 45.1%). Most families reported an annual household income between \$53 000 to \$105 999 CAD (n = 85, 64%), with 6.1% of respondents reporting an annual household income of over \$160 000 CAD. Most households had two (n = 91, 68.4%) or three (n = 27, 20.3%) adults at home who cared for children, with almost all the households having at least two adults caring for the child (n = 126, 94.7%). A full summary is provided in the Appendix (see Table D2).

**Table 2***Summary of Demographics – Parental and Household Characteristics*

Demographic Characteristic	<i>n</i>	%
<b>Parental Age</b>		
under 30	5	3.9
30 - 34	30	22.7
35 - 39	50	37.7
40 - 44	36	27.1
45 and over	12	9.1
<b>Parent Sex</b>		
Female	89	66.9
Male	44	33.1
<b>Hours worked per week</b>		
20 and under	6	4.6
21 - 39	67	50.4
40 or more	60	45.1
<b>Annual Family Income</b>		
\$20,000 - \$52,999	24	18.0
\$53,000 - \$105,999	85	64.0
\$106,000 - \$264,999	20	15.0
Over \$265,000	3	2.3
Prefer not to answer	1	0.8
<b>Highest Level of Education</b>		
Bachelor's degree or college diploma	91	68.4
Graduate degree or more	31	23.3
High school or some college	11	8.3
<b>Parental Marital Status</b>		
Married	124	93.2
Divorced or separated	5	3.8
Common-law and other	4	3.1
<b>Number of Care-taking Adults</b>		
1	7	5.3
2	91	68.4
3 or more	35	26.4

Parent Relationship to Child		
Biological Mother	84	63.2
Biological Father	43	32.3
Stepparent	4	3.1
Other	2	1.6

*Note. N = 133 for TI*

## Data analyses

### *Repeated measures ANOVA*

To address our first research question: “How did ADHD symptom severity change throughout the pandemic amongst children and adolescents in Canada?”, we conducted a within-subjects (3) ADHD symptom severity by (2) Time within-subject repeated-measures ANOVA. The time variable reflected data collected in Spring 2021 and Fall 2022. The outcome variable was the change in overall ADHD symptom severity in overall ADHD, ADHD-Hyperactivity/impulsivity, and ADHD-inattentiveness. This gave us an overview of the change in ADHD symptom severity throughout the pandemic.

### *Hierarchical regression*

To address our second research question: “How does a child's developmental stage at the onset of the pandemic impact ADHD symptom severity and trajectory?”, we conducted a hierarchical linear regression. We examined the impact of age and the interaction of age and initial symptoms on ADHD symptom severity change between Spring 2021 and Fall 2022. To do this, we controlled for the impact of initial symptom severity at T1 by entering initial symptoms as a controlled variable. Thus, our predictor variables were age and the interaction between age and initial symptoms. We added the interaction term to explicitly examine the moderation effect of a child's age on the relationship between time and ADHD symptom severity. In sum, we conducted three linear regressions to examine the changes in ADHD symptom severity, one for each presentation of ADHD.

### ***Assumptions***

**Sphericity.** Mauchly's test of sphericity was conducted to assess the sphericity assumption, and the Greenhouse-Geisser correction was applied.

**Normality.** To test whether residuals are normally distributed, we evaluated the Shapiro-Wilk test for each time point and level of ADHD symptom. Also, we conducted Q-Q plots to visually inspect deviations from normality. As the sample size is large (i.e.,  $n > 30$  per condition), we proceed with the repeated measures ANOVA.

**Independence.** The independence assumption was met across different participants in our within-subject design via our sampling method. Namely, only one child per family was able to participate in the study.

### ***Power analysis***

A power analysis was conducted using G\*Power 3.1. We conducted a two-tail test for mean differences between two dependent means, or matched pairs. We verified that our sample is sufficiently powered to detect a moderate effect size of  $r = 0.5$  ( $n = 133$ ).

## Results

### Repeated measures ANOVA

A 3x2 within-subject repeated measures ANOVA was conducted to evaluate the effects of ADHD presentations and time on changes in ADHD symptom severity. The main effect of time was highly significant,  $F(1, 132) = 333.548, p < .001$ , indicating statistically significant changes in ADHD symptom severity between the spring of 2021 and the fall of 2022 (see Figure D in the Appendix). However, the interaction effect between ADHD presentations and time was not significant,  $F(1, 132) = .407, p = .525$ , suggesting that changes in symptom severity did not differ significantly between the ADHD presentations.

The sphericity assumption was tested using Mauchly's test. The Greenhouse-Geisser correction was applied as the assumption of sphericity was violated for the ADHD factor and the interaction term. This means that the variance of differences between levels of these two factors was not equal. The Greenhouse-Geisser correction adjusts the degrees of freedom to reduce the risk of false positives (Type I Error). The corrected results showed significant effects for ADHD,  $F(1, 132) = 4.349, p = .039$ , and time,  $F(1, 132) = 333.548, p < .001$ , but not for the interaction,  $F(1, 132) = .407, p = .525$ . That is, while the factors of ADHD presentations and time both significantly influenced the changes in symptom severity, the effect of time did not differ based on ADHD presentation.

### Hierarchical linear regression

To explore the factors contributing to changes in ADHD symptoms, we conducted a hierarchical regression analysis. We controlled for ADHD symptom severity at T1 and explored the participants' initial age at T1 and the interaction between initial age and initial symptoms as predictor variables. Three separate regression models were conducted, one for each ADHD presentation of combined, hyperactive/impulsive, and inattentive.

The first model examined combined ADHD symptoms and yielded a significant result for the impact of initial symptoms on the amount of symptom change,  $R^2 = .504$ ,  $F(1,131) = 133.063$ ,  $p < .001$  (see Figure F1 in the Appendix). The addition of the child's initial age and the interaction term did not significantly improve the predictive power of the model,  $\Delta R^2 = .003$ ,  $F(1, 130) = .767$ ,  $p = .383$ . Similarly, for inattentive symptoms, initial symptoms significantly predicted changes in symptom severity,  $R^2 = .482$ ,  $F(1, 131) = 121.655$ ,  $p < .001$ . Adding initial age to the interaction term did not significantly improve the model's predictive power,  $\Delta R^2 = .007$ ,  $F(2,129) = .750$ ,  $p = .454$  (See Figure F2 in the Appendix). For hyperactive/impulsive symptoms, while initial symptoms significantly predicted changes in symptom severity,  $R^2 = .470$ ,  $F(1,131) = 116.229$ ,  $p < .001$ , adding initial age and the interaction term did not significantly enhance the model's predictive power,  $\Delta R^2 = .006$ ,  $F(2,129) = .772$ ,  $p = .464$  (see Figure F3 in the Appendix).

Scatterplots revealed that as initial ADHD symptom severity increased, the amount of symptom change from T1 and T3 decreased (see Figures F1-3 in the Appendix). That is, participants with fewer initial symptoms showed a greater increase in symptoms over time, and participants with the highest initial symptoms showed a decrease in symptom severity over time. However, data were scarce for participants with higher ADHD symptom scores (i.e., CASI scores  $> 9$ ). These trends were consistent across all three ADHD presentations (i.e., combined, hyperactive/impulsive, inattentive).

## Limitations

The demographics of our sample pose considerations for the interpretation and generalizability of our results (see Table D1 in the Appendix). Our sample is more educated than the Canadian average, with only 8.6% of parents reporting high school or some college education as their highest level of education achieved, compared to the national data of 32.9% (Government of Canada, 2022). Ethnically, our sample was predominantly white (n = 104, 78.2%), followed by Indigenous (n = 15, 11.3%). When compared with the Canadian population, both groups are over-represented, as approximately 69.8% of Canadians identify as white, while 5% identify as indigenous. Interestingly, most children in our study had at least two adults in the household (94.7%), with over one-fourth having three or more caretaking adults (n = 35, 26.4%). This may suggest more availability of adult support compared to the Canadian average. The high number of caretaking adults also suggests multigenerational homes and related cultural dynamics that differ from the prototypical Canadian family of Western-European descent. Such cultural practices are not captured by the demographic categories of our study, as Canadian households of Western-European heritage do not typically have three or more caretaking adults living together. In contrast, single-parent households were underrepresented (5.3%) compared to the national average of 19% (Statistics Canada, 2022). These factors should be considered when interpreting the findings, as will be explored in the Discussions.

Within Canada, pandemic response measures varied regionally, with Ontario having extended school closures. Quebec, uniquely among Canadian provinces, implemented a nearly six-month curfew. Meanwhile, Atlantic Canada created an "Atlantic Bubble" to allow intra-regional travel without quarantine, though movement was later restricted due to rising case numbers. Alberta and British Columbia initially adopted less stringent measures but reintroduced restrictions as cases surged. In our study, participants from Ontario (n = 45,

33.8%), British Columbia (n = 34, 25.6%), and Alberta (n = 21, 15.79%) composed most of our sample. This somewhat aligns with the Canadian demographic. However, the low representation from Quebec (n=5, 3.8%) contrasts with its large population as the second-most populous province, accounting for over 20% of the national population (Statistics Canada, 2022).

These differences in pandemic response measures likely led to differential experiences across regions and provinces. Such variability may limit the interpretability and generalizability of results across provinces. Accordingly, our results are more reflective of the provinces most represented in our sample and may be less applicable to other provinces or Canada as a whole. Future studies may explore provincial and regional impacts of differential pandemic response measures across Canada.

Though the recruitment methods were efficient and practical given the financial, time, and logistical constraints during the pandemic, it increased the likelihood of a selection bias. Namely, recruitment through ADHD-affiliated institutions, social media platforms, and self-referral likely favored participants with internet access and familiarity with ADHD resource networks, thus impacting the representativeness of the sample. While efforts were made to retain participants, the demanding nature of the pandemic may have affected participants' ability to remain engaged. Thus, attrition may overrepresent households that are more resilient and well-resourced. This is reflected in the distribution of initial ADHD symptom severity, where we observe a skew toward lower symptom severity. Future studies may consider strategies to address these constraints.

While genetic and biological factors play a significant role in ADHD, parental perceptions contribute significantly to diagnostic trends and symptom severity (Garcia-Argibay et al., 2024; Miklósi et al., 2024). For instance, Canadian researchers Swansburg and colleagues noted that 34% of parents reported a worsening of ADHD symptoms in their

children compared to pre-pandemic levels (2021). Thus, readers should consider the impact of parent-report measures to assess ADHD symptom severity. The study used the ADHD sub-scale of the CASI, a widely used and validated clinical measure, consisting of 8 items on a 4-point Likert scale for ADHD. Since ADHD is highly heterogeneous in its presentation with a high comorbid rate, a situationally based measure that assesses each ADHD symptom criterion in more than one setting both increases the validity of the assessment and widens the range of symptom severity. This would also lessen the likelihood that the symptoms reflect a change in parental perception of symptom severity, more so than a reliable change in symptom severity. However, although such longer-form, situationally based measures would more thoroughly assess ADHD symptoms and provide a more reliable rating, it is more costly in terms of training and time for the researchers and the participants. This poses a barrier to their implementation, especially in longitudinal studies, where retention is a concern.

Future studies may also explore the role of symptom management strategies in explaining the observed results. Studies may also attempt to replicate the results with a larger sample of participants from all age groups and a broader range of symptom severities. For our study, most participants were in late elementary or early middle school ( $m = 9.62$ ,  $SD = 3.05$ ) and of moderate symptom severity, with a mean around the clinical cut-off of ADHD CASI scores. A larger sample that is more evenly distributed across age and symptom severity may be better powered to detect lower effect sizes and explore whether pre-pandemic trends in hyperactive/impulsive symptoms persist.

## Discussion

Our study explored the changes in ADHD symptom severity during the COVID-10 pandemic, between the spring of 2021 and the fall of 2022, and arrived at several noteworthy findings. Per existing literature, an increase in symptom severity was observed across all three ADHD presentations (Auro et al., 2024). We also found a strong relationship between the severity of symptoms at the start and the amount of symptom change. Regardless of the ADHD presentation (i.e., whether hyperactive/impulsive, inattentive, or combined), those with the lowest symptom severity saw a worsening of symptoms over the year, while those with the highest symptom severity saw a slight decrease in symptoms over the same period. Those with the mildest symptoms at the start saw a greater change in symptoms than those with the most severe symptoms. In short, severity change was closely linked to initial symptom severity, but not with age.

The findings of this study highlight the complex relationship between ADHD symptom severity and the transition back to in-person learning following the COVID-19 pandemic. The timing of our study coincided with the reopening of schools across Canada. At the first data collection point in the spring of 2021, most elementary and secondary schools had returned or were in the process of returning to in-person schooling. By the second data collection point of Fall 2022, schools had resumed in-person learning for about one school year.

The results suggest that the return to in-person learning environments did not uniformly benefit students with ADHD. For those with lower symptom severity, the transition may have introduced new challenges, such as increased academic demands, social pressures, and reduced flexibility compared to remote learning. This may have been particularly difficult after months of remote learning and limited social contact with peers. Conversely, individuals with the most severe symptoms may have experienced a stabilization or slight

reduction in symptom severity due to the reintroduction of external supports, such as teacher supervision, routines, and specialized educational resources, which were less accessible in remote learning settings.

Our results are consistent with the growing literature on ADHD throughout the pandemic, which demonstrated divergent impacts of the pandemic on the mental health of children and adolescents (Cost et al., 2022). For example, a French epidemiological study explored the well-being of children and adolescents with ADHD during the COVID-19 lockdowns (Bobo et al., 2020). The study found that the mental health of about one-third of the participants deteriorated, one-third reported an improvement, and another one-third reported no change. That is, the pandemic may have been experienced differently for those with low and high ADHD symptoms. For instance, those with higher initial symptoms are more likely to have had more negative experiences associated with school, such as bullying, social and peer conflicts, and classroom challenges. For those with higher initial levels of ADHD, social distancing may have provided a more controlled and less stressful environment, thus leading to a reduction in symptoms during the pandemic (Cost et al., 2022). Accordingly, the transition back to in-person schooling may have added new sources of stress for some children. While speculative, returning to in-person classes may have helped some children stabilize their symptoms (i.e., whether that be through more school-based resources, fewer distractions, or more structure) while posing a significant challenge for others, after a prolonged period of remote and hybrid learning.

We did not find the ceiling effect or the floor effect to explain the observed trends in changes in symptom severity over time. The ceiling effect, whereby individuals with very high levels of initial symptom severity may have less room for further increase, was thought to partially explain the smaller amount of symptom severity change for participants with the highest initial symptoms. Likewise, the floor effect, where those with very low levels of

initial symptom severity may have no room for further decrease, was thought to explain the increase in symptom severity. However, the distribution of initial symptom severity was normally distributed and did not suggest a ceiling or floor effect.

Differences in symptom management strategies may partially explain the observed trends in symptom severity. One Canadian study observed that adolescent participants with poorer emotion regulation before the pandemic were at risk for experiencing a worsening of all mental health symptoms by the spring of 2020, which was especially true for participants with ADHD (Breux et al., 2021). While speculative, removing support structures and disruptions in routine during the lockdowns may have been more detrimental for those without robust support systems and symptom management outside the school system. Children and adolescents with higher initial levels of ADHD are more likely to have been diagnosed earlier and receive treatment and medication that extends outside school settings. Such strategies were likely implemented pre-pandemic. As a result, children and adolescents with higher initial symptoms of ADHD may have benefited from more reliable coping strategies during the pandemic compared to those with milder initial symptoms.

The absence of age-related differences in symptom changes aligns with prior research that suggests pandemic-related stressors affected individuals across all age groups similarly (Winfield et al., 2023). This further supports the view that the primary drivers of ADHD symptom change during the pandemic were likely environmental (e.g., changes in routine) rather than developmental factors. Further, our results suggest that pandemic-related environmental disruptions, including the return to in-person schooling, disproportionately affected those with mild ADHD symptoms while providing some stabilization for those with severe symptoms. These patterns underscore the importance of tailored support for individuals across the ADHD spectrum during and after the pandemic, and other periods of societal disruption.

Based on pre-pandemic literature, we expect to see a decrease in hyperactive/impulsive symptoms with increased age. Although we observed this trend in our sample, it did not reach statistical significance. This could suggest that our sample was insufficiently powered to detect this trend. Our sample's composition and the relatively short study period may have also hindered our ability to detect developmental trends in hyperactive/impulsive symptoms. However, it may be that the pandemic has slowed down the decrease in hyperactive/impulsive symptoms as children age (Achterberg et al., 2021). This has been observed in the literature but has yet to be confirmed for Canadian populations.

As mentioned in the Limitations section, our sample represented a higher socioeconomic background than the average Canadian household; we would expect a clinical ADHD sample — such as ours — to be slightly below the average. While results from Canadian data are limited (Espinete et al., 2022), research from the USA and Europe highlights the correlation between low-income households and higher ADHD symptom scores, underdiagnosis, and less access to treatment (Finkel, 2011; National Center for Health Statistics, 2024). Moreover, a review of cohort studies from six major WEIRD (i.e., Western, educated, industrialized, rich, democratic) countries found that children from households with higher incomes and maternal education were less likely to be diagnosed with ADHD by middle childhood (Spencer et al., 2022). Almost all the households in our study were married ( $n = 124$ , 93.2%) with at least two caretaking adults ( $n = 126$ , 94.8%). In contrast, children with ADHD have long been associated with higher divorce rates, though the relationship between the two is complex (Schermerhorn et al., 2012). Accordingly, we would expect the results of this study to be more exaggerated if replicated with a sample more representative of the Canadian average or a prototypical ADHD household.

## **Theoretical implications**

Our results pose several interesting considerations for how the life course theory of child development and the diathesis-stress model may be applied to understand changes in ADHD symptom severity. Solely focusing on the stressors induced by the pandemic may be insufficient to explain the results; protective factors and resiliency should also be considered.

Our results align well with the life course theory by illustrating that ADHD symptom trajectories are influenced by both individual characteristics (e.g., baseline severity) and environmental contexts (e.g., pandemic-related disruptions). Within the life course theory, the pandemic represents an abrupt and widespread macrocosmic shift with the potential to impact developmental trajectory in far-reaching ways. We saw this reflected in our results in the net increase of ADHD symptom severity across all three presentations, regardless of age, between the spring of 2021 and the fall of 2022. The theory also highlights the dynamic interactions between individual characteristics and environmental contexts over time, which were also reflected in our results. Namely, individuals with higher initial ADHD symptoms fared better than those with milder symptoms. This aligns with the theory's emphasis on how environmental stressors (e.g., school closures, lack of structure) can exacerbate vulnerabilities. Further, it aligns with the theory's focus on heterogeneity in developmental pathways.

However, the life course theory also holds that age, or the stage of development during which a disruptive event occurs, is an important factor in determining the impact of such events. We did not see age as a significant factor for changes in symptom severity in our sample (this may be because the study period was too short to capture age-related differences in symptom trajectories). Even so, our findings suggest that extreme stressors that span multiple facets of daily living, like the pandemic, may temporarily override typical age-related patterns in ADHD development. In other words, a child's developmental stage may be

less impactful than environmental factors in the case of the pandemic. Additionally, rather than pre-existing vulnerabilities (i.e., initial ADHD symptom severity), environmental factors may have played a greater role in determining the amount of symptom severity change during and post-pandemic. An environmental-based explanation, rather than a psychobiological lens that highlights individual susceptibilities, may be better suited to describe the widespread impact of the pandemic on ADHD symptom severity change (Carroll et al., 2021).

Similarly, from a diathesis-stress perspective, these results challenge traditional assumptions and provide nuanced insights into how the diathesis-stress model applies to ADHD during a global crisis. Although the model suggests that individuals with greater vulnerabilities (e.g., higher initial ADHD severity) are more susceptible to negative outcomes, the current findings indicate a more complex interaction. In our results, we saw that participants with lower initial symptoms saw the largest increase in symptom severity, while those with the highest initial symptoms saw a decrease. When we consider cumulative risk and protective factors, our results could be interpreted to suggest that the lack of healthy coping mechanisms and resources outside of the school system was more pertinent to the worsening of ADHD symptoms than baseline ADHD symptom severity. From our results, we suspect that children with milder symptoms may have been less equipped with coping mechanisms or interventions pre-pandemic and during the post-pandemic transition back to in-person schooling, making them more susceptible to environmental disruptions. Their ADHD symptoms may have been less actively managed before the pandemic. Thus, they may have faced greater disruptions during pandemic-related transitions, leading to greater symptom exacerbation. Conversely, those with severe symptoms may have already been equipped with interventions that mitigate further deterioration (Summerton et al., 2023). In other words, the absence of protective factors for individuals with milder ADHD symptoms

resulted in higher cumulative risk. Thus, our results suggest that protective factors are equally important when analyzing cumulative risk or vulnerability to chronic environmental stressors.

### **Practical Implications**

The results underscore the importance of tailored support for individuals across the ADHD spectrum during periods of heightened stress and societal disruption. Families, schools, and policymakers should prioritize interventions that maintain routine, predictability, and continued support for students with ADHD during times of crisis and transition back towards post-crisis routine. Providing effective and accessible mental health support that leverages community resources should be prioritized to mitigate ADHD symptom exacerbation. ADHD-related services by the school system should also be adapted for the home environment.

For schools, this may look like adapting individualized education plans for remote and hybrid learning and the transition back to in-person schooling. It may include psychoeducation for teachers on alternative learning strategies and evaluation models, such as breaking tasks into smaller steps and using positive reinforcement. Increased collaboration between families and schools for the common goal of instilling healthy coping mechanisms and creating consistent routines reduces the negative impact of social isolation measures and related disruptions on children and adolescents with ADHD. Next, policymakers should ensure schools develop contingency plans to maintain academic and behavioral support during and after widespread social crises. A portion of this plan should consider proactively developing symptom management and coping strategies for students with ADHD in the home setting and supporting adjustment back to in-person learning. By addressing these practical implications, policymakers, families, and schools can better support children with ADHD

during widespread societal disruptions, reducing the risk of long-term negative outcomes while fostering resilience across the ADHD spectrum.

## Conclusion

The COVID-19 pandemic introduced unprecedented disruptions to the lives of children and adolescents, with significant implications for the mental health of children and adolescents, especially those with ADHD. Our study explored changes in ADHD symptom severity, focusing on the period between the spring of 2021 and the fall of 2022, during a time marked by school closures, remote learning, and the subsequent transition back to in-person education. Consistent with existing literature, we observed a general increase in ADHD symptom severity across all three presentations (hyperactive/impulsive, inattentive, and combined). Notably, our findings revealed that individuals with milder symptoms at baseline experienced the greatest increases in severity over the study period, whereas those with more severe symptoms showed stability or even slight improvements in symptoms.

We began the study expecting to find age-specific vulnerabilities of children and adolescents with ADHD between the spring of 2021 and the fall of 2022. Our results suggest that initial symptom severity, rather than age, is a greater indicator of vulnerability for children and adolescents with ADHD. These findings challenge traditional assumptions about developmental transitions in ADHD and the importance of developmental stages when viewed from the life course theory. Further, the absence of age-related effects suggests that pandemic-related stressors may have been universally impactful across age groups, overriding developmental differences and typical age-related patterns.

Our study applied the life course theory of child development to the novel event of the COVID-19 pandemic. The results suggest that macro-level stressors disrupted typical developmental pathways, particularly for those with milder ADHD symptoms. Conversely, slight improvements in those with more severe ADHD symptoms may reflect the stabilizing influence of protective factors. The diathesis-stress model further supports our interpretations of how preexisting vulnerabilities interact with environmental stressors to influence symptom

trajectories. However, the results also pointed to the importance of protective factors, which are not emphasized in the model. Future research may explore the mechanisms underlying these trends and identify specific protective factors that mitigated the negative impacts of the pandemic and the post-pandemic return to in-person education.

Our findings also hold several practical implications. Understanding the impacts of the pandemic on children and adolescents with ADHD is crucial for developing effective interventions and support strategies. For instance, it may be worthwhile to focus resources on building coping strategies and home-based systems of support for children and adolescents with milder ADHD symptoms. Along these lines, the results may also assist in identifying at-risk families and children within Canada and beyond. Accordingly, with a better understanding of specific challenges posed by the COVID-19 pandemic response measures for children and adolescents with ADHD, policymakers, educators, and mental health professionals may be better equipped to prevent and mitigate the long-term negative impacts of pandemic-like events. Tailored preventative measures and interventions for families of children and adolescents with ADHD can extend past the school system to heighten the resiliency of these protective factors.

## References

- Achterberg, M., Dobbelaar, S., Boer, O. D., & Crone, E. A. (2021). Perceived stress as mediator for longitudinal effects of the COVID-19 lockdown on wellbeing of parents and children. *Scientific Reports*, *11*(1), Article 1. <https://doi.org/10.1038/s41598-021-81720-8>
- Aurini, J., & Davies, S. (2021). COVID-19 school closures and educational achievement gaps in Canada: Lessons from Ontario summer learning research. *Canadian Review of Sociology*, *58*(2), 165–185. <https://doi.org/10.1111/cars.12334>
- Auro, K., Holopainen, I., Perola, M., Havulinna, A. S., & Raevuori, A. (2024). *JAMA Network Open*, *7*(6), e2418204. <https://doi.org/10.1001/jamanetworkopen.2024.18204>
- Becker, S. P., Breaux, R., Cusick, C. N., Dvorsky, M. R., Marsh, N. P., Sciberras, E., & Langberg, J. M. (2020). Remote learning during COVID-19: Examining school practices, service continuation, and difficulties for adolescents with and without Attention-Deficit/Hyperactivity Disorder. *Journal of Adolescent Health*, *67*(6), 769–777. <https://doi.org/10.1016/j.jadohealth.2020.09.002>
- Benner, A. D., & Mistry, R. S. (2020). Child development during the COVID-19 pandemic through a Life Course Theory lens. *Child Development Perspectives*, *14*(4), 236–243. <https://doi.org/10.1111/cdep.12387>
- Bobo, E., Lin, L., Acquaviva, E., Caci, H., Franc, N., Gamon, L., Picot, M.-C., Pupier, F., Speranza, M., Falissard, B., & Purper-Ouakil, D. (2020). [How do children and adolescents with attention deficit hyperactivity disorder (ADHD) experience lockdown during the COVID-19 outbreak?]. *L'Encephale*, *46*(3S), S85–S92. <https://doi.org/10.1016/j.encep.2020.05.011>
- Breaux, R., Dvorsky, M. R., Marsh, N. P., Green, C. D., Cash, A. R., Shroff, D. M., Buchen, N., Langberg, J. M., & Becker, S. P. (2021). Prospective impact of COVID-19 on

- mental health functioning in adolescents with and without ADHD: Protective role of emotion regulation abilities. *Journal of Child Psychology and Psychiatry*, 62(9), 1132–1139. <https://doi.org/10.1111/jcpp.13382>
- Brooks, S. K., Webster, R. K., Smith, L. E., Woodland, L., Wessely, S., Greenberg, N., & Rubin, G. J. (2020). The psychological impact of quarantine and how to reduce it: Rapid review of the evidence. *The Lancet*, 395(10227), 912–920. [https://doi.org/10.1016/S0140-6736\(20\)30460-8](https://doi.org/10.1016/S0140-6736(20)30460-8)
- Browne, D. T., Wade, M., May, S. S., Maguire, N., Wise, D., Estey, K., & Frampton, P. (2021). Children’s mental health problems during the initial emergence of COVID-19. *Canadian Psychology / Psychologie Canadienne*, 62, 65–72. <https://doi.org/10.1037/cap0000273>
- Carroll, S. L., Shewark, E. A., Hyde, L. W., Klump, K. L., & Burt, S. A. (2021). Understanding the effects of the COVID-19 pandemic on youth psychopathology: Genotype–environment interplay. *Biological Psychiatry Global Open Science*, 1(4), 345–353. <https://doi.org/10.1016/j.bpsgos.2021.07.004>
- Cortese, S., Asherson, P., Sonuga-Barke, E., Banaschewski, T., Brandeis, D., Buitelaar, J., Coghill, D., Daley, D., Danckaerts, M., Dittmann, R. W., Doepfner, M., Ferrin, M., Hollis, C., Holtmann, M., Konofal, E., Lecendreux, M., Santosh, P., Rothenberger, A., Soutullo, C., ... Simonoff, E. (2020). ADHD management during the COVID-19 pandemic: Guidance from the European ADHD Guidelines Group. *Lancet Child Adolescent Health*, 4(6), Article 6.
- Cost, K. T., Crosbie, J., Anagnostou, E., Birken, C. S., Charach, A., Monga, S., Kelley, E., Nicolson, R., Maguire, J. L., Burton, C. L., Schachar, R. J., Arnold, P. D., & Korczyk, D. J. (2022). Mostly worse, occasionally better: Impact of COVID-19 pandemic on

- the mental health of Canadian children and adolescents. *European Child & Adolescent Psychiatry*, 31(4), 671–684. <https://doi.org/10.1007/s00787-021-01744-3>
- Dvorsky, M. R., Breaux, R., Cusick, C. N., Fredrick, J. W., Green, C., Steinberg, A., Langberg, J. M., Sciberras, E., & Becker, S. P. (2021). Coping with COVID-19: Longitudinal impact of the pandemic on adjustment and links with coping for adolescents with and without ADHD. *Research on Child and Adolescent Psychopathology*, 50(5), 605–619. <https://doi.org/10.1007/s10802-021-00857-2>
- El Jaouhari, M., Edjoc, R., Waddell, L., Houston, P., Atchessi, N., Striha, M., & Bonti-Ankomah, S. (2021). Impact of school closures and re-openings on COVID-19 transmission. *Canada Communicable Disease Report*, 47(12), 515–523. <https://doi.org/10.14745/ccdr.v47i12a02>
- Elder Jr., G. H. (1998). The life course as developmental theory. *Child Development*, 69(1), 1–12. <https://doi.org/10.1111/j.1467-8624.1998.tb06128.x>
- Espinet, S. D., Graziosi, G., Toplak, M. E., Hesson, J., & Minhas, P. (2022). A review of Canadian diagnosed ADHD prevalence and incidence estimates published in the past decade. *Brain Sciences*, 12(8), 1051. <https://doi.org/10.3390/brainsci12081051>
- Faraone, S. V., Biederman, J., & Mick, E. (2006). The age-dependent decline of attention deficit hyperactivity disorder: A meta-analysis of follow-up studies. *Psychological Medicine*, 36(2), 159–165. <https://doi.org/10.1017/S003329170500471X>
- Finkel, E. (2011). *Parental income, education and the diagnosis of ADHD in children and adolescents: The case for Germany* (SSRN Scholarly Paper No. 2006377). Social Science Research Network. <https://doi.org/10.2139/ssrn.2006377>
- Garcia-Argibay, M., Kuja-Halkola, R., Lundström, S., Lichtenstein, P., Cortese, S., & Larsson, H. (2024). Changes in parental attitudes toward attention-

- deficit/hyperactivity disorder impairment over time. *JCPP Advances*, 4(3), e12238.  
<https://doi.org/10.1002/jcv2.12238>
- Government of Canada, S. C. (2022, February 9). *2021 census of population—Canada*.  
<https://www12.statcan.gc.ca/census-recensement/2021/dp-pd/prof/index.cfm?Lang=E>
- Government of Canada, S. C. (2021, March 15). *School closures and COVID-19: Interactive tool*. <https://www150.statcan.gc.ca/n1/pub/71-607-x/71-607-x2021009-eng.htm>
- Government of Canada, S. C. (2022, February 9). *2021 census of population—Canada*.  
<https://www12.statcan.gc.ca/census-recensement/2021/dp-pd/prof/index.cfm?Lang=E>
- Hai, T., Swansburg, R., MacMaster, F. P., & Lemay, J.-F. (2021). Impact of COVID-19 on educational services in Canadian children with attention-deficit/hyperactivity disorder. *Frontiers in Education*, 6. <https://www.frontiersin.org/articles/10.3389/feduc.2021.614181>
- Hankin, B. L., & Abela, J. R. Z. (2005). *Development of psychopathology: A vulnerability-stress perspective*. SAGE Publications.
- Harris, A. N., Stoppelbein, L., Greening, L., Becker, S. P., Luebbe, A., & Fite, P. (2014). Child routines and parental adjustment as correlates of internalizing and externalizing symptoms in children diagnosed with ADHD. *Child Psychiatry & Human Development*, 45(2), 243–253. <https://doi.org/10.1007/s10578-013-0396-4>
- Hume, S., Brown, S. R., & Mahtani, K. R. (2023). School closures during COVID-19: An overview of systematic reviews. *BMJ Evidence-Based Medicine*, 28(3), 164–174.  
<https://doi.org/10.1136/bmjebm-2022-112085>
- Imran, N., Zeshan, M., & Pervaiz, Z. (2020). Mental health considerations for children & adolescents in COVID-19 pandemic. *Pakistan Journal of Medical Sciences*, 36(COVID19-S4), S67–S72. <https://doi.org/10.12669/pjms.36.COVID19-S4.2759>

- Katzman, M. A., Bilkey, T. S., Chokka, P. R., Fallu, A., & Klassen, L. J. (2017). Adult ADHD and comorbid disorders: Clinical implications of a dimensional approach. *BMC Psychiatry, 17*, 302. <https://doi.org/10.1186/s12888-017-1463-3>
- Korpa, T., Pappa, T., Chouliaras, G., Sfinari, A., Eleftheriades, A., Katsounas, M., Kanakagantenbein, C., & Pervanidou, P. (2021). Daily behaviors, worries and emotions in children and adolescents with ADHD and learning difficulties during the COVID-19 pandemic. *Children, 8*(11), Article 11. <https://doi.org/10.3390/children8110995>
- Lahey, B. B., Lee, S. S., Sibley, M. H., Applegate, B., Molina, B. S. G., & Pelham, W. E. (2016). Predictors of adolescent outcomes among 4–6-year-old children with attention-deficit hyperactivity disorder. *Journal of Abnormal Psychology, 125*(2), 168–181. <https://doi.org/10.1037/abn0000086>
- Livingstone, L. T., Coventry, W. L., Corley, R. P., Willcutt, E. G., Samuelsson, S., Olson, R. K., & Byrne, B. (2016). Does the environment have an enduring effect on ADHD? A longitudinal study of monozygotic twin differences in children. *Journal of Abnormal Child Psychology, 44*(8), 1487–1501. <https://doi.org/10.1007/s10802-016-0145-9>
- Mactavish, A., Mastronardi, C., Menna, R., Babb, K. A., Battaglia, M., Amstadter, A. B., & Rappaport, L. M. (2021). Children’s mental health in southwestern Ontario during summer 2020 of the COVID-19 pandemic. *Journal of the Canadian Academy of Child and Adolescent Psychiatry, 30*(3), 177–190.
- McKinney, A. A., Canu, W. H., & Schneider, H. G. (2013). Distinct ADHD symptom clusters differentially associated with personality traits. *Journal of Attention Disorders, 17*(4), 358–366. <https://doi.org/10.1177/1087054711430842>
- Meherali, S., Punjani, N., Louie-Poon, S., Abdul Rahim, K., Das, J. K., Salam, R. A., & Lassi, Z. S. (2021). Mental health of children and adolescents amidst COVID-19 and

- past pandemics: A rapid systematic review. *International Journal of Environmental Research and Public Health*, 18(7), Article 7. <https://doi.org/10.3390/ijerph18073432>
- Melegari, M. G., Giallonardo, M., Sacco, R., Marcucci, L., Orecchio, S., & Bruni, O. (2021). Identifying the impact of the confinement of Covid-19 on emotional-mood and behavioural dimensions in children and adolescents with attention deficit hyperactivity disorder (ADHD). *Psychiatry Research*, 296, 113692. <https://doi.org/10.1016/j.psychres.2020.113692>
- Miklósi, M., Kovács, B., Janovicz, J., Lelki, F., & Kassai, R. (2024). Adult attention-deficit/hyperactivity symptoms and parental cognitions: A meta-analysis. *Frontiers in Psychiatry*, 14. <https://doi.org/10.3389/fpsy.2023.1321078>
- National Center for Health Statistics. (2024). *Attention-Deficit/Hyperactivity Disorder in children ages 5–17 years: United States, 2020–2022*. <https://doi.org/10.15620/cdc/148043>
- National Institute of Mental Health. (2024). *Attention-Deficit/Hyperactivity Disorder: What you need to know*. <https://www.nimh.nih.gov/health/publications/attention-deficit-hyperactivity-disorder-what-you-need-to-know>
- Niina, A., Eyre, O., Wootton, R., Stergiakouli, E., Thapar, A., & Riglin, L. (2022). Exploring ADHD symptoms and associated impairment across development. *Journal of Attention Disorders*, 26(6), 822–830. <https://doi.org/10.1177/10870547211025612>
- Nonweiler, J., Rattray, F., Baulcomb, J., Happé, F., & Absoud, M. (2020). Prevalence and associated factors of emotional and behavioural difficulties during COVID-19 pandemic in children with neurodevelopmental disorders. *Children*, 7(9), Article 9. <https://doi.org/10.3390/children7090128>
- Patte, K. A., Battista, K., Ferro, M. A., Bélanger, R. E., Wade, T. J., Faulkner, G., Pickett, W., Riazi, N. A., Michaelson, V., Carsley, S., & Leatherdale, S. T. (2023). School

- learning modes during the COVID-19 response and pre- to during pandemic mental health changes in a prospective cohort of Canadian adolescents. *Social Psychiatry and Psychiatric Epidemiology*, 59(1), 137. <https://doi.org/10.1007/s00127-023-02557-2>
- Rogers, M. A., & MacLean, J. (2023). ADHD symptoms increased during the Covid-19 Pandemic: A meta-analysis. *Journal of Attention Disorders*, 27(8), 800–811. <https://doi.org/10.1177/10870547231158750>
- Salari, N., Ghasemi, H., Abdoli, N., Rahmani, A., Shiri, M. H., Hashemian, A. H., Akbari, H., & Mohammadi, M. (2023). The global prevalence of ADHD in children and adolescents: A systematic review and meta-analysis. *Italian Journal of Pediatrics*, 49(1), 48. <https://doi.org/10.1186/s13052-023-01456-1>
- Saulle, R., De Sario, M., Bena, A., Capra, P., Culasso, M., Davoli, M., De Lorenzo, A., Latke, L. S., Marra, M., Mitrova, Z., Paduano, S., Rabaglietti, E., Sartini, M., & Minozzi, S. (2022). School closures and mental health, wellbeing and health behaviours among children and adolescents during the second COVID-19 wave: A systematic review of the literature. *Epidemiologia E Prevenzione*, 46(5–6), 333–352. <https://doi.org/10.19191/EP22.5-6.A542.089>
- Schermerhorn, A. C., D’Onofrio, B. M., Slutske, W. S., Emery, R. E., Turkheimer, E., Harden, K. P., Heath, A. C., & Martin, N. G. (2012). Offspring ADHD as a risk factor for parental marital problems: Controls for genetic and environmental confounds. *Twin Research and Human Genetics*, 15(6), 700–713. <https://doi.org/10.1017/thg.2012.55>
- Settersten, R. A., Bernardi, L., Härkönen, J., Antonucci, T. C., Dykstra, P. A., Heckhausen, J., Kuh, D., Mayer, K. U., Moen, P., Mortimer, J. T., Mulder, C. H., Smeeding, T. M., van der Lippe, T., Hagestad, G. O., Kohli, M., Levy, R., Schoon, I., & Thomson, E.

- (2020). Understanding the effects of Covid-19 through a life course lens. *Advances in Life Course Research*, 45, 100360. <https://doi.org/10.1016/j.alcr.2020.100360>
- Sibley, M. H., Ortiz, M., Gaias, L. M., Reyes, R., Joshi, M., Alexander, D., & Graziano, P. (2021). Top problems of adolescents and young adults with ADHD during the COVID-19 pandemic. *Journal of Psychiatric Research*, 136, 190–197. <https://doi.org/10.1016/j.jpsychires.2021.02.009>
- Silk, T. J., Malpas, C. B., Beare, R., Efron, D., Anderson, V., Hazell, P., Jongeling, B., Nicholson, J. M., & Sciberras, E. (2019). A network analysis approach to ADHD symptoms: More than the sum of its parts. *PLoS One*, 14(1), e0211053. <https://doi.org/10.1371/journal.pone.0211053>
- Spencer, N. J., Ludvigsson, J., Bai, G., Gauvin, L., Clifford, S. A., Awad, Y. A., Goldhaber-Fiebert, J. D., Markham, W., Faresjö, Å., White, P. A., Raat, H., Jansen, P., Nikiema, B., Mensah, F. K., McGrath, J. J., & Group, E. C. (2022). Social gradients in ADHD by household income and maternal education exposure during early childhood: Findings from birth cohort studies across six countries. *PLOS ONE*, 17(3), e0264709. <https://doi.org/10.1371/journal.pone.0264709>
- Summerton, A., Bellows, S. T., Westrupp, E. M., Stokes, M. A., Coghill, D., Bellgrove, M. A., Hutchinson, D., Becker, S. P., Melvin, G., Quach, J., Efron, D., Stringaris, A., Middeldorp, C. M., Banaschewski, T., & Sciberras, E. (2023). Longitudinal associations between COVID-19 stress and the mental health of children with ADHD. *Journal of Attention Disorders*, 27(10), 1065–1074. <https://doi.org/10.1177/10870547231168334>
- Swansburg, R., Hai, T., MacMaster, F. P., & Lemay, J.-F. (2021). Impact of COVID-19 on lifestyle habits and mental health symptoms in children with attention-

- deficit/hyperactivity disorder in Canada. *Paediatrics & Child Health*, 26(5), e199–e207. <https://doi.org/10.1093/pch/pxab030>
- UNESCO. (2020). *Education: From school closure to recovery*. <https://www.unesco.org/en/covid-19/education-response>
- UNICEF. (2021). *COVID-19: Schools for more than 168 million children globally have been completely closed for almost a full year, says UNICEF*. <https://www.unicef.org/press-releases/schools-more-168-million-children-globally-have-been-completely-closed>
- Vaillancourt, T., Szatmari, P., Georgiades, K., & Krygsman, A. (2021). The impact of COVID-19 on the mental health of Canadian children and youth. *FACETS*, 6, 1628–1648. <https://doi.org/10.1139/facets-2021-0078>
- Walsh, S., Chowdhury, A., Braithwaite, V., Russell, S., Birch, J. M., Ward, J. L., Waddington, C., Brayne, C., Bonell, C., Viner, R. M., & Mytton, O. T. (2021). Do school closures and school reopenings affect community transmission of COVID-19? A systematic review of observational studies. *BMJ Open*, 11(8), e053371. <https://doi.org/10.1136/bmjopen-2021-053371>
- Welch, T. (2021, April 1). The pandemic and child and youth mental health. *Children's Mental Health Ontario - CMHO*. <https://cmho.org/pandemic-and-child-and-youth-mental-health/>
- Willcutt, E. G. (2012). The prevalence of DSM-IV attention-deficit/hyperactivity disorder: A meta-analytic review. *Neurotherapeutics*, 9(3), 490–499. <https://doi.org/10.1007/s13311-012-0135-8>
- Winfield, A., Sugar, C., & Fenesi, B. (2023). The impact of the COVID-19 pandemic on the mental health of families dealing with attention-deficit hyperactivity disorder. *PLOS ONE*, 18(3), e0283227. <https://doi.org/10.1371/journal.pone.0283227>

Wong, J. (2020, August 13). School starts in a month, but Canada's most populous province still doesn't know what that will look like. *CBC News*.

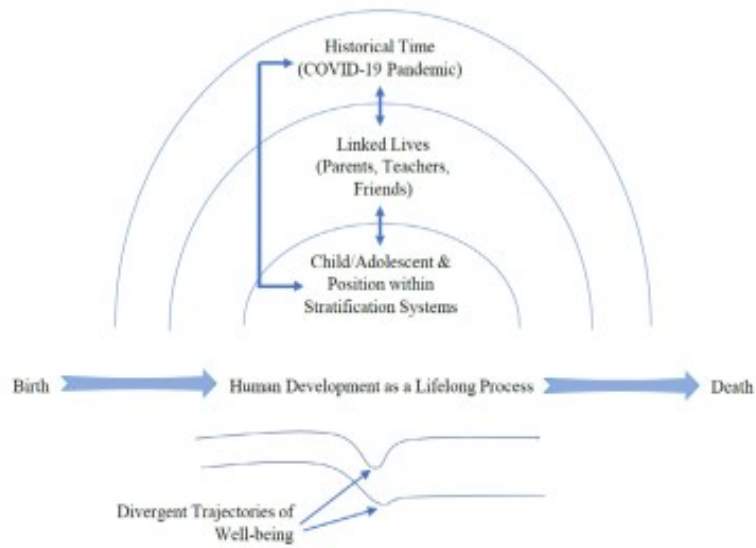
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## Appendix

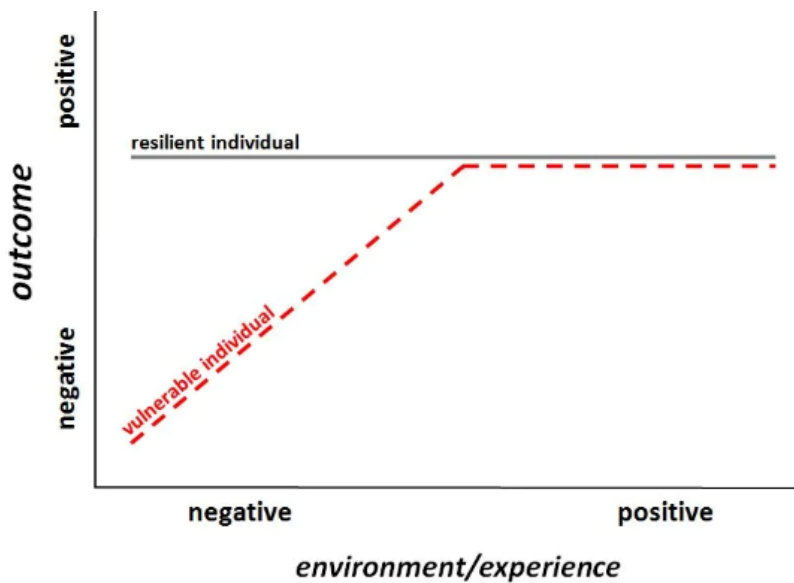
**Table A.** Summary of back-to-school COVID-19 measures across Canadian provinces and territories (as of Aug. 13, 2020)

	<b>Full-Time Classroom</b>	<b>Cohorts</b>	<b>Daily Self-Screening*</b>	<b>Mandatory Masks</b>	<b>Distancing</b>
<b>Alberta</b>	Yes (Gr. K-12)	Yes	Yes	Gr. 4-12	When possible. Use markings in hallways to guide traffic flow.
<b>British Columbia</b>	Yes (Gr. K-12)	Yes	Yes	No	Avoid physical contact. Maintain spacing between desks.
<b>Manitoba</b>	Yes (Gr. K-8)	Yes	Yes	Gr. 5-12 on school buses	Two metres when not within a cohort. Desks kept 1m apart.
<b>New Brunswick</b>	Yes (Gr. K-8)	Yes	Yes	Gr. 6-12 in common areas, hallways, & buses.	Gr. 9-12 One metre in class, common areas: two metres.
<b>Newfoundland &amp; Labrador</b>	Undecided	Undecided	Undecided	Undecided	Final back-to-school plan release delayed.
<b>Northwest Territories</b>	Yes (Gr. K-12)	Yes	Yes	No	1m between students in Gr. 7-12. K-6 do not need to distance within bubbles.
<b>Nova Scotia</b>	Yes (Gr. K-12)	Yes	Yes	In high school hallways, common areas, & on school buses.	Distancing of 2m encouraged. Desks to be distanced. Markings in hallways to aid flow.
<b>Nunavut</b>	Yes (Gr. K-12)	Yes	Yes	No	Avoid physical contact.
<b>Ontario</b>	Yes (Gr. K-8)	Yes	Yes	Gr. 4-12	Grades 9-12 at some schools.
<b>Prince Edward Island</b>	Yes (Gr. K-12)	Yes	Yes	Gr.5 and up in common areas. Optional in class.	Distance between cohorts. Desks to be distanced.
<b>Quebec</b>	Yes (Gr. K-9)	Yes	Yes	Gr.5 and up in common areas. Optional in class.	One metre between students in different groups. 2m between staff and students.
<b>Saskatchewan</b>	School divisions decide.	School divisions decide.	School divisions decide.	School divisions decide.	Minimize physical contact among younger students. Distance wherever possible.
<b>Yukon</b>	Yes (Gr. K-12)	Yes	Yes	No	Students and staff need to distance between groups. Hallway traffic will be managed.

*\*"Self-screening" refers to the responsibility of students and parents for daily symptom screening before heading to school. Adapted from CBC News. Retrieved from: [https://globalnews.ca/news/7321061/coronavirus-back-to-school-canada/?utm\\_source=chatgpt.com](https://globalnews.ca/news/7321061/coronavirus-back-to-school-canada/?utm_source=chatgpt.com)*



**Figure A.** Life course theory model. Applied to the impact of the COVID-19 pandemic on children and adolescents’ trajectories and well-being. Retrieved from Benner & Mistry, 2020.



**Figure B.** Diathesis stress model.

**Table B.** Items of the Child and Adolescent Symptom Inventory – Progress Monitor.

*Item<sup>a</sup>*

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1. Fails to give attention to details
2. Difficulty paying attention
3. Difficulty following instructions
4. Difficulty organizing tasks
5. Difficulty remaining seated
6. Difficulty doing things quietly
7. Is "on the go"
8. Difficulty awaiting turn
9. Defies what you tell them to do
10. Angry and resentful
11. Takes anger out on others
12. Deliberately annoys others
13. Argues with adults
14. Bullies, threatens, or intimidates
15. Starts physical fights
16. Destroys other's property
17. Acts restless or edgy
18. Irritable
19. Tense or unable to relax
20. Controlling worries
21. Worries parents will be hurt
22. Worries disaster will separate parents
23. Upset when separated from parents
24. Excessively shy
25. Cries, freezes, or withdraws from interacting
26. Depressed for most of the day
27. Little interest in pleasurable activities
28. Low energy level
29. How often do above interfere with school work or social activities?

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<sup>a</sup>Truncated version of item.

(Lavigne et al., 2009)

**Table C.** CASI-PM-P raw score cut-offs for non-clinical range.

Category	Preschool Age (3-5 Year)		Elementary School Age (6-12 Year)		Middle/Junior/ High School (12-18 Year)	
	Males	Females	Males	Females	Males	Females
ADHD: I	<6	<5	<6	<4	<6	<5
ADHD: HI	<6	<5	<5	<4	<3	<2

Adopted from CASI-PM Manual (Sprafkin et al., 2010)

**Table D1.** Detailed summary of demographics – child characteristics.

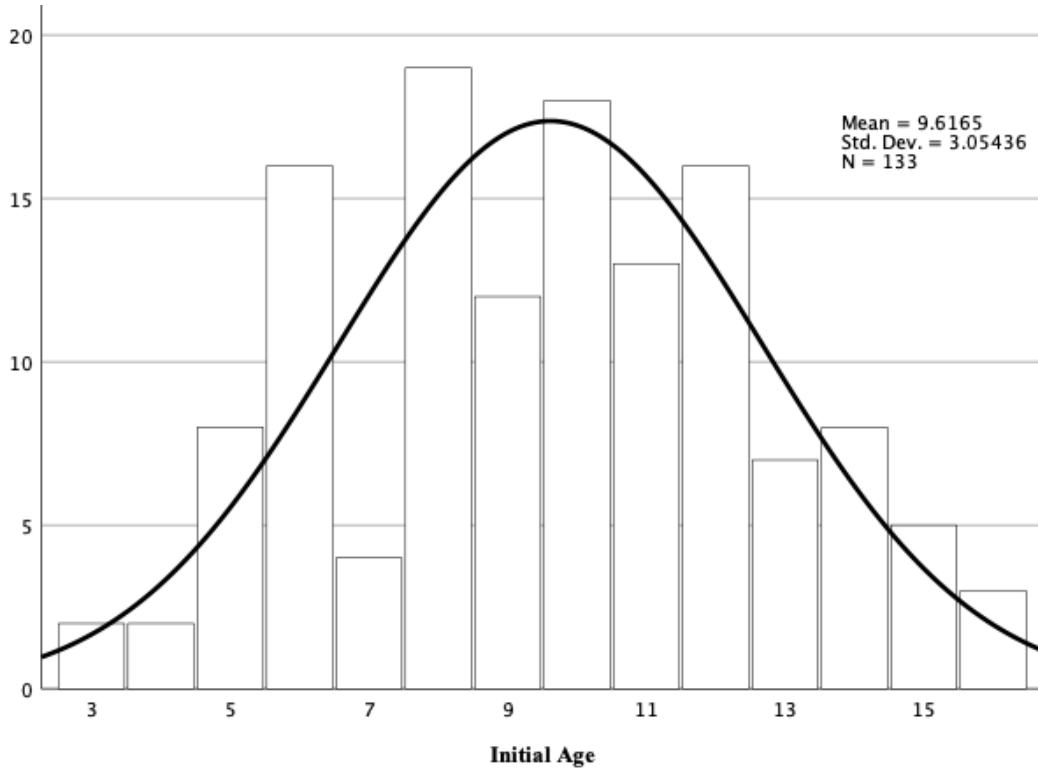
Demographic Characteristic	<i>n</i>	%
<b>Child Age (in years)</b>		
3	2	1.5
4	2	1.5
5	8	6
6	16	12
7	4	3
8	19	14.3
9	12	9
10	18	13.5
11	13	9.8
12	16	12
13	7	5.3
14	8	6
15	5	3.8
16	3	2.3
17	0	0
18	0	0
<b>Child Sex</b>		
Male	68	51.1
Female	65	48.9
<b>Child Ethnicity</b>		
White/Caucasian	104	78.2
Aboriginal/First Nations/Métis/Inuit	15	11.3
Black	4	3
Prefer not to answer	4	3
Missing	3	2.3
South Asian	1	0.8
Japanese	1	0.8
Multi-racial	1	0.8
Filipino	0	0
Latin American	0	0
<b>Diagnoses ADHD</b>		
Yes	115	86.5
No	18	13.5

Number of Diagnosed Co-Morbid Disorders		
0	7	5.3
1	38	28.6
2	60	45.1
3	16	12
4	10	7.5
5	1	0.8
6	1	0.8
Province/Territory		
Ontario	45	33.8
British Columbia	34	25.6
Alberta	21	15.8
Nova Scotia	8	6
Manitoba	5	3.8
Quebec	5	3.8
Northwest Territories	5	3.8
Newfoundland and Labrador	4	3
New Brunswick	2	1.5
Nunavut	2	1.5
Saskatchewan	1	0.8
Prince Edward Island	0	0
Missing	1	0.8
<i>Note. N = 133 for TI</i>		

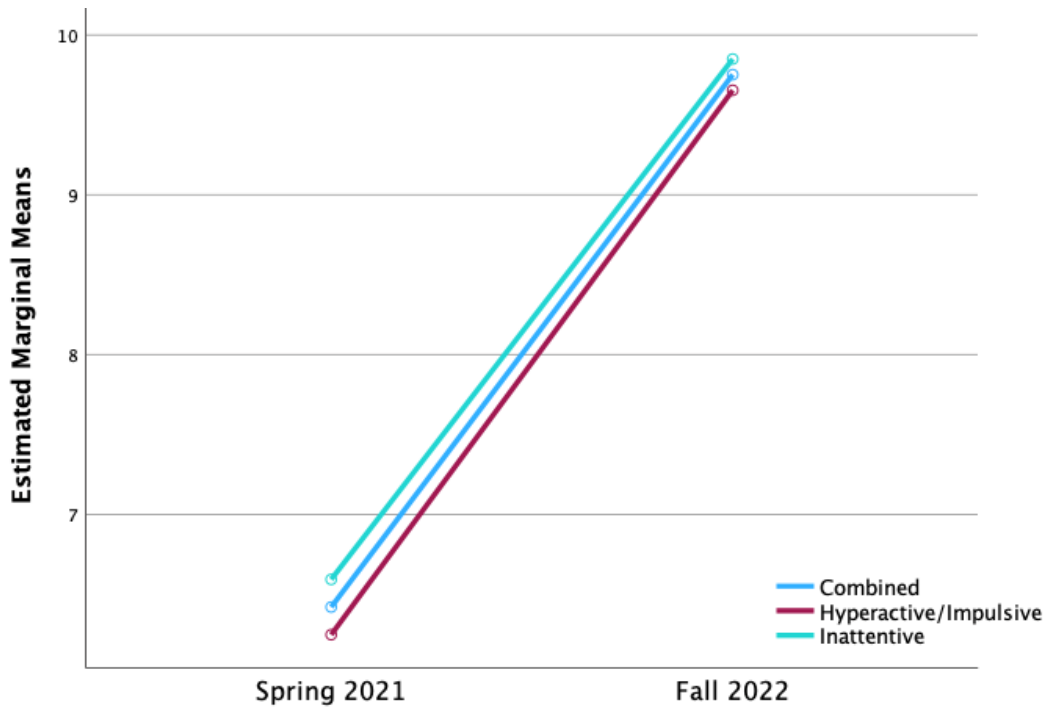
**Table D2.** Summary of demographics – parental and household characteristics.

Demographic Characteristic	n	%
<b>Parental Age</b>		
27	1	0.8
28	1	0.8
29	3	2.3
30	3	2.3
31	12	9
32	3	2.3
33	5	3.8
34	7	5.3
35	11	8.3
36	13	9.8
37	5	3.8
38	13	9.8
39	8	6
40	11	8.3
41	6	4.5
42	10	7.5
43	5	3.8
44	4	3
45	8	6
46	3	2.3
47	1	0.8
<b>Parent Sex</b>		
Female	89	66.9
Male	44	33.1
<b>Hours worked per week</b>		
0-5	1	0.8
6-20	5	3.8
21-39	67	50.4
40 or more	60	45.1
<b>Annual Family Income</b>		
\$20,000 - \$52,999	24	18.1
\$53,000 - \$105,999	85	64
\$106,000 - \$145,999	11	8.4
\$146,000 - \$264,999	9	3.8
Over \$265000	3	2.3
Prefer not to answer	1	0.8

<b>Household Highest Level of Education</b>		
Bachelor's degree	60	45.1
College Diploma	31	23.3
Master's degree	24	18
Some college	8	6
Some graduate work	5	3.8
High school or GED	3	2.3
Doctoral degree	2	1.5
<b>Parental Marital Status</b>		
Married	124	93.2
Separated	4	3
Living together as if married	3	2.3
Divorced	1	0.8
Prefer not to answer	1	0.8
Single, never married	0	0
<b>Number of Adults in the Home Who Care for the Children</b>		
1	7	5.3
2	91	68.4
3	27	20.3
4	3	2.3
5	4	3
6	1	0.8
<b>Parent Relationship to Child</b>		
Biological Mother	84	63.2
Biological Father	43	32.3
Stepfather	3	2.3
Stepmother	1	0.8
Adoptive Father	1	0.8
Other	1	0.8
Foster Mother	0	0
Foster Father	0	0
Adoptive Mother	0	0
Parent's Partner (living in household)	0	0
<i>Note. N = 133 for TI</i>		



**Figure C.** Age distribution of child and adolescent participants.



**Figure D.** ADHD symptom severity from Spring 2021 to Fall 2022 by symptom clusters.

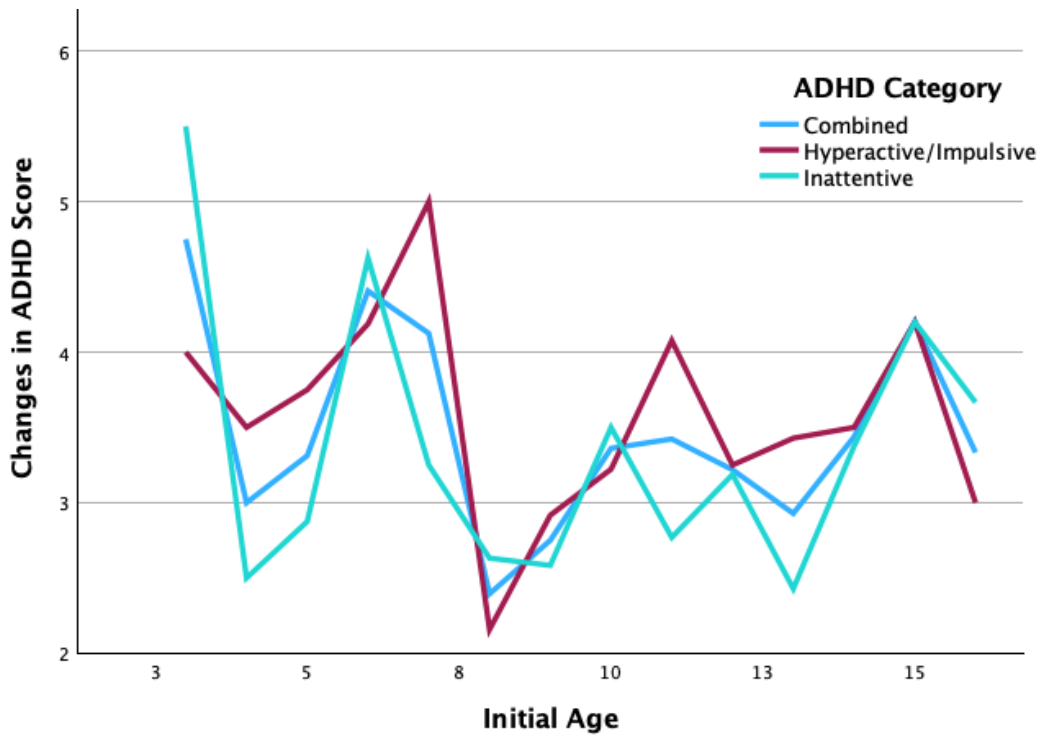


Figure E. Initial age vs. changes in symptoms.

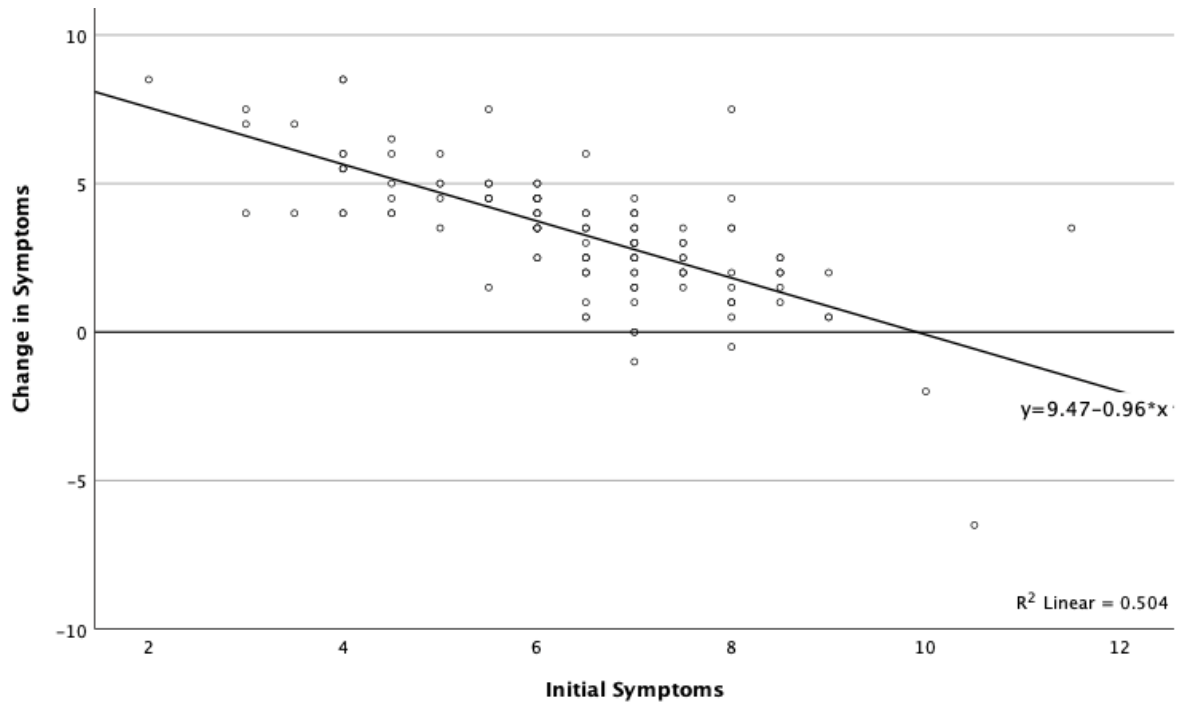
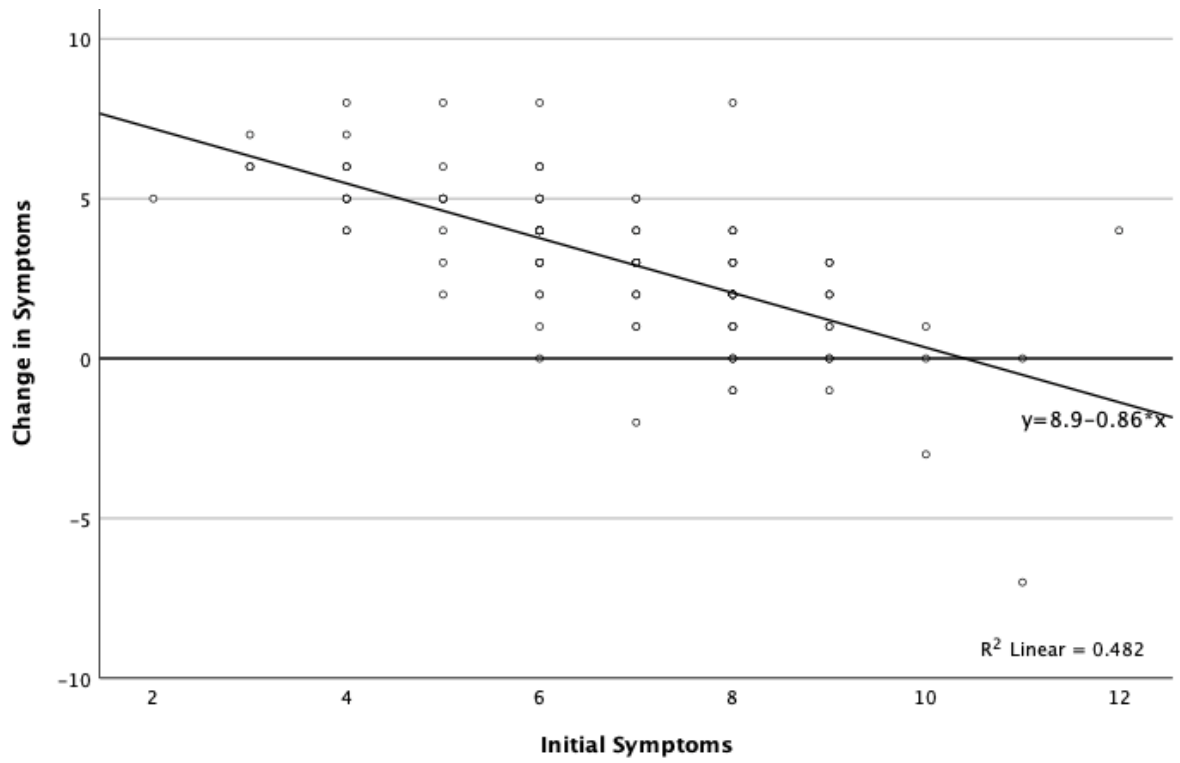
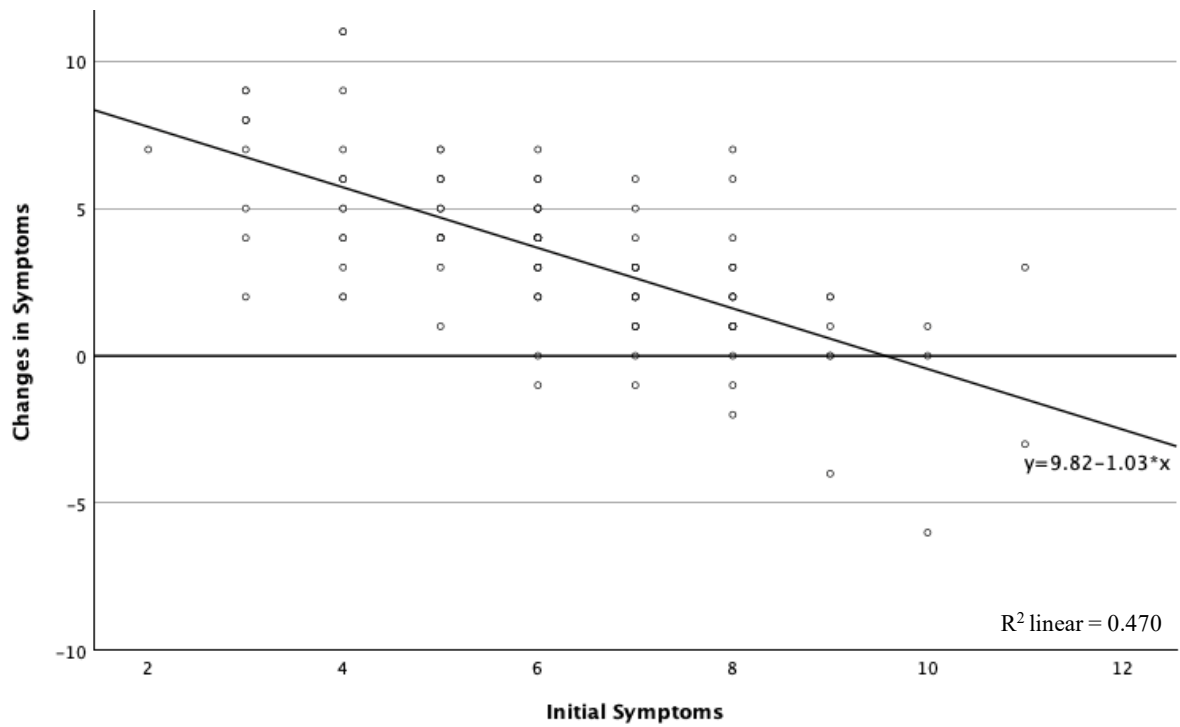


Figure F1. ADHD combined – initial symptoms vs. symptom change.



**Figure F2.** ADHD inattentive – initial symptoms vs. symptom change.



**Figure F3.** ADHD hyperactive/impulsive – initial symptoms vs. symptom change.