Psychological Distress and Mental Illness in Emerging Adults with Learning Disabilities

by

Samantha Leslie Chown

A thesis

presented to the University of Waterloo

in fulfilment of the

thesis requirement for the degree of

Master of Science

in

Public Health and Health Systems

Waterloo, Ontario, Canada, 2021

Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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

Abstract

Background: Individuals with learning disabilities (LDs) have an increased risk for mental illness. The association between LDs and mental illness varies across sex, age, and among those with co-morbidities. While LDs and the emerging adult developmental period are independent risk factors for mental illness, the association between LDs and mental illness in emerging adults is unclear. Therefore, the mental health of emerging adults with LDs is a public health concern worth further consideration.

Objectives: The purpose of this study was to 1) investigate psychological distress in emerging adults with LDs, 2) explore the clinical importance of the association between LDs and mental illness in emerging adults, and 3) examine the modification of age, sex, attention-deficit/hyperactivity disorder (ADHD), and disability impairment on the association between LDs and mental illness.

Methods: The current study utilized the 2012 Canadian Community Health Survey – Mental Health (n=25,113), which was a cross-sectional investigation of Canadians ≥15 years from the ten Canadian provinces. The study sample was composed of individuals aged 15-29 years (n =5630), with similar age and sex distributions. The exposure was self-reported diagnosis of an LD, and the outcome was Kessler Psychological Distress (K6) Scale scores. Multiple linear regression was used to examine the association between learning disabilities and continuous psychological distress scores, and logistic regression was used to examine the association between learning disabilities and binary K6 scores (scores <13 or ≥13). Moderation by age, sex, ADHD, and World Health Organization Disability Assessment Schedule (WHODAS) 2.0 scores was determined. Multicollinearity and model fit were evaluated. All analyses utilized survey weights.

Results: The weighted frequency of those with LDs was approximately 421 (7.5%). Emerging adults with LDs displayed a higher mean score (1.6 vs. 1.3) and had a greater proportion with scores greater than or equal to the cut-point of 13 (7.0% vs. 2.5%) compared to those without LDs. There was no concern for multicollinearity. After controlling for demographic, psychosocial, and health covariates, emerging adults with LDs (1) displayed higher log-transformed K6 scores (β=0.10, p=0.149, adjusted R^2=0.26), and (2) had a higher odds of K6 scores ≥13 [Odds Ratio (OR)=1.17, 95% CI=0.60-2.27] compared to those without LDs. However, the full linear and logistic regression models did not demonstrate statistical significance. Additionally, there was no statistically significant moderation in the adjusted linear regression between LDs and continuous K6 scores. However, males (OR=2.39, 95% CI=1.01-5.67) and those aged 15-19 years (OR=0.18, 95% CI=0.04-0.78) or 25-29 years (OR=3.87, 95% CI=1.05-14.30) had higher odds of K6 scores above the clinical cut-point. Stratification by ADHD-status and WHODAS 2.0 scores was not statistically significant.

Conclusion: The current epidemiological study confirmed that emerging adults with LDs had clinically important higher K6 scores and were more likely to have K6 scores at or above the cut-point compared to emerging adults without LDs. Additionally, age and sex were significant moderators in the association. The study findings suggest a need for improved awareness and resources in higher education and the workplace for emerging adults with learning disabilities.

Acknowledgments

Firstly, I would like to express endless thanks to my supervisor, Dr. Mark Ferro. I do not know where I would be without your support and faith in me. It truly was a privilege to work with you and learn from you, and I feel blessed to have had the opportunity to be under your wing. You were not just my supervisor, you are my mentor and friend, and I hope to be graced by more "dad jokes," coffee chats, and life advice in the future.

I would like to extend gratitude to my committee members, Dr. Dillon Browne and Dr. Scott Leatherdale, for their expertise and words of encouragement throughout the process. You truly helped make the intellectual vulnerability of research (writing and presenting) as undaunting as can be! Additionally, thank you to the members of the ARCH Lab for welcoming me into the lab so warmly and for providing their insightful feedback along the way.

Thank you to my friends within and outside of the University of Waterloo – you know who you are. All the laughs, tears, and hugs have been my fuel to keep going, especially when I had to make difficult decisions. I do not think I would have reached this point without you. Reminiscing on all the hugs in whatever part of the Health Sciences Complex we were in (seriously though, who really knows if we were in BMH or AHS?), the Grad House Open Mics and breaking it down to Skrillex, and the restaurant and brewery expeditions make me realize how fortunate I am to have such incredible people in my life. I love you guys.

To my family – (especially) Mom, Dad, Nicky, Tara, Megan, Becky, Katie, Hannah, Colleen, and Magda – thank you for checking in with me and cheering me on, even if you do not understand graduate school or what I have been doing for the past 2.5 years. You have been there with me when I was at my lowest points throughout my educational journey, and I am so appreciative of your love. A special thank you to my twin, Katie, for being a listening ear and voice of reason. Few people have the luxury of having a twin, much less one that is their best friend. I appreciate you and love you, wombmate and best mate.

My sincerest thanks to my partner, Adam, for his advice and patience. You pushed me to believe in myself, stand up for myself, and never stop seeking opportunities for growth. I am lucky to have you by my side, and I am so excited to take on my next adventure with you.

I am grateful to the faculty and staff at the School of Public Health and Health Systems for their kindness and wealth of knowledge, all the thoughtful chats, and for supporting my GSA advocacy work. A special shoutout to Carol for being my SPHHS mama!

Lastly, as a religious person, I am indebted to my faith community. I have found peace and strength in my most trying times, and I have always felt anchored. God is good all the time!

No one could have anticipated the challenge that this year would bring but going out into the world as a student of Public Health empowers me to continue sharing my passion and advocating for improvements wherever possible. In a peculiar way, I do not want to close this chapter of my life, but alas…

Dedication

To my Nagymama. Thank you for the unconditional love and support you gave me. There is not a day that goes by that I do not remember our conversations and Hungarian lessons when I got from school or before you went to sleep. I will continue to try my best to make you proud. Én nagyon szeretlek.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

ADHD	Attention-deficit/hyperactivity disorder
CCHS-MH	Canadian Community Health Survey – Mental Health
CI	Confidence interval
CNS	Central nervous system
DSM-IV	*Diagnostic and Statistical Manual of Mental Disorders*, 4th edition
DSM-5	*Diagnostic and Statistical Manual of Mental Disorders*, 5th edition
K6	Kessler Psychological Distress Scale
LD/LDs	Learning disability/disabilities
OR	Odds ratio
SPS	Social Provisions Scale
SE	Standard error
WHO-CIDI	World Health Organization Composite International Diagnostic Interview
WHODAS	World Health Organization Disability Assessment Schedule

1.0 Background

1.1 Historical Overview of Learning Disabilities

Throughout the 1800s in Europe, physicians and researchers recognized individuals with unique disabilities that were marked by unexpected challenges in speech, learning, and inattention (Hammill, 1993). The decades that followed saw interventions that were directed at modifying educational environments, many of which were conducted in the United States (Fletcher et al., 2007). However, it was not until 1963 that the term "learning disabilities" (LDs) was first coined by American psychologist Samuel Kirk (Fletcher et al., 2007; Kirk, 1963). His definition of LDs described children with impaired development in language, speech, reading, and communication skills that were not due to sensory deficits or intellectual disabilities (Kirk, 1963; Wicks-Nelson & Israel, 2013), which constitute another type of developmental disability marked by low intellectual and adaptive functioning (National Academies of Science, 2015; Parekh, 2017). Kirk's assertion incited policy changes that supported and protected individuals with LDs, especially with respect to their education (Fletcher et al., 2007). However, these policy changes identified a lack of consensus on a definition for LD. Consequently, various approaches to defining and operationalizing LDs have been used, often heavily informed by the Individuals with Disabilities Education Act (IDEA) – an educational policy developed by the United States federal government (Fletcher et al., 2007; Wicks-Nelson & Israel, 2013). Unlike what was seen in the United States, the Canadian federal government has not developed a definition for LDs, essentially leaving the onus on provincial administrations, who do not share a consistent definition (D'Intino, 2017). In the United Kingdom, there is no distinction between intellectual disabilities and learning disabilities, further complicating the challenges with identifying LDs. Arriving at a shared definition and operationalization across government policy, education, research, and clinical practice is a persistent challenge plaguing the field today.

1.2 Learning Disability Definition, Neurobiology, and Etiology

Alternatively termed "specific learning disorders" or "learning disorders," LDs are defined in the *Diagnostic and Statistical Manual of Mental Disorders*, 5th edition (DSM-5) as "difficulties in learning and using academic skills that have persisted for at least six months regardless of appropriate interventions" and are not related to other conditions, such as sensory deficits or intellectual disabilities (American Psychiatric Association, 2013). LDs in the DSM-5 fall under one disability with multiple manifestations, deviating from the *Diagnostic and Statistical Manual of Mental Disorders*, 4th edition (DSM-IV) in which there were four specific learning disorders – reading disorder, mathematics disorder, disorder of written expression, and learning disorder-not otherwise specified (Pennington & Peterson, 2015). Impaired skills still relate to reading, writing, and mathematics, contributing to the respective common LD types: dyslexia, dysgraphia, and dyscalculia (Pennington & Peterson, 2015).

Many studies have found that individuals with LDs display atypical brain anatomy and physiology, impacting grey and white matter in various brain regions. Postmortem and imaging studies in individuals with reading and language impairments have shown abnormalities in the left hemisphere of the brain. The planum temporale, the core of Wernicke's area (the main language centre in the brain), is a commonly implicated region that shows atypical hemispheric symmetry (Eliez et al., 2000; Hynd et al., 1991). Additionally, the inferior frontal gyrus, fusiform gyrus, and the temporoparietal cortex have been associated with reading disorder (Ashkenazi et al., 2013; Eliez et al., 2000; Hynd et al., 1991; Pennington & Peterson, 2015). In those with mathematics disorder, impacted areas include bilateral parietooccipital areas, and more

specifically decreased grey matter in the right intraparietal sulcus, left inferior frontal gyrus, bilateral middle frontal gyrus, and anterior cingulate cortex, as well as decreased white matter in the right parahippocampal gyrus (Rotzer et al., 2008). Although studies on brain structure have been impacted by heterogeneous methodology, functional brain imaging studies have shown altered activation in the frontal, occipital, and temporal regions compared to non-LD controls (S. E. Shaywitz & Shaywitz, 2001). In a positron emission tomography study, individuals with dyslexia had less activation in the right hemisphere (McCrory et al., 2000). On the contrary, another study showed that left hemisphere brain regions responsible for phonological processing, letter-sound conversion, and whole word recognition have shown underactivation, while right hemisphere regions have shown overactivation (Pennington & Peterson, 2015). In those with mathematics disorder, the left inferior parietal region has been associated, with decreased activation in the intraparietal sulcus, ventral occipitotemporal cortex, superior parietal lobule, and prefrontal cortex (Ashkenazi et al., 2013). Nevertheless, less is known about brain activation in those with mathematics disorder relative to those with reading disorder.

Considering the abnormalities found in brain structure and function, decades of research assert that LDs are caused by central nervous system (CNS) dysfunction as a result of (1) genetic or hereditary influences, (2) biochemical abnormalities, (3) insult or injury to the CNS, and (4) environmental influences (Hammill et al., 1987; Margai & Henry, 2003; Stanton-Chapman et al., 2001). Today, LDs are considered a neurodevelopmental disorder (Ontario Psychological Association, 2018), and risk factors continue to be investigated.

1.2.1 Non-Modifiable Risk Factors

With scientific advancement, genetics have been shown to exert a role in the development of LDs. In fact, 23-65% of children with dyslexia have a parent with dyslexia (S. E. Shaywitz & Shaywitz, 2001). In those with a family history, the mean prevalence of dyslexia was 45% [95% CI (39%, 51.2%), I^2 = 36.5%, Tau^2 = 0.08] (Snowling & Melby-Lervag, 2016), and the mean prevalence of dyscalculia was 40-64% (Shalev et al., 2001). Additionally, twin studies of spoken or written language disorders have demonstrated a pooled concordance rate of 79.9% for monozygotic twins and 46.2% for dizygotic twins, indicating that shared genetics play an important role in LDs (Stromswold, 2001). Furthermore, LDs have been associated with various genetic loci and candidate genes, although dependent on the type and presentation (Fletcher & Grigorenko, 2017; Stromswold, 2001). In reading disorder, four commonly identified loci are DYX1 on chromosome 15q, DYX2 on 6p, DYX5 on 3p, and DYX on 18p; the DYX loci has led to the discovery of four candidate genes for dyslexia, which include *DYX1C1*, *DCDC2*, *KIAA0319*, and *ROBO1* (Becker et al., 2017; Gibson & Gruen, 2008). While it should be noted that most studies identifying a genetic mechanism for LD focus on dyslexia (the most common LD), there is clear evidence from familial, twin, and genetic studies that LDs have a strong genetic component, which has implications for early detection (Pennington & Peterson, 2015).

There are sex-based differences in LD prevalence, with an approximate 2.4:1 ratio of males to females (Stanton-Chapman et al., 2001). However, males present more frequently with symptoms that are disruptive to educators and therefore have higher referral rates to special education services (Cortiella & Horowitz, 2014), which may explain prevalence differences across sex. Consequently, the prevalence of females with LDs may be underestimated and fewer females may receive the adequate treatment needed (Cortiella & Horowitz, 2014). There are sex-based differences in neurobiological activation; females had bilateral activation during phonological processing, whereas males had lateralized activation in the left inferior frontal

regions (B. A. Shaywitz et al., 1995). Sex-based differences in LD type have also been suggested, with a higher prevalence of spelling or combined spelling and reading deficits in males, and a higher prevalence of isolated and combined mathematics deficits in females (Moll et al., 2014), although this finding is inconsistent (Görker, 2019). Taken together, the research identifies preliminary sex-based differences in the neurobiological processes, symptomatic presentation, and prevalence rates of LDs.

1.2.2 Modifiable Risk Factors

Acquired insult or injury to the CNS may lead to LDs. Individual-level risk for LDs has been associated with very low birth weight, low five-min Apgar score [a score denoting the newborn's status with respect to colour, heart rate, reflexes, muscle tone, and respiration (Watterberg et al., 2015)], as well as late or no prenatal care, premature birth, and maternal drug, tobacco, or alcohol use during pregnancy (National Institute for Learning Development Canada, n.d.; Stanton-Chapman et al., 2001). Environmental contaminants have also been associated with CNS dysfunction related to LDs. In a study that mapped the prevalence of LD cases by neighbourhood, higher prevalence of LDs were found in areas that had more environmental pollution (i.e., lead toxicity, air pollution from factories, etc.) (Margai & Henry, 2003). Other environmental factors implicated in LDs are single-parent homes, low parental educational attainment, poor nutrition, and overcrowding; although these factors are not causes, but are rather connected to the aforementioned pre- and post-natal risk factors (Margai & Henry, 2003; Stanton-Chapman et al., 2001). Further, supportive and enriching environments, such as responsive parenting, positively influence learning, academic, and social success (Madigan et al., n.d.; Robledo-Ramón & García-Sánchez, 2012; Sahu et al., 2018). It must be noted that LDs are present in all ethnicities and socioeconomic statuses, and thus are *not* caused by these factors (Hayes et al., 2018; Ontario Psychological Association, 2018). Convincingly, LDs appear to be connected to pre- and post-natal damage to the CNS.

1.3 Symptoms, Diagnosis, and Treatment

LD presentation is diverse depending on the type(s) of LD, which result from the cognitive processes that are implicated (Hayes et al., 2018). As such, there is no defined group of symptoms that characterize LDs (Pratt & Patel, 2007), but typical signs include poor memory, inability to distinguish different letters, numerals, or sounds, and difficulty following direction (Hayes et al., 2018). Symptoms of LDs usually present in school-aged children as academic deficits, such as in word recognition, fluency [i.e., "the ability to read connected text rapidly, smoothly, effortlessly, and automatically with little conscious attention to decoding" (Meyer & Felton, 1999)], reading comprehension, and computation (Fletcher et al., 2007). Specific characteristics of LDs often vary by age, involving more complex academic skills over time (Hayes et al., 2018), as well as by sex, where males more commonly present with externalizing symptoms (Willcutt & Pennington, 2000).

Diagnostic criteria for LDs have evolved with advancements in LD research. Previously, a discrepancy between academic achievement and intellectual potential was an important diagnostic consideration, but this approach has since been discredited for various reasons, including measurement errors and biased assessment of those who are low-income or culturally/linguistically diverse (Hayes et al., 2018; Ontario Psychological Association, 2018; Wicks-Nelson & Israel, 2013). Notably, LDs do not impact intelligence, as would occur in intellectual disabilities (American Psychiatric Association, 2013). The DSM-5 criteria for an LD diagnosis is predicated on at least one deficit in reading, written expression, or mathematical

reasoning that has persisted for at least six months irrespective of intervention (American Psychiatric Association, 2013; Wicks-Nelson & Israel, 2013). However, there continues to be variability in LD assessment. In an attempt to ensure consistency, the Consensus Statement by the Ontario Psychological Association identified that an LD diagnosis is made if *all* of the following criteria are met: (1) history of below age-level academic function or significant support in maintaining academic functioning, (2) below-average academic achievement in at least one aspect of reading, writing, or mathematics, (3) evidence that difficulties are due to psychological processes, (4) a minimum of average skills needed for thinking and reasoning, and (5) evidence that the difficulties cannot be due primarily to other conditions/disorders (i.e., hearing or visual impairments), cultural/linguistic diversity, lack of motivation or effort, or poor environment (i.e., inadequate education, psychosocial adversity) (Ontario Psychological Association, 2018). Diagnosis may be challenging as LDs may co-occur across LD types and are often comorbid with attention-deficit/hyperactivity disorder (ADHD) or developmental language disorders (Ontario Psychological Association, 2018; Pratt & Patel, 2007; Willcutt et al., 2019). The evaluation of an LD is quite extensive and multifaceted, incorporating standardized achievement and cognitive measures and a clinical assessment that accounts for the medical, familial, and educational history of an individual (American Psychiatric Association, 2013). Additionally, cultural/linguistic diversity is an important consideration in LD assessments, such as using an individual's first language or establishing whether errors in symbols, terminology, and procedures are due to education from a different country (Ontario Psychological Association, 2018). Ultimately, through differential diagnosis, presence of an LD and the affected academic domains would be determined to inform treatment.

Current treatment for LDs is highly individualized and is developed with collaboration from parents, educators, and medical professionals. Treatment changes with age, transitioning from a focus on remediation – when there is more brain plasticity (Pratt & Patel, 2007) – to a focus on compensation and lifestyle adjustments (Lagae, 2008). It has been shown that treatment is more effective at younger ages (Suggate, 2010); thus, early diagnosis is essential for better treatment outcomes (Fletcher & Grigorenko, 2017). The most effective interventions are explicit, differentiated according to academic domain, and of appropriate intensity with respect to LD severity (Fletcher & Grigorenko, 2017). Yet, most intervention studies pertain to dyslexia, resulting in a lack of substantial evidence for other LDs (Pennington & Peterson, 2015). Diverse treatment needs contribute to a lack of standardized accommodation practices, which are further complicated by the provincial jurisdiction of education in Canada (D'Intino, 2017). Although there are various treatments with different degrees of effectiveness, it is important to note that LDs persist throughout life (Fletcher et al., 2007).

1.4 Public Health Impact

Due to challenges in defining and diagnosing LDs, prevalence estimates vary (Hayes et al., 2018). Studies have reported a prevalence ranging from 4-9% for reading deficits and 3-7% for mathematics deficits (American Psychiatric Association, 2013). In the 2017 Canadian Survey on Disability, approximately 4% of Canadians 15 years of age or older had a learning-related disability, with a slightly higher prevalence of 6% among those aged 15 to 24 years (Morris et al., 2018). The same survey found that 77% of youth with disabilities had mental health-related disabilities and/or LDs (Easter Seals, 2019). Generally, living with a disability has negative implications for education, employment and income (Easter Seals, 2019). There was a 3.5-fold higher odds of not completing secondary school in those with reading difficulties relative to the control group (Smart et al., 2017), and 87% of youth with disabilities who were not in school or

employed had a mental health-related disability, an LD, or both (Easter Seals, 2019). Consequently, there are substantial economic implications. The majority of LD costs (61.4%) fall on individuals with LDs and their families, with the rest falling on public programs and private sector insurers (Crawford, 2007). Research into the direct and indirect costs of LDs found that the simple incremental cost (i.e., the differences in the direct/indirect costs of those with and without LDs) from birth to retirement was approximately $3.08 trillion, which was about $1.982 million per person (Crawford, 2007). The same report found that the "present value" (i.e., the value that a future sum of money is worth now) in year 2000 dollars totaled $707 billion, which was about $455,208 per person (Crawford, 2007). While the estimates of those living with LDs are influenced by changing definitions, it is clear that LDs have significant health and economic implications.

2.0 Learning Disabilities and Mental Health

2.1 Overview

Learning disabilities impact individuals in a variety of ways, including academically, socially, and emotionally. A plethora of studies have found an increased risk of mental illness, such as stress, anxiety, depression, and suicide in those with LDs (Francis et al., 2019). Moreover, those with LDs had a 2.6 times greater odds of reporting self-assessed poor or fair mental health and a 3.3 times greater odds of seeing a professional for mental health reasons (Wilson et al., 2009). The mechanisms operating in the association between LDs and psychopathology are complex and multilevel, implicating genetic, neurophysiological, psychological, and environmental factors.

A recent review of this association asserted the combination of genetic and environmental factors (Hendren et al., 2018). Still, the effect of a shared cognitive correlate was unclear, highlighting the need for greater inquiry into overlapping genetic etiologies (Hendren et al., 2018). More well-founded, however, are the impacts of psychological and environmental factors on those with LDs, which may result in psychiatric comorbidity (Bonifacci et al., 2016; Hendren et al., 2018). One such consideration in the development of psychiatric disorders for individuals with LDs is socioemotional maladjustment (Haft, Chen, et al., 2019). Individuals with LDs have displayed greater impairment on scores of clinical maladjustment and emotional symptoms compared to those without LDs (Martínez & Semrud-Clikeman, 2004), which relates to previous literature regarding challenges with social skills, such as poor ability to recognize social cues (Thaler et al., 2010). A study on college students with LDs, ADHD, and combined LD/ADHD found that they rated themselves lower in academics and psychosocial status (i.e., popularity, social self-confidence) and also reported more school disengagement, substance use, and emotional difficulties (i.e., felt overwhelmed, depressed) compared to their peers without disabilities (DuPaul et al., 2017). These challenges are further complicated by school failure and bullying, which have been associated with anxiety and depression (Baumeister et al., 2008; Carroll & Iles, 2006; Willcutt & Pennington, 2000).

With consideration of the risk/resiliency framework discussed in Morrison et al. (1997), resilience plays a role in the correlation between disease burden and mental health (Mannino, 2015; Morrison & Cosden, 1997). For instance, self-esteem and self-understanding were shown to be protective for emotional adjustment, and self-esteem has been shown to account for 23% of the variation in depression risk in those with LDs (Phetcharat et al., 2012). As resilience is influenced by external factors, such as familial stress during childhood or adolescence (Valdez et al., 2013), it becomes increasingly clear that social support by family, friends, and other care providers is critical for the mental health of emerging adults with disabilities (Raskind et al., 1999).

2.1.1 Depression

Depression has been associated with LDs across various age groups, especially for children and adolescents in school settings. In a meta-analysis on depression scores in students with LDs, there was a significant positive relationship [d = 0.35, 95% CI (0.27, 0.43)] when compared to students without LDs; however, there was significant heterogeneity across studies (Maag & Reid, 2006). Children with reading disorder also had higher depressive symptom scores compared to those with nonverbal LDs and typical development (Mammarella et al., 2016). In a nationally representative study of adolescents, LDs were associated with emotional distress [odds ratio (OR) = 1.89] and suicide attempts (OR = 1.67) (Svetaz et al., 2000). A later study on Canadian adolescents and adults had similar findings with a 2.8, 2.4, and 2.9-fold odds of

reporting high distress, depressive episodes, and suicidal thoughts, respectively, compared to those without LDs (Wilson et al., 2009). The positive association between LDs and depression was maintained in adulthood when compared to adults without LDs (d = 0.27, p<0.001) (Klassen et al., 2013).

2.1.2 Anxiety

Many studies have shown an association between LDs and anxiety. A meta-analysis of anxious symptomatology in kindergarten to grade 12 students found a statistically significant positive relationship (d = 0.61), although there was considerable heterogeneity and the potential for publication bias (I^2 = 81.79%) (Nelson & Harwood, 2011). The association was not supported in a study on general anxiety scores in youth with LDs and/or ADHD when compared to those without (Haft, Chen, et al., 2019). However, the subtype of anxiety may be related to the type of LD as a study on specific anxiety scores found that symptoms of the social anxiety subtype were higher in children with reading disorder and nonverbal LD compared to children with typical development, while children with nonverbal LD scored higher in the separation anxiety and school anxiety subtypes compared to the groups with reading disorder and typical development (Mammarella et al., 2016). Nevertheless, a study on adolescents and adults founds that those with LDs had a 2.4-fold odds of reporting anxiety disorders compared to those without LDs (Wilson et al., 2009). The positive association was maintained in adulthood, as found in a meta-analysis of adults with LDs, which found a significantly higher amount had anxiety compared to those without LDs (d = 0.43, p<0.001) (Klassen et al., 2013).

2.1.3 Comorbid Learning Disabilities and Mental Illness

The mental health of those with LDs may be related to whether they have an isolated LD or a combination of LDs. In a study on emotional adjustment and school functioning in adolescents with one or multiple LDs, those with multiple LDs demonstrated significantly higher scores on measures of clinical maladjustment, emotional symptoms index, school maladjustment, attitude to school, and sense of inadequacy, as well as poorer scores on clinical scales of depression and atypicality compared to those who were typically achieving; there were no significant differences compared to those with a single LD (Martínez & Semrud-Clikeman, 2004). Another study found that a higher percentage of individuals with reading disorder, mathematics disorder, or combined were more likely to have conduct disorder; those with combined disorders had a higher rate of depression; and those with mathematics disorder were more likely to be associated with substance use (Willcutt et al., 2019). Moreover, those with combined reading disorder and mathematics disorder had a higher rate of depression, while those with mathematics disorder were more likely to display alcohol misuse or cannabis use (Willcutt et al., 2019). The association between LDs and mental illness was further supported in a recent study (Visser et al., 2020).

Students with LDs and ADHD represent the largest proportion of students with disabilities (Gregg, 2009). In those with reading disorder, there was a higher likelihood of meeting diagnostic criteria for ADHD (Willcutt & Pennington, 2000). Additionally, the associations between reading disorder and oppositional disorder, conduct disorder, and aggression were mediated by ADHD (Willcutt & Pennington, 2000) Although there was a significant association between reading disorder and anxiety and depression symptoms when controlling for ADHD (Willcutt & Pennington, 2000; Wilson et al., 2009), it must be noted that comorbid LDs and ADHD resulted in greater odds of poor mental health outcomes when compared to those with LDs alone (Wilson et al., 2009). However, there was not a significant difference in anxiety or

depression between college students with dyslexia, ADHD, or comorbid dyslexia/ADHD compared to each other or to those without either condition (Nelson & Gregg, 2012).

Substance use disorders are also prevalent in individuals with LDs. In a study on adolescents, those with LDs were at an increased risk for substance use disorders compared to those without (Beitchman et al., 2001). However, when the substance was alcohol, there were not significant differences in use between those with and without LDs (Maag et al., 1994; McNamara et al., 2008). The association between LDs and substance abuse is also present in those with ADHD, which is closely linked with LDs (Daw, 2001). Those with LD and comorbid LD/ADHD reported more smoking and marijuana use – but not hard drug use – compared to those without LDs (McNamara et al., 2008); yet, psychosocial factors (i.e., maternal relationship, engagement in school and extracurricular activities, etc.) were partial mediators in the relationship between LD or LD/ADHD and risk-taking activities (McNamara et al., 2008). First-year college students with LD, ADHD, or comorbid LD/ADHD had greater substance use than their peers without disabilities, which was significantly higher in the groups with ADHD compared to LD alone (DuPaul et al., 2017). The increased risk for substance use disorder in those with LDs was maintained in adulthood (Cederlöf et al., 2017).

2.2 Learning Disabilities Over the Lifespan

As LDs are typically diagnosed when individuals are in school, most studies investigate the relationship between LDs and mental health in school-aged youth. Psychopathology in children and adolescents with LDs has been attributed to academic difficulties and social pressures (Raskind et al., 1999). Considering that LDs persist throughout life, there are implications for the mental health of adults with LDs as they are faced with lower postsecondary educational attainment, higher unemployment, and the loss of their support system (Aro et al., 2019; Gerber, 2012; Undheim, 2003). In those with LDs, there was a positive association between age and symptoms of mental illness, compared to an unclear age trend across different mental health variables in those without LDs (Wilson et al., 2009). First and second-year college students with dyslexia, ADHD, or comorbid dyslexia/ADHD displayed more depression and anxiety symptoms compared to transitioning high school students (Nelson & Gregg, 2012). A meta-analysis on internalizing problems in adults with LDs found a positive overall effect size ($d = 0.51$, $p<0.001$), which was not moderated by school status (Klassen et al., 2013). When studies were aggregated by age, it was found that those grouped into early adulthood (i.e., those <30 years) had more internalizing problems than those in middle adulthood (30+ years) ($Q_b(1) = 11.74$, $p<0.001$) (Klassen et al., 2013). In a recent study investigating those classified with LDs in childhood mental health, it was determined that a higher proportion of those with LDs received sickness allowance or disability pensions and reimbursement for psychoactive medication expenses compared to those without LDs in adult-age (20-39 years) (Aro et al., 2019), suggesting that LDs contribute to later-life poor mental health outcomes. Although much less is known about adults with LDs, and there are few longitudinal investigations, it appears that mental illness remains a concern into adulthood.

2.3 Sex Differences and Mental Health in People with Learning Disabilities

Sex differences in the mental health of those with LDs have often demonstrated that females are more likely to have symptoms of mental illness, as well as a tendency towards internalizing symptoms. Females with LDs were found to have a higher likelihood of distress, depression, anxiety disorders, professional consultation, suicidal thoughts, and self-assessed poor or fair mental health compared to males (Wilson et al., 2009). In a study on twin youth with

reading disorder, females showed internalizing behaviours, such as depressive symptoms, somatic complaints, and withdrawn behaviours, compared to males who showed more externalizing behaviours, such as ADHD and/or aggression (Willcutt & Pennington, 2000). In teenagers with dyslexia, females exhibited moderate depression compared to minimal depression in males (Alexander-Passe, 2006), which was supported in a study on college students (Nelson & Gregg, 2012). Similarly, females with LDs demonstrated a higher likelihood of attempting suicide (9%) versus males with LDs (4%) and females without LDs (5%), as well as a higher odds of suicide in females (OR = 1.84) compared to males (OR = 1.43) (Svetaz et al., 2000).

Sex-based differences in mental illness may be related to divergent sources of stress and coping mechanisms (Petersen et al., 1993). Females with dyslexia have shown lower self-esteem scores compared to males (Alexander-Passe, 2006), as well as higher stress from peer interaction, teacher interaction, and academic self-concept scores compared to higher academic stress in males with dyslexia (Alexander-Passe, 2008). Manifestations of stress in females with dyslexia were highest in the behavioural category, which assesses actions, reactions, or behaviours towards others; on the contrary, males scored the highest in the emotional (fear, shyness, and loneliness) and physiological (nausea, tremors, or rapid heart rate) categories (Alexander-Passe, 2008). Moreover, females with dyslexia use more emotional and avoidance-based coping, and males use task-based coping (Alexander-Passe, 2006). In totality, LDs manifest differently across the sexes, resulting in unique mental health challenges that may suggest the need for specific treatment approaches.

2.4 Summary of Learning Disabilities and Mental Health

Beyond definitional inconsistencies and diverse challenges with implications for education, employment, and income, there is a demonstrated association between LDs and mental illness. Individuals with LDs experience a heightened risk of stress, substance use disorders, anxiety, depression, and suicide compared to those without LDs. Additionally, there is evidence to suggest that symptoms of mental illness manifest differently among males and females and across different age groups, as well as among those with co-occurring LDs or other types of mental illness. However, these associations are not yet conclusive. Further research into the mental health of those with LDs is essential to inform diagnosis and prevention strategies across the lifespan.

3.0 Rationale

Emerging adulthood is a new developmental period from ages 18-29 years, first coined in 2000, to address the delayed entrance into adulthood that resulted from significant societal changes between the 1960s and 1970s – the Technology Revolution, the Sexual Revolution, the Women's Movement, and the Youth Movement (Arnett, 2014). Emerging adulthood is defined by five common characteristics: identity exploration, instability, self-focus, feeling in-between, and possibilities/optimism (Arnett, 2014). This period has shown increased substance use experimentation compared to adolescence (Macleod & Brownlie, 2014; Wood et al., 2018), as well as substantial mental illness while facing gaps in insurance coverage (Norona et al., 2014). Although the presence of an LD is a risk factor for mental illness, the association between LDs and mental illness in emerging adults is unclear. Studies on the mental health of those with LDs have found that few individuals reach "clinical severity" for their respective mental illness (Morrison & Cosden, 1997), which may contribute to a lower likelihood for mental health-related treatment in those with less severe LDs. However, to detect *symptoms* of depression and anxiety, psychological distress has been used in the general population. Defined as "a set of painful mental and physical symptoms that are associated with normal fluctuations of mood in most people" (American Psychological Association, n.d.), predictors of psychological distress include sex, income, education, physical health, and social support (Canadian Institute for Health Information, 2012). Yet, psychological distress has not been well-studied in emerging adults with LDs. Considering that emerging adults with LDs experience the loss of their school-based support system when transitioning from secondary school to higher education or the workplace, there is an increased need for resources, support, and advocacy for those with LDs (Ascherman & Shaftel, 2017). As such, the first two aims of this investigation were to illuminate mental illness by investigating psychological distress in emerging adults with LDs at a population level. The study findings may help inform interventions that consider the relevant mental health implications.

There are differences across this developmental period when considering the characteristics that mark emerging adulthood. As these individuals navigate their education, employment, and long-term partnerships, those aged 18-25 years relate more to identity explorations, instability, and self-focus than those aged 26-29 years, with a decreasing trend of feeling in-between as age increases (Arnett, 2014). Emerging adults of both sexes prioritize education and careers (Arnett, 2014), but women who want children tend to makes career choices that are conducive to motherhood, as well as desire having children earlier than men (Norona et al., 2014). Moreover, these transitions are further complicated in emerging adults with ADHD, who experience delayed transition into adulthood (Baggio et al., 2019), as well as greater challenges in higher education and the workplace (Abecassis et al., 2017). Age, sex, and comorbidities may elucidate heterogenous challenges that have mental health implications in emerging adults, especially in those with LDs. However, the impact of age, sex, ADHD, and World Health Organization Disability Assessment Schedule (WHODAS) 2.0 – a measure of health and disability (World Health Organization, 2018) – on the association between LD and mental illness in emerging adults is not yet known. These characteristics help inform direct and specific treatment of mental illness in those with LDs. Therefore, the final aim of this study was to examine the modification of age, sex, ADHD, and WHODAS 2.0 scores on the association between LDs and mental illness in emerging adults in order to support previous findings and inform targeted interventions.

4.0 Research Questions

With the current knowledge gaps in the literature, the research questions and hypotheses for this study are:

1) Do emerging adults with LDs have higher psychological distress scores, as measured using the Kessler Psychological Distress Scale (K6), compared to those without LDs?

It was hypothesized that emerging adults with LDs would have higher psychological distress scores than individuals without LDs.

2) Are emerging adults with LDs more likely to meet the clinical cut-point for serious mental illness, as measured by the Kessler Psychological Distress (K6) score, compared to those without LDs?

It was hypothesized that emerging adults with LDs would have a higher odds of having K6 scores at or above the clinical cut-point of 13 that has been applied to the general population.

3) Does age, sex, ADHD and/or WHODAS 2.0 scores modify the association between LDs and psychological distress scores?

Modification by age was postulated with the 20-24-year age group demonstrating the highest scores as they transition to higher education or the workplace. Likewise, as females typically display more symptoms of anxiety and depression than males (Nelson & Gregg, 2012), it was hypothesized that sex would modify this relationship such that females would have higher distress scores compared to males. It was also predicted that the presence of ADHD would modify the association such that the association between LD and psychological distress would be stronger compared to those without ADHD. Lastly, as WHODAS 2.0 scores measure physical/mental impairment, it was predicted that severity of impairment would modify the association between LDs and psychological distress.

5.0 Methods

5.1 Study Population

The current project was secondary data analysis of the 2012 Canadian Community Health Survey – Mental Health (CCHS-MH) data set, a Canada-wide survey completed by Statistics Canada. The CCHS-MH utilized a cross-sectional study design to collect data on mental health, mental health and substance use disorders, and service utilization (Statistics Canada, 2013). Inclusion criteria were Canadians aged 15 years or over in each of the ten provinces, and exclusion criteria were peoples living on Indigenous reserves, full-time members of the Canadian Forces, and institutionalized individuals (Statistics Canada, 2013). Using the area frame from the Canadian Labour Force Survey as the sampling frame, a three-stage sampling design was conducted: 1) geographical and/or socioeconomic strata were created and six clusters were selected using the probability proportional to size method; 2) households within each cluster were systematically selected; and 3) one participant from all eligible members of a household was randomly selected using a computer application that accounted for each individual's selection probability (Statistics Canada, 2013). Of the 36,443 households, 29,088 (79.8%) agreed to participate, resulting in 25,113 (86.3%) study participants. As such, the combined household and individual response rate was 68.9% (Statistics Canada, 2014a). Data collection took place between January and December 2012 in six two-month collection periods using computer assisted personal interviewing, a type of computer-assisted interviewing (Statistics Canada, 2013).

5.2 Analytic Sample

Given the complex survey design of the CCHS-MH, the data were weighted to account for how many Canadians each participant represented, in turn allowing for population-level interpretations. The weighting was multi-step and adjusted for out-of-scope dwellings and non-respondents through removal and reallocation of survey weights (Statistics Canada, 2013). Finally, "winsorization" trimming and calibration were completed to limit the effect of outliers and calibrate the population estimates according to the provincial levels (Statistics Canada, 2013). The study sample for this investigation included participants between 15-29 years of age (n = 5630). As such, those with missing data on K6 scores were excluded (n = 26). Refer to Table 1 for predictors of missing K6 scores (Appendix A).

5.3 Measures

5.3.1 Learning Disability

The primary exposure for all research questions was self-reported identification of an LD diagnosis by a health professional that was expected to last or has already lasted six months or more via the survey question: "Do you have a learning disability" (Statistics Canada, 2014a). Participants who responded "yes" or "no" in the survey were included in the analyses (n = 5629), and those who answered "don't know," "refusal," or "not stated" were excluded (n = 1). Self-reported data on dyslexia have shown to be useful in place of objective tests (Schulte-Körne et al., 1997), and computer interviewing may minimize underreporting of sensitive topics compared to traditional interview practices (Waterton & Duffy, 1984).

5.3.2 Psychological Distress

For all three research questions, the outcome of interest was psychological distress using the Kessler Psychological Distress Scale (K6) scores (n = 5604), excluding those with K6 scores "not stated" (n = 26). The K6 is a shortened version of the K10, both of which measure

nonspecific distress over a one month period to identify those with serious mental illness, as reflected in the DSM-IV criteria for major depression and generalized anxiety disorder (R. C. Kessler et al., 2002). With administration around two minutes in duration, the K6 ascertains how often participants feel nervous, hopeless, restless or fidgety, so depressed that nothing could cheer them up, that everything was an effort, and worthless, as well as assesses the frequency of these feelings compared to normal, whether or not they impacted work or daily activities, how often professional help was sought out, and whether a physical health problem was the main cause (*K10 and K6 Scales*, 2005). Using a five-point Likert scale, each of the six items are coded from zero (none of the time) to four (all of the time) and then summed to result in a final score between 0 and 24. A cut-point of 13 is used when analyzing the general population, with scores ≥13 indicating probable serious mental illness (*K10 and K6 Scales*, 2005; Ronald C. Kessler et al., 2003). The K6 has demonstrated excellent internal consistency (Cronbach's alpha = 0.89) (R. C. Kessler et al., 2002) and has successfully predicted serious mental illness in several epidemiological studies (Ferro, 2019; Kang et al., 2015), including in emerging adults (Bessaha, 2017).

5.3.3 Health and Psychosocial Factors

Health covariates included self-reported identification of ADHD diagnosis; past 12-month medication use for emotions, mental health, alcohol, or drug problems; a derived variable on help received in the past 12 months; the WHODAS 2.0 score; lifetime substance use disorder; lifetime major depressive episode; and lifetime generalized anxiety disorder. Throughout the survey, respondents were reminded to report conditions diagnosed by a health professional that were expected to last or had already lasted for six months or more. Attention deficit/hyperactivity disorder was recorded by self-report of a diagnosis (n = 5626), with categorical responses "yes," "no," "don't know," "refusal," or "not stated" (Statistics Canada, 2014a). Past-year medication usage was measured by asking participants if they had taken medication to help with problems with emotions, mental health, alcohol, or drugs in the past 12 months (n = 5624), with respondents answering "yes," "no," "don't know," or "refusal" (Statistics Canada, 2014a). The derived variable of help received in the past year for problems with emotions, mental health, or use of alcohol or drugs encompassed help received via information, medication, counselling/therapy, other or none (n = 5617), and it was coded as "yes," "no," or "not stated" (Statistics Canada, 2014b). The 12-item WHODAS 2.0 scores were used to assess previous-month health and disability across cultures and in general and clinical settings (WHO Disability Assessment Schedule 2.0 (WHODAS 2.0), 2018). In the CCHS-MH (n = 5607), this variable was derived from scores that range from 0 (no disability) to 100 (full disability) and was coded as "lowest recordable degree of disability" to "40 or more (high degree of disability)," or "not stated" (Statistics Canada, 2014b). The WHODAS 2.0 is a valid and reliable measure of disability in youth (Kimber et al., 2015), including in those with or without physical or mental conditions (Tompke et al., 2018). Two recent systematic reviews confirmed its strong psychometric properties (Federici et al., 2017), which included high internal consistency (α = 0.81-0.96) and good test-retest reliability (ICC: 0.77-0.88) (Saltychev et al., 2019). In the CCHS-MH, lifetime any substance use disorder, major depressive episode, and generalized anxiety disorder criteria were based on the World Health Organization Composite International Diagnostic Interview (WHO-CIDI) 3.0, an internationally-used tool that has demonstrated adequate validity and excellent reliability in assessing 12-month and lifetime symptoms of mental illness (G Andrews & Peters, 1998). Any substance use disorder encompassed both drugs and alcohol, and it was coded as "yes," "no," or "not stated" (Statistics

Canada, 2014a). Similarly, both lifetime major depressive episode and generalized anxiety disorder were coded as "yes," "no," or "not stated" (Statistics Canada, 2014a). Participants coded as "yes" or "no" will be included (substance use disorder: n = 5532; major depressive episode: n = 5612; generalized anxiety disorder: n = 5604).

An additional grouping of psychosocial covariates included Social Provisions Scale (SPS) – 10 scores and whether the respondent had any family members with emotions, mental health, alcohol, or drug problems. SPS-10 is a shortened version of the 24-item SPS that measures perceived availability of social support via five social provisions: emotional support or attachment, social integration, reassurance of worth, reliable alliance, and guidance (Cutrona & Russell, 1987; Orpana et al., 2019). Each question is coded using a four-point Likert scale from one (strongly disagree) to four (strongly agree) and is then summed to give a value between 10 and 40, where higher scores represent higher social support (Orpana et al., 2019). In the CCHS-MH, those without scores are labeled "not stated" (n = 88). The SPS-10 has demonstrated excellent concurrent validity ($r = 0.93$, $p<0.001$), internal consistency ($\alpha = 0.88$), and construct validity (95% predictive power) (Caron, 2013), and it has been utilized in various epidemiological surveys (Orpana et al., 2019). The survey question corresponding to family members' emotional, mental health, alcohol or drug problems is a categorical variable that was recorded by asking participants "Do any of your family members have problems with their emotions, mental health, or use of alcohol or drugs?" (n = 5526) with responses "yes," "no," "no family members," "don't know," or "refusal" (Statistics Canada, 2014a). Both variables are implicated in mental illness; social support is considered an important aspect in the "success and failure" of those with LDs (Nalavany et al., 2011), and there is an increased risk for mental illness when an individual has family members who have mental illness or they live in an environment that contains substance abuse (WHO Secretariat for the development of a comprehensive mental health action plan, 2012).

5.3.4 Demographic Factors

Demographic characteristics included in the analyses were age, sex, respondent's current school status (attending school, college, CEGEP, or university at time of survey), and total household income from all sources. In the CCHS-MH, age was recorded by asking participants their age, and then creating a categorical variable by grouping them into five-year age increments (Statistics Canada, 2014a). The emerging adults in this study were the 15-19-, 20-24-, and 25-29-year age groups (n = 5630). Sex was recorded by asking participants if they were male or female (n = 5630), which was subsequently coded as a binary categorical variable (Statistics Canada, 2014a). School status was determined by asking participants if they were currently attending school, college, CEGEP, or university (n = 5615), and it was coded as a categorical variable with responses "yes," "no," "don't know," "refusal," or "not stated" (Statistics Canada, 2014a). Total household income was a derived categorical variable (n = 5622) with responses "no income or less than $20,000," "$20,000-$39,999," "$40,000-$59,999," "$60,000-$79,999," "$80,000 or more," or "not stated" (Statistics Canada, 2014b).

5.4 Statistical Methods

5.4.1 Overview

SAS software version 9.4 (SAS Institute Inc., Cary, NC) was used to complete the analyses. All analyses incorporated the normalized sampling weight (WTS_N), which was calculated by dividing the master sampling weight (WTS_M) by the average of the master sample weight ($\bar{x} = 1202.19$), as represented in the following equation:

$$WTS\_N = \frac{WTS\_M}{\bar{x}_{WTS\_M}}$$

Due to the survey nature of the CCHS-MH data, survey weights were used in order to infer at the population level (Statistics Canada, 2013). Although the use of sample weights has been debated, it was determined that using SAS *SURVEY* procedures would produce the most accurate estimates (Cassell, 2006; Wells, 2017).

5.4.2 Analyses

5.4.2.1 Sample Characteristics

Univariate analyses were completed for the outcome and all predictors. *PROC SURVEYMEANS* was used for numerical variables and *PROC SURVEYFREQ* was used for categorical variables. As previously mentioned, the outcome variable of continuous K6 scores was not normally distributed, as indicated by the distribution. Thus, the scores were log-transformed to more closely approximate a normal distribution (Figures 1-2).

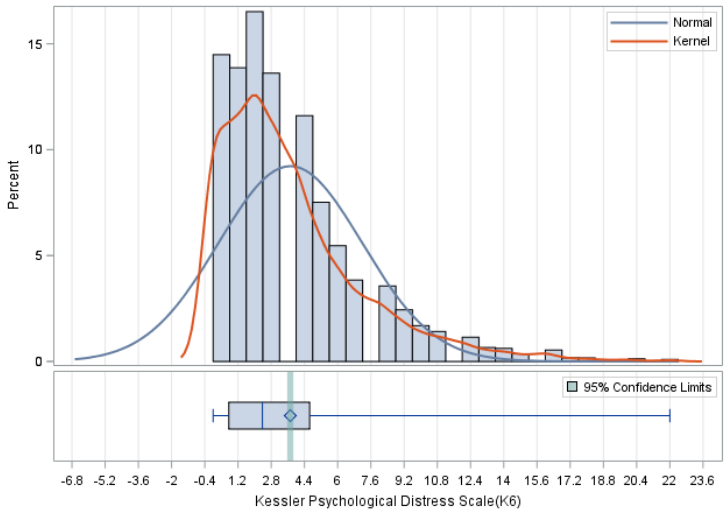

Figure 1: Distribution of Continuous K6 Scores Prior to Log Transformation

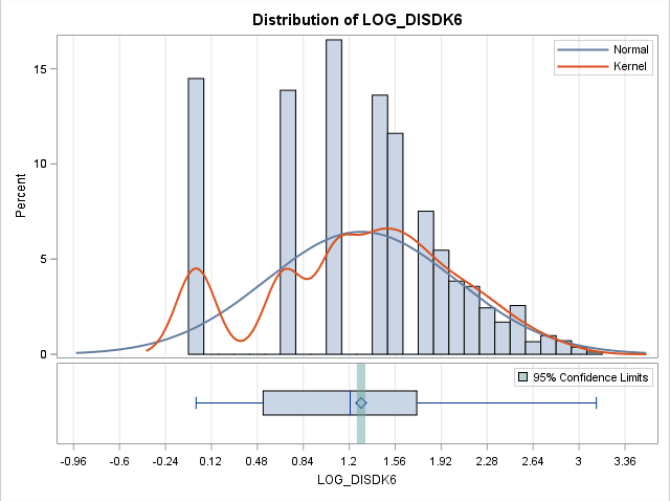

Figure 2: Distribution of Log-Transformed K6 Scores

Bivariate analyses were conducted for those with and without LDs using the *SURVEYFREQ* procedure for categorical variables and the *SURVEYREG* procedure for continuous variables. Rao-Scott χ^2 tests were calculated for categorical variables and *t* values were produced for comparison of means across each group. In assessing for multicollinearity, variance inflation factor and tolerance were calculated from the R^2 scores that were produced from regressing LD status on all other independent variables.

5.4.2.2 Objective One

For the first research question, multiple linear regression was completed using the *SURVEYREG* procedure. The crude model (Appendix C: Model 1) used the binary LD variable as the exposure and the log-transformed K6 scores as the continuous outcome. In three steps, demographic, psychosocial, and health covariate blocks were included in the model, respectively, to ascertain the relative contribution of each grouping (Appendix C: Models 2-4). The full model was used to examine the association between psychological distress scores on those with and without LDs. Model fit was assessed by evaluating the R^2 and residuals.

5.4.2.3 Objective Two

To investigate the clinical importance of the association between LDs and K6 scores, logistic regression was completed using the *SURVEYLOGISTIC* procedure. The crude model (Appendix C: Model 5) used the binary LD variable as the exposure, and the outcome was a derived binary variable of K6 scores (i.e., scores <13 or ≥ 13). Similar to the first research question, demographic, psychosocial, and health covariate blocks will be included in three consecutive steps to ascertain the relative contribution of each grouping (Appendix C: Models 6-8). The full model was used to examine the association between LDs and binary K6 scores. Model fit was assessed by evaluating the C-statistic.

5.4.2.4 Objective Three

To investigate effect modification by age, sex, ADHD status, and WHODAS 2.0 scores, stratified linear and logistic regression analyses were completed. For WHODAS 2.0 scores, a binary variable was created to delineate those within the top tenth percentile (i.e., clinically significant disability) (Gavin Andrews et al., 2009). Multiple linear regression was completed using the *SURVEYREG* procedure with the crude and adjusted (full) models that contained the log-transformed continuous outcome (Appendix C: Models 1 and 4). Logistic regression was completed using the *SURVEYLOGISTIC* procedure with the crude and adjusted (full) models that contained the binary K6 outcome (Appendix C: Models 5 and 8).

5.5 Ethics Approval and Data Access

In accordance with the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans, usage of the CCHS-MH did not require ethics approval as it is a publicly available file from Statistics Canada (Canadian Institutes of Health Research et al., 2018).

6.0 Results

6.1 Univariate Analyses

Univariate statistics are displayed in Table 1. Of the survey respondents between 15-29 years of age with complete data, the weighted frequency of those with LDs was approximately 421 (7.5%). The age, sex, and school status variables displayed a similar distribution across the levels (Table 1). A trend across income was present where the frequency increased with increasing income. Approximately 38% of respondents had a family member(s) with emotions, mental health, alcohol, or drug problems. The weighted mean [standard error (SE)] for the Social Provisions Scale-10 scores was 36.53 (0.09), indicating, on average, high perceived social support. The weighted mean (SE) for the continuous WHODAS 2.0 score was 4.25 (0.16), demonstrating low impairment, on average. For emotions, mental health, alcohol, or drug problems, 6.7% of respondents identified using medication in the past 12 months, while 15.9% reported receiving help (i.e., information, medication, counseling/therapy, other) in the past 12 months. Additionally, 5.5% of the sample reported having ADHD. Respondents who reported lifetime major depressive episode, lifetime generalized anxiety disorder, or lifetime any substance use disorder composed 10.6%, 6.9%, and 22.9% of the sample, respectively. The mean (SE) of the log-transformed K6 score was 1.3 (0.02), and 2.8% of the sample had scores equal to or more than the K6 cut-point of 13.

Table 1: Univariate Study Sample Characteristics (n = 5630)

Characteristics	**N(%) or Mean(SE)**
Age (years)	
15-19 years	1908 (33.9%)
20-24 years	1799 (32.0%)
25-29 years	1922 (34.1%)
Sex	
Female	2661 (47.3%)
Currently attending school, college, CEGEP, or university	2667 (47.7%)
Income	
No income or <$20,000	308 (5.5%)
$20,000-39,999	665 (11.8%)
$40,000-59,999	908 (16.1%)
$60,000-79,999	992 (17.6%)
$80,000 or more	2755 (49.0%)
Has a Learning Disability	421 (7.5%)
WHODAS 2.0 scores	4.3 (0.2)
Has ADHD	311 (5.5%)
Used Medication in Past 12 Months for Emotions, Mental Health, Alcohol or Drug Problems	377 (6.7%)
Received Help in Past 12 Months for Emotions, Mental Health, Alcohol or Drug Problems	892 (15.9%)
Has Family Member with Emotions, Mental Health, Alcohol or Drug Problems	2098 (37.8%)
SPS-10 scores	36.5 (0.1)
Lifetime Any Substance Use Disorder	1273 (22.9%)
Lifetime Major Depressive Episode	596 (10.6%)
Lifetime Generalized Anxiety Disorder	387 (6.9%)
Kessler Psychological Distress Scale	3.7 (3.5)
Log-transformed Kessler Psychological Distress Scale	1.3 (0.02)
Kessler Psychological Distress Scale Scores ≥13	159 (2.8%)

SE = Standard Error

6.2 Bivariate Analyses

Bivariate exploratory data analyses are displayed in Table 2. There was a significant difference across emerging adults with and without LDs in both outcome variables (log-transformed K6 scores: p<.001; binary K6 scores: p<.001). Individuals with LDs displayed a higher mean score (1.6 vs. 1.3) and had a greater proportion with scores greater than or equal to the cut-point of 13 (7.0% vs. 2.5%). The association between LD status and all predictors were statistically significant at α=0.05, except for age (p=0.259) and school status (p=0.323); however, they were retained in the regression analyses as they were considered theoretically important in the association between LDs and psychological distress scores.

6.2.1 Demographic variables

In those with LDs, the 15-19-year category was higher (40.3%) than the 20-24 and 25-29 year age groups, while those without LDs had a similar distribution across age groups. Among

those with LDs, the percentage of males (63.1%) was approximately two times that of females (36.9%), compared to a similar distribution in those without LDs. The income percentages demonstrate that those with LDs have higher proportions in the three lowest income brackets, compared to those without LDs who displayed an increasing trend across income brackets.

6.2.2 Psychosocial variables

The Social Provisions Scale-10 scores displayed relatively similar means (35.3 vs. 36.6) in those with and without LDs, although there was a statistically significant difference ($p<.001$). In those with LDs, 45.9% reported having a family member(s) with emotion, mental health, alcohol or drug problems, compared to 37.2% in those without LDs.

6.2.3 Health variables

The WHODAS 2.0 mean score in those with LDs was higher compared to those without LDs (8.0 vs. 3.9). Those with LDs displayed 35% comorbidity with ADHD, which was substantially higher than those without LDs (3.1%). In addition, individuals with LDs had reported higher past 12-month medication use for emotions, mental health, alcohol, or drug problems (15.5% vs. 6.0%), as well as a higher percentage of help received for emotions, mental health, alcohol, or drug problems (31.7% vs. 14.6%). Among emerging adults with LDs, 34.7% reported lifetime any substance use disorder, 17.4% reported lifetime major depressive episode, and 11.3% reported lifetime generalized anxiety disorder, while those without LDs reported 22.0%, 10.1%, and 6.6%, for lifetime substance use disorder, major depressive episode, and generalized anxiety disorder, respectively.

Table 2: Bivariate Study Sample Characteristics (n = 5630)

Characteristics	With Learning Disabilities	Without Learning Disabilities	Rao-Scott χ^2 (P-value) or t-value (P-value)
	N(%) or Least Squares Mean(SE)		
Demographic			
Age (years)			2.70 (0.259)
15-19 years	170 (40.3%)	1739 (33.4%)	
20-24 years	128 (30.4%)	1671 (32.1%)	
25-29 years	123 (29.3%)	1799 (34.5%)	
Sex			7.54 (0.006)*
Female	155 (36.9%)	2506 (48.1%)	
Male	266 (63.1%)	2703 (51.9%)	
Currently attending school, college, CEGEP, or university	184 (43.8%)	2482 (48.0%)	0.98 (0.323)
Income			11.63 (0.020)*
No income or <$20,000	31 (7.4%)	277 (5.3%)	
$20,000-39,999	73 (17.3%)	592 (11.4%)	
$40,000-59,999	84 (19.9%)	824 (15.8%)	
$60,000-79,999	54 (13.0%)	937 (18.0%)	
$80,000 or more	179 (42.5%)	2577 (49.5%)	
Health/Psychosocial			
WHODAS 2.0 score	8.0 (0.75)	3.9 (0.17)	5.37 (<.001)*
Has ADHD	147 (35.0%)	164 (3.1%)	246.71(<.001)*
Used Medication in Past 12 Months for Emotions, Mental Health, Alcohol or Drug Problems	65 (15.5%)	311 (6.0%)	26.53 (<.001)*
Received Help in Past 12 Months for Emotions, Mental Health, Alcohol or Drug Problems	133 (31.7%)	758 (14.6%)	34.04 (<0.001)*
Has Family Member with Emotions, Mental Health, Alcohol or Drug Problems	189 (45.9%)	1909 (37.2%)	4.03 (0.045)*
SPS-10 Scores	35.3 (0.35)	36.6 (0.09)	-3.81 (<0.001)*
Lifetime Any Substance Use Disorder	142 (34.7%)	1130 (22.0%)	11.23 (0.001)*
Lifetime Major Depressive Episode	73 (17.4%)	523 (10.1%)	8.32 (0.004)*
Lifetime Generalized Anxiety Disorder	47 (11.3%)	340 (6.6%)	5.63 (0.018)*
Outcome			
Log-transformed Kessler Psychological Distress Scale	1.6 (0.06)	1.3 (0.02)	5.48 (<.001)*
Kessler Psychological Distress Scale Scores ≥13	29 (7.01%)	129 (2.50%)	17.44 (<.001)

SE = Standard Error; *p<0.05

6.3 Assessments for Multicollinearity

All associations demonstrated high tolerance (i.e., >0.8) and low variance inflation factor values (i.e., <2.5), indicating no concern for multicollinearity (Table 3). Consequently, all variables were retained in the regression analyses.

Table 3: Multicollinearity of Learning Disabilities and Independent Variables

Bivariate Association	**Variance Inflation Factor**	**Tolerance**
LD x Sex	1.0035	0.9965
LD x Age	1.0016	0.9984
LD x School Status	1.0005	0.9995
LD x Income	1.0048	0.9952
LD x Family member(s) with emotional, mental health, alcohol or drug problems	1.0022	0.9978
LD x SPS-10 Scores	1.0074	0.9927
LD x WHODAS Scores	1.0151	0.9851
LD x ADHD	1.0747	0.9305
LD x Medication usage in past 12 months for emotions, mental health, alcohol, or drug problems	1.0078	0.9923
LD x Help received in past 12 months for emotions, mental health, alcohol, or drug problems	1.0127	0.9875
LD x Substance Use Disorder	1.0057	0.9943

6.4 Regression Analyses

6.4.1 Objective 1

Linear regression analyses are displayed in Table 4. In the crude model (Model 1) between LD status and K6 scores, having an LD was associated with a 0.35 unit increase in the log-transformed K6 score ($p<.001$). After controlling for the sociodemographic factors (Model 2), the estimate remained the same ($\beta=0.35$; $p<.001$). When psychosocial factors were adjusted for (Model 3), having an LD was associated with a 0.28 ($p<.001$) unit increase in the log-transformed K6 score. When all covariates were included (Model 4), the unit change in the log-transformed K6 scores was 0.10 for those with LDs, although the association was no longer statistically significant ($p=0.149$). Residual analyses for each regression model exhibited normality (Appendix B).

Table 4: Log-Transformed K6 Scores Regressed on Learning Disability

	Model 1 β-coefficient (SE) [P-value]	**Model 2 β-coefficient (SE) [P-value]**	**Model 3 β-coefficient (SE) [P-value]**	**Model 4 β-coefficient (SE) [P-value]**
Adjusted R^2	0.01	0.03	0.12	0.26
Intercept	1.27 (0.02) [<.001]	1.23 (0.04) [<.001]	2.81 (0.17) [<.001]	2.04 (0.17) [<.001]
Has a learning disability	0.35 (0.06) [<.001]	0.35 (0.06) [<.001]	0.28 (0.06) [<.001]	0.10 (0.07) [0.149]
Demographic				
Age (*vs. 15 to 19 years*)				
20-24 years		-0.01 (0.04) [0.811]	-0.01 (0.04) [0.784]	0.01 (0.03) [0.835]
25-29 years		-0.13 (0.05) [0.005]	-0.13 (0.04) [0.004]	-0.09 (0.04) [0.029]
Female		0.11 (0.03) [.001]	0.10 (0.03) [0.002]	0.09 (0.03) [0.004]
Currently attending school, college, CEGEP, or university		0.03 (0.04) [0.486]	0.05 (0.03) [0.128]	0.11 (0.03) [0.001]
Income (*vs. $80,000 or more*)				
No income or <$20,000		-0.01 (0.09) [0.885]	-0.11 (0.10) [0.267]	-0.16 (0.11) [0.151]
$20,000-39,999		0.07 (0.05) [0.142]	-0.00 (0.05) [0.954]	-0.05 (0.04) [0.222]
$40,000-59,999		0.05 (0.05) [0.317]	-0.02 (0.05) [0.708]	-0.01 (0.04) [0.767]
$60,000-79,999		0.00 (0.05) [0.977]	-0.03 (0.05) [0.589]	-0.01 (0.04) [0.840]
Psychosocial				
SPS-10 Scores			-0.05 (0.00) [<.001]	-0.03 (0.00) [<.001]
Has Family Member with Emotions, Mental Health, Alcohol or Drug Problems			0.28 (0.04) [<.001]	0.10 (0.03) [0.004]
Health				
Used Medication in Past 12 Months for Emotions, Mental Health, Alcohol or Drug Problems				0.15 (0.05) [0.004]
Received Help in Past 12 Months for Emotions, Mental Health, Alcohol or Drug Problems				0.31 (0.04) [<.001]
Has ADHD				0.09 (0.08) [0.278]
WHODAS 2.0 Scores				0.03 (0.00) [<.001]
Lifetime Substance Use Disorder				0.23 (0.04) [<.001]

SE = Standard Error

6.4.2 Objective 2

Logistic regression analyses are displayed in Table 5. In the crude model (Model 5) between LD status and binary K6 scores, the odds of having K6 scores above the cut-point was 2.95 higher in those with LDs compared to those without (95% CI=1.74-4.99). After controlling for the sociodemographic factors (Model 6), the odds of having K6 scores above the cut-point remained higher in those with LDs compared to those without (OR=2.77, 95% CI=1.59-4.85). When psychosocial factors were adjusted for (Model 7), the odds of having K6 scores above the cut-point was 2.16 higher in those with LDs compared to those without (95% CI=1.15-4.09). After including all covariates (Model 8), the odds of having K6 scores greater than or equal to the cut-point was 17% higher in those with LDs compared to those without, although this association was not statistically significant (95% CI=0.60-2.27). The C-statistic values demonstrated that Model 8, which included all covariates, was the strongest model.

Table 5: Logistic Regression of Binary K6 Scores on Learning Disability

	Model 5 OR (95% CI)	**Model 6 OR (95% CI)**	**Model 7 OR (95% CI)**	**Model 8 OR (95% CI)**
C-Statistic	0.56	0.68	0.83	0.92
Has a learning disability	2.95 (1.74, 4.99)	2.77 (1.59, 4.85)	2.16 (1.15, 4.09)	1.17 (0.60, 2.27)
Demographic				
Age (*vs. 15 to 19 years*)				
20-24 years		0.85 (0.50, 1.43)	0.81 (0.45, 1.47)	0.92 (0.48, 1.77)
25-29 years		0.53 (0.29, 0.97)	0.44 (0.23, 0.83)	0.47 (0.23, 0.98)
Female		1.88 (1.15, 3.06)	2.08 (1.24, 3.50)	1.90 (1.07, 3.38)
Currently attending school, college, CEGEP, or university		1.82 (1.13, 2.92)	0.60 (0.35, 1.04)	0.65 (0.36, 1.17)
Income (*vs. $80,000 or more*)				
No income or <$20,000		1.18 (0.52, 2.66)	0.65 (0.24, 1.76)	0.42 (0.10, 1.68)
$20,000-39,999		1.63 (0.93, 2.87)	0.99 (0.55, 1.78)	0.69 (0.34, 1.39)
$40,000-59,999		0.97 (0.55, 1.73)	0.66 (0.35, 1.26)	0.56 (0.28, 1.12)
$60,000-79,999		0.52 (0.26, 1.03)	0.51 (0.25, 1.05)	0.50 (0.21, 1.17)
Psychosocial				
SPS-10 Scores			0.77 (0.74, 0.81)	0.82 (0.78, 0.87)
Has Family Member with Emotions, Mental Health, Alcohol or Drug Problems			2.78 (1.57, 4.94)	0.95 (0.48, 1.86)
Health				
Used Medication in Past 12 Months for Emotions, Mental Health, Alcohol or Drug Problems				1.49 (0.73, 3.03)
Received Help in Past 12 Months for Emotions, Mental Health, Alcohol or Drug Problems				4.68 (2.40, 9.11)
Has ADHD				1.10 (0.53, 2.31)
WHODAS 2.0 Scores				1.10 (1.08, 1.12)
Lifetime Substance Use Disorder				1.70 (1.00, 2.90)

OR = Odds Ratio; CI = Confidence Interval

6.4.3 Objective 3

Stratified linear and logistic regression analyses were completed, and unadjusted and adjusted models are displayed in Tables 6-13.

6.4.3.1 Age-Stratified Analyses

The crude (unadjusted) estimate of effect was 0.35 (p<.001), and the adjusted estimate of effect was 0.10 (p=0.149) (Table 4). The unadjusted age strata all demonstrated statistically significant estimates. However, none of the age categories presented statistically significant results after adjustment for potential confounders. Thus, effect modification was present, as demonstrated by the difference in stratum-specific estimates, but the estimates were not statistically significant (Table 6).

Table 6: Age-Stratified Analysis of Log-Transformed K6 Scores Regressed on Learning Disabilities

Association	**Estimate (P-value)**	
	Unadjusted	***Adjusted***
Has LD x 15 to 19 years	0.28 (0.001)	0.06 (0.523)
Has LD x 20 to 24 years	0.28 (0.008)	-0.02 (0.763)
Has LD x 25 to 29 years	0.47 (0.001)	0.28 (0.088)

The crude (unadjusted) OR for the association between LDs and the binary K6 outcome was 2.95 (1.74, 4.99), and the adjusted OR was 1.17 (0.60, 2.27) (Table 5). The unadjusted analyses stratified by age exhibited effect modification in all age categories, although the result of the 15-19-year age group was not statistically significant. When adjusted for potential confounders, stratification by age displayed effect modification, although the results were only statistically significant for the 15-19-year and 25-29-year age groups. More specifically, the OR in the 15-19-year age group indicated that there was a protective effect such that those in this age category were 82% less likely to have K6 scores above the cut-point. On the contrary, the OR in the 25-29-year age group found that LDs were more likely to have K6 scores above the cut-point (i.e., more likely to have “serious mental illness”) (Table 7).

Table 7: Age-Stratified Analysis of Binary K6 Scores Regressed on Learning Disabilities

Association	**OR (95% CI)**	
	Unadjusted	***Adjusted***
Has LD x 15 to 19 years	1.06 (0.49, 2.32)	0.18 (0.04, 0.78)
Has LD x 20 to 24 years	4.69 (1.93, 11.38)	2.00 (0.81, 4.93)
Has LD x 25 to 29 years	4.40 (1.65, 11.77)	3.87 (1.05, 14.30)

OR = Odds Ratio; CI = Confidence Interval

6.4.3.2 Sex-Stratified Analyses

Similarly, the unadjusted linear association between LDs and log-transformed K6 scores demonstrated effect modification by sex, and the estimates were statistically significant. Upon inclusion of potential confounders, effect modification was still present, but the results were no longer statistically significant (Table 8).

Table 8: Sex-Stratified Analysis of Log-Transformed K6 Scores Regressed on Learning Disabilities

Association	**Estimate (P-value)**	
	Unadjusted	***Adjusted***
Has LD x Male	0.31 (0.000)	0.12 (0.240)
Has LD x Female	0.44 (<.001)	0.05 (0.469)

The unadjusted logistic regression analyses stratified by sex exhibited statistically significant effect modification. After adjustment for potential confounders, effect modification was present, but the OR was only statistically significant for males. Therefore, males with LDs were more likely to have K6 scores above the cut-point (Table 9).

Table 9: Sex-Stratified Analysis of Binary K6 Scores Regressed on Learning Disabilities

Association	**OR (95% CI)**	
	Unadjusted	***Adjusted***
Has LD x Male	2.99 (1.33, 6.73)	2.39 (1.01, 5.67)
Has LD x Female	3.38 (1.66, 6.88)	0.65 (0.24, 1.78)

OR = Odds Ratio; CI = Confidence Interval

6.4.3.3 Attention-Deficit/Hyperactivity Disorder-Stratified Analyses

The unadjusted linear association demonstrated effect modification by ADHD status, although the result was only statistically significant for the group with no ADHD. When potential confounders were adjusted for, effect modification was present, but neither group had statistically significant estimates (Table 10).

Table 10: ADHD-Stratified Analysis of Log-Transformed K6 Scores Regressed on Learning Disabilities

Association	**Estimate (P-value)**	
	Unadjusted	***Adjusted***
Has LD x Has ADHD	0.04 (0.831)	-0.08 (0.440)
Has LD x Does not have ADHD	0.31 (0.000)	0.15 (0.068)

The unadjusted logistic regression analyses stratified by ADHD found that effect modification was present, although the OR was only statistically significant in the those without ADHD. When adjusted for potential confounders, effect modification by ADHD was still present, but neither group produced statistically significant results (Table 11).

Table 11: ADHD-Stratified Analysis of Binary K6 Scores Regressed on Learning Disabilities

Association	**OR (95% CI)**	
	Unadjusted	***Adjusted***
Has LD x Has ADHD	1.61 (0.53, 4.90)	3.00 (0.82, 11.00)
Has LD x Does not have ADHD	2.64 (1.29, 5.38)	1.09 (0.47, 2.52)

OR = Odds Ratio; CI = Confidence Interval

6.4.3.4 WHODAS 2.0-Stratified Analyses

The unadjusted linear association of LDs and log-transformed K6 scores stratified by scores ≥ the 90th percentile or < the 90th percentile (i.e., clinically significant disability) displayed effect modification, but the results were only statistically significant in the <90th percentile group. In the adjusted analyses, there was a difference across strata, but neither stratum showed statistically significant estimates (Table 12).

Table 12: WHODAS 2.0-Stratified Analysis of Log-Transformed K6 Scores Regressed on Learning Disabilities

Association	**Estimate (P-value)**	
	Unadjusted	***Adjusted***
Has LD x WHODAS 2.0 Scores ≥ 90th Percentile	0.17 (0.113)	0.05 (0.527)
Has LD x WHODAS 2.0 Scores < 90th Percentile	0.28 (0.000)	0.16 (0.060)

The unadjusted logistic regression between LDs and binary K6 scores demonstrated no effect modification when stratified by WHODAS 2.0 scores above or below the 90th percentile. However, effect modification was found after adjustment for potential confounders, but the ORs were not statistically significant (Table 13).

Table 13: WHODAS 2.0-Stratified Analysis of Binary K6 Scores Regressed on Learning Disabilities

Association	**OR (95% CI)**	
	Unadjusted	***Adjusted***
Has LD x WHODAS 2.0 Scores ≥ 90th Percentile	1.84 (0.94, 3.60)	1.66 (0.70, 3.94)
Has LD x WHODAS 2.0 Scores < 90th Percentile	1.85 (0.69, 4.95)	0.78 (0.26, 2.33)

OR = Odds Ratio; CI = Confidence Interval

7.0 Discussion

7.1 Overview

The current study sought to examine the association between LDs and psychological distress in emerging adults to further elucidate the mental health of those with LDs. Few studies have considered emerging adulthood as a single population to explore this association. Considering it is well-documented that emerging adults are already at an increased risk for mental illness, such as anxiety, depression, and substance use disorders (Macleod & Brownlie, 2014), the current study explored the combined impact of LDs and emerging adulthood on mental health.

The study sample with LDs reflected previous North American data, including higher reports of LDs in males (Stanton-Chapman et al., 2001). Additionally, the proportion of the sample with ADHD, including comorbid LD and ADHD, was similar to previous findings (Abecassis et al., 2017; DuPaul et al., 2013), as were the proportions of major depressive episodes and generalized anxiety disorder (Hasin et al., 2018; Thaler et al., 2010). Unfortunately, prevalence rates of substance use disorder are unclear in those with LDs. Given the study sample who reported substance use disorder, major depressive episodes, and generalized anxiety disorder, higher proportions of reported past 12-month medication use and help received in those with LDs was unsurprising. However, an interesting discovery was that approximately half of emerging adults with LDs reported having a family member with emotion, mental health, alcohol, or drug problems, which may have implications not only for underlying genetic influences on their own mental health but also the quality of their support system.

7.2 Objectives One and Two

The hypothesis of objective one was confirmed: emerging adults with LDs displayed higher continuous log-transformed K6 scores than those without LDs. The impact of LDs on mental health was further supported in objective two, which used a derived binary K6 score and found that emerging adults with LDs were more likely to have K6 scores at or above the cut-point where 13 identifies “serious mental illness” in the general population. Although these results were not statistically significant, they suggest clinically important increased psychological distress in those with LDs. Moreover, the results from objective one and two align with the bivariate analyses, as those with LDs had higher proportions of lifetime major depressive episodes and generalized anxiety disorder. These findings also support the previous work by Svetaz, Ireland, & Blum (2000), as well as the finding by Wilson et al. (2009), the latter of which utilized a derived variable for distress from K6 scores. There is little research on psychological distress specifically in those with LDs; however, psychological distress in populations with disabilities have been investigated. In a recent study, those with disabilities who had reported disability discrimination, disability avoidance (i.e., avoiding activities because of their disability), or both were over two times more likely to report psychological distress (Temple & Kelaher, 2018). While psychological distress would likely present differently in those with visible disabilities compared to invisible disabilities, it is evident that living with a disability creates additional challenges for navigating daily life, which may in turn affect mental health. Although the K6 has not been validated in those with LDs, this finding reinforces the abundant literature on the association between LDs and internalizing disorders.

7.3 Objective Three

The hypothesis for objective three, which predicted the presence of effect modification, yielded mixed results. Effect modification was present in all adjusted models. Yet, there were no statistically significant effects in the moderation by age, sex, ADHD status, or WHODAS 2.0 scores in the linear regression between LDs and continuous K6 scores. Stratification in the logistic regression between LDs and binary K6 scores found statistically significant ORs in males and for those aged 15-19 years or 25-29 years.

7.3.1 Moderation by Age

The findings suggest that there was a protective effect in the association between LDs and psychological distress within the youngest age category, while the association in the older age categories had the opposite direction of effect. Previous studies have identified differences in mental health outcomes for students in high school compared to students in college (Nelson & Gregg, 2012), where a major life transition occurs, so the difference in effect was anticipated. Yet, the change in the direction of effect was not. One possible explanation for why the youngest stratum (15-19 years) shows a protective effect could be that they may be receiving more school-based support as part of this group may still be in secondary school, while those of the upper age strata may no longer have the school-based support system. Additionally, the youngest stratum have access to universal healthcare, especially mental health services, which is disrupted in adults (Nguyen et al., 2017). Alternatively, it is possible that years-with-diagnosis plays a role in the psychological distress across age groups, and perhaps influences the effect. For example, an emerging adult may have experienced a recent diagnosis, or they may have been diagnosed years prior to the study – regardless of the age strata they are within. Receiving a recent diagnosis for LDs has a negative effect on health-related quality of life (Karande et al., 2009). On the contrary, living with a diagnosis for longer may allow for time to adjust to diagnosis and seek out the necessary supports, which has shown to improve quality of life (Moseholm et al., 2016). In turn, this may influence the level of psychological distress. Due to the cross-sectional nature of this study, this association could not be investigated, but the number of years an individual lives with a diagnosis is a recommended consideration for longitudinal studies.

7.3.2 Moderation by Sex

Unlike the results of the linear regression, the logistic regression found that the association between LDs and psychological distress was protective in females but was a risk factor in males, with the only statistically significant results in males. As the K6 is based on anxious and depressive symptomatology, it was surprising that females did not demonstrate statistically significant higher K6 scores or had a higher likelihood of having scores above the K6 cut-point, given that a plethora of studies have identified that females with LDs are more likely to display internalizing disorders. Further, this result is unanticipated given that women have shown higher psychological distress due to gendered stressors (i.e., in the work and family) and access to resources (Bilodeau et al., 2020; Nurullah, 2010), which would be relevant in emerging adulthood. Nevertheless, the sex-based effect on the association between LDs and internalizing disorders has not been consistent, as demonstrated in a meta-analysis by Klassen et al. (2013) where moderation by sex was not found. It is possible that the findings of the current study could be a function of the dataset. More specifically, perhaps the outcome of K6 scores was not

sensitive enough to demonstrate a sex-based difference, especially given that the data do not include "institutionalized" individuals who may have disproportionately high psychological distress. Moreover, inclusion of covariates (i.e., SPS-10 scores) not previously investigated may have influenced the association. Unfortunately, without statistically significant results in the female stratum, determining the sex-based differences in the association between LDs and psychological distress is not possible.

7.3.3 Moderation by ADHD Status

Learning disabilities were not significantly associated with psychological distress when stratified by ADHD status. The effect of ADHD on the mental health of those with LDs has shown mixed results. Some studies have demonstrated significant poor mental health outcomes in those with comorbid ADHD/LD compared to those with LDs alone (Wilson et al., 2009), while others have not found a difference in internalizing symptomatology between these two groups (Nelson & Gregg, 2012). This may be due, in part, to the type(s) of LD that is comorbid with ADHD (Willcutt et al., 2019), which cannot be ascertained in the present study. Moreover, previous studies have noted that differences in those with LD, ADHD, or both may be impacted by psychosocial variables and substance use (DuPaul et al., 2017), which were considered and adjusted for in the present study. While there was a lack of statistical significance in the moderation of LD and psychological distress, it should be noted that comorbid ADHD has implications for family functioning and health service use (Browne et al., 2013), and this may ultimately impact the mental health of those with disabilities.

7.3.4 Moderation by WHODAS 2.0 Scores

Lastly, LDs were not significantly associated with psychological distress in those with or without clinically significant disability as measured using the WHODAS 2.0 scores. While the linear regression did not display statistically significant effect modification, the logistic regression did, and it trended in the expected direction for those with clinically significant disability. Considering that it assesses level of impairment in physical and mental domains, it was expected that severity of impairment would modify the association between LDs and psychological distress. As previously stated, it is possible that the study sample, which did not include individuals in institutions, did not include those who experience the most severe impairment. However, it is also possible that the inclusion of certain covariates, such as social support and help received, may have attenuated the impact of functional disability on psychological distress.

7.4 Mechanisms in the Comorbidity of Learning Disabilities and Mental Illness

The current study has affirmed the association between LDs and mental illness through linear and logistic regression, as well as identified the presence of effect modification within this association. Although not within the scope of this investigation, the mechanisms operating in this association are complex, with the literature comprising significant support for the effect of environmental factors on the mental health of individuals with LDs. Ultimately, emerging adults with LDs experience similar personal and interpersonal challenges as those without LDs, but the effect is exacerbated by the presence of an LD (Haft, Duong, et al., 2019). With the mechanisms in mind, the environment becomes especially important in mitigating potential or existing mental health challenges. Research into the supports and barriers to these major life transitions for

individuals with disabilities emphasizes the person-environment interaction (Stewart et al., 2014). In a qualitative systematic review on students with LDs in higher education, fear of stigmatization, lack of policies/resources, and inconsistencies across departments created barriers to success, while self-determination and family/peer support were supportive (Canadian Institute for Health Information, 2012; Gow et al., 2020). As more individuals with LDs are pursuing higher education than in the past, educational and workplace policies and practice are paramount in ensuring that they transition successfully. If these supports are not in place, then there may be unintentional impacts on the mental health of emerging adults with LDs.

7.5 Implications

The broad implication of the present research pertains to awareness of and support for emerging adults with LDs. As mental illness impacts a significant proportion of emerging adults, and the transition from child/adolescent mental health services to adult mental health services is fragmented (Nguyen et al., 2017), systems thinking is needed when developing interventions (Hamdani et al., 2011). Firstly, awareness of LDs is important so that earlier interventions can occur. Not only does an earlier diagnosis result in better LD treatment outcomes, but the formal diagnosis by a registered psychologist includes a component on social, emotional, and behavioural strengths that considers internalizing and externalizing behaviours/disorders, which could also lead to treatment recommendations related to mental health (Ontario Psychological Association, 2018). Economically, earlier diagnosis enables individuals with LDs to benefit from school-based support and insurance coverage. As assessments for LD diagnoses by a registered psychologist often range from $2000-2500, this may not be accessible to emerging adults without insurance coverage or those in challenging financial positions (Learning Disability Association of Ontario, n.d.). Furthermore, post-secondary institutions may not offer accommodations without a formal assessment (Learning Disability Association of Ontario, n.d.), which many students are unaware of prior to beginning their post-secondary education, and this can create a barrier to success.

Within higher education and the workplace, lack of knowledge, stigma, and discrimination become especially important for those with invisible disabilities (Lindsay et al., 2018). Students with these types of disabilities are often faced with additional difficulties in disclosure due to fear of discreditation (Waterfield & Whelan, 2017), as well as lack of acceptance and accommodation (Lindsay et al., 2019). While appropriate accommodations are debated and a one-size-fits-all approach is not encouraged, resources to improve awareness should be provided in higher education and workplace settings. Informed educators and employers may, in turn, create supportive environments, which may help individuals with disabilities feel comfortable with disclosing their disability and seeking accommodation (Lindsay et al., 2019). Moreover, inclusive environments help reduce disability discrimination, which has been associated with negative mental health impacts (Temple & Kelaher, 2018). Taken together, the mental health challenges faced by emerging adults with LDs may be lessened by improved policy and practice within post-secondary institutions and the workplace.

Future research on emerging adulthood as a developmental period that is particularly vulnerable to mental health challenges is warranted. Additionally, future studies on the longitudinal association between LDs and mental illness in emerging adults are necessary to elucidate how LDs may impact mental health over time. As some individuals may experience

mental health challenges before becoming aware of their LD diagnosis, it would be important to see how a diagnosis may affect mental health outcomes. Moreover, future investigations should consider personal and interpersonal factors, such as measures of resiliency, which may help in the understanding of the mechanisms implicated in the association between LDs and psychological distress. In a longitudinal investigation with these covariates, it would be possible to explore how changes in the support system may influence mental well-being. For instance, if an individual moves from a less supportive to more supportive environment, or vice versa, this may provide further evidence for improved policy and practice. Furthermore, future studies should determine the psychometric properties of the K6 in those with LDs. If validated in this population, then the K6 could be adopted in initial mental health assessments, or perhaps in an LD screen, as a quick measure to suggest mental health support to those in need.

7.6 Strengths and Limitations

A perceived strength of this study is the broad encapsulation of LDs in the exposure of interest. Although it may be asserted that a self-reported identification of having an LD is a weakness, this broad identification accommodates the definitional and operational challenges that have impacted LD research. Additionally, the mental health of emerging adults with LDs has not been studied extensively, even though this developmental period is marked by changes that may be particularly challenging for those with LDs, such as transition to higher education or the workplace. Thus, the current study adds to the existing literature on emerging adults with invisible disabilities. Furthermore, this study examined potential modifiers in the association between LDs and psychological distress that other studies may not have had the sample size or data to investigate. As a result, these results aid in identifying additional considerations for intervention. The methodology of this study is also a strength as secondary data analysis is a relatively quick and cost-effective way to investigate associations not previously researched. Lastly, the CCHS-MH data, which are representative of the Canadian population, allow for high external validity within a Canadian context.

One limitation of the current study is that there is no information about type or severity of the LD, which would likely alter the measures of mental health. However, when considering the diagnostic challenges, it is difficult to ascertain these aspects of LDs; thus, the generalized identification of LD may avoid misclassification bias. Severity may also have been controlled for by the inclusion of the WHODAS 2.0 as a covariate. Secondly, there was also limited data on participant primary language, either through language or immigrant status variables, which meant that language could not be accounted for in the association between LD and psychological distress. While language may have implications on academic success, it is important to note that discretion is usually applied during diagnoses in order to account for language, culture, and immigration (Ontario Psychological Association, 2018), although this information is not contained in the data set. As this is a cross-sectional design, a temporal association between LDs and psychological distress cannot be asserted since both the exposure and outcome were recorded simultaneously. However, this study is hypothesis-generating and may encourage future cohort studies. Additionally, since the study utilized self-reporting, there is a potential for reporting bias – specifically recall and social desirability biases. There is a risk for recall bias as participants may have made errors remembering information from the past; social desirability bias is a concern as there was a great deal of sensitive personal information that participants may not have wanted to disclose. However, both types of information bias were likely minimized due

to confidentiality procedures and the use of validated measures, which contain neutral questions (i.e., WHO-CIDI) (Althubaiti, 2016). Due to the methodological strengths of the CCHS-MH, this study was unlikely impacted by bias. Lastly, stratified analyses may explain the lack of statistical significance as it created smaller sample sizes, and thus wider confidence intervals. Yet, the results warrant further investigation into effect modification by age, sex, ADHD status, and disability impairment.

8.0 Conclusion

The main conclusion from the current study is that emerging adults with LDs are more likely to have clinically significant higher psychological distress compared to emerging adults without LDs. The results support previous literature on the positive association between LDs and mental illness, and they also add to sparse research of this association in emerging adulthood. In addition, effect modification was present for all moderators, but it was only statistically significant for age and sex. Specifically, adjusted models were statistically significant for males and for those in the 15-19-year and 25-29-year age categories. Although this is broadly consistent with previous findings, the role that age and sex play in the association requires more attention. While not statistically significant, the current data also suggest that ADHD status and disability impairment should be investigated to further understand how comorbidity is implicated in this association. Nevertheless, using a representative sample of the Canadian population, this epidemiological inquiry provides a basis for improved policy and practice that considers the prevalence of mental illness in those with LDs. Improved awareness and support in post-secondary institutions and the workplace that reflect individual needs may help equip those with LDs to better face challenges. In turn, increased support may help reduce mental illness in individuals with LDs or other invisible disabilities, especially as they navigate emerging adulthood.

References

Abecassis, M., Isquith, P. K., & Roth, R. M. (2017). Characteristics of ADHD in the Emerging Adult: an Overview. *Psychological Injury and Law*, *10*(3), 197–208. https://doi.org/10.1007/s12207-017-9293-7

Alexander-Passe, N. (2006). How dyslexic teenagers cope: An investigation of self-esteem, coping and depression. *Dyslexia*, *12*(4), 256–275. https://doi.org/10.1002/dys.318

Alexander-Passe, N. (2008). The sources and manifestations of stress amongst school-aged dyslexics, compared with sibling controls. *Dyslexia, 14*(4), 291–313. https://doi.org/10.1002/dys.351

Althubaiti, A. (2016). Information bias in health research: Definition, pitfalls, and adjustment methods. *Journal of Multidisciplinary Healthcare*, *9*, 211–217. https://doi.org/10.2147/JMDH.S104807

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders, 5 ed.* (5th ed.). American Psychiatric Association.

American Psychological Association. (n.d.). *Psychological Distress*. American Psychological Association. Retrieved July 20, 2020, from https://dictionary.apa.org/psychological-distress

Andrews, G, & Peters, L. (1998). *The psychometric properties of the Composite International Diagnostic Interview*.

Andrews, Gavin, Kemp, A., Sunderland, M., von Korff, M., & Ustun, T. B. (2009). Normative data for the 12 item WHO disability assessment schedule 2.0. *PLoS ONE*, *4*(12), 1–6. https://doi.org/10.1371/journal.pone.0008343

Arnett, J. J. (2014). *Emerging Adulthood: The Winding Road from the Late Teens Through the Twenties*. Oxford University Press. https://books.google.ca/books?id=MGuJBAAAQBAJ

Aro, T., Eklund, K., Eloranta, A. K., Närhi, V., Korhonen, E., & Ahonen, T. (2019). Associations Between Childhood Learning Disabilities and Adult-Age Mental Health Problems, Lack of Education, and Unemployment. *Journal of Learning Disabilities*, *52*(1), 71–83. https://doi.org/10.1177/0022219418775118

Ascherman, L. I., & Shaftel, J. (2017). Facilitating Transition from High School and Special Education to Adult Life: Focus on Youth with Learning Disorders, Attention-Deficit/Hyperactivity Disorder, and Speech/Language Impairments. *Child and Adolescent Psychiatric Clinics of North America*, *26*(2), 311–327. https://doi.org/10.1016/j.chc.2016.12.009

Ashkenazi, S., Black, J. M., Abrams, D. A., Hoeft, F., & Menon, V. (2013). Neurobiological Underpinnings of Math and Reading Learning Disabilities. In *Journal of Learning Disabilities* (Vol. 46, Issue 6, pp. 549–569). https://doi.org/10.1177/0022219413483174

Baggio, S., Studer, J., Fructuoso, A., Grazioli, V. S., Heller, P., Wolff, H., Gmel, G., & Perroud, N. (2019). Does level of attention deficit-hyperactivity disorder symptoms predicts poor transition into adulthood? *International Journal of Public Health*, *64*(2), 165–172.

https://doi.org/10.1007/s00038-018-1147-x

Baumeister, A. L., Storch, E. A., & Geffken, G. R. (2008). Peer victimization in children with learning disabilities. *Child and Adolescent Social Work Journal*, *25*(1), 11–23. https://doi.org/10.1007/s10560-007-0109-6

Becker, N., Vasconcelos, M., Oliveira, V., Santos, F. C. Dos, Bizarro, L., Almeida, R. M. M. D., Salles, J. F. De, & Carvalho, M. R. S. (2017). Genetic and environmental risk factors for developmental dyslexia in children: systematic review of the last decade. *Developmental Neuropsychology*, *42*(7–8), 423–445. https://doi.org/10.1080/87565641.2017.1374960

Beitchman, J. H., Wilson, B., Douglas, L., Young, A., & Adlaf, E. (2001). Substance use disorders in young adults with and without LD: Predictive and concurrent relationships. *Journal of Learning Disabilities*, *34*(4), 317–332. https://doi.org/10.1177/002221940103400407

Bessaha, M. L. (2017). Factor Structure of the Kessler Psychological Distress Scale (K6) Among Emerging Adults. *Research on Social Work Practice*, *27*(5), 616–624. https://doi.org/10.1177/1049731515594425

Bilodeau, J., Marchand, A., & Demers, A. (2020). Psychological distress inequality between employed men and women: A gendered exposure model. *SSM - Population Health*, *11*. https://doi.org/10.1016/j.ssmph.2020.100626

Bonifacci, P., Storti, M., Tobia, V., & Suardi, A. (2016). Specific Learning Disorders: A Look Inside Children's and Parents' Psychological Well-Being and Relationships. *Journal of Learning Disabilities*, *49*(5), 532–545. https://doi.org/10.1177/0022219414566681

Browne, D. T., Rokeach, A., Wiener, J., Hoch, J. S., Meunier, J. C., & Thurston, S. (2013). Examining the Family-Level and Economic Impact of Complex Child Disabilities as a Function of Child Hyperactivity and Service Integration. *Journal of Developmental and Physical Disabilities*, *25*(2), 181–201. https://doi.org/10.1007/s10882-012-9295-z

Canadian Institute for Health Information. (2012). *The Role of Social Support in Reducing Psychological Distress*. www.cihi.ca

Canadian Institutes of Health Research, Natural Sciences and Engineering Research Council of Canada, & Social Sciences and Humanities Research Council. (2018). *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans.* https://ethics.gc.ca/eng/documents/tcps2-2018-en-interactive-final.pdf

Caron, J. (2013). Une validation de la forme abrégée de l'Échelle de provisions sociales : l'ÉPS-10 items [A validation of the Social Provisions Scale: the SPS-10 items]. *Santé Mentale Au Québec*, *38*(1), 297–318.

Carroll, J. M., & Iles, J. E. (2006). An assessment of anxiety levels in dyslexic students in higher education. *British Journal of Educational Psychology*, *76*(3), 651–662. https://doi.org/10.1348/000709905X66233

Cassell, D. L. (2006). Sample Survey Data and the Procs You OUGHT To Be Using. *Western Users of SAS Software 2006*, 1–13. Sample Survey Data and the Procs You OUGHT To Be Using

Cederlöf, M., Maughan, B., Larsson, H., D'Onofrio, B. M., & Plomin, R. (2017). Reading problems and major mental disorders-co-occurrences and familial overlaps in a Swedish nationwide cohort. *Journal of Psychiatric Research, 91,* 124–129. https://doi.org/10.1016/j.jpsychires.2017.03.014

Cortiella, C., & Horowitz, S. H. (2014). *The State of Learning Disabilities Facts, Trends and Emerging Issues*.

Crawford, C. (2007). *Learning Disabilities in Canada: Economic Costs to Individuals, Families, and Society,*. https://www.ldac-acta.ca/downloads/pdf/research/5B -Economic Costs of LD - Jan 2002 RJune_2007.pdf

Cutrona, C., & Russell, D. (1987). The Provisions of Social Relationships and Adaptation to Stress. In W. H. Jones & D. Perlman (Eds.), *Advances in Personal Relationships* (Vol. 1, pp. 37–67). JAI Press.

D'Intino, J. S. (2017). Learning disabilities in Canada: Definitions and accommodations. *Canadian Psychology, 58*(3), 228–237. https://doi.org/10.1037/cap0000116

Daw, J. (2001). Substance abuse linked to learning disabilities and behavioral disorders. *Monitor on Psychology, 32*(7). http://www.apa.org/monitor/jun01/disorders

DuPaul, G. J., Gormley, M. J., & Laracy, S. D. (2013). Comorbidity of LD and ADHD: Implications of DSM-5 for Assessment and Treatment. *Journal of Learning Disabilities, 46*(1), 43–51. https://doi.org/10.1177/0022219412464351

DuPaul, G. J., Pinho, T. D., Pollack, B. L., Gormley, M. J., & Laracy, S. D. (2017). First-Year College Students With ADHD and/or LD: Differences in Engagement, Positive Core Self-Evaluation, School Preparation, and College Expectations. *Journal of Learning Disabilities, 50*(3), 238–251. https://doi.org/10.1177/0022219415617164

Easter Seals. (2019). *Disability in Canada: Facts and Figures*. https://easterseals.ca/english/wp-content/uploads/2019/10/Disability-in-Canada-Facts-Figures-updated-Oct-2019.pdf

Eliez, S., Rumsey, J. M., Giedd, J. N., Schmitt, J. E., Patwardhan, A. J., & Reiss, A. L. (2000). Morphological alteration of temporal lobe gray matter in dyslexia: An MRI study. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 41*(5), 637–644. https://doi.org/10.1111/1469-7610.00650

Federici, S., Bracalenti, M., Meloni, F., & Luciano, J. V. (2017). World Health Organization disability assessment schedule 2.0: An international systematic review. *Disability and Rehabilitation, 39*(23), 2347–2380. https://doi.org/10.1080/09638288.2016.1223177

Ferro, M. A. (2019). The Psychometric Properties of the Kessler Psychological Distress Scale (K6) in an Epidemiological Sample of Canadian Youth. *Canadian Journal of Psychiatry, 64*(9), 647–657. https://doi.org/10.1177/0706743718818414

Fletcher, J. M., & Grigorenko, E. L. (2017). Neuropsychology of learning disabilities: The past and the future. *Journal of the International Neuropsychological Society, 23*(9-10 Special Issue), 930–940. https://doi.org/10.1017/S1355617717001084

Fletcher, J. M., Lyon, G. R., Fuchs, L. S., & Barnes, M. A. (2007). *Learning Disabilities: From*

Identification to Intervention (1st ed.). The Guilford Press.

Francis, D. A., Caruana, N., Hudson, J. L., & McArthur, G. M. (2019). The association between poor reading and internalising problems: A systematic review and meta-analysis. *Clinical Psychology Review*, *67*, 45–60. https://doi.org/10.1016/j.cpr.2018.09.002

Gerber, P. J. (2012). The impact of learning disabilities on adulthood: A review of the evidenced-based literature for research and practice in adult education. *Journal of Learning Disabilities*, *45*(1), 31–46. https://doi.org/10.1177/0022219411426858

Gibson, C. J., & Gruen, J. R. (2008). The human lexinome: Genes of language and reading. *Journal of Communication Disorders*, *41*(5), 409–420. https://doi.org/10.1016/j.jcomdis.2008.03.003

Görker, I. (2019). The Prevalence and Gender Differences in Specific Learning Disorder. In *Learning Disabilities-Neurological Bases, Clinical Features and Strategies of Intervention* (p. 13). IntechOpen. https://doi.org/http://dx.doi.org/10.5772/57353

Gow, M. A., Mostert, Y., & Dreyer, L. (2020). The promise of equal education not kept: Specific learning disabilities - The invisible disability. *African Journal of Disability*, *9*, 647. https://doi.org/10.4102/ajod.v9i0.647

Gregg, N. (2009). *Adolescents and adults with learning disabilities and ADHD: Assessment and accommodation*. Guilford Press.

Haft, S. L., Chen, T., LeBlanc, C., Tencza, F., & Hoeft, F. (2019). Impact of mentoring on socio-emotional and mental health outcomes of youth with learning disabilities and attention-deficit hyperactivity disorder. *Child and Adolescent Mental Health*, *24*(4), 318–328. https://doi.org/10.1111/camh.12331

Haft, S. L., Duong, P. H., Ho, T. C., Hendren, R. L., & Hoeft, F. (2019). Anxiety and Attentional Bias in Children with Specific Learning Disorders. *Journal of Abnormal Child Psychology*, *47*(3), 487–497. https://doi.org/10.1007/s10802-018-0458-y

Hamdani, Y., Jetha, A., & Norman, C. (2011). Systems thinking perspectives applied to healthcare transition for youth with disabilities: A paradigm shift for practice, policy and research. *Child: Care, Health and Development*, *37*(6), 806–814. https://doi.org/10.1111/j.1365-2214.2011.01313.x

Hammill, D. D. (1993). A brief look at the learning disabilities movement in the United States. *Journal of Learning Disabilities*, *26*(5), 295–310. https://doi.org/10.1177/002221949302600502

Hammill, D. D., Leigh, J. E., Mcnutt, G., & Larsen, S. C. (1987). A New Definition of Learning Disabilities. *Journal of Learning Disabilities*, *20*(2), 109–113.

Hasin, D. S., Sarvet, A. L., Meyers, J. L., Saha, T. D., Ruan, W. J., Stohl, M., & Grant, B. F. (2018). Epidemiology of adult DSM-5 major depressive disorder and its specifiers in the United States. *JAMA Psychiatry*, *75*(4), 336–346. https://doi.org/10.1001/jamapsychiatry.2017.4602

Hayes, A. M., Dombrowski, E., Shefcyk, A. H., & Bulat, J. (2018). *Learning Disabilities*

Screening and Evaluation Guide for Low- and Middle-Income Countries. https://doi.org/10.3768/rtipress.2018.op.0052.1804

Hendren, R. L., Haft, S. L., Black, J. M., White, N. C., & Hoeft, F. (2018). Recognizing psychiatric comorbidity with reading disorders. *Frontiers in Psychiatry*, *9*(MAR). https://doi.org/10.3389/fpsyt.2018.00101

Hynd, G. W., Marshall, R., & Gonzalez, J. (1991). Learning disabilities and presumed central nervous system dysfunction. *Learning Disability Quarterly*, *14*(4), 283–296. https://doi.org/10.2307/1510664

K10 and K6 Scales. (2005). National Comorbidity Survey. https://www.hcp.med.harvard.edu/ncs/k6_scales.php

Kang, Y. K., Guo, W. J., Xu, H., Chen, Y. H., Li, X. J., Tan, Z. P., Li, N., Gesang, Z. R., Wang, Y. M., Liu, C. B., Luo, Y., Feng, J., Xu, Q. J., Lee, S., & Li, T. (2015). The 6-item Kessler psychological distress scale to survey serious mental illness among Chinese undergraduates: Psychometric properties and prevalence estimate. *Comprehensive Psychiatry*, *63*, 105–112. https://doi.org/10.1016/j.comppsych.2015.08.011

Karande, S., Bhosrekar, K., Kulkarni, M., & Thakker, A. (2009). Health-related quality of life of children with newly diagnosed specific learning disability. *Journal of Tropical Pediatrics*, *55*(3), 160–169. https://doi.org/10.1093/tropej/fmn099

Kessler, R. C., Andrews, G., Colpe, L. J., Hiripi, E., Mroczek, D. K., Normand, S. L. T., Walters, E. E., & Zaslavsky, A. M. (2002). Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychological Medicine*, *32*(6), 959–976. https://doi.org/10.1017/S0033291702006074

Kessler, Ronald C., Barker, P. R., Colpe, L. J., Epstein, J. F., Gfroerer, J. C., Hiripi, E., Howes, M. J., Normand, S. L. T., Manderscheid, R. W., Walters, E. E., & Zaslavsky, A. M. (2003). Screening for serious mental illness in the general population. *Archives of General Psychiatry*, *60*(2), 184–189. https://doi.org/10.1001/archpsyc.60.2.184

Kimber, M., Rehm, J., & Ferro, M. A. (2015). Measurement invariance of the WHODAS 2.0 in a population-based sample of youth. *PLoS ONE*, *10*(11), e0142385. https://doi.org/10.1371/journal.pone.0142385

Kirk, S. (1963). Behavioral Diagnosis and Remediation of Learning Disabilities. *Conference on Exploring Problems of the Perceptually Handicapped Child*, 1–23.

Klassen, R. M., Tze, V. M. C., & Hannok, W. (2013). Internalizing Problems of Adults With Learning Disabilities: A Meta-Analysis. *Journal of Learning Disabilities*, *46*(4), 317–327. https://doi.org/10.1177/0022219411422260

Lagae, L. (2008). Learning Disabilities: Definitions, Epidemiology, Diagnosis, and Intervention Strategies. *Pediatric Clinics of North America*, *55*(6), 1259–1268. https://doi.org/10.1016/j.pcl.2008.08.001

Learning Disability Association of Ontario. (n.d.). *Adults with LD and Assessment*. https://www.ldao.ca/introduction-to-ldsadhd/articles/about-assessment/adults-with-ld-and-assessment/

Lindsay, S., Cagliostro, E., & Carafa, G. (2018). A systematic review of workplace disclosure and accommodation requests among youth and young adults with disabilities. In *Disability and Rehabilitation* (Vol. 40, Issue 25, pp. 2971–2986). Taylor and Francis Ltd. https://doi.org/10.1080/09638288.2017.1363824

Lindsay, S., Cagliostro, E., Leck, J., Shen, W., & Stinson, J. (2019). Disability disclosure and workplace accommodations among youth with disabilities. *Disability and Rehabilitation*, *41*(16), 1914–1924. https://doi.org/10.1080/09638288.2018.1451926

Maag, J. W., Irvin, D. M., Reid, R., & Vasa, S. E. (1994). Prevalence and Predictors of Substance Use: A Comparison Between Adolescents With and Without Learning Disabilities. *Journal of Learning Disabilities*, *27*(4), 223–234.

Maag, J. W., & Reid, R. (2006). Depression Among Students with Learning Disabilities: Assessing the Risk. *Journal of Learning Disabilities*, *39*(1), 3–10.

Macleod, K. B., & Brownlie, E. B. (2014). Mental health and transitions from adolescence to emerging adulthood: Developmental and diversity considerations. *Canadian Journal of Community Mental Health*, *33*(1), 77–86. https://doi.org/10.7870/cjcmh-2014-007

Madigan, S., Wade, M., Plamondon, A., Browne, D., & Jenkins, J. M. (n.d.). *Birth Weight Variability and Language Development: Risk, Resilience, and Responsive Parenting*. https://doi.org/10.1093/jpepsy/jsv056

Mammarella, I. C., Ghisi, M., Bomba, M., Bottesi, G., Caviola, S., Broggi, F., & Nacinovich, R. (2016). Anxiety and depression in children with nonverbal learning disabilities, reading disabilities, or typical development. *Journal of Learning Disabilities*, *49*(2), 130–139. https://doi.org/10.1177/0022219414529336

Mannino, J. E. (2015). Resilience and Transitioning to Adulthood among Emerging Adults with Disabilities. *Journal of Pediatric Nursing*, *30*(5), e131–e145. https://doi.org/10.1016/j.pedn.2015.05.017

Margai, F., & Henry, N. (2003). A community-based assessment of learning disabilities using environmental and contextual risk factors. *Social Science & Medicine*, *56*(5), 1073–1085.

Martínez, R. S., & Semrud-Clikeman, M. (2004). Functioning of Young Adolescents Learning Disabilities. *Journal of Learning Disabilities*, *37*(5), 411–420. https://doi.org/10.1177/00222194040370050401

McCrory, E., Frith, U., Brunswick, N., & Price, C. (2000). Abnormal functional activation during a simple word repetition task: A PET study of adult dyslexics. *Journal of Cognitive Neuroscience*, *12*(5), 753–762. https://doi.org/10.1162/089892900562570

McNamara, J., Vervaeke, S. L., & Willoughby, T. (2008). Learning disabilities and risk-taking behavior in adolescents: A comparison of those with and without comorbid attention-deficit/hyperactivity disorder. *Journal of Learning Disabilities*, *41*(6), 561–574. https://doi.org/10.1177/0022219408326096

Meyer, M. S., & Felton, R. H. (1999). Repeated reading to enhance fluency: Old approaches and new directions. *Annals of Dyslexia*, *49*(1), 283–306.

Moll, K., Kunze, S., Neuhoff, N., Bruder, J., & Schulte-Körne, G. (2014). Specific learning disorder: Prevalence and gender differences. *PLoS ONE*, *9*(7), e103537. https://doi.org/10.1371/journal.pone.0103537

Morris, S., Fawcett, G., Brisebois, L., & Hughes, J. (2018). *Canadians Survey on Disabilities: A demographic, employment and income profile, 2017*. https://www150.statcan.gc.ca/n1/en/daily-quotidien/181128/dq181128a-eng.pdf?st=ehaI_KDQ

Morrison, G. M., & Cosden, M. A. (1997). Risk, resilience, and adjustment of individuals with learning disabilities. *Learning Disability Quarterly*, *20*(1), 43–60. https://doi.org/10.2307/1511092

Moseholm, E., Rydahl-Hansen, S., Overgaard, D., Wengel, H. S., Frederiksen, R., Brandt, M., & Lindhardt, B. (2016). Health-related quality of life, anxiety and depression in the diagnostic phase of suspected cancer, and the influence of diagnosis. *Health and Quality of Life Outcomes*, *14*(1), 1–12. https://doi.org/10.1186/s12955-016-0484-9

Nalavany, B. A., Carawan, L. W., & Rennick, R. A. (2011). Psychosocial experiences associated with confirmed and self-identified dyslexia: A participant-driven concept map of adult perspectives. *Journal of Learning Disabilities*, *44*(1), 63–79. https://doi.org/10.1177/0022219410374237

National Academies of Science, E. and M. (2015). *Mental Disorders and Disabilities Among Low-Income Children*. National Academies Press.

National Institute for Learning Development Canada. (n.d.). *Learning Disabilities*. Retrieved May 4, 2020, from https://nildcanada.org/learning-disabilities/

Nelson, J. M., & Gregg, N. (2012). Depression and anxiety among transitioning adolescents and college students with ADHD, dyslexia, or comorbid ADHD/dyslexia. *Journal of Attention Disorders*, *16*(3), 244–254. https://doi.org/10.1177/1087054710385783

Nelson, J. M., & Harwood, H. (2011). Learning disabilities and anxiety: A meta-analysis. *Journal of Learning Disabilities*, *44*(1), 3–17. https://doi.org/10.1177/0022219409359939

Nguyen, T., Embrett, M. G., Barr, N. G., Mulvale, G. M., Vania, D. K., Randall, G. E., & DiRezze, B. (2017). Preventing Youth from Falling Through the Cracks Between Child/Adolescent and Adult Mental Health Services: A Systematic Review of Models of Care. *Community Mental Health Journal*, *53*(4), 375–382. https://doi.org/10.1007/s10597-017-0098-7

Norona, J. C., Preddy, T. M., & Welsh, D. P. (2014). *How Gender Shapes Emerging Adulthood* (Jeffrey Jensen Arnett (Ed.); Vol. 1). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199795574.013.13

Nurullah, A. S. (2010). Gender Differences in Distress: The Mediating Influence of Life Stressors and Psychological Resources. *Asian Social Science*, *6*(5), 27–35. https://doi.org/10.5539/ass.v6n5p27

Ontario Psychological Association. (2018). *Ontario Psychological Association Guidelines for diagnosis and assessment of children, adolescents, and adults with learning disabilities*

(Issue June). http://www.ldao.ca/wp-content/uploads/OPA-Guidelines-for-Diagnosis-Assessment-of-Learning-Disabilities-Sept.-7-2018-1.pdf

Orpana, H. M., Lang, J. J., & Yurkowski, K. (2019). Validation of a brief version of the social provisions scale using canadian national survey data. *Health Promotion and Chronic Disease Prevention in Canada*, *39*(12), 323–332. https://doi.org/10.24095/hpcdp.39.12.02

Parekh, R. (2017). *What is Intellectual Disability?* American Psychiatric Association. https://www.psychiatry.org/patients-families/intellectual-disability/what-is-intellectual-disability

Pennington, B. F., & Peterson, R. L. (2015). Neurodevelopmental Disorders: Learning Disorders. *Psychiatry*, *1*, 765–778. http://ebookcentral.proquest.com/lib/oculcarleton-ebooks/detail.action?docID=1895577.

Petersen, A. C., Compas, B. E., Brooks-Gunn, J., Stemmler, M., Ey, S., & Grant, K. E. (1993). Depression in Adolescence. *American Psychologist*, *48*(2), 155.

Phetcharat, M., Putdivarnichapong, W., Sitthimongkol, Y., & Apinuntavech, S. (2012). Predicting factors for risk of depression in adolescents with learning disorders. *Journal of the Medical Association of Thailand*, *95*(11), 1480–1484.

Pratt, H. D., & Patel, D. R. (2007). Learning Disorders in Children and Adolescents. *Primary Care: Clinics in Office Practice*, *34*(2), 361–374. https://doi.org/10.1016/j.pop.2007.04.014

Raskind, M. H., Goldberg, R. J., Higgins, E. L., & Herman, K. L. (1999). Patterns of Change and Predictors of Success in Individuals With Learning Disabilities: Results From a Twenty-Year Longitudinal Study. *Learning Disabilities Research and Practice*, *14*(1), 35–49. https://doi.org/10.1207/sldrp1401_4

Robledo-Ramón, P., & García-Sánchez, J.-N. (2012). The Family Environment of Students with Learning Disabilities and ADHD. In W. Sittiprapaporn (Ed.), *Learning Disabilities* (pp. 129–148). http://www.intechopen.com/books/learning-disabilities/the-family-environment-of-students-with-learning-disabilities-and-adhd

Rotzer, S., Kucian, K., Martin, E., Von Aster, M., Loenneker, T., & Rotzer, S. (2008). Optimized voxel-based morphometry in children with developmental dyscalculia Optimized Voxel-Based Morphometry in Children with Developmental Dyscalculia Running title: Brain morphometry in dyscalculic children. *NeuroImage*, *39*(1), 417–422.

Sahu, A., Bhargava, R., Sagar, R., & Mehta, M. (2018). *Perception of Families of Children with Specific Learning Disorder: An Exploratory Study*. https://doi.org/10.4103/IJPSYM.IJPSYM_148_18

Saltychev, M., Katajapuu, N., Bärlund, E., & Laimi, K. (2019). Psychometric properties of 12-item self-administered World Health Organization disability assessment schedule 2.0 (WHODAS 2.0) among general population and people with non-acute physical causes of disability–systematic review. *Disability and Rehabilitation*, 1–6. https://doi.org/10.1080/09638288.2019.1643416

Schulte-Körne, G., Deimel, W., & Remschmidt, H. (1997). Can self-report data on deficits in reading and spelling predict spelling disability as defined by psychometric tests? *Reading*

and Writing, *9*(1), 55–63. https://doi.org/10.1023/A:1007941403441

Shalev, R. S., Manor, O., Kerem, B., Ayali, M., Badichi, N., Friedlander, Y., & Gross-Tsur, V. (2001). Developmental Dyscalculia Is a Familial Learning Disability. *Journal of Learning Disabilities*, *34*(1), 59–65. https://doi.org/10.1177/002221940103400105

Shaywitz, B. A., Shaywitz, S. E., Pugh, K. R., Constable, R. T., Skudlarski, P., Fulbright, R. K., Bronen, R. A., Fletcher, J. M., Shankweiler, D. P., Katz, L., & Gore, J. C. (1995). Sex differences in the functional organization of the brain for language. *Nature*, *373*(1), 607–609.

Shaywitz, S. E., & Shaywitz, B. A. (2001). The Neurobiology of Reading and Dyslexia. In *Focus on Basics* (Vol. 5, Issue A).

Smart, D., Youssef, G. J., Sanson, A., Prior, M., Toumbourou, J. W., & Olsson, C. A. (2017). Consequences of childhood reading difficulties and behaviour problems for educational achievement and employment in early adulthood. *British Journal of Educational Psychology*, *87*(2), 288–308. https://doi.org/10.1111/bjep.12150

Snowling, M. J., & Melby-Lervag, M. (2016). Oral Language Deficits in Familial Dyslexia: A Meta-Analysis and Review. *Psychological Bulletin*, *142*(5), 498–545. https://doi.org/10.1037/bul0000037.supp

Stanton-Chapman, T. L., Chapman, D. A., & Scott, K. G. (2001). Identification of Early Risk Factors for Learning Disabilities. *Journal of Early Intervention*, *24*(3), 193–206. https://doi.org/10.1177/105381510102400305 01

Statistics Canada. (2013). *Canadian Community Health Survey (CCHS) - Mental Health User Guide [Microdata files]*. http://odesi1.scholarsportal.info/documentation/CCHS_2012_MH/cchs_mh_gid.pdf

Statistics Canada. (2014a). *Canadian Community Health Survey, 2012: Mental Health component [public-use microdata file]*.

Statistics Canada. (2014b). *Canadian Community Health Survey (CCHS) - Mental Health [Public Use Microdata File]: Derived Variable (DV) Specifications*. http://odesi1.scholarsportal.info/documentation/CCHS_2012_MH/cchs_mh_derived_variables.pdf

Stewart, D., Law, M., Young, N. L., Forhan, M., Healy, H., Burke-Gaffney, J., & Freeman, M. (2014). Complexities during transitions to adulthood for youth with disabilities: person–environment interactions. *Disability and Rehabilitation*, *36*(23), 1998–2004. https://doi.org/10.3109/09638288.2014.885994

Stromswold, K. (2001). The heritability of language: A review and metaanalysis of twin, adoption, and linkage studies. *Language*, *77*(4), 647–723. https://doi.org/10.1353/lan.2001.0247

Suggate, S. P. (2010). Why what we teach depends on when: Grade and reading intervention modality moderate effect size. *Developmental Psychology*, *46*(6), 1556–1579. https://doi.org/10.1037/a0020612

Svetaz, M. V., Ireland, M., & Blum, R. (2000). Adolescents with learning disabilities: Risk and protective factors associated with emotional well-being: findings from the National Longitudinal Study of Adolescent Health. *Journal of Adolescent Health*, *27*(5), 340–348. https://doi.org/10.1016/S1054-139X(00)00170-1

Temple, J. B., & Kelaher, M. (2018). Is disability exclusion associated with psychological distress? Australian evidence from a national cross-sectional survey. *BMJ Open*, *8*(5), 1–10. https://doi.org/10.1136/bmjopen-2017-020829

Thaler, N. S., Kazemi, E., & Wood, J. J. (2010). Measuring anxiety in youth with learning disabilities: Reliability and validity of the multidimensional anxiety scale for children (MASC). *Child Psychiatry and Human Development*, *41*(5), 501–514. https://doi.org/10.1007/s10578-010-0182-5

Tompke, B. K., Tang, J., Oltean, I. I., Buchan, M. C., Reaume, S. V., & Ferro, M. A. (2018). Measurement Invariance of the WHODAS 2.0 Across Youth With and Without Physical or Mental Conditions. *Assessment*, 1073191118816435. https://doi.org/10.1177/1073191118816435

Undheim, A. M. (2003). Dyslexia and psychosocial factors. A follow-up study of young Norwegian adults with a history of dyslexia in childhood. *Nordic Journal of Psychiatry*, *57*(3), 221–226. https://doi.org/10.1080/08039480310001391

Valdez, C. R., Chavez, T., & Woulfe, J. (2013). Emerging adults' lived experience of formative family stress: The family's lasting influence. *Qualitative Health Research*, *23*(8), 1089–1102. https://doi.org/10.1177/1049732313494271

Visser, L., Kalmar, J., Linkersdörfer, J., Görgen, R., Rothe, J., Hasselhorn, M., & Schulte-Körne, G. (2020). Comorbidities Between Specific Learning Disorders and Psychopathology in Elementary School Children in Germany . In *Frontiers in Psychiatry* (Vol. 11, p. 292). https://www.frontiersin.org/article/10.3389/fpsyt.2020.00292

Waterfield, B., & Whelan, E. (2017). Learning disabled students and access to accommodations: socioeconomic status, capital, and stigma. *Disability & Society*, *32*(7), 986–1006. https://doi.org/10.1080/09687599.2017.1331838

Waterton, J. J., & Duffy, J. C. (1984). A Comparison of Computer Interviewing Techniques and Traditional Methods in the Collection of Self-Report Alcohol Consumption Data in a Field Survey. *International Statistical Review*, *52*(2), 173–182.

Watterberg, K. L., Aucott, S., Benitz, W. E., Cummings, J. J., Eichenwald, E. C., Goldsmith, J., Poindexter, B. B., Puopolo, K., Stewart, D. L., Wang, K. S., Ecker, J. L., Wax, J. R., Borders, A. E. B., El-Sayed, Y. Y., Heine, R. P., Jamieson, D. J., Mascola, M. A., Minkoff, H. L., Stuebe, A. M., … Wharton, K. R. (2015). The apgar score. *Pediatrics*, *136*(4), 819–822. https://doi.org/10.1542/peds.2015-2651

Wells, C. R. (2017). Analysis of complex survey data using SAS. *Western Users of SAS Software 2017*. https://doi.org/10.1016/S0169-2607(00)00088-2

WHO Secretariat for the development of a comprehensive mental health action plan. (2012). *Risks to mental health: an overview of vulnerabilities and risk factors*.

https://www.who.int/mental_health/mhgap/risks_to_mental_health_EN_27_08_12.pdf

Wicks-Nelson, R., & Israel, A. C. (2013). *Abnormal Child and Adolescent Psychology* (A. Dodge (Ed.); 8th ed.). Pearson Education Inc.

Willcutt, E. G., McGrath, L. M., Pennington, B. F., Keenan, J. M., DeFries, J. C., Olson, R. K., & Wadsworth, S. J. (2019). Understanding comorbidity between specific learning disabilities. *New Directions for Child and Adolescent Development*, *2019*(165), 91–109. https://doi.org/10.1002/cad.20291

Willcutt, E. G., & Pennington, B. F. (2000). Psychiatric comorbidity in children and adolescents with reading disability. *Journal of Child Psychology and Psychiatry*, *41*(8), 1039–1048.

Wilson, A. M., Deri Armstrong, C., Furrie, A., & Walcot, E. (2009). The mental health of canadians with self-reported learning disabilities. *Journal of Learning Disabilities*, *42*(1), 24–40. https://doi.org/10.1177/0022219408326216

Wood, D., Crapnell, T., Lau, L., Bennett, A., Lotstein, D., Ferris, M., & Kuo, A. (2018). Emerging Adulthood as a Critical Stage in the Life Course. In N. Halfon, C. B. Forrest, R. M. Lerner, & E. M. Faustman (Eds.), *Handbook of life course health development* (pp. 123–144). Springer.

World Health Organization. (2018). *WHO Disability Assessment Schedule 2.0 (WHODAS 2.0)*. World Health Organization. https://www.who.int/classifications/icf/more_whodas/en/

Appendix A

Table A1: Predictors of Missing Kessler Psychological Distress (K6) Scale Data (n = 26)

Variables	**OR (95% CI)**
Age	0.51 (0.22, 1.19)
Sex	0.61 (0.19, 1.98)
School Status	0.35 (0.11, 1.10)
Income	0.96 (0.59, 1.54)
Has a Learning Disability	0.52 (0.12, 2.29)
WHODAS 2.0	1.00 (0.93, 1.07)
Has ADHD	0.52 (0.09, 3.12)
Past 12-month Medication Use for Emotions, Mental Health, Alcohol or Drug Problems	1.34 (0.16, 10.91)
Help Received in Past 12 Months for Emotions, Mental Health, Alcohol or Drug Problems	1.04 (0.25, 4.22)
Has Family Member with Emotions, Mental Health, Alcohol or Drug Problems	5.12 (1.16, 22.49)
SPS-10 Scores	0.97 (0.82, 1.15)
Lifetime Any Substance Use Disorder	5.61 (0.68, 46.70)
Lifetime Major Depressive Episode	0.60 (0.13, 2.81)
Lifetime Generalized Anxiety Disorder	0.72 (0.15, 3.34)

OR = Odds Ratio; CI = Confidence Interval

Appendix B

Table B1: Normality of Residuals from Regression of Log-Transformed K6 Scores on Learning Disabilities

Test	Statistic (P-value)			
	Model 1	**Model 2**	**Model 3**	**Model 4**
Kolmogorov-Smirnoff	0.11 (<.010)	0.07 (<.010)	0.05 (<.010)	0.05 (<.010)
Cramer-von Mises	8.96 (<.005)	3.69 (<.005)	3.87 (<.005)	4.01 (<.005)
Anderson-Darling	67.79 (<.005)	32.17 (<.005)	25.96 (<.005)	26.47 (<.005)

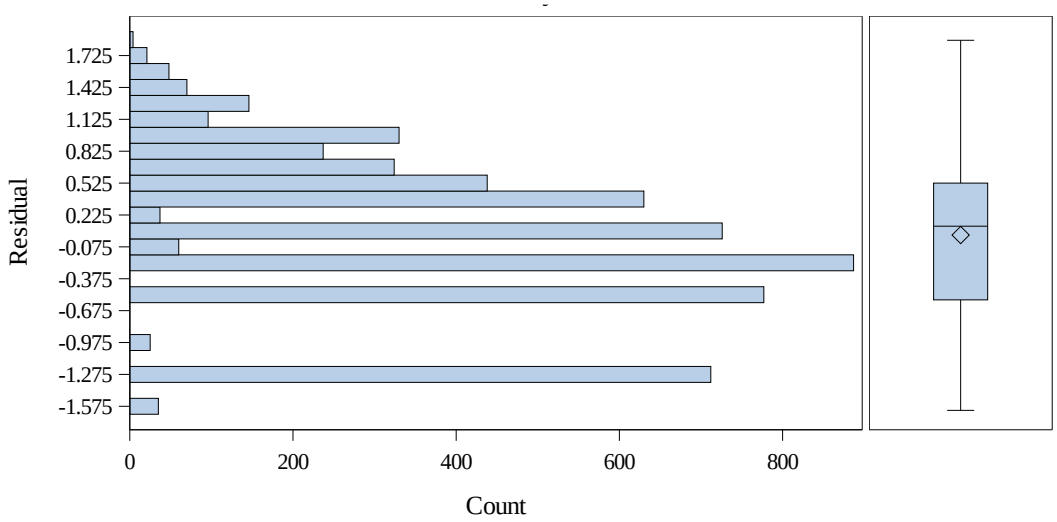

Figure B1: Distribution of Residuals for Model 1

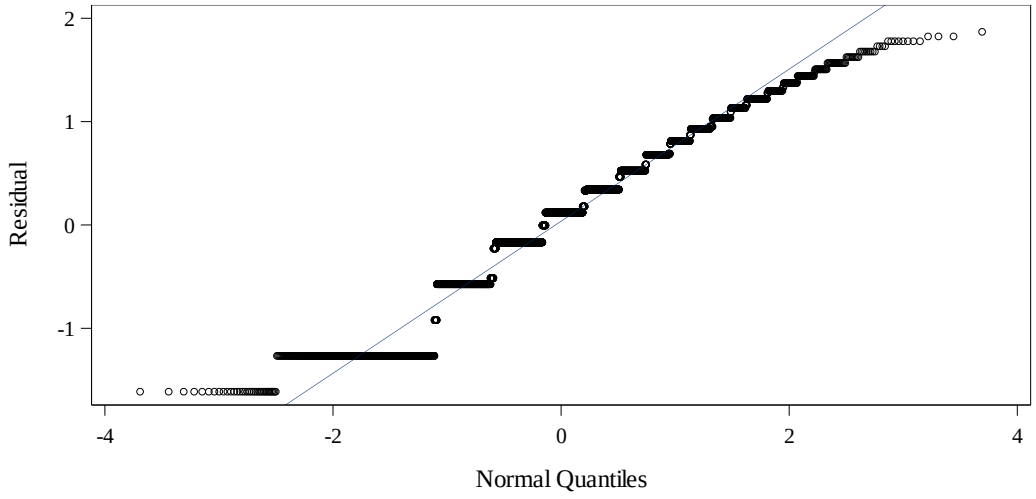

Figure B2: Q-Q Plot of Residuals for Model 1

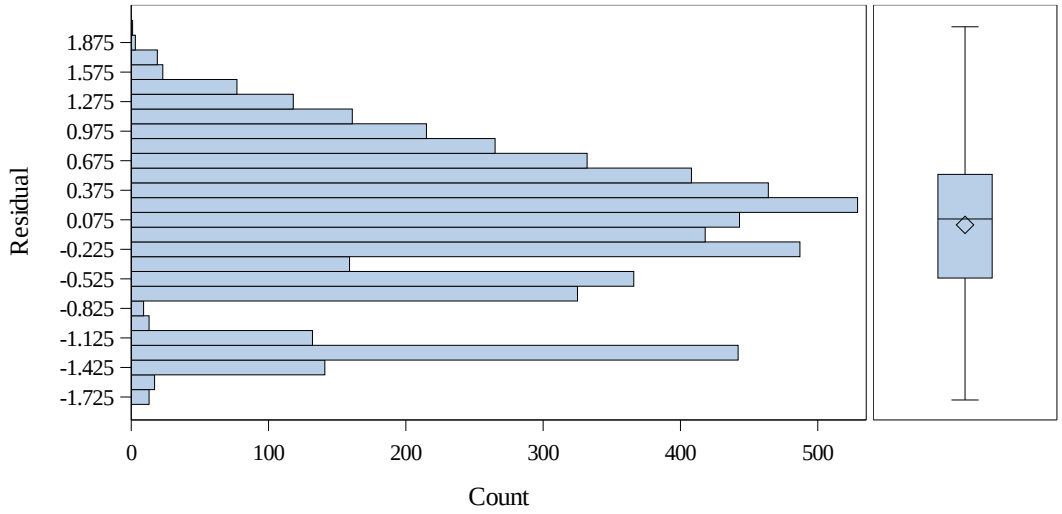

Figure B3: Distribution of Residuals for Model 2

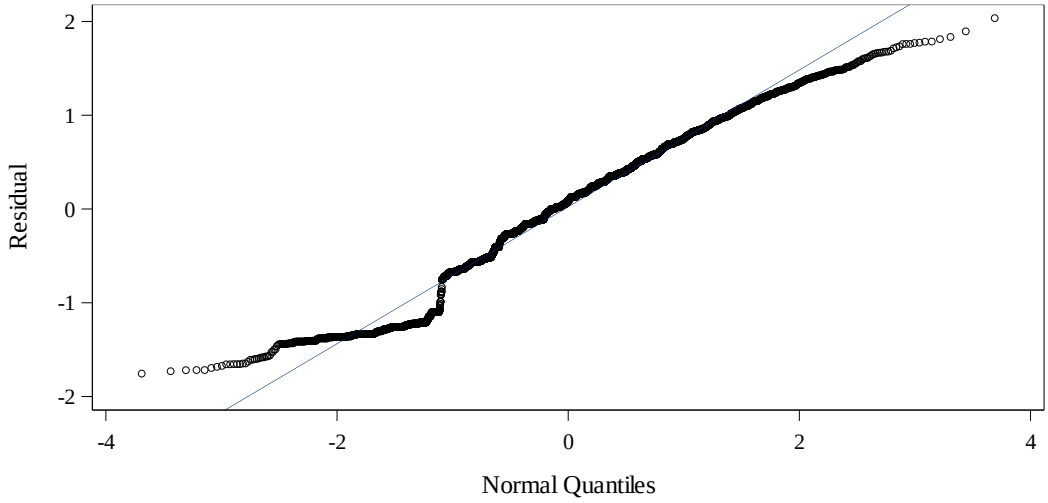

Figure B4: Q-Q Plot of Residuals for Model 2

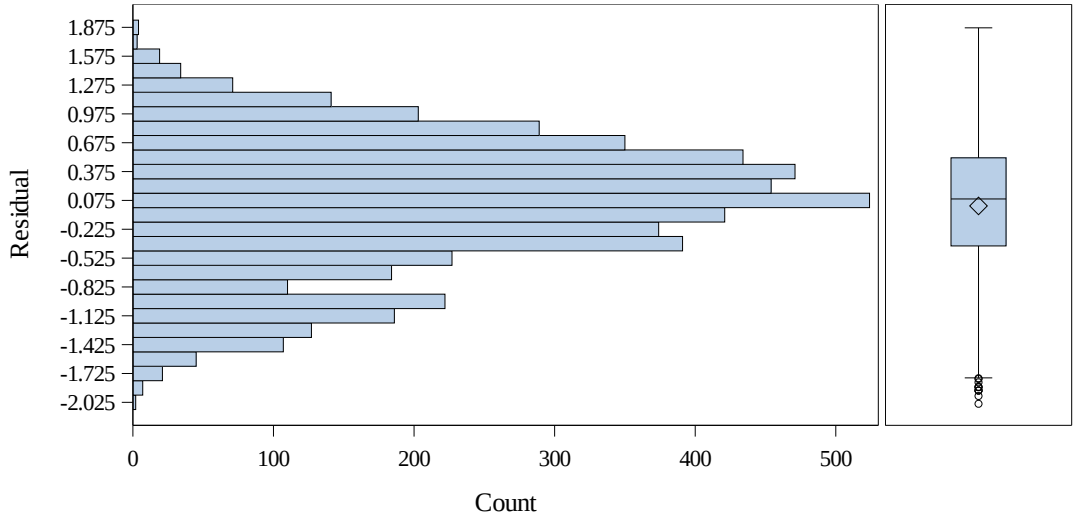

Figure B5: Distribution of Residuals for Model 3

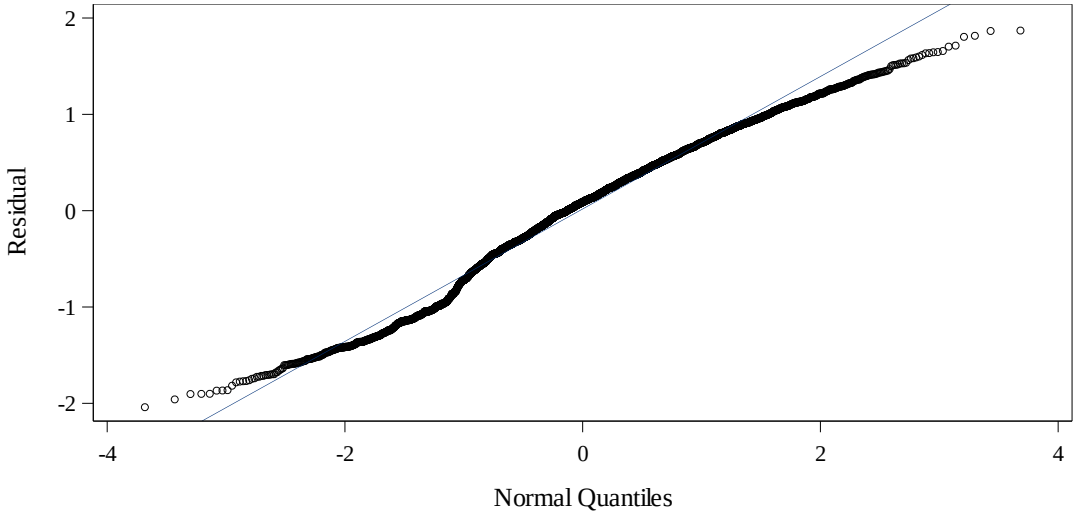

Figure B6: Q-Q Plot of Residuals for Model 3

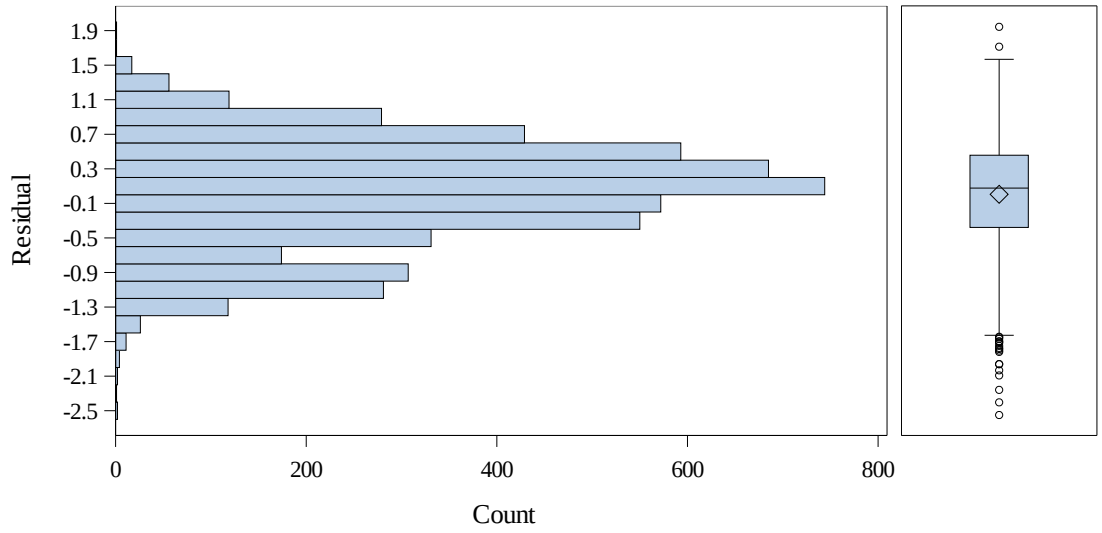

Figure B7: Distribution of Residuals for Model 4

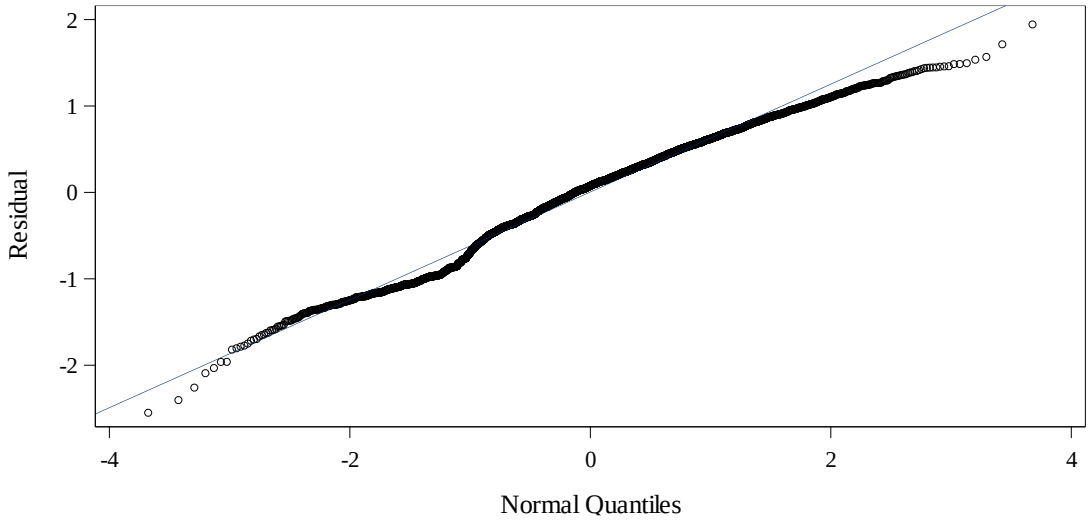

Figure B8: Q-Q Plot of Residuals for Model 4

Appendix C

Model 1: Crude Model of Log-transformed K6 Scores Regressed on LD

$$Y_i = \beta_0 + \beta_1 X_{1i} + \varepsilon_i$$

Where,

Y_i is the observed outcome value for K6 scores
X_{1i} is the observed predictor value for learning disabilities
β_0 is the fixed unknown intercept
β_1 is the fixed unknown slope corresponding to learning disabilities
ε_i is the unknown random noise, where $\varepsilon_i \overset{\text{iid}}{} N(0, \sigma^2)$ and for any $i \neq j, (X_i, Y_i) \perp (X_j, Y_j)$.

Model 2: Log-transformed K6 Scores Regressed on LD + Demographic Characteristics

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \varepsilon_i$$

Where,

Y_i is the observed outcome value for K6 scores
X_{1i} is the observed predictor value for learning disabilities
X_{2i} is the observed predictor value for age
X_{3i} is the observed predictor value for sex
X_{4i} is the observed predictor value for school status
X_{5i} is the observed predictor value for total income from all sources
β_0 is the fixed unknown intercept
β_1 is the fixed unknown slope corresponding to learning disabilities
β_2 is the fixed unknown slope corresponding to age
β_3 is the fixed unknown slope corresponding to sex
β_4 is the fixed unknown slope corresponding to school status
β_5 is the fixed unknown slope corresponding to total income from all sources
ε_i is the unknown random noise, where $\varepsilon_i \overset{\text{iid}}{} N(0, \sigma^2)$ and for any $i \neq j, (X_i, Y_i) \perp (X_j, Y_j)$.

Model 3: Log-transformed K6 Scores Regressed on LD + Demographic Characteristics + Psychosocial Factors

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + \beta_7 X_{7i} + \varepsilon_i$$

Where,

Y_i is the observed outcome value for K6 scores
X_{1i} is the observed predictor value for learning disabilities
X_{2i} is the observed predictor value for age
X_{3i} is the observed predictor value for sex
X_{4i} is the observed predictor value for school status
X_{5i} is the observed predictor value for total income from all sources

X_{6i} is the observed predictor value for SPS-10 Scores
X_{7i} is the observed predictor value for whether the respondent has any family members with emotions, mental health, alcohol, or drug problems
β_0 is the fixed unknown intercept
β_1 is the fixed unknown slope corresponding to learning disabilities
β_2 is the fixed unknown slope corresponding to age
β_3 is the fixed unknown slope corresponding to sex
β_4 is the fixed unknown slope corresponding to school status
β_5 is the fixed unknown slope corresponding to total income from all sources
β_6 is the fixed unknown slope corresponding to SPS-10 Scores
β_7 is the fixed unknown slope corresponding to whether the respondent has any family members with emotions, mental health, alcohol, or drug problems
ε_i is the unknown random noise, where $\varepsilon_i \overset{\text{iid}}{} N(0, \sigma^2)$ and for any $i \neq j, (X_i, Y_i) \perp \left(X_j, Y_j\right)$.

Model 4: Log-transformed K6 Scores Regressed on LD + Demographic Characteristics + Psychosocial Factors + Health Factors

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + \beta_7 X_{7i} + \beta_8 X_{8i} + \beta_9 X_{9i} + \beta_{10} X_{10i} + \beta_{11} X_{11i} + \beta_{12} X_{12i} + \varepsilon_i$$

Where,

Y_i is the observed outcome value for K6 scores
X_{1i} is the observed predictor value for learning disabilities
X_{2i} is the observed predictor value for age
X_{3i} is the observed predictor value for sex
X_{4i} is the observed predictor value for school status
X_{5i} is the observed predictor value for total income from all sources
X_{6i} is the observed predictor value for SPS-10 Scores
X_{7i} is the observed predictor value for whether the respondent has any family members with emotional, mental health, alcohol, or drug problems
X_{8i} is the observed predictor value for ADHD
X_{9i} is the observed predictor value for past 12-month medication use for emotions, mental health, alcohol, or drug problems
X_{10i} is the observed predictor value for help received in past 12 months
X_{11i} is the observed predictor value for World Health Organization Disability Assessment Schedule (WHODAS 2.0) score
X_{12i} is the observed predictor value for lifetime any substance use disorder
β_0 is the fixed unknown intercept
β_1 is the fixed unknown slope corresponding to learning disabilities
β_2 is the fixed unknown slope corresponding to age
β_3 is the fixed unknown slope corresponding to sex
β_4 is the fixed unknown slope corresponding to school status
β_5 is the fixed unknown slope corresponding to total income from all sources
β_6 is the fixed unknown slope corresponding to SPS-10 Scores

β_7 is the fixed unknown slope corresponding to whether the respondent has any family members with emotional, mental health, alcohol, or drug problems
β_8 is the fixed unknown slope corresponding to ADHD
β_9 is the fixed unknown slope corresponding to past 12-month medication use for emotions, mental health, alcohol, or drug problems
β_{10} is the fixed unknown slope corresponding to help received in past 12 months
β_{11} is the fixed unknown slope corresponding to World Health Organization Disability Assessment Schedule (WHODAS 2.0) score
β_{12} is the fixed unknown slope corresponding to lifetime any substance use disorder
ε_i is the unknown random noise, where $\varepsilon_i \overset{\text{iid}}{} N(0, \sigma^2)$ and for any $i \neq j, (X_i, Y_i) \perp (X_j, Y_j)$.

Model 5: Binary K6 Scores Regressed on LD

$$\eta_i = \beta_0 + \beta_1 X_{1i}$$

Where,
η_i is the log odds of i-th subject having K6 Cut-point ≥13
β_0 is the fixed unknown intercept
β_1 is the fixed unknown effect of learning disabilities
X_{1i} is the observed risk factor for learning disabilities
Where for any $i \neq j,\ (X_i, Y_i) \perp (X_j, Y_j)$

Model 6: Binary K6 Scores Regressed on LD + Demographic Characteristics

$$\eta_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i}$$

Where,

η_i is the log odds of i-th subject having K6 Cut-point ≥13
β_0 is the fixed unknown intercept
β_1 is the fixed unknown effect of learning disabilities
β_2 is the fixed unknown effect of age (in years)
β_3 is the fixed unknown effect of sex
β_4 is the fixed unknown effect of school status
β_5 is the fixed unknown effect of total income from all sources
X_{1i} is the observed risk factor for learning disabilities
X_{2i} is the observed risk factor for age (in years)
X_{3i} is the observed risk factor for sex
X_{4i} is the observed risk factor for dichotomous school status
X_{5i} is the observed risk factor for total income from all sources
Where for any $i \neq j,\ (X_i, Y_i) \perp (X_j, Y_j)$

Model 7: Binary K6 Scores Regressed on LD + Demographic Characteristics + Psychosocial Factors

$$\eta_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + \beta_7 X_{7i}$$

Where,

η_i is the log odds of i-th subject having K6 Cut-point ≥13
β_0 is the fixed unknown intercept
β_1 is the fixed unknown effect of learning disabilities
β_2 is the fixed unknown effect of age (in years)
β_3 is the fixed unknown effect of sex
β_4 is the fixed unknown effect of school status
β_5 is the fixed unknown effect of total income from all sources
β_6 is the fixed unknown effect of SPS-10 Scores
β_7 is the fixed unknown effect of whether the respondent has any family members with emotional, mental health, alcohol, or drug problems
X_{1i} is the observed risk factor for learning disabilities
X_{2i} is the observed risk factor for age (in years)
X_{3i} is the observed risk factor for sex
X_{4i} is the observed risk factor for dichotomous school status
X_{5i} is the observed risk factor for total income from all sources
X_{6i} is the observed risk factor for SPS-10 Scores
X_{7i} is the observed risk factor for whether the respondent has any family members with emotions, mental health, alcohol, or drug problems
Where for any $i \neq j,\ (X_i, Y_i) \perp (X_j, Y_j)$

Model 8: Binary K6 Scores Regressed on LD + Demographic Characteristics + Psychosocial Factors + Health Factors

$$\eta_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + \beta_7 X_{7i} + \beta_8 X_{8i} + \beta_9 X_{9i} + \beta_{10} X_{10i} + \beta_{11} X_{11i} + \beta_{12} X_{12i}$$

Where,

η_i is the log odds of i-th subject having K6 Cut-point ≥13
β_0 is the fixed unknown intercept
β_1 is the fixed unknown effect of learning disabilities
β_2 is the fixed unknown effect of age (in years)
β_3 is the fixed unknown effect of sex
β_4 is the fixed unknown effect of school status
β_5 is the fixed unknown effect of total income from all sources
β_6 is the fixed unknown effect of SPS-10 Scores
β_7 is the fixed unknown effect of whether the respondent has any family members with emotional, mental health, alcohol, or drug problems
β_8 is the fixed unknown effect of ADHD
β_9 is the fixed unknown effect of past 12-month medication use for emotions, mental health, alcohol, or drug problems
β_{10} is the fixed unknown effect of help received in past 12 months
β_{11} is the fixed unknown effect of World Health Organization Disability Assessment Schedule (WHODAS 2.0) score
β_{12} is the fixed unknown effect of lifetime substance use disorder

X_{1i} is the observed risk factor for learning disabilities
X_{2i} is the observed risk factor for age (in years)
X_{3i} is the observed risk factor for sex
X_{4i} is the observed risk factor for dichotomous school status
X_{5i} is the observed risk factor for total income from all sources
X_{6i} is the observed risk factor for SPS-10 Scores
X_{7i} is the observed risk factor for whether the respondent has any family members with emotions, mental health, alcohol, or drug problems
X_{8i} is the observed risk factor for ADHD
X_{9i} is the observed risk factor for past 12-month medication use for emotions, mental health, alcohol, or drug problems
X_{10i} is the observed risk factor for help received in past 12 months
X_{11i} is the observed risk factor for World Health Organization Disability Assessment Schedule (WHODAS 2.0) score
X_{12i} is the observed risk factor for lifetime substance use disorder
Where for any $i \neq j,\ (X_i, Y_i) \perp (X_j, Y_j)$