TRAUMA AND SUBSTANCE USE AMONG DIFFERING SAMPLES

Characterizing Associations Between Trauma and Substance Use and Related Problems Among Samples with Differing Clinical Presentation & Severity

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LAY ABSTRACT

Psychological distress following a traumatic event, known as traumatic stress, is often associated with problematic alcohol and/or substance use. The co-occurrence of these two confers a heightened risk of other mental health problems. As such, studying how these phenomena are associated with one another and what about each thing is more important to the association is important to understand. The purpose was to examine the connection between these phenomena among three different groups of people: two treatment-seeking groups and non-treatment seeking group one group. Traumatic stress was associated with problematic substance use in all three groups. In addition, other factors like mentally escaping from your body and having difficulties with regulating your emotions explained how traumatic stress and problematic substance use were connected to each other. These findings can help clinicians hone their treatment programs to better help individuals struggling with traumatic stress and problematic substance use.

ABSTRACT

Posttraumatic stress disorder (PTSD) and substance use disorder (SUD) frequently co-occur. Comorbid PTSD+SUD confers heightened risk of other mental health concerns, suicidality, mortality, and functional impairment. Current treatments for comorbid PTSD+SUD show inconsistent results, highlighting the need for a more comprehensive understanding of the associations between PTSD and SUD symptoms. The current dissertation aimed to characterize the associations between PTSD and SUD using structural equation modelling among three different samples with differing clinical severity and presentation: (1) concurrent disorders sample with a high prevalence of PTSD; (2) an in-patient sample seeking treatment for PTSD; and (3) a subclinical sample of healthcare workers and public safety personnel. Data were extracted from multiple clinical databases across different studies to evaluate the associations between PTSD symptoms and alcohol/cannabis/substance use-related problems. Furthermore, the role of underlying mechanisms such as dissociation and emotion dysregulation, which are associated with both PTSD and SUD, were analyzed. All analyses used a structural equation modelling framework to represent the complex clinical presentation of comorbid PTSD+SUD analytically. A relatively consistent pattern of results was observed across the three samples. Global PTSD symptoms were significantly associated with cannabis-related problems, alcohol-related problems, and other illicit substance-related problems. Among PTSD symptoms, the reactivity symptom cluster (characterized by symptoms of hypervigilance, irritability, reckless behaviour, problems with concentration and sleep disturbances) was significantly associated with alcohol/cannabis/substance-related

problems across among the three samples. Furthermore, underlying mechanisms such as dissociation and emotion dysregulation significantly mediated the relations between PTSD symptoms and alcohol/cannabis/substance-related problems. Overall, the current results contribute to the limited literature examining the associations between PTSD and SUD symptoms. Lastly, the current results have important clinical implications for identifying efficacious treatment targets for comorbid PTSD+SUD.

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LIST OF ABBREVIATIONS AND SYMBOLS

PTSD: Posttraumatic Stress Disorder

AUD: Alcohol Use Disorder

SUD: Substance Use Disorder

CUD: Cannabis Use Disorder

OUD: Opioid Use Disorder

DSM-5: Diagnostic Statistics Manual for Mental Disorders-5

SCID: Structured Clinical Interview for Diagnostic Statistics Manual-5

APA: American Psychological Association

COPE: Concurrent Treatments of PTSD and Substance Use Disorders Using Prolonged Exposure

SEM: Structural Equation Modelling

PCL-5: Posttraumatic Stress Disorder Checklist for DSM-5

MDI: Multiscale Dissociation Inventory

DERS: Difficulties in Emotion Regulation Scale

ACES: Adverse Childhood Experiences Scale

AUDIT: Alcohol Use Disorder Identification Test

CUDIT: Cannabis Use Disorder Identification Test

DUDIT: Drug Use Disorders Identification Test

DASS-21: Depression, Anxiety, Stress Scale – 21 item version

HCWs: Healthcare Workers

PSP: Public Safety Personnel

X^2 = Chi-square

β = beta estimate

DECLARATION OF ACADEMIC ACHEIVEMENT

Chapter 2: The Concurrent Disorders Outpatient Service team collected data for this project. MA is one of the principal investigators of the dataset, and HP was given access to the data to analyze the specific research question. HP was responsible for conceptualizing the research question (with assistance from MA), developing the theoretical structural equation models, conducting the formal data analyses (with assistance from AO and KA), and writing the manuscript for publication. In addition, KH, AO, KA, SP, HR, MM, JB, JM, and MA provided valuable feedback on the data analyses and manuscript. This chapter is **published** in its entirety in the Canadian Journal of Psychiatry:

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Chapter 4: Data for this project was collected as part of a larger study on examining mental health and other psychological variables among healthcare workers and public safety personnel. MM and RL are the principal investigators of the dataset, and HP was given access to the data to analyze the specific research question. HP was responsible for conceptualizing the research question, developing the theoretical structural equation models, conducting the formal data analyses, and writing the manuscript for publication. In addition, BE, AD, KA, FH, SR, AM, CO, HS, RM, AN, RL, and MM provided valuable feedback on the data analyses and manuscript. This chapter is **submitted** in its entirety to the European Journal of Psychotraumatology:

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Chapter 1. General Introduction

1.1 What is Posttraumatic Stress Disorder?

Posttraumatic stress disorder (PTSD) is a mental health disorder characterized by the experience of psychological distress following exposure to a traumatic event (American Psychological Association, 2013). Symptoms of PTSD are typically categorized into four clusters according to the Diagnostic Statistical Manual for Mental Disorders-5th version (DSM-5). The first is Intrusions, which are involuntary experiences of recurring thoughts and memories related to a traumatic event. The second is Avoidance, which involves avoiding places and things that serve as reminders of the traumatic event. The third is Negative Alterations in Cognition and Mood (NACM), which consists of a persistent negative emotional state and distorted thoughts about the traumatic event and often focus on guilt and shame. The fourth is Reactivity (also known as Alterations in Arousal), which consists of a variety of behaviours and reactions (e.g., hypervigilance, irritability, reckless behaviours, trouble with sleep and concentration) related to altered arousal following exposure to the traumatic event (American Psychological Association, 2013). It is estimated that ~30% of individuals with PTSD present with the dissociative subtype of PTSD (Armour et al., 2014; Lanius et al., 2012; McKinnon et al., 2016; Tsai et al., 2015; Wolf, Lunney, et al., 2012; Wolf, Miller, et al., 2012). Here, individuals present with the four main symptom clusters and endorse trauma-related dissociative symptoms of

depersonalization and derealization. Depersonalization is characterized as feelings of being detached from one's body as if one were an outside observer of their mental processes and bodily actions (American Psychological Association, 2013). Derealization is characterized as experiences of unreality in one's surroundings (i.e., the world around the individual is experienced as dreamlike, distorted, or unreal; American Psychological Association, 2013). Notably, the dissociative subtype of PTSD is associated with more severe clinical presentations (Galatzer-Levy et al., 2011; Ozer et al., 2003; Stein et al., 2013) and more significant functional impairment (Boyd et al., 2018; Park et al., 2021). In the United States, approximately 90% of individuals are exposed to at least one instance of trauma and approximately 10% develop PTSD following exposure (Kilpatrick et al., 2013). A similar rate is observed in Canada, with approximately 9% of Canadians reporting having PTSD within their lifetime (Van Ameringen et al., 2008). The estimated cost of illness burden for mental health in Canada is over $50 billion per year, including healthcare costs, loss in productivity and reductions in health-related quality of life (Lim et al., 2008; Smetanin et al., 2012).

1.2 What is Substance Use Disorder?

Substance Use Disorders (SUDs) are a significant public health problem across Canada (Canadian Centre on Substance Abuse, 2010; Canadian Centre on Substance Use and Addiction, 2017, 2018; Rehm et al., 2006), with 6 million individuals in Canada meeting the criteria for SUD during their lifetime (Pearson et al., 2013). SUDs (an overarching term including alcohol use disorder [AUD]) is generally characterized as a

cluster of cognitive, behavioural, and physiological symptoms that occur despite experiencing significant substance-related problems (American Psychological Association, 2013). In the DSM-5, eleven criteria characterize a SUD. Criteria one to four (i.e., greater use than anticipated, desire to cut down on use, time spent obtaining substance, and craving for substance) can be generally categorized as impaired control over substance use. Criteria five to seven (i.e., failure to fulfill work obligations, continuing use despite persistent social and interpersonal problems, and giving up or reducing involvement in social activities) are related to social impairment resulting from substance use. Criteria eight and nine deal with the risky use of substances (i.e., using substances in situations in physically hazardous situations and continuing substance use despite awareness of physical or psychological problems that have been caused or exacerbated by substance use). Lastly, criteria ten and eleven are psychophysiological symptoms (i.e., tolerance buildup, where greater amounts of substances are needed to achieve the desired effect and experiencing withdrawal symptoms when stopping use). These disorders are associated with substantial adverse outcomes, including negative health consequences, interpersonal problems, legal problems, and a negative impact on public safety. In the United States, 14.4 million adults ages 18 or older met the criteria for alcohol use disorder (AUD) based on the 2018 National Survey on Drug Use and Health (Substance Abuse and Mental Health Services Administration (SAMHSA), 2018). In Canada, the illness burden of substance use is estimated to be $40 billion per year (Stockwell et al., 2020). Of this total, $14.6 billion can be attributed to alcohol and tobacco, while $3.5 billion to opioids and $2.8 billion to cannabis (Stockwell et al., 2020).

1.3 Comorbid PTSD and SUD

Concurrent disorders, also known as co-occurring or dual diagnosis disorders (commonly used term in the USA for concurrent disorders), are defined as having a combined diagnosis of major psychiatric disorders and an addictive disorder, such as alcohol or other substance use disorder (AUD/SUD). Concurrent disorders are prevalent in psychiatric samples, with 20% of individuals experiencing mental illness also reporting co-occurring substance use. In addition, individuals experiencing mental health issues are twice as likely to have a substance use problem than the general population in their lifetime (Rush et al., 2008).

Comorbid PTSD+SUD falls under the umbrella of concurrent disorders; as such, both disorders should be analyzed in conjunction with the other to understand the impact each disorder has on the clinical presentation and the other disorder. Of individuals meeting the criteria for PTSD, 27.8% report alcohol dependence and 25.5% report substance dependence according to the DSM-4 criteria (Van Ameringen et al., 2008). Data from the 2010 National Epidemiologic Survey on Alcohol and Related Conditions (N = 34,653) estimated that 46.4% of individuals meeting the criteria for PTSD also meet the criteria for a SUD (Pietrzak et al., 2011). These rates remained stable in the 2016 wave (Smith et al., 2016). Within treatment-seeking samples, patients with PTSD are 14 times more likely to meet the criteria for a SUD than patients without PTSD (Chilcoat & Menard, 2004; Ford et al., 2007). Comorbid PTSD and SUD represent a particularly challenging clinical presentation, whereby accurate identification and targeted treatments are critical. In addition, the presence of comorbid PTSD and SUD confers a heightened risk of other

mental health concerns, suicidality, mortality, and functional impairment (Back et al., 2000; Driessen et al., 2008; McDevitt-Murphy et al., 2010; Ouimette et al., 2000, 2006; Pietrzak et al., 2011; Stinson et al., 2005; Tarrier & Gregg, 2004; Tate et al., 2007) underscoring the critical need to study the associations between PTSD and SUD to potentially inform effective treatment targets for structured therapies targeting symptoms of both disorders simultaneously.

1.3.1 Etiology of Comorbid PTSD+SUD

Four main hypotheses exist to explain the potential etiology of comorbid PTSD+SUD (Hien et al., 2021; María-Ríos & Morrow, 2020): (1) self-medication hypothesis, (2) susceptibility hypothesis, (3) high-risk hypothesis, and (4) shared liability hypothesis.

First, the self-medication hypothesis posits that individuals with PTSD may use substances to cope with their symptoms (Back et al., 2006; Chilcoat & Breslau, 1998; Hien et al., 2010; Khantzian, 1985, 1997). This hypothesis requires symptoms of the psychiatric disorder to have developed prior to substance use and the use of substances has to be directly related to their psychiatric symptoms. For example, an individual experiences an acute traumatic event such as a vehicular accident and develops PTSD following the accident. In order to cope with their PTSD symptoms, the individual starts using substances which would then lead to comorbid PTSD+SUD would be a prototypic hypothetical scenario falling under the self-medication hypothesis.

Second, the susceptibility hypothesis posits that early life stressors leading to PTSD increase the vulnerability to developing SUD (Kendler et al., 2000; Young-Wolff et al., 2011, 2012). Here, the underlying mechanism to explain the etiology of comorbid PTSD+SUD is constrained to early life stressors, such as childhood abuse. An individual who experiences childhood adversity could develop PTSD and, in doing so, be susceptible to a later diagnosis of SUD as a result of having PTSD due to early life stressors. Unlike the self-medication hypothesis, which does not specify early-life stressors as the shared event precipitating the development of PTSD and SUD, the susceptibility hypothesis constrains the origin of PTSD and subsequent SUD to only early-life stressors.

Third, the high-risk hypothesis posits that individuals engaging in problematic substance use may experience or be exposed to a traumatic event due to their problematic substance use (Davis et al., 2009; Haller & Chassin, 2014; Windle, 1994). The opposite pattern of the self-medication hypothesis would be observed here. Substance use and its related problems would have to precede a potentially traumatic event from which PTSD symptoms could develop. For example, an individual driving under the influence of alcohol gets into a vehicular accident and develops PTSD symptoms following the accident, which they had not experienced ever before the accident would be a depiction of the high-risk hypothesis.

Lastly, the shared liability hypothesis posits a complex, reciprocal, and reinforcing relationship between PTSD and SUD (Gilpin & Weiner, 2017; López-Castro et al., 2015; Norman et al., 2012). Within the shared liability hypothesis, shared genetic, neural, environmental, and psychosocial risk factors contribute to the development of PTSD and

SUD. It is posited that stimuli (substance use or a potentially traumatic event) can activate shared neural pathways and maladaptive coping strategies, leading to the development of one or both disorders. This hypothesis differs from the susceptibility hypothesis as it does not constrain the origin point for developing PTSD and SUD to early life stressors only. In addition, the shared liability hypothesis does not specify one disorder preceding the other, unlike the self-medication and high-risk hypotheses.

Data exists supporting each of these four hypotheses; realistically, the etiology of comorbid PTSD+SUD is probably much more complex and diverse depending on the type of trauma (acute vs chronic; simple vs. complex) experiences, the number of substances an individual uses, how frequently they use them, and associated problems. In addition, the etiology and associations between PTSD and SUD may be further complicated by polysubstance use rather than mono-substance use. Lastly, the number of traumas experienced could also influence the etiology of PTSD and SUD, as some individuals may be resilient after experiencing one or two traumas. However, later trauma exposure may trigger the development of PTSD and SUD. Overall, the ecologically and clinically relevant etiology of comorbid PTSD+SUD may be a combination of all these hypotheses.

1.3.2 Efficacy of Treatments for Comorbid PTSD+SUD

Individuals diagnosed with concurrent disorders often have highly complex and severe psychiatric sequelae, requiring specialized treatment intervention (Babor et al., 2008; Hakobyan et al., 2020; Kessler et al., 2003). Nevertheless, a general lack of consensus exists on best practices concerning integrative services and intervention

strategies (Karapareddy, 2019), further compounded by the fact that research commonly focuses on these disorders in isolation. In addition, the presence of PTSD and SUD confer heightened risk of other mental health concerns, suicidality, mortality, and functional impairment (Pietrzak et al., 2011). Although reductions in alcohol and/or substance use problems following treatment for PTSD have been reported in some studies (Bedard-Gilligan et al., 2018; Hien et al., 2010; Roberts et al., 2015), other studies have linked comorbid presentation to poor treatment response and increased relapse risk compared to either disorder alone (Flanagan et al., 2016; Roberts et al., 2015). There is a growing need to better understand the nuances of comorbid presentations to address these concerns with the ultimate goal of developing treatment paths that lead to improved outcomes.

Integrative treatment approaches such as Concurrent Treatments of PTSD and Substance Use Disorders Using Prolonged Exposure (COPE) (Back et al., 2014) directly target both PTSD and substance use, whereby sustained reductions in both disorders are evident (Back et al., 2019). Interestingly, COPE is no more effective than relapse prevention therapy when PTSD is subthreshold relative to meeting full criteria (Ruglass et al., 2017), furthering the notion that comprehensive diagnostic clarification is key to effective treatment outcomes.

1.4 Current State of the Research on the Associations between PTSD and SUD

Few high-resolution studies report associations between specific symptom clusters of PTSD and SUD in people with both diagnoses. However, the extant literature

demonstrates primary associations between PTSD symptoms and substance use (Kearns et al., 2019; Lebeaut et al., 2020; Lee et al., 2015; Mahoney et al., 2022; Ouimette et al., 2010; Palmisano et al., 2021; Read et al., 2004; Sullivan & Holt, 2008; Tripp et al., 2015; Walton et al., 2018). Of the ten studies that exist, six of them analyzed alcohol-related problems only (Lebeaut et al., 2020; Lee et al., 2015; Palmisano et al., 2021; Read et al., 2004; Tripp & McDevitt-Murphy, 2015; Walton et al., 2018), one analyzed substance use and its related problems (Mahoney et al., 2022), and four studies examined co-use of substances (Kearns et al., 2019; Ouimette et al., 2010; Sullivan & Holt, 2008). As indicated, seven of the ten studies analyzed substance use outcomes in isolation (i.e., alcohol only or substance use only). Of the three studies analyzing co-use, two studies only evaluated group differences in substance use outcomes as a function of PTSD diagnosis (Kearns et al., 2019; Sullivan & Holt, 2008), and only one study analyzed continuous associations between PTSD symptoms and substance use via the prospective prediction of subsequent substance use following elevation in PTSD symptoms (Ouimette et al., 2010).

1.4.1 Associations between PTSD, SUD, and Comorbid PTSD+SUD with other Cognitive Factors

A vast body of literature points to dissociation as a highly salient feature of PTSD and alcohol-related problems. The current version of the DSM includes a dissociative subtype for PTSD characterized by symptoms of depersonalization and derealization, indicating that dissociation plays a crucial role in PTSD clinical presentation and severity, underscoring the need to examine dissociative symptoms among patients seeking treatment

for PTSD (American Psychological Association, 2013). Here, dissociation is thought to involve detachment from immediate somatic or environmental experience, occurring during acute trauma (but can happen distally from acute trauma exposure) and thus modulating its immediate psychophysiological impact (Spiegel, 2012). Dissociation can be generally characterized as a psychological escape when no physical escape is possible (Putnam, 1991). Typically, individuals with the dissociative subtype of PTSD present with a history of more severe early-life trauma (Stein et al., 2013) and higher PTSD severity scores (Armour et al., 2014; Galatzer-Levy et al., 2011; Steuwe et al., 2012; Wolf, Miller, et al., 2012) than those without the subtype. Notably, dissociation has also been linked to alcohol (Craparo et al., 2014; Evren et al., 2011; Zdankiewicz-Ścigała & Ścigała, 2018) and/or substance use (Najavits & Walsh, 2012; Schäfer et al., 2010; Wenzel et al., 1996). These studies point towards a clear association of PTSD severity and dissociation with alcohol/substance use and problems related to use. Critically, however, despite this comprehensive body of knowledge establishing key associations between PTSD and dissociation, PTSD and alcohol, and alcohol and dissociation, the potential unifying mechanisms underlying these three variables have yet to be explored.

On the other hand, emotion dysregulation has a vast body of literature to show its associations with PTSD (Bradley et al., 2011; Fitzgerald et al., 2018; Pencea et al., 2020; Powers et al., 2015; Raudales et al., 2019; Weiss et al., 2019, 2020) and to a lesser extent, substance use (Garke et al., 2021; Kirisci et al., 2015). However, associations between emotion dysregulation and alcohol/substance use have been studied extensively via comorbid PTSD and AUD/SUD (Westphal et al., 2017), where emotion dysregulation

mediates the relation between childhood trauma and subsequent substance use (Barahmand et al., 2016; Mandavia et al., 2016; Messman-Moore & Bhuptani, 2017; Weiss, Tull, Lavender, et al., 2013), PTSD symptoms and alcohol/substance use (Tripp et al., 2015; Tripp & McDevitt-Murphy, 2015; Tull et al., 2015; Weiss, Tull, Anestis, et al., 2013), and other associated outcomes (Hien et al., 2017; Weiss et al., 2012).

1.5 The Gap in the Literature

Despite the importance of these relations, there is a lack of consensus on which PTSD symptom clusters are more strongly associated with AUD/SUD. Prior studies typically evaluated associations between PTSD and alcohol and drug use separately despite the high overlap between the use of these substances. Multivariate statistical methods such as structural equation modelling (SEM) examine multiple variables within a single analytic framework, potentially providing a more valid representation of the complex clinical presentation of concurrent disorders. Understanding the interaction between using different substances and PTSD symptom severity may be necessary for developing efficacious therapeutic interventions for comorbid PTSD+SUD, given the challenges with current treatments.

1.6 Aims of Dissertation

The overarching purpose of this dissertation was to utilize an SEM framework to explore the associations between PTSD symptoms and alcohol/cannabis/substance use problems among three samples of different clinical severity and presentation.

Chapter 2 - This study analyzed the associations between PTSD symptomatology and alcohol and/or substance use frequencies and related problems in a sample of outpatient clients with concurrent disorders. Using SEM, we simultaneously characterized the relations between PTSD and cannabis use disorder (CUD)/SUD. A secondary objective was to analyze the associations between specific PTSD symptom clusters and alcohol use disorder (AUD)/SUD.

Chapter 3 – This study examined the mediating effects of dissociative symptomatology on the well-established relation between PTSD severity and alcohol-related problems among a treatment-seeking clinical sample meeting diagnosis for PTSD. A secondary exploratory objective was to examine the mediating role of dissociation between specific PTSD symptom clusters and alcohol-related problems.

Chapter 4 – This analyzed the global and symptom cluster level associations between PTSD and alcohol/substance-related problems among samples of HCWs and PSP with data collected during the height of the pandemic. Furthermore, this study examined the roles of underlying mechanisms (i.e., emotion dysregulation and dissociation) in assessing the associations between PTSD symptoms (global and individual symptom clusters) and alcohol/substance-related problems.

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Chapter 2. Outpatient Treatment-Seeking Concurrent Disorders Sample

2.1 Introduction

Given the lack of substantial literature examining the associations between PTSD and substance use-related problems in an ecologically valid analytical framework (discussed in Chapter 1), the purpose of Chapter 2 is to create and establish that analytical framework through the use of structural equation modelling (SEM). A majority of prior literature examining associations between PTSD symptoms and substance use did so within an isolated, mono-substance framework (Lebeaut et al., 2020; Lee et al., 2015; Palmisano et al., 2021; Read et al., 2004; Tripp & McDevitt-Murphy, 2015; Walton et al., 2018). However, this is not an ecologically valid representation as most individuals who use substances are poly-substance users (i.e., use more than one substance concurrently and/or simultaneously). As such, the use of multivariate statistical methods such as SEM to examine multiple variables within a single analytic framework is crucial because it allows for studying the associations between PTSD and each substance of choice and controls for

the associations between each of the substances themselves. Thus, potentially providing a more valid representation of the complex associations between co-occurring disorders.

The associations between PTSD and SUD generally present with a more severe and complex clinical presentation (Babor et al., 2008; Back et al., 2000; Driessen et al., 2008; Hakobyan et al., 2020; Kessler et al., 2003; McDevitt-Murphy et al., 2010; Ouimette et al., 2000, 2006; Pietrzak et al., 2011; Stinson et al., 2005). SEM was used to create an ecologically helpful analytical framework. Therefore, with SEM, the paper presented in this chapter aimed to analyze the associations between PTSD symptoms and substance use-related problems among a sample of treatment-seeking individuals with concurrent disorders.

Data was collected as part of the intake battery at the Concurrent Disorders Outpatient Service (CDOS) clinic before being admitted into outpatient treatment. The sample analyzed in the present paper represents a treatment-seeking outpatient concurrent disorders sample. While PTSD was not the main focus of admission or treatment within this sample, the sample indicated a relatively high prevalence of PTSD and substance use.

The primary author of this study (HP) conceptualized the research question, developed the theoretical structural equation models, conducted the formal data analysis, and wrote the manuscript for publication.

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2.2 Posttraumatic Stress Disorder Symptomatology and Substance Use in an Outpatient Concurrent Disorders Sample

Patel H., Holshausen, K., Oshri, A., Andrews, K., Penta, S., Raymond, H., McKinnon, M., Brasch, J., MacKillop, J., & Amlung, M. (2021). Posttraumatic stress disorder and substance use in an outpatient concurrent disorders sample. *Canadian Journal of Psychiatry 66*(9), 788-797. doi: 10.1177/07067437211011851

ABSTRACT

Objective: Posttraumatic Stress Disorder (PTSD) and Substance Use Disorders (SUDs) present a complex and often severe clinical presentation within a concurrent disorders context. The objective of the current study was to examine associations between PTSD symptoms and SUD outcomes to better understand the clinical phenomenon of comorbid PTSD and SUD. Multivariate statistical methods were used to test the hypothesis that elevated PTSD symptoms, both at the level of global severity and specific PTSD symptom clusters, are associated with greater substance use and related problems.

Methods: Data were collected from an intake assessment battery within a specialized concurrent disorders outpatient service in Hamilton, ON. The sample comprised 326 participants (mean age = 37.19, 45.4% female). Structural equation models examined associations between PTSD and alcohol, cannabis, and substance use frequency and problems, controlling for age and sex. Alcohol was ultimately dropped from the model due to non-significant bivariate associations.

Results: Higher global PTSD symptomatology was significantly associated with higher cannabis and other substance use frequency and related problems. Analyses using PTSD cluster scores showed higher scores for Alterations in Arousal were positively associated with cannabis-related problems, drug-related problems, and cannabis and other substance use frequency. Avoidance was significantly associated with cannabis frequency and cannabis-related problems. In general, effect sizes were small in magnitude, accounting for between 9-25% of variance.

Conclusion: Significant cluster-level associations indicate the importance of specific PTSD symptoms (hyperarousal, avoidance) in relation to substance use when identifying therapeutic targets individuals presenting with comorbid PTSD-SUD. This multivariate approach provides a higher resolution and potentially more clinically informative representation of the complex clinical presentation of PTSD and SUD in a concurrent disorder population and could guide the development of more effective treatment paths.

INTRODUCTION

Concurrent disorders, also known as co-occurring or dual diagnosis disorders, are defined as having a combined diagnosis of one or more major psychiatric disorders and an addictive disorder, such as alcohol or other substance use disorder (AUD/SUD). Concurrent disorders are prevalent in psychiatric samples, with 20% of individuals experiencing mental illness also reporting co-occurring substance use, and individuals experiencing mental health issues are twice as likely to have a substance use problem compared to the general population in their lifetime [1]. Finally, up to 50% of individuals with schizophrenia have concurrent substance use[2]. Individuals diagnosed with concurrent disorders often have extraordinarily complex and severe psychiatric sequelae which may require specialized treatment intervention[3–5]. Yet, a general lack of consensus exists on best practices concerning integrative services and intervention strategies[6], further compounded by the fact that research commonly focuses on these disorders in isolation.

Posttraumatic stress disorder (PTSD) can develop following exposure to a traumatic event.[7] Symptoms of PTSD are typically categorized into four clusters: Intrusive thoughts and memories, Avoidance behaviours, Negative Alterations in Cognition and Mood (NACM), and Alterations in Arousal[7]. Approximately 9% of Canadians report having PTSD within their lifetime[8]. Of individuals meeting criteria for PTSD, 27.8% report alcohol use/dependence and 25.5% report substance use/dependence[8]. Data from the 2010 National Epidemiologic Survey on Alcohol and Related Conditions (N = 34,653) estimated that 46.4% of individuals meeting criteria for PTSD also meet criteria for a substance use disorder (SUD)[9] and these rates remained stable in the 2016 wave[10]. Within treatment-

seeking samples, patients with PTSD are 14 times more likely to meet criteria for a SUD than patients without PTSD[11,12].

Comorbid PTSD and SUD represent a particularly challenging clinical presentation, whereby accurate identification and targeted treatments are critical. The presence of PTSD and SUD confer heightened risk of other mental health concerns, suicidality, mortality, and functional impairment[9]. Although reductions in alcohol and/or substance use problems following treatment for PTSD have been reported in some studies[13–15], other studies have linked comorbid presentation to poor treatment response and increased relapse risk compared to PTSD or SUD alone[15,16]. To address these concerns, there is a growing need to better understand the nuances of comorbid presentations with the ultimate goal of developing treatment paths that lead to improved outcomes.

There are few high-resolution studies reporting associations between specific symptom clusters of PTSD and SUD in people with both diagnoses. The extant literature demonstrates some basic associations between PTSD symptom clusters and substance use. Among individuals receiving inpatient treatment for SUD, those with comorbid SUD and AUD reported greater intrusion / re-experiencing symptoms than patients without a comorbid AUD[17]. Women with a comorbid addictive disorder and PTSD reported higher acuity of PTSD symptoms among the Re-experiencing, Avoidance and Numbing, and Arousal clusters compared to women with a PTSD diagnosis but no addictive disorders[18]. Among individuals concurrently diagnosed with PTSD and AUD/SUD, fluctuations in PTSD symptoms were associated with alcohol and cocaine use disorder symptoms the following week, potentially supporting a self-medication conceptualization[19]. Among

military veterans, PTSD symptoms were uniquely associated with alcohol misuse, whereby clusters of Intrusions, NACM, and Hyperarousal symptoms significantly accounted for greater variance in alcohol misuse more so than demographic or military-related variables or co-occurring diagnoses of depression and/or anxiety. Greater PTSD symptom severity in clusters of NACM and Alterations in Arousal are seen in individuals who engage in co-use of alcohol and cannabis compared to those who use alcohol alone[20]. Taken together, these associations indicate a strong unique relationship between PTSD and substance use which needs to be accounted for when identifying therapeutic targets for intervention[21].

Despite the importance of these relations, there is a lack of consensus as to which PTSD symptom clusters are more strongly associated with AUD/SUD and prior studies typically evaluated associations between PTSD and alcohol and drug use separately despite high overlap between the use of these substances. Multivariate statistical methods such as structural equation modelling (SEM) examine multiple variables within a single analytic framework, potentially providing a more valid representation of the complex clinical presentation of concurrent disorders. Lastly, to our knowledge, there are no published studies examining associations between PTSD symptom clusters and frequency of use of alcohol and other substances. Understanding the interaction between the use of different substances and PTSD symptom severity may be important in developing therapeutic interventions. As such, this study analyzed the associations between PTSD symptomatology and alcohol and/or substance use frequencies and related problems in a sample of outpatient clients with concurrent disorders. Using SEM, we characterized the

pattern of relationships between PTSD and AUD/SUD simultaneously to better understand the clinical phenomenon of comorbid PTSD and AUD/SUD.

METHODS

Participants

Participants were drawn from a Concurrent Disorders Research Database maintained by the Peter Boris Centre for Addictions Research at McMaster University in collaboration with the Concurrent Disorders Outpatient Service (CDOS)—a specialized outpatient treatment service for concurrent disorders—at St. Joseph's Healthcare Hamilton. Participants in the study were referred to the CDOS by a community-based physician, after discharge from a psychiatric admission, by another clinic at the psychiatric hospital, or self-referred. Patients have a wide range of psychiatric diagnoses, including anxiety, mood and psychotic disorders, as well as problematic substance use. The CDOS serves patients whose mental health disorder is considered too severe for addiction-focused treatment programs. The population is representative of patients with concurrent disorders who can access a tertiary care mental health program.

This study used a naturalistic design involving an intake battery administered to all clients at their initial appointment in the CDOS outpatient clinic. The only exclusion from completing the battery was acute distress or significant neurocognitive impairment, as judged by the clinical team. Participants for the current study had to be at least 18 years of age, have provided written informed consent for the database, and report at least one-lifetime traumatic event on the Brief Trauma Questionnaire. Understanding of the consent form was confirmed by an interview-based consent verification form. There was no

compensation for participants since assessments were part of standard care. The research database was approved by the Hamilton Integrated Review Ethics Board (HiREB #0863). A total of 450 clients completed the clinical battery between February 2018 to November 2019. Of these, 359 (79.8%) consented to the database, and the final sample included 329 participants who reported lifetime exposure to at least one traumatic event.

Measures

Testing occurred in a private cubicle prior to the client's first appointment. The computerized battery lasted ~35 minutes and was collected using Research Electronic Data Capture (REDCap) software[22,23]. If computer literacy was an issue, participants completed a paper/pencil version.

The battery included self-report questionnaires assessing demographics, addiction and mental health screens, and psychological assessments. Demographic variables included sex assigned at birth and age. The mental health measures included validated assessments for psychiatric disorders (e.g., major depressive disorder, anxiety disorders, psychosis, PTSD, borderline personality disorder, etc.). A subset of these measures was analyzed in the present study, as described below.

Alcohol, Cannabis, and Drug Use. Alcohol use frequency and alcohol-related problems were measured using the Alcohol Use Disorders Identification Test (AUDIT)[24], a self-report screen assessing the frequency and severity of alcohol use. Scores on the AUDIT range from 0–40 and a cutoff of 20 or greater indicates possible AUD. The Cannabis Use Disorder Identification Test-Revised (CUDIT-R)[25] assessed cannabis use frequency and related problems. Scores on the CUDIT-R ranged from 0–32, and a cutoff

of 13 has high discriminant validity in concurrent disorders samples[25]. The Drug Use Disorders Identification Test (DUDIT)[26,27] assessed the severity of drug-related problems. Scores on the DUDIT ranged from 0-44, and a cutoff of 25 was chosen based on published research[26]. Since the CUDIT-R was included, the DUDIT instructions explicitly excluded cannabis. Frequency of illicit drug use was assessed using the NIDA modified version of the World Health Organization Alcohol Smoking and Substance Involvement Test (ASSIST)[28]. Drug categories included cocaine, methamphetamine, prescription stimulants, street opioids (e.g., heroin, opium), prescription opioids (e.g., oxycodone, hydrocodone), sedatives/sleeping pills, and an open-ended "other" category (none reported). Frequency of use was reported from 1 ("once or twice") to 4 ("daily or almost daily"). These scores were used within SEM to generate a latent factor of substance use. These self-report measures are well-validated and have been shown to accurately reflect actual substance use [29–33].

Psychological Variables. PTSD symptoms were assessed using the Posttraumatic Stress Disorder Checklist for Diagnostic and Statistical Manual-5 (PCL-5)[34]. The PCL-5 is a 20-item measure comprised of four clusters corresponding to the DSM-5 diagnostic criteria: Cluster B (Intrusive thoughts and memories), Cluster C (Avoidance behaviours), Cluster D (Negative Alterations in Cognition and Mood), and Cluster E (Alterations in Arousal). Scores on the PCL-5 range from 0–80, with the following subscale ranges: Cluster B (0 – 20), Cluster C (0 – 8), Cluster D (0 – 28), and Cluster E (0 – 20). SEM was used to generate a single latent factor of PTSD symptoms from the cluster scores, as described below. A shortened version of the Brief Trauma Questionnaire (BTQ) was administered to assess lifetime experiences of traumatic events[35]. This shortened version only assessed

endorsement of a type of trauma (yes/no) while the severity of the experience was not evaluated. Symptoms of depression, anxiety, and psychosis were assessed via the Patient Health Questionnaire (PHQ-9)[36], General Anxiety Disorder-7[37], and the Prodromal Questionnaire (PQ-16)[38], respectively.

Data Analysis Plan

Descriptive statistics and zero-order correlations were run among the study variables. Structural equation modelling was implemented in MPlus Version 8.0[39] using maximum likelihood estimation to assess the effects of a latent PTSD factor (described below) on substance use outcomes while controlling for age and sex (male = 0; female = 1). As cannabis use and severity were assessed separately from drug use, cannabis and other drugs were entered separately in the models. Two primary models were specified to evaluate the effects of a latent PTSD factor on cannabis and substance use frequency and severity. Follow-up models specified the effects of individual PTSD symptom clusters on the frequency and severity variables. The PTSD latent factor was determined with a measurement model comprised of four PTSD symptom cluster scores extracted from the PCL-5: Intrusions (Cluster B), Avoidance (Cluster C), NACM (Cluster D), and Alterations in Arousal (Cluster E). Prior to modelling, substance use measures (CUDIT, AUDIT, and DUDIT) were square-root transformed based on benchmarks of skewness >2 and kurtosis >7[40]. There were no significant outliers within the sample (Zs > 3.29). We used two-tailed tests with a statistical significance of $\alpha < 0.05$. Following established conventions[41,42], an excellent-fitting model had a comparative fit index (CFI) and Tucker Lewis Index (TLI) ≥

0.95, standardized root mean squared residual (SRMR) of ≤ 0.08 and root mean square error of approximation (RMSEA) ≤ 0.06.

RESULTS

Descriptive Statistics and Correlations

The sample consisted of 326 participants (45.4% female sex) with a mean age of 37.19 years (SD=11.78). Sample characteristics are presented in Table 1. The most frequently endorsed types of trauma were adult physical assault (71.5%), serious injury (59.8%), and unwanted sexual contact (59.2%). Furthermore, 61% of the sample met criteria for a provisional diagnosis of PTSD[43]. Alcohol and cannabis use was most common, with 90.5% and 72.1% of the sample reporting monthly or greater use, respectively (Figure 1). The three most commonly used illicit substances were cocaine (35.9%), sedatives (29.1%), and prescription opioids (17.8%).

Substance Use Related Problems Structural Equation Model

A measurement model (Figure 2) assessing the PTSD latent factor was specified. Factor loadings for the PTSD latent factor were significant and in the predicted direction; all indicators exceeded .70. A SEM was specified in which a latent PTSD factor predicted cannabis and substance use-related problems, with age and sex included as covariates (see Figure 3). AUDIT was not included within the model due to its lack of bivariate association with PTSD variables (Supplemental Table 1).

The pathway from PTSD to CUDIT and DUDIT was assessed. Among control variables, age and sex were significantly and negatively associated with CUDIT (age: β=-.363, p<.001; sex: β=-.195, p<.001) and DUDIT (age: β=-.153, p<.05; sex: β=-.222,

p<.001). Modification indices suggested covarying the residuals of Intrusions and Avoidance clusters. The final model and fit indices are presented in Figure 3. Within the model, PTSD was significantly associated with CUDIT (β=.290, p<.001) and DUDIT (β=.282, p<.001) scores. PTSD shows significant positive associations with cannabis- and substance-related problems. Overall, the model significantly accounted for 24.6% of the variance in CUDIT scores and 12.9% of the variance in DUDIT scores.

A secondary model was specified in which the effect of individual cluster scores was assessed for cannabis and substance use-related problems. Age and sex were included as covariates. AUDIT was not included within the model. A just-identified model emerged indicating model fit indices could not be determined. However, estimates revealed a significant association between the Alterations in Arousal cluster and CUDIT scores (Arousal: β=.270, p<.01). For DUDIT scores, a significant association was only observed with the Alterations in Arousal cluster (β=.276, p<.01). Thus, higher scores for the Alterations in Arousal cluster were associated with higher cannabis- and substance-related problems.

Substance Use Frequency Structural Equation Model

A SEM with a latent PTSD factor predicting cannabis and substance use frequencies was specified. Substance Use Frequency was specified as a latent factor comprised of endorsement frequencies reported on the NIDA-Modified Assist. Age and sex were included as covariates. Cannabis use frequency was kept as a separate outcome variable to reflect the delineation between CUDIT and DUDIT scores in the prior model. Refer to Figure 4 for a visual representation of this model. AUDIT was not included within the

model due to its lack of association with PTSD variables (see Supplemental Table 1 for bivariate correlations).

Factor loadings for the Substance Use Frequency latent factor were significant and in the predicted direction; all indicators exceeded .40 except for prescription stimulants and sedatives, which were trimmed from the model due to low factor loading (λ=.247; λ=.295, respectively). Next, the pathway from PTSD to cannabis use and Substance Use Frequency was tested. Among the control variables, age was significantly associated with cannabis use (β=-.290, p<.001) but not Substance Use (β=-.072, p>.05). Sex was not significantly associated with any other variable and was trimmed from the model. Modification indices suggested covarying the residuals of Intrusions and Avoidance clusters. The final model and fit indices are presented in Figure 4. Higher PTSD scores were significantly associated with greater cannabis use frequency (β=.223, p<.001) and higher scores on the Substance Use Frequency latent factor (β=.283, p<.001). Overall, the model significantly accounted for 15.6% of the variance in cannabis use frequency and 9.2% of the variance in Substance Use Frequency.

A secondary model was specified in which the effect of individual cluster scores was assessed for cannabis and substance use frequencies. Age and sex were included as covariates. AUDIT was not included within the model. Among control variables, age and sex were significantly associated with cannabis use (age: β = -.302, p < .001; sex: β = -.154, p < .01) but not Substance Use (age: β = -.075, p > .05; sex: β = -.084, p > .05). Modification indices suggested covarying the residuals of Intrusions and Avoidance clusters. The final model was adequately fitting (χ^2(23, N=326) = 37.913, p<.05, TLI=.880, CFI=.931,

RMSEA=0.045, SRMR=0.033). Within the model, scores on the Alterations in Arousal cluster, but no other clusters, were positively associated with greater cannabis use frequency (β=.355, p<.001) and Substance Use Frequency (β=.372, p<.01). Thus, greater symptoms related to Alterations in Arousal were associated with greater frequency of cannabis and other drug use.

DISCUSSION

This study is among the first to use a SEM framework to model associations between PTSD symptoms and cannabis and illicit drug use and severity in a clinical sample of people with concurrent disorders. We observed significant associations between global PTSD symptomatology and cannabis- and substance-related problems as well as frequency of use. The Alterations in Arousal cluster drove the associations between both frequency and problems for cannabis and other substances, whereas the Avoidance cluster was uniquely associated with cannabis outcomes. The effect sizes were generally in the small range and the associations accounted for between 9-25% of variance in the substance use outcomes. Additional factors beyond PTSD-related symptoms likely contribute to substance use in this sample, which is highly plausible given the complex clinical presentation of people with concurrent disorders.

These results corroborate previous studies analyzing associations between PTSD symptom clusters and cannabis use and other SUDs. Similar to the current cluster associations, prior research has shown associations between Arousal and Avoidance clusters and substance-use frequency and severity in people with PTSD+SUD[44,45]. The current results contrast with prior literature showing an inverse relationship between

Avoidance and heroin use[46] whereas we found a positive association between Avoidance and substance use. These prior studies used DSM-IV criteria and clusters for PTSD which were changed in the DSM-5. Of the limited studies examining DSM-5 PTSD criteria, alcohol misuse was shown to be significantly associated with Intrusions, NACM, and Arousal[21]. However, alcohol use and related problems were not significantly associated with PTSD in our sample. Collectively, these results are generally consistent with existing findings underscoring the importance of recognizing the associations between PTSD symptom clusters and substance use when identifying intervention targets.

The lack of significant associations with alcohol variables was surprising and somewhat inconsistent with prior literature. Greater Arousal symptoms were observed in women with comorbid PTSD+AUD than those with comorbid PTSD+SUD[44]. However, another study in women who experienced intimate partner violence found that PTSD clusters of Avoidance, Numbing, and Hyperarousal were not associated with alcohol use but were associated with drug use, similar to the present findings[18]. One potential explanation for the lack of alcohol-related results is prior research indicating that associations between PTSD and alcohol may be temporally-specific. Acute increases in PTSD symptoms were predictive of greater alcohol consumption in the following hours and the next day among adults meeting criteria for PTSD and AUD[47]. Considering the current study was cross-sectional, similar temporal associations could not be explored. The lack of associations may also be related to the clinical focus of the CDOS in which clients with a primary AUD and no other SUD are commonly referred to other alcohol-focused services.

From a clinical perspective, these findings highlight the need to assess both substance use and comorbid psychiatric conditions, particularly PTSD, to ensure appropriate treatment can be provided. Integrative treatment approaches such as Concurrent Treatments of PTSD and Substance Use Disorders Using Prolonged Exposure (COPE)[48] directly target both PTSD and substance use, whereby sustained reductions in both disorders are evident[49]. Interestingly, COPE is no more effective than relapse prevention therapy when PTSD is subthreshold relative to meeting full criteria[50], furthering the notion that comprehensive diagnostic clarification is key to effective treatment outcomes. This study further clarifies relations among specific types of substance use and PTSD symptom clusters. While outcomes of different PTSD treatments do not appear to differentially affect PTSD symptom clusters among individuals without SUD[51], these findings may not hold among a concurrent sample where PTSD clusters *are* differentially related to frequency and problems associated with different substances. Application of integrative treatments like COPE and additional targeted modules depending on type and patterns of substance use may yield the greatest outcomes.

These results should be considered in the context of the study's limitations. First, the current data is cross-sectional and cannot determine temporal associations. Second, although all participants reported at least one traumatic event on the BTQ, formal diagnostic interviews to confirm PTSD diagnosis were not available. Additionally, as adverse childhood experiences were not assessed, the implications of those events on the development of PTSD and substance use cannot be elucidated. Future studies should include a formal diagnosis of PTSD or utilize multiple assessments for PTSD to avoid

shared method variance along with assessments of adverse childhood experiences in the development of complex PTSD. Third, alcohol, cannabis, and substance use frequencies were self-report and not verified with biochemical testing, although prior research indicates the validity of self-report data in the assessment of substance use rates [29–33]. Differences in frequency response options across the substance use measures prevented coding by psychoactive effect (e.g., stimulant, sedative, etc.) which limited our ability to characterize the self-medication effects that may have been operant for specific PTSD symptoms. These effects should be explored in future studies. Finally, all participants were recruited from a single clinic within one hospital which may limit generalizability to other populations and clinical settings.

CONCLUSION

The results of this study build upon prior literature and add novel findings of associations between cannabis and other drug use and related problems with PTSD symptomatology. Significant associations between the Arousal cluster score with cannabis and substance-related problems and frequencies but not alcohol underscores the importance of studying these associations further. The use of multivariate statistics presents a potentially more nuanced representation of the complex clinical presentation of concurrent disorders when identifying therapeutic targets for intervention especially among complex concurrent disorder samples where treatment outcomes are generally poor.

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Table 1. Sample Characteristics and Zero-Order Correlations

	M (SD)
Age	37.19 (11.78)
Sex	45% Female
PTSD	41.47 (20.56)
Provisional PTSD Diagnosis (%)	61%
Intrusions	9.28 (5.92)
Avoidance	4.17 (2.79)
NACM	15.68 (7.82)
Arousal	12.34 (6.52)
BTQ	3.67 (1.82)
CUDIT Total	7.28 (7.85)
CUDIT ≥ 20 (%)	23%
DUDIT Total	11.19 (14.15)
DUDIT ≥ 25 (%)	23%
AUDIT Total	16.34 (11.49)
AUDIT ≥ 20 (%)	44%
Psychosis	6.40 (4.17)
Depression	16.36 (7.29)
Anxiety	13.30 (6.06)

Note: means and standard deviations presented except for variables where percentages (%) are presented. PTSD = sum scores the PTSD Checklist (PCL-5). NACM = Negative Alterations in Cognition and Mood. BTQ = Brief Trauma Questionnaire (mean number of items endorsed). AUDIT = Alcohol Use Disorder Identifications Test (sum score). CUDIT = Cannabis Use Disorder Identification Test (sum score). DUDIT = Drug Use Disorders Identification Test (sum score). Psychosis = sum scores on the Prodromal Questionnaire (PQ-16; scale range 0-16; cutoff for probable psychosis ≥ 6). Depression = sum scores on the Patient Health Questionnaire (PHQ-9; scale range 0-27; cutoff for moderate severity ≥ 15). Anxiety = sum scores on the Generalized Anxiety Disorder (GAD-7; scale range 0-21; cutoff for moderate severity ≥ 10).

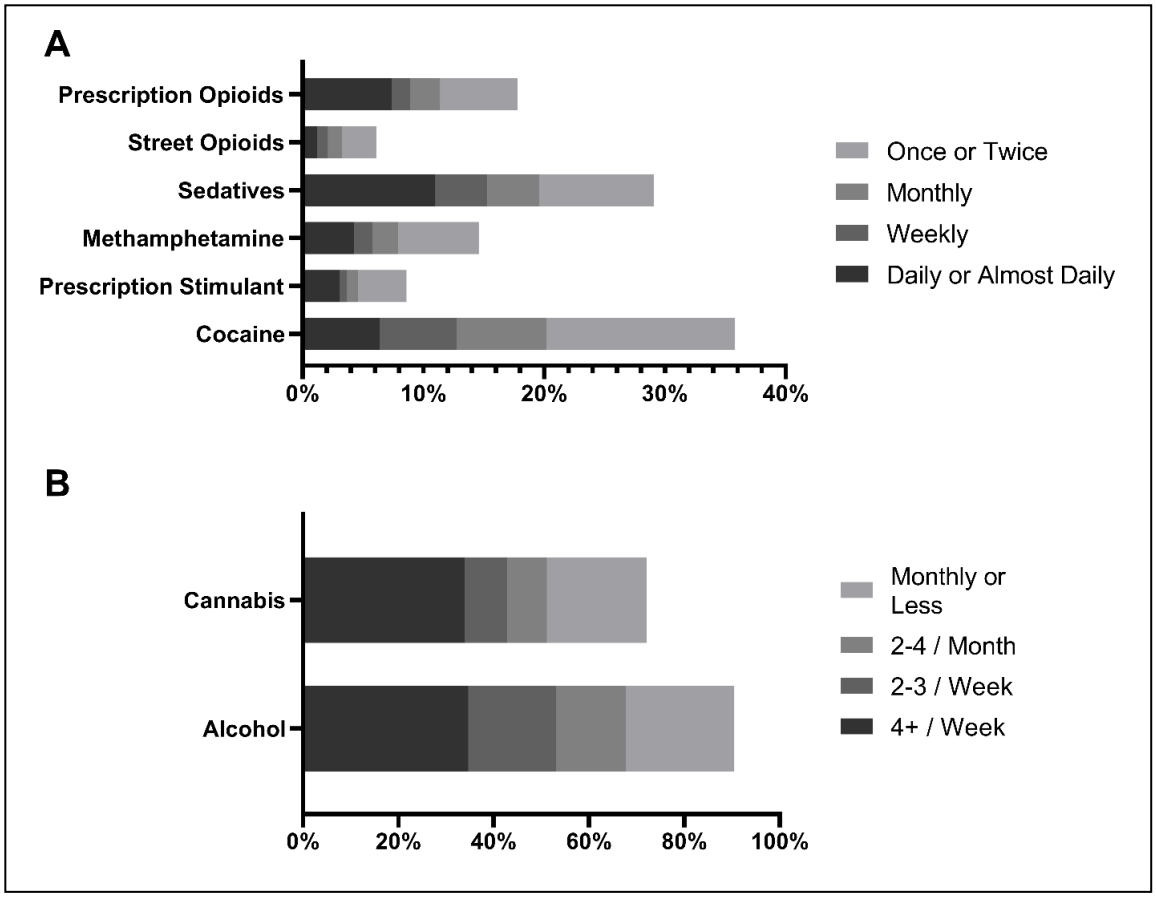

Figure 1. Alcohol and/or Substance Use Frequencies.

Frequency of reported use for alcohol, cannabis, and illicit substances. Alcohol and cannabis frequencies were extracted from item 1 on the AUDIT and CUDIT, respectively. Illicit substance use frequencies were extracted from the NIDA Modified-Assist. Frequencies are for illicit substances are reported in percentages of sample endorsing daily (darkest grey), weekly (second darkest grey), monthly (second lightest grey), and once or twice (lightest grey). Frequencies for alcohol and cannabis use are reported in percentages of sample endorsing >4/week (darkest grey), 2-3/week (second darkest grey), 2-4/month (second lightest grey), and monthly or less use (lightest grey).

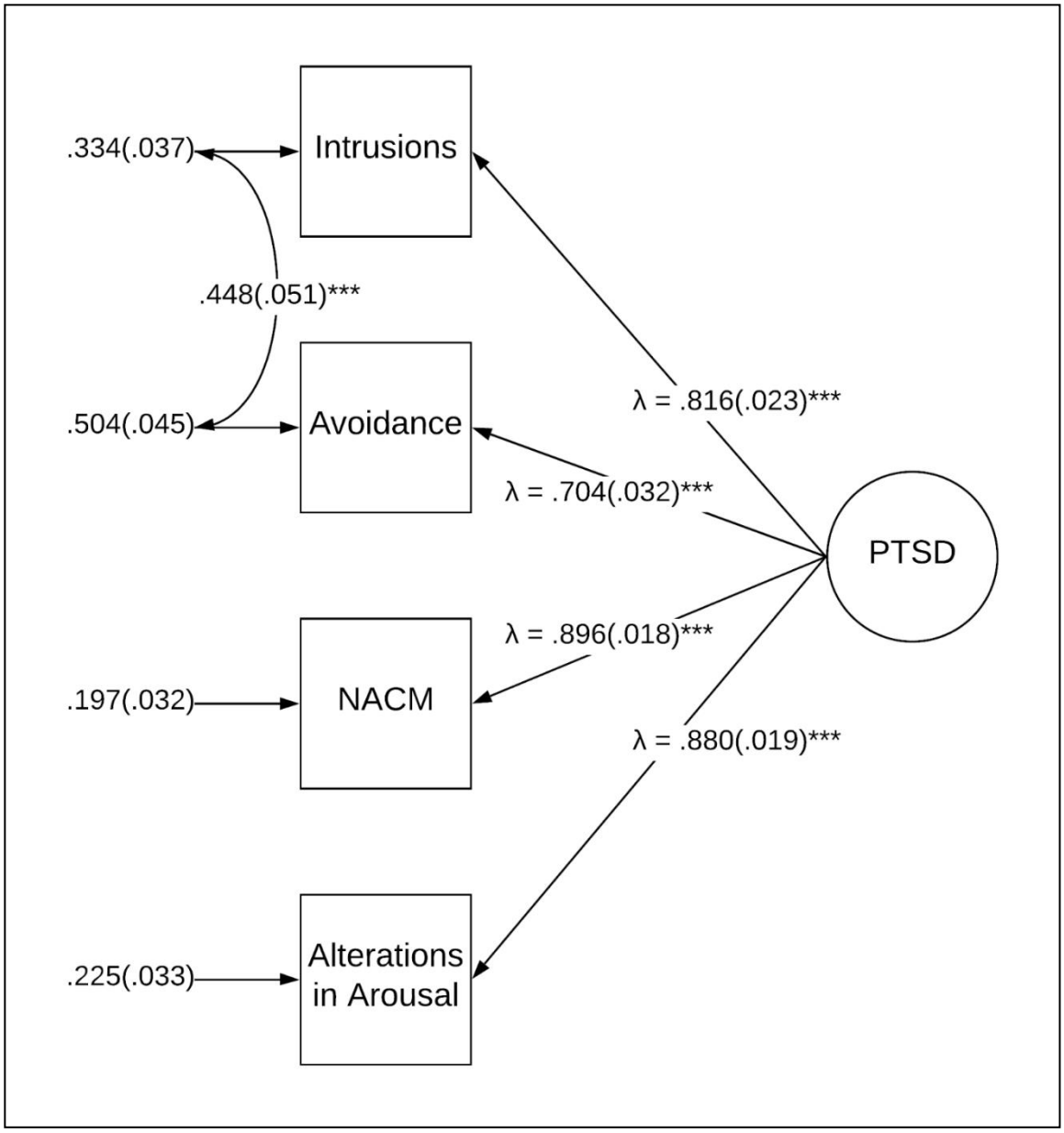

Figure 2. Measurement model for PTSD latent factor.

All values are standardized. Standard errors for residuals and covariances in parentheses. PTSD = PTSD latent factor, NACM = Negative Alterations in Cognition and Mood. Model fit was excellent ($\chi^2(1, N = 326) = 0.840$, $p > .05$, TLI = 1.00, CFI = 1.00, RMSEA = 0.000, SRMR = 0.003). * $p < .05$; ** $p < .01$; *** $p < .001$

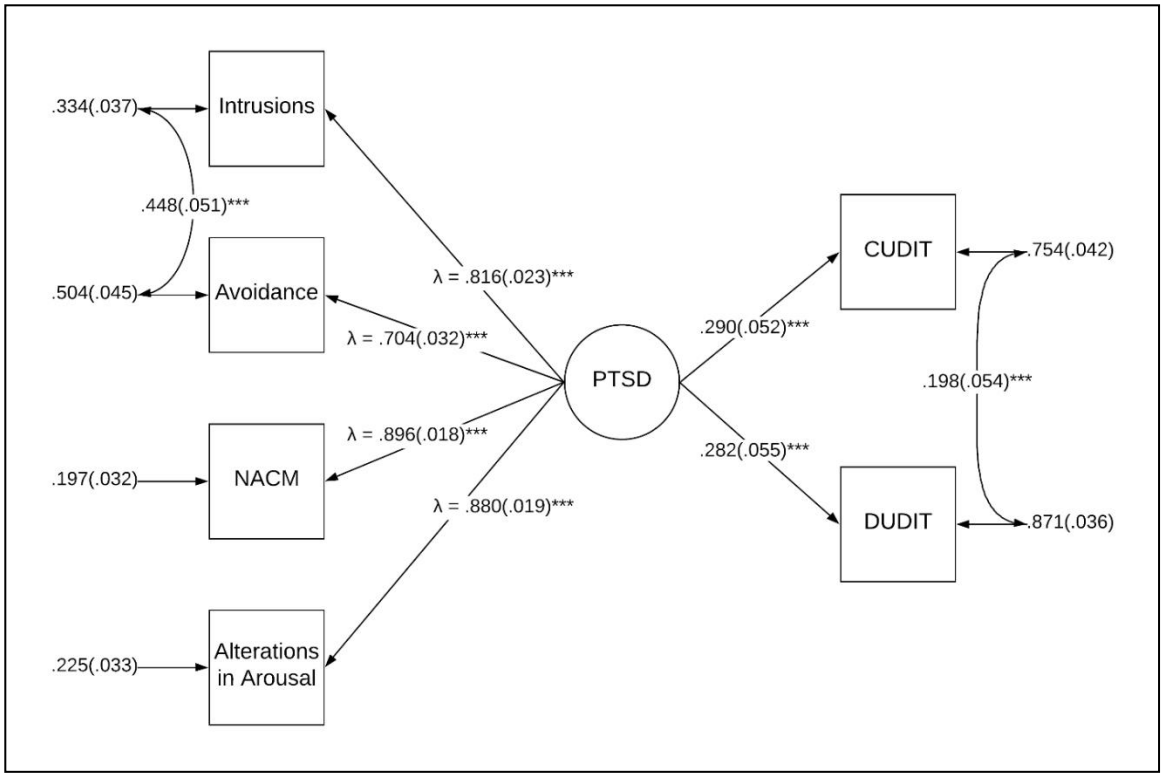

Figure 3. Structural equation model assessing substance-related problems as a function of PTSD symptom severity.

All values are standardized. Standard error for residuals and covariances in parentheses. PTSD = PTSD latent factor, NACM = Negative Alterations in Cognition and Mood, CUDIT = cannabis use related problems, DUDIT = substance use related problems. Age and sex were controlled for. Model fit was excellent ($\chi^2(13, N = 326) = 15.831$, $p > .05$, TLI = .994, CFI = .997, RMSEA = 0.03, SRMR = 0.02). * $p < .05$; ** $p < .01$; *** $p < .001$

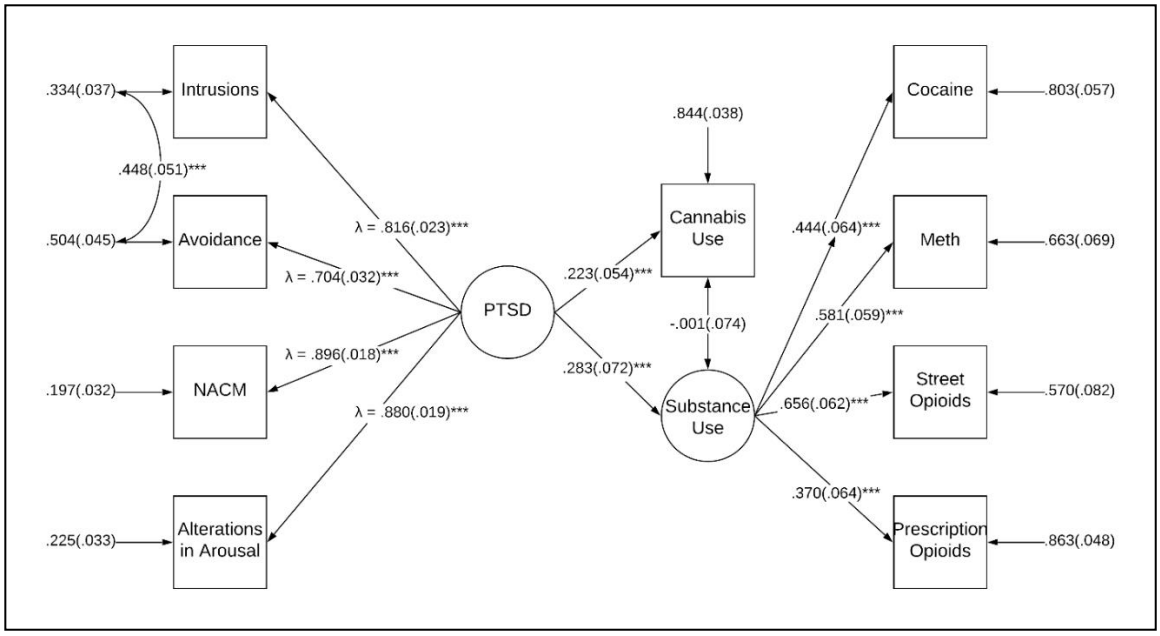

Figure 4. Structural equation model assessing cannabis and substance use frequencies as a function of PTSD symptom severity.

All values are standardized. Standard error for residuals and covariances in parentheses. PTSD = PTSD latent factor, NACM = Negative Alterations in Cognition and Mood, Substance Use = illicit substance use frequencies latent factor, Cannabis Use = cannabis use frequency score. Age was controlled for. Model fit was excellent: ($\chi^2(30, N = 326) = 58.256$, $p < .01$, TLI = .962, CFI = .974, RMSEA = 0.054, SRMR = 0.039). * $p < .05$; ** $p < .01$; *** $p < .001$.

SUPPLEMENTAL MATERIALS

Supplemental Table 1. Bivariate Correlations between Variables of Interest.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Age	1													
2. Sex	-.104	1												
3. PTSD	-.163**	.241**	1											
4. Intrusions	-.161**	.235**	.894**	1										
5. Avoidance	-.152**	.249**	.787**	.758**	1									
6. NACM	-.131*	.211**	.924**	.728**	.639**	1								
7. Arousal	-.146**	.190**	.905**	.721**	.610**	.789**	1							
8. BTQ	.088	-.029	.430**	.409**	.414**	.348**	.394**	1						
9. CUDIT	-.359**	-.084	.266**	.195**	.204**	.248**	.278**	.105	1					
10. DUDIT	-.144**	-.111*	.258**	.192**	.158**	.237**	.289**	.202**	.255**	1				
11. AUDIT	.029	-.073	-.033	-.032	.000	-.043	-.023	.015	-.062	-.138*	1			
12. Psychosis	-.195**	.087	.554**	.511**	.385**	.470**	.559**	.281**	.216**	.286**	-.051	1		
13. Depression	-.130*	.168**	.566**	.418**	.373**	.565**	.571**	.100	.197**	.149**	.057	.410**	1	
14. Anxiety	-.115*	.180**	.599**	.475**	.391**	.574**	.609**	.141*	.189**	.150**	.008	.398**	.798**	1

Note: $^{**}p < .01$; $^{*}p < .05$; PTSD = sum scores the PTSD Checklist (PCL-5). NACM = Negative Alterations in Cognition and Mood. BTQ = Brief Trauma Questionnaire (mean number of items endorsed). AUDIT = Alcohol Use Disorder Identifications Test (sum score). CUDIT = Cannabis Use Disorder Identification Test (sum score). DUDIT = Drug Use Disorders Identification Test (sum score). Psychosis = sum scores on the Prodromal Questionnaire (PQ-16). Depression = sum scores on the Patient Health Questionnaire (PHQ-D). Anxiety = sum scores on the Generalized Anxiety Disorder (GAD-7).

Supplemental Table 2. Partial Correlations between Variables of Interest (controlling for age and sex).

	1	2	3	4	5	6	7	8	9	10	11	12
1. PTSD	-											
2. Intrusions	**.885**	-										
3. Avoidance	**.769**	**.737**	-									
4. NACM	**.920**	**.709**	**.612**	-								
5. Arousal	**.901**	**.705**	**.586**	**.778**	-							
6. BTQ	**.467**	**.442**	**.449**	**.373**	**.424**	-						
7. CUDIT	**.261**	**.179**	**.197**	**.247**	**.275**	**.140**	-					
8. DUDIT	**.277**	**.205**	**.173**	**.252**	**.305**	**.213**	**.203**	-				
9. AUDIT	-.016	-.018	.017	-.030	-.007	.005	-.071	**-.151**	-			
10. Psychosis	**.539**	**.494**	**.361**	**.454**	**.544**	**.307**	**.170**	**.277**	-.042	-		
11. Depression	**.542**	**.386**	**.338**	**.545**	**.550**	**.118**	**.187**	**.157**	.074	**.390**	-	
12. Anxiety	**.577**	**.445**	**.355**	**.552**	**.590**	**.157**	**.186**	**.160**	.022	**.380**	**.790**	-

Note: bolded values indicate significance at $p < .01$; PTSD = sum scores the PTSD Checklist (PCL-5). NACM = Negative Alterations in Cognition and Mood. BTQ = Brief Trauma Questionnaire (mean number of items endorsed). AUDIT = Alcohol Use Disorder Identifications Test (sum score). CUDIT = Cannabis Use Disorder Identification Test (sum score). DUDIT = Drug Use Disorders Identification Test (sum score). Psychosis = sum scores on the Prodromal Questionnaire (PQ-16). Depression = sum scores on the Patient Health Questionnaire (PHQ-D). Anxiety = sum scores on the Generalized Anxiety Disorder (GAD-7).

2.3 Discussion

This study was among the first of a relatively few studies to use an SEM framework to analyze associations between PTSD symptoms and cannabis and other illicit substance use and their related problems. It was also the first study to analyze these associations within a treatment-seeking sample seeking outpatients with concurrent disorders. In general, this study developed and established the analytical framework for the papers discussed in Chapters 3 and 4.

This paper highlighted significant associations between global PTSD symptoms and cannabis use-related problems and illicit substance use-related problems. Furthermore, among the specific symptom clusters of PTSD, the Reactivity (a.k.a., Alterations in Arousal) cluster was significantly associated with cannabis and illicit substance use-related problems. In addition, specific to cannabis use-related problems, the Avoidance cluster was significantly associated. Despite additional factors beyond PTSD-related symptoms likely contributing to substance use-related problems in this sample, the significant associations observed emphasize the importance of studying these associations further. Furthermore, they highlight potential therapeutic targets for intervention among individuals with complex concurrent disorders where treatment outcomes are generally poor.

While this study builds upon prior literature and proposes and validates an SEM analytical framework to examine the associations between PTSD symptoms and substance use-related problems, this study has a few limitations. The two significant limitations are the lack of significant associations seen with alcohol use-related problems and a lack of

dissociation as a critical variable of interest. Chapter 3 addresses these limitations using the same SEM analytical framework among a different clinical sample.

Chapter 3. In-patient PTSD Treatment Seeking Sample

3.1 Introduction

As discussed in the previous chapter, two significant limitations in the previous chapter were the lack of significant associations between PTSD symptoms and alcohol-related problems and dissociation as a critical variable of interest within the analyses. As such, the purpose of this chapter was to address both limitations among a sample of individuals seeking inpatient treatment for PTSD.

PTSD is significantly associated with dissociative symptoms (Armour et al., 2014; Galatzer-Levy et al., 2011; Steuwe et al., 2012; Wolf et al., 2012) and alcohol use-related problems (Kilpatrick et al., 2003; Pietrzak et al., 2011; Van Ameringen et al., 2008). Furthermore, dissociative symptomatology has also been linked to alcohol use and its related problems (Craparo et al., 2014; Evren et al., 2011; Najavits & Walsh, 2012; Schäfer et al., 2010; Zdankiewicz-Ścigała & Ścigała, 2018). However, a unifying mechanism between these three variables has not yet been explored. Therefore, the paper presented in this chapter aimed to examine dissociative symptoms as a potential mediator between PTSD symptoms and alcohol-related problems among an inpatient PTSD treatment-seeking sample.

Data were collected as a part of a clinical intake battery prior to starting inpatient treatment at the Homewood Health Centre in the Posttraumatic Stress Recovery Unit. Therefore, the sample in the current study represents an inpatient sample seeking treatment for PTSD primarily as referred to by a licensed clinician. PTSD was the primary focus, with alcohol use-related problems being assessed as an associated variable of interest. Furthermore, this study used the same SEM framework introduced in Chapter 2 to analyze the mediating role of dissociation in the relation between PTSD and alcohol-related problems.

The primary author of this study (HP) conceptualized the research question, developed the theoretical structural equation models, conducted the formal data analysis, and wrote the manuscript for publication.

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3.2 Dissociative Symptomatology Mediates the Relation Between Posttraumatic Stress Disorder Severity and Alcohol-Related Problems

Patel, H., O'Connor, C., Andrews, K., Amlung, M., Lanius, R., & McKinnon, M. C. (2022). Dissociative symptomatology mediates the relation between posttraumatic stress disorder severity and alcohol-related problems. *Alcoholism: Clinical and Experimental Research*, *46*(2), 289-299. doi: 10.1111/acer.14764

ABSTRACT

Background: Up to 50% of individuals with Posttraumatic Stress Disorder (PTSD) endorse problematic alcohol use. Typically, these individuals present with more complex and often more severe PTSD symptoms than those who do not report problematic alcohol use. Emerging literature suggests that heightened symptoms of dissociation are likewise associated with increased PTSD symptom severity. Despite this knowledge, the role of dissociation in the relation between PTSD severity and alcohol-related problems has yet to be examined. Here, we explore the mediating role of dissociative symptomatology on the association between PTSD severity and alcohol-related problems within a PTSD treatment-seeking sample. **Methods:** Structural equation modelling was used to test the mediating role of dissociative symptomatology between PTSD severity and alcohol-related problems. Participants [N = 334; mean age (SD) = 44.29 (9.77), 50% female] were drawn from a clinical intake battery database for PTSD in-patient treatment services at Homewood Health Care, Guelph, ON, Canada. A subset of battery measures assessing PTSD severity, dissociative symptomatology, and alcohol-related problems were submitted to analysis. **Results:** A significant positive association emerged between PTSD severity and alcohol-related problems ($\beta = .127$, $p < .05$) in the absence of dissociative symptomatology. Critically, however, when added to this model, dissociative symptomatology (six unique facets of dissociation assessed by the Multiscale Dissociation Inventory) mediated the relation between PTSD severity and alcohol-related problems. Specifically, increased PTSD severity was associated with higher dissociative symptomatology ($\beta = .566$, $p < .0001$) that was in turn associated with greater alcohol-related problems ($\beta = .184$, $p < .05$).

Conclusions: Taken together, these results suggest that dissociative symptomatology plays a key role in explaining the relation between PTSD severity and alcohol-related problems. Future studies should examine the impact of targeting specifically dissociative symptomatology in the treatment of individuals with PTSD who endorse alcohol-related problems.

INTRODUCTION

Posttraumatic stress disorder (PTSD) develops following exposure to a traumatic event (American Psychological Association (APA), 2013) and is a highly prevalent and functionally de-habilitating (Norman et al., 2007; Westphal et al., 2011) mental health disorder with 7-8% of the population meeting criteria for PTSD at some point in their lives (Kessler et al., 1995). Here, symptoms of PTSD are categorized into four clusters: Intrusive thoughts and memories, Avoidance behaviours, Negative Alterations in Cognition and Mood (NACM), and Alterations in arousal (American Psychological Association (APA), 2013). Earlier work surrounding the self-medication hypothesis posits that individuals with PTSD may use substances to cope with their symptoms (Khantzian, 1985). Indeed, PTSD is often associated with alcohol and/or substance use, with data from the 2010 National Epidemiologic Survey on Alcohol and Related Conditions (N = 34,653) estimating that 46.4% of individuals meeting criteria for PTSD also meet criteria for a substance use disorder (SUD; Pietrzak et al., 2011). Moreover, a 2016 follow-up on this survey confirmed that these rates of alcohol and/or substance use remained stable over the intervening six-year period highlighting the high prevalence rate was not overestimated in the previous survey (Smith et al., 2016).

Among Canadians where the present study is situated, 9.6% of individuals meet criteria for PTSD with 27.8% of those individuals reporting alcohol use/dependence (Van Ameringen et al., 2008). Critically, comorbid PTSD and AUD/SUD is often associated with a heightened risk of other mental health concerns, suicidality, mortality, and functional impairment (Kilpatrick et al., 2003; Pietrzak et al., 2011), rendering it essential to examine

the associations between PTSD and AUD/SUD to inform evidence-based treatment methodologies.

A wide body of literature points to dissociation as a highly salient feature of PTSD, where the DSM-5 including a dissociative subtype of PTSD that must be explored in any patient presenting for clinical assessment of the disorder (American Psychological Association (APA), 2013). Here, dissociation is thought to involve detachment from immediate somatic or environmental experience, occurring during acute trauma and thus modulating its immediate psychophysiological impact (Spiegel, 2012). Put simply, dissociation is a psychological escape when no physical escape is possible (Putnam, 1991). Typically, individuals with the dissociative subtype of PTSD present with a history of more severe early-life trauma (Stein et al., 2013) and higher PTSD severity scores (Wolf et al., 2012) than those without the subtype.

Notably, dissociation has also been linked to alcohol (Craparo et al., 2014; Evren et al., 2011; Zdankiewicz-Ścigała and Ścigała, 2018) and/or substance use (Najavits and Walsh, 2012; Schäfer et al., 2010; Wenzel et al., 1996). Prior reports have examined dissociation as a predictor variable with alcohol or substance use and its related problems as outcomes (Craparo et al., 2014; Evren et al., 2011; Najavits and Walsh, 2012; Schäfer et al., 2010; Wenzel et al., 1996). After controlling for PTSD severity, the majority of these studies reveal significant associations between dissociative symptomatology and alcohol and/or substance use and its related problems even in the presence of PTSD severity (Evren et al., 2011; Najavits and Walsh, 2012), as well as with childhood adversity (Evren et al., 2011; Schäfer et al., 2010) and alexithymia (Craparo et al., 2014). Interestingly, a related

study found associations between dissociative symptomatology and alcohol and/or cocaine use and its related problems for lifetime use but not recent use (Wenzel et al., 1996). Taken together, these studies point towards a clear association of PTSD severity and dissociation with both alcohol use and problems related to use. To note, PTSD psychopathology has been more closely linked to alcohol-related problems rather than consumption (Angkaw et al., 2015; Bulloch et al., 2012; Simons et al., 2018; Wilson et al., 2017). Critically, however, despite this wide body of knowledge establishing key associations between PTSD and dissociation, PTSD and alcohol, and alcohol and dissociation, the potential unifying mechanisms underlying these three variables have yet to be explored.

In numerous previous reports, dissociation has been included as an independent variable of interest in relation to alcohol use and its related problems (Craparo et al., 2014; Evren et al., 2011; Najavits and Walsh, 2012; Schäfer et al., 2010; Wenzel et al., 1996). To our knowledge, however, no studies have examined dissociation as a mediator between PTSD severity and alcohol-related problems. Accordingly, the primary objective of the present study was to examine the mediating effects of dissociative symptomatology on the well-established relation between PTSD severity and alcohol-related problems among a treatment-seeking clinical sample meeting diagnosis for PTSD. Given the cross-sectional nature of these data, an alternate model was also tested to examine PTSD severity as a mediator between dissociative symptomatology and alcohol-related problems. Consistent with prior literature (Dworkin et al., 2018; McGlinchey et al., 2021; Patel et al., 2021; Walton et al., 2018), a secondary exploratory objective was to examine the mediating role of dissociation between specific PTSD symptom clusters and alcohol-related problems.

METHODS

Participants

Participants were drawn from a clinical intake battery database from the Program for Traumatic Stress Recovery at Homewood Health Care, Guelph, ON. The program is a specialized in-patient treatment program for individuals seeking treatment for posttraumatic stress disorder. To be admitted to the program, individuals must: (1) be 18 years of age or older, and (2) be able to participate in group therapy in a mixed community milieu.

Participants were informed their data would be used for research purposes; however, each individual was provided with the option to opt-out from having their data be used for research with no penalty to their care. There was no compensation for participants as assessments were part of standard care. The research database was approved by the Homewood Research Ethics Board (REB #18-07). A total of 402 clients completed the clinical intake battery between September 2017 to November 2019. Of these, 9 participants were excluded due to readmissions to the program and 59 participants were excluded due to missing data on the dependent variable of interest. The final sample consisted of 334 individuals receiving inpatient care for PTSD as deemed necessary by a clinician and met the 33+ cut-off score for provisional PTSD diagnosis on the Posttraumatic Stress Disorder Checklist (PCL-5; Blevins et al., 2015).

Measures

Data were collected occurred during the first week of a client's admission to the program. All measures were administered electronically to participants using Voxco

Survey software. The battery included self-report questionnaires assessing demographics, mental health screens, alcohol use, and psychological assessments. Demographic variables included age and sex, provided by participants at admission. Self-report measures included validated assessments for psychiatric disorders and mechanisms/predictors of psychiatric disorder severity. A subset of these measures was analyzed in the present study, as described below.

Posttraumatic Stress Disorder Severity. PTSD symptoms and severity in the past month were assessed using the Posttraumatic Stress Disorder Checklist for Diagnostic and Statistical Manual-5 (PCL-5; Blevins, Weathers, Davis, Witte, & Domino, 2015). The PCL-5 is a 20-item measure comprised of four clusters corresponding to the DSM-5 diagnostic criteria: Cluster B (Intrusive thoughts and memories), Cluster C (Avoidance behaviours), Cluster D (Negative Alterations in Cognition and Mood), and Cluster E (Alterations in Arousal). Scores on the PCL-5 range from 0–80, with the following subscale ranges: Cluster B (0 – 20), Cluster C (0 – 8), Cluster D (0 – 28), and Cluster E (0 – 20). SEM was used to generate a single latent factor of PTSD symptoms from the cluster scores, as described below.

Dissociative Symptomatology. The Multiscale Dissociation Inventory was used to assess dissociative symptoms within the past month (Briere et al., 2005). The MDI is a 30-item self-report questionnaire and measures six different types of dissociative response: (1) Disengagement, (2) Depersonalization, (3) Derealization, (4) Emotional Constriction/Numbing, (5) Memory Disturbance, and (6) Identity Dissociation. Items are rated on a scale of 1 (“never”) to 5 (“very often”). Scores on the MDI range from 30-150

and higher scores indicate greater dissociative symptomatology endorsement. SEM was used to generate a single latent factor of dissociative symptoms from the subscale scores, as described below.

Alcohol-Related Problems. Alcohol use frequency and alcohol-related problems experienced over the past 12 months were measured using the Alcohol Use Disorders Identification Test (AUDIT), a 10-item self-report screen assessing the frequency and severity of alcohol use (Saunders et al., 1993). The AUDIT assesses both consumption of alcohol (three items) and problems related to alcohol consumption (seven items). As such, typically within the literature, the AUDIT is referred to assessing alcohol-related problems rather than consumption. Scores on the AUDIT range from 0–40 and a cut-off of 8 or greater indicates clinically hazardous alcohol use. The sum score on the AUDIT was included as the outcome variable in the mediation model.

Emotion Dysregulation. The Difficulties in Emotion Regulation Scale (DERS) is a 36-item self-report questionnaire assessing six facets of emotion regulation within the past month: (1) non-acceptance of emotional responses, (2) difficulty engaging in goal-directed behaviour, (3) impulse control difficulties, (4) lack of emotional awareness, (5) limited access to emotion regulation strategies, and (6) lack of emotional clarity (Gratz and Roemer, 2004; Hallion et al., 2018). Items are rated on a scale of 1 (“almost never”) to 5 (“almost always”). Scores on the DERS range from 36-180 and higher scores indicate more difficulty in emotion regulation. DERS sum score was utilized as a covariate in the mediation model.

Childhood Adversity. The Adverse Childhood Experience Scale (ACES) is a 10-item self-report questionnaire used to assess the endorsement of adverse childhood experiences (Merrick et al., 2017). Participants are asked to indicate "yes" or "no" to a variety of adverse childhood experiences. Scores on the ACES range from 0-10. Higher scores indicate greater endorsement of adverse childhood experiences. A sum score on the ACES was used as a covariate in the mediation model.

Data Analysis Plan

Descriptive statistics and zero-order correlations were run among the study variables. Structural equation modelling was implemented in MPlus Version 8.4 (Muthén and Muthén, 2017) using maximum likelihood estimation to assess the mediating effects of dissociative symptomatology on the association between PTSD severity and alcohol-related problems. The following latent factors were used within the mediation model. A latent factor for PTSD was created using the four symptom cluster scores from the PCL-5: Intrusions (Cluster B), Avoidance (Cluster C), NACM (Cluster D), and Alterations in Arousal (Cluster E) (refer to supplemental figure 1 for measurement model). A latent factor for dissociative symptomatology was created using the six subscales of dissociation on the MDI: Disengagement, Depersonalization, Derealization, Emotional Constriction/Numbing, Memory Disturbance, and Identity Dissociation (refer to supplemental figure 2 for measurement model). The mediation model tested the direct and indirect (mediated by dissociation) effects of PTSD severity on alcohol-related problems. An alternate model was specified, using the same variables as above, in which the dissociation and PTSD latent factors were switched to account for the cross-sectional nature

of the data. An exploratory model for our secondary objective was also conducted examining the mediatory effects of dissociative symptomatology on the individual PTSD symptom clusters rather than global PTSD severity indicated by the latent factor. The secondary mediation model tested the direct and indirect (mediated by dissociation) effects of the four PTSD symptom clusters [Intrusions (Cluster B), Avoidance (Cluster C), NACM (Cluster D), and Alterations in Arousal (Cluster E)] on alcohol-related problems while controlling for age, sex, emotion dysregulation, and childhood adversity. Before modelling, the alcohol-related problems measure (AUDIT sum score) and the Identity Dissociation subscale from the MDI were square-root transformed based on benchmarks of skewness >2 and kurtosis >7 (Curran et al., 1996). There were no significant outliers within the sample (Zs > 3.29). We used two-tailed tests with a statistical significance of $\alpha < 0.05$. Following established conventions (Hu and Bentler, 1999; Schreiber et al., 2006), an excellent-fitting model has a comparative fit index (CFI) and Tucker Lewis Index (TLI) $\geq$ 0.95, standardized root mean squared residual (SRMR) of $\leq$ 0.08 and root mean square error of approximation (RMSEA) $\leq$ 0.06.

RESULTS

Descriptive Statistics

The sample consisted of 334 participants (50% female) with a mean age of 44.29 (SD = 9.77). Sample characteristics can be found in Table 1. 26.6% of the sample met criteria for hazardous alcohol use (i.e., $\geq$ 8 on AUDIT). Furthermore, 88.6% of the sample reported at least one adverse childhood experience. Depression (M = 23.14) and anxiety

(M = 21.18) scores were moderate within the sample (refer to Table 1) given the range of scores (0 – 42) on each measure.

Primary Mediation Analysis

Prior to the mediation analyses, measurement models were specified for PTSD severity and Dissociative Symptomatology (as described prior). Measurement models for both latent variables can be found in the Supplemental Materials. Prior to the mediation analyses, the association between PTSD severity and alcohol-related problems was first examined. The pathway from PTSD severity to alcohol-related problems was examined with age and sex included as covariates within the model. The path from PTSD severity to alcohol-related problems was significant ($\beta = .127$, $p = .03$). Among covariates, age was significantly associated with alcohol-related problems ($\beta = -.198$, $p < .001$). Sex, emotional dysregulation, and childhood adversity were not significantly associated with any of the variables and were trimmed from the model for parsimony.

When evaluating the mediating effects of dissociative symptomatology, the paths between (1) PTSD severity and alcohol-related problems, (2) PTSD severity and dissociative symptomatology, and (3) dissociative symptomatology and alcohol-related problems were assessed. Covariates in the model include age, sex, emotional dysregulation, and childhood adversity. Among covariates, sex and childhood adversity were not significantly associated with any other variables and thus were trimmed from the model for parsimony. Age was significantly associated with alcohol-related problems ($\beta = -.187$, $p < .001$) but not dissociative symptomatology ($\beta = -.019$, $p = .690$) whereas emotional dysregulation was significantly associated with dissociative symptomatology ($\beta = .213$, p

< .001) but not alcohol-related problems (β = .006, p = .933). In the presence of the significant covariates and dissociative symptomatology added as a mediator, the direct path from PTSD severity to alcohol-related problems (β = -.004, p = .971) was no longer significant. The path from PTSD severity to dissociative symptomatology was significant (β = .565, p < .001) and the path from dissociative symptomatology to alcohol-related problems was significant (β = .184, p = .04). Refer to Figure 1 for the mediation model including direct and indirect effects of PTSD severity on alcohol-related problems.

Alternate Mediation Model

To account for the cross-sectional nature of the data, an alternate model was specified using the same variables as the primary mediation model; however, the predictor and mediator variables were switched. Here, PTSD severity was specified as the mediator and dissociative symptomatology was specified as the predictor. Thus, this alternate model tested the paths from (1) dissociative symptomatology to alcohol-related problems, (2) dissociative symptomatology to PTSD severity, and (3) PTSD severity to alcohol-related problems. Age was the only significant covariate in the model given a significant association with alcohol-related problems. Sex, emotion dysregulation, and childhood adversity were not significantly associated with anything and thus were subsequently trimmed from the model for parsimony. The direct path from dissociative symptomatology to alcohol-related problems (β = .081, p < .05) was still significant in the presence of PTSD severity as a mediator. The path from dissociative symptomatology to PTSD severity was significant (β = .507, p < .001); however, the path from PTSD severity to alcohol-related problems was not significant (β = -.005, p > .05). Refer to Figure 2 for the alternate

mediation model including direct and indirect effects of dissociative symptomatology on alcohol-related problems.

Secondary Cluster Model

A secondary model was specified in which the PTSD latent factor was replaced with the individual symptom clusters: (1) Intrusions (Cluster B), Avoidance (Cluster C), NACM (Cluster D), and Alterations in Arousal (Cluster E) to examine direct and indirect (mediated by dissociation) associations between specific symptoms clusters and alcohol-related problems. Similar to the primary model, before assessing the mediating effects of dissociation, pathways between each symptom cluster and alcohol-related problems were assessed with age, sex, emotion dysregulation, and childhood adversity as covariates. Only the Alterations in Arousal cluster was significantly associated with alcohol-related problems ($\beta = -.191$, $p < .001$); the other symptom clusters were not significantly associated with alcohol-related problems (Intrusions: $\beta = -.039$, $p = .554$; Avoidance: $\beta = .015$, $p = .799$; NACM: $\beta = -.046$, $p = .534$). Among covariates, only age was significantly associated with alcohol-related problems; sex, emotion dysregulation, and childhood adversity were not significantly associated with alcohol-related problems and were subsequently trimmed from the model for parsimony.

When evaluating the mediating effects of dissociative symptomatology, the paths between: (1) each PTSD symptom cluster and alcohol-related problems, (2) each symptom cluster and dissociative symptomatology, and (3) dissociative symptomatology and alcohol-related problems were assessed. Covariates in the model include age, sex, emotional dysregulation, and childhood adversity. Sex and childhood adversity were not

significantly associated with any other variables and thus were trimmed from the model for parsimony. Whereas age was significantly associated with alcohol-related problems (β = -.185, p = .001) but not dissociative symptoms (β = .014, p = .772), emotion dysregulation was associated with dissociative symptomatology (β = .321, p < .001) but not alcohol-related problems (β = .008, p = .912). All direct paths from each PTSD symptom cluster and alcohol-related problems were no longer significant (Intrusions: β = -.07, p = .296; Avoidance: β = .032, p = .599; NACM: β = -.07, p = .346; Alterations in Arousal: beta = .100, p = .166). Paths from each PTSD symptom cluster to dissociative symptomatology were significant for: Intrusions (β = .189, p = .001), NACM (β = .229, p < .001), and Alterations in Arousal (β = .189, p = .002) but not Avoidance (β = -.098, p = .058). The path from dissociative symptomatology to alcohol-related problems was significant (β = .192, p = .008). Please refer to Figure 3 for mediation model including direct and indirect effects of each PTSD symptom cluster on alcohol-related problems.

DISCUSSION

To our knowledge, this was the first study to examine the mediatory effects of dissociative symptomatology on the relation between PTSD severity and alcohol-related problems among a treatment-seeking sample of patients diagnosed with PTSD. The results are consistent with the hypothesis that dissociation significantly and positively mediates the relation between PTSD severity and alcohol-related problems. Greater PTSD severity was associated with heightened dissociative symptoms, which in turn was associated with greater alcohol-related problems. This pattern of results was not observed in the alternate model, where greater dissociative symptoms were associated with heightened PTSD

severity, but greater PTSD severity did not significantly associate with alcohol-related problems. The lack of significant mediating effect by PTSD severity indicates a unique mediating role of dissociative symptomatology between PTSD severity and alcohol-related problems. Notably, exploratory analyses examining the individual symptom clusters of PTSD further support the mediating role of dissociative symptoms between Intrusions, NACM, and Alterations in arousal with alcohol-related problems; the same mediating effects were not observed for the Avoidance symptom cluster.

Interestingly, there was a lack of significant sex differences seen in the current study which is inconsistent with prior findings in the literature with females showing greater severity of PTSD symptoms as compared to males (Ramikie and Ressler, 2018). Furthermore, males show greater prevalence of AUD as compared to females (Agabio et al., 2016); however, females show greater health related problems related to alcohol consumption than males (Agabio et al., 2016). Given that the sample was 50% female, it is interesting that sex differences were not observed given significant power for analyses. A potential explanation for these inconsistent results includes an absence of gender assessment in addition to sex, which may have eroded any gender related effects as patients were forced to into a binary response for sex. However, it is important to note that there is also a gender bias in seeking mental health care where women are more likely to seek help than men (Klose and Jacobi, 2004; Pattyn et al., 2015; Rhodes and Goering, 1994) thus gender bias is a limitation to be considered among established gender differences in the literature.

Dissociation has been linked previously to alcohol and substance use and its related problems (Wenzel et al., 1996), even after controlling for PTSD severity (Evren et al., 2011; Najavits and Walsh, 2012), childhood adversity (Evren et al., 2011; Schäfer et al., 2010), and alexithymia (Craparo et al., 2014). These prior findings are consistent with current results supporting a significant positive association between dissociation and alcohol-related problems. The present study, however, was the first to examine the underlying mechanisms of this relation by revealing the mediating role of dissociative symptoms between PTSD severity and alcohol-related problems. In addition to revealing this potential mechanism, these findings suggest that individuals with PTSD and heightened symptoms of dissociation are more likely to experience greater severity of alcohol-related problems in comparison to individuals with PTSD not experiencing dissociation.

Taken together, the results of the current study are consistent with the self-medication hypothesis, which suggests that individuals use substances and/or alcohol to cope with psychiatric symptoms (Khantzian, 1985). Given that the presence of heightened dissociation among individuals with PTSD appears related to greater functional impairment (Boyd et al., 2018), it is probable that those individuals with PTSD experiencing heightened levels of dissociation may also be more likely to use alcohol and/or substances maladaptively, thus heightening the risk of alcohol and/or substance-related problems in this disorder. The specific targeting of dissociative symptoms may prove helpful as a clinical intervention for treatment-seeking individuals with PTSD who also endorse problematic alcohol use. Indeed, there is a promising adjunctive treatment program for dissociative patients called the Treatment of Patients with Dissociative Disorders (TOP

DD) that helps stabilize emotion dysregulation and safety concerns among highly dissociated individuals (Brand et al., 2019).

The exploratory model examining the mediating role of dissociation between PTSD symptom clusters and alcohol-related problems follows prior literature closely (Dworkin et al., 2018; McGlinchey et al., 2021; Patel et al., 2021; Walton et al., 2018) which has pointed towards significant relations between the Intrusion, NACM, and Alterations in Arousal clusters of PTSD and alcohol misuse (Walton et al., 2018) in the absence of dissociation. In the present study involving a large number of treatment-seeking inpatients, however, only the Alterations in arousal symptom cluster associated directly with alcohol-related problems in the absence of dissociation. By contrast, the Intrusion and NACM clusters were significantly associated with alcohol-related problems within this sample, but indirectly through dissociative symptoms, whereas Alterations in arousal remained significantly associated with alcohol-related problems indirectly through dissociation. To note, whereas Walton et al. (2018) found direct associations between alcohol misuse and each of the four PTSD symptom clusters among predominantly male, military veterans, to increase power, our sample comprised a heterogeneous group of multiple groups (military and civilians) experiencing PTSD. Moreover, 50% of the present sample identified as being of the female sex.

Interestingly, Dworkin et al. (2018) found differential PTSD cluster associations with alcohol and other substance use disorders. Whereas among individuals with alcohol use disorder, significant associations emerged between Avoidance symptoms in the absence of other substance use, among individuals with comorbid alcohol and cocaine use

disorder, Alterations in arousal were significantly associated with heightened PTSD symptom severity. Although the present study is somewhat inconsistent in failing to reveal an association between Avoidance and alcohol-related problems, we did observe a significant association between alcohol-related problems and Alterations in arousal, in the absence of dissociation. Indeed, when dissociation was included, Alterations in arousal remained indirectly and significantly associated with alcohol-related problems; Avoidance problems, however, were not significantly associated suggesting dissociation may be a highly specific underlying mechanism of the relation between Avoidance symptoms in PTSD and heightened alcohol abuse.

In a pattern inconsistent with our findings, Patel et al. (2021) did not find any significant associations between PTSD symptom clusters and alcohol-related problems among a sample of individuals seeking treatment for concurrent disorders. Notably, the sample in Patel et al. (2021) was recruited from an outpatient clinic, where patients with primary alcohol use disorders were not treated, thus potentially accounting for the lack of any significant associations in this sample. Finally, McGlinchey et al. (2021) conducted a network analysis between symptoms of PTSD and alcohol use disorder among a sample of Irish military veterans and found the "reckless behaviour" symptom (part of Alterations in Arousal cluster) yielded the strongest associations with alcohol use disorder symptoms. This finding, in particular, is consistent with the current findings linking Alterations in arousal with alcohol-related problems directly (in the absence of dissociation) and indirectly (through dissociative symptoms), thus lending further support to the hypothesis that Alterations in arousal symptom cluster exert a critical role in the influence of PTSD

severity on alcohol-related problems. It is important to note that, despite the clinical utility of examining the relations between these variables, the model explored here was exploratory thus warranting further urgently needed investigation.

Overall, the results of the present study align with the present literature and add to the field by identifying a potential mechanism of the association between PTSD and alcohol-related problems. These findings are also clinically relevant given that PTSD and alcohol use are highly comorbid and alcohol use among individuals with PTSD has been linked to greater PTSD severity and reduced treatment response (Kilpatrick et al., 2003; Pietrzak et al., 2011). Moreover, dissociation has also been linked to alcohol use and its related problems (Craparo et al., 2014; Evren et al., 2011; Zdankiewicz-Ścigała and Ścigała, 2018). Taken together, dissociation plays a unique role in the relation between PTSD severity and alcohol-related problems making it a critical target for intervention among clinical samples to potentially increase treatment response among individuals with PTSD endorsing alcohol use.

This study is not without limitations. First, all data within the study were self-report; all measures utilized within the study, however, are validated measures commonly used within the literature. Importantly, the AUDIT questionnaire is intended to be a screener for the potential presence of an AUD rather than assessing the severity of AUD symptoms, which is only done by a semi-structured interview with a licensed clinician. Second, the term mediation is used throughout to describe the relation between PTSD severity, dissociation, and alcohol-related problems, however, given these data are cross-sectional, longitudinal studies are needed to determine the true mediating role of dissociative

symptoms on the relation between PTSD severity and alcohol-related problems. Third, another limitation is that the time frames for each of the self-report measures is different given that the AUDIT assesses alcohol related problems within the past 12 months whereas the PCL-5 and MDI assess symptoms experienced within the past month. Fourth, all participants included within the sample met cut-off scores for probable PTSD (≥ 33 according to the PCL-5; Blevins et al., 2015). Thus, additional research will be required to further determine whether the present findings hold among trauma-exposed but resilient individuals (subthreshold experiences of PTSD symptoms) who endorse alcohol use and its related problems.

In conclusion, this is the first study to reveal the mediating role of dissociation in the relation between PTSD severity and alcohol-related problems. Future studies should examine not only the mediating role of dissociation among trauma-exposed resilient individuals but also use longitudinal study designs to examine whether peri-traumatic or post-traumatic dissociation emerges as the most significant mediator between PTSD severity and alcohol-related problems. Furthermore, future studies should also evaluate gender differences in the mediating role of dissociation in the relation between PTSD symptom severity and alcohol related problems as it was not observed within this sample. On balance, the present findings point towards the critical need to explore clinically dissociative symptomatology among treatment-seeking individuals with PTSD who endorse using alcohol. Identifying and subsequently targeting dissociative symptomatology clinically has the potential to enhance treatment efficacy among

individuals who present with more complex clinical presentations of PTSD due to their comorbid alcohol use.

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TABLES

Table 1. Sample Characteristics.

	Mean (Standard Deviation)
Age	44.29 (9.77)
Gender (%)	50% Female
Education (%)	38.3% (diploma / bachelor's degree) 26.3% (some college / university)
Depression	23.14 (10.68)
Anxiety	21.18 (10.11)
Childhood Adverse Event Endorsement	88.6% (≥ 1 adverse event)
AUDIT Total	6.19 (8.24)
Hazardous Alcohol Use (%)	26.6%
PCL Total	57.99 (11.06)
Avoidance	6.38 (1.70)
Intrusions	14.08 (3.79)
Negative Alterations	21.01 (4.30)
Reactivity	16.52 (4.11)
MDI Total	76.39 (22.60)
Disengagement	17.72 (4.23)
Depersonalization	10.90 (4.99)
Derealization	12.57 (4.78)
Emotional Constriction	14.69 (5.83)
Identity Dissociation	7.17 (3.74)
Memory Disturbances	13.33 (5.08)

Note: all values presented are mean (standard deviation) except for gender, education, childhood adversity endorsement, and hazardous alcohol use which are percentages.

FIGURES

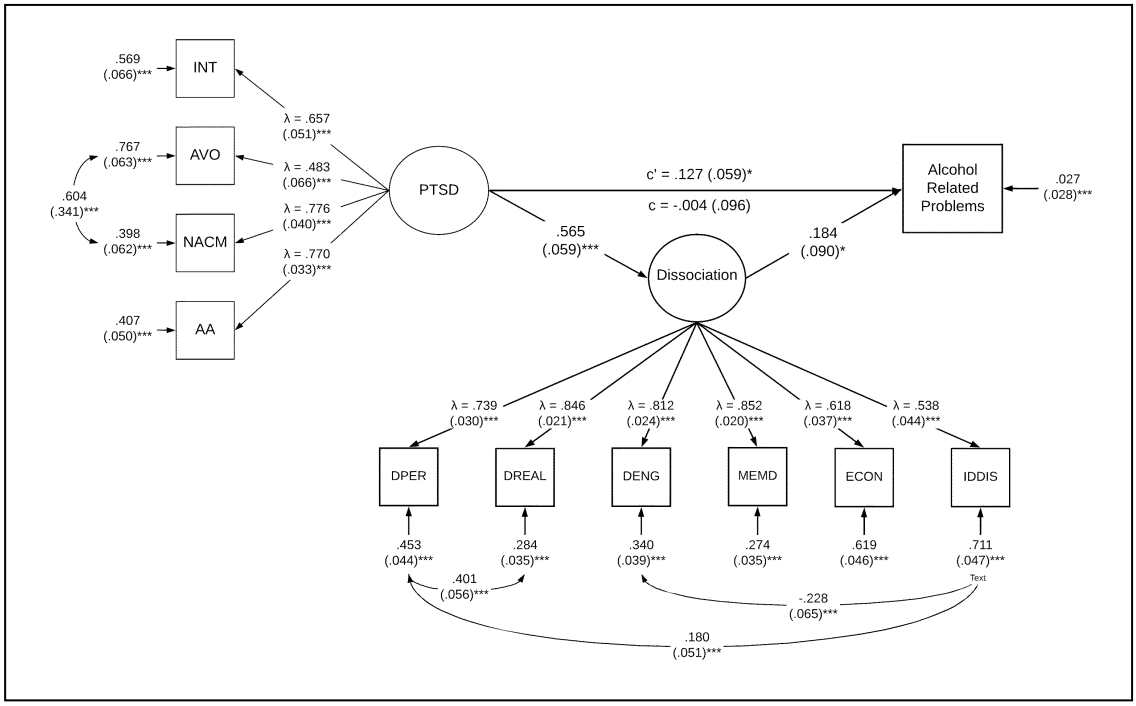

Figure 1. Primary mediation model assessing effects of dissociative symptomatology on the relation between PTSD severity and alcohol-related problems.

All values are standardized. Standard error for residuals and covariances in parentheses. PTSD = PTSD latent factor, INT = Intrusions, AVO = Avoidance NACM = Negative Alterations in Cognition and Mood, AA = Alterations in Arousal, DPER = Depersonalization, DREAL = Derealization, DENG = Disengagement, MEMD = Memory Disturbance, ECON = Emotional Constriction/Numbing, IDDIS = Identity Dissociation. Age, sex, emotion dysregulation, and childhood adversity were controlled for. Model fit was adequate ($\chi^2(56, N = 334) = 125.67$, $p < .0001$, TLI = .946, CFI = .961, RMSEA = 0.06 [95% CI = .047 - .075], SRMR = 0.04). * $p < .05$; ** $p < .01$; *** $p < .001$

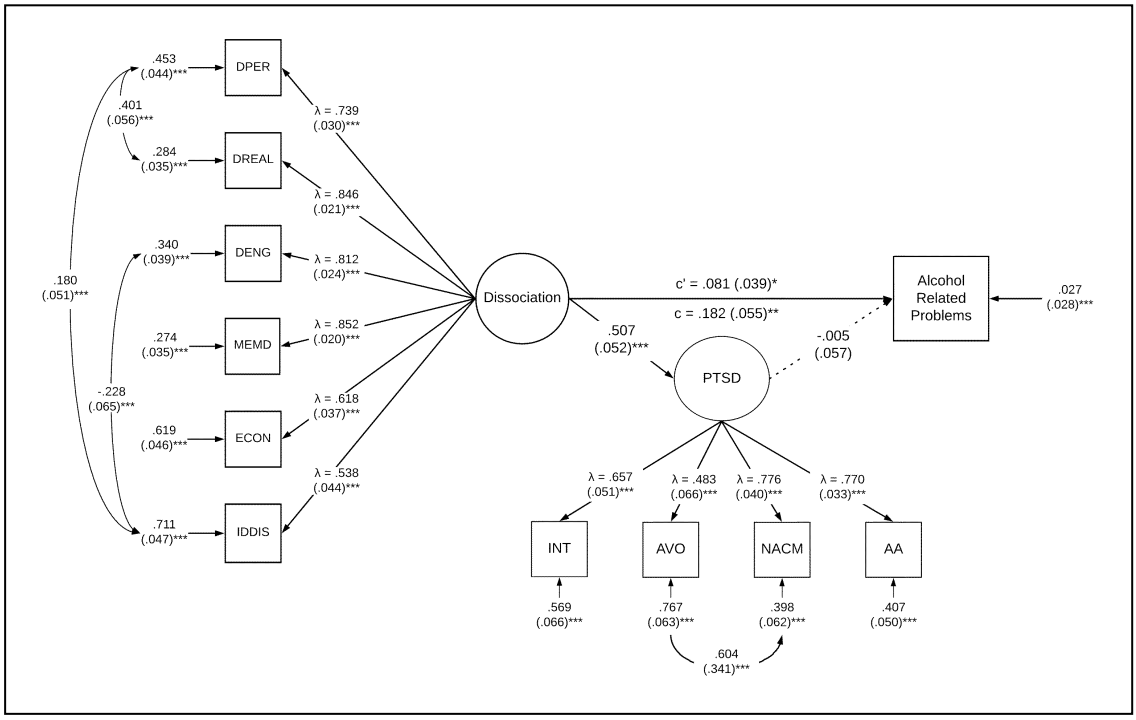

Figure 2. Alternate mediation model assessing effects of PTSD severity on the relation between dissociative symptomatology and alcohol-related problems.

All values are standardized. Standard error for residuals and covariances in parentheses. PTSD = PTSD latent factor, INT = Intrusions, AVO = Avoidance NACM = Negative Alterations in Cognition and Mood, AA = Alterations in Arousal, DPER = Depersonalization, DREAL = Derealization, DENG = Disengagement, MEMD = Memory Disturbance, ECON = Emotional Constriction/Numbing, IDDIS = Identity Dissociation. Age, sex, emotion dysregulation, and childhood adversity were controlled for. Model fit was adequate ($\chi^2(58, N = 334) = 150.54$, $p < .0001$, TLI = .931, CFI = .948, RMSEA = 0.07 [95% CI = .056 - .083], SRMR = 0.05). * $p < .05$; ** $p < .01$; *** $p < .001$

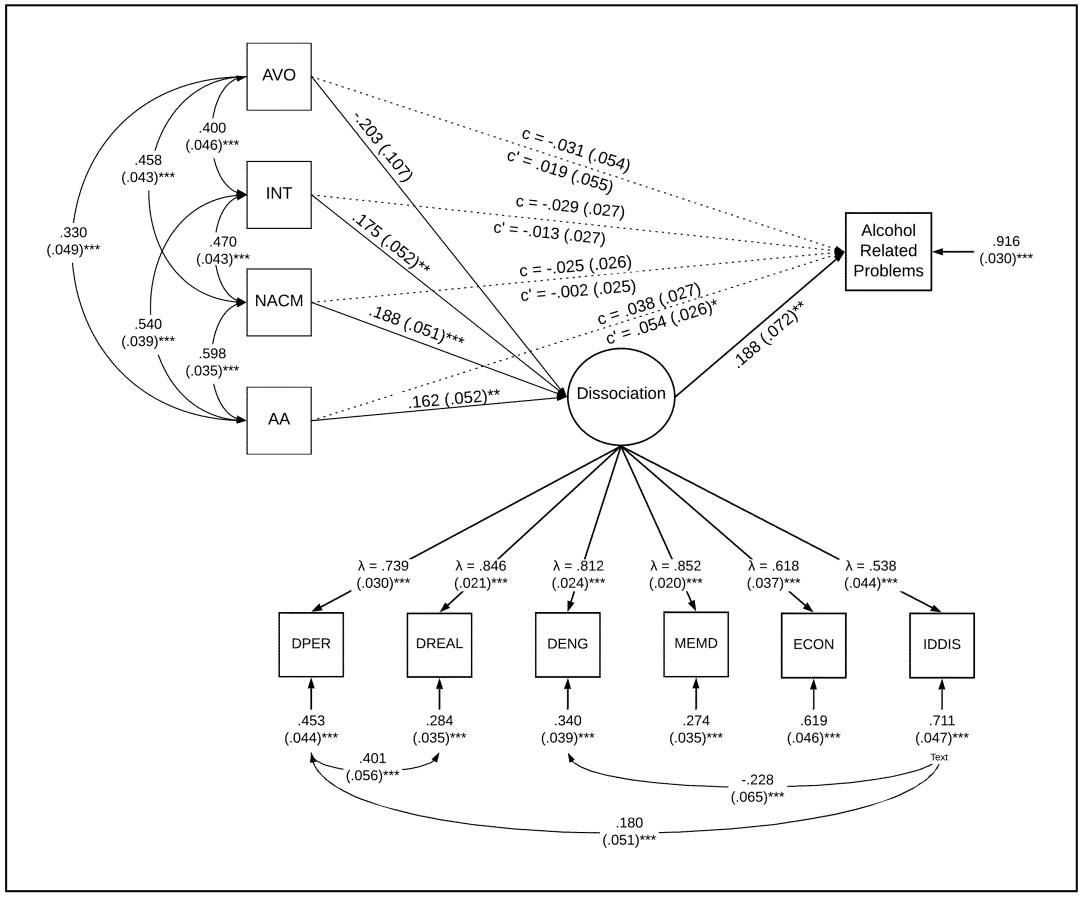

Figure 3. Secondary mediation model assessing effects of dissociative symptomatology on the relation between PTSD symptom clusters and alcohol-related problems.

All values are standardized. Standard error for residuals and covariances in parentheses. PTSD = PTSD latent factor, INT = Intrusions, AVO = Avoidance NACM = Negative Alterations in Cognition and Mood, AA = Alterations in Arousal, DPER = Depersonalization, DREAL = Derealization, DENG = Disengagement, MEMD = Memory Disturbance, ECON = Emotional Constriction/Numbing, IDDIS = Identity Dissociation. Age, sex, emotion dysregulation, and childhood adversity were controlled for. Model fit

was adequate ($\chi^2(43, N = 334) = 89.42$, $p < .0001$, TLI = .948, CFI = .965, RMSEA = 0.06 [95% CI = .040 - .073], SRMR = 0.03). * $p < .05$; ** $p < .01$; *** $p < .001$

SUPPLEMENTAL MATERIALS

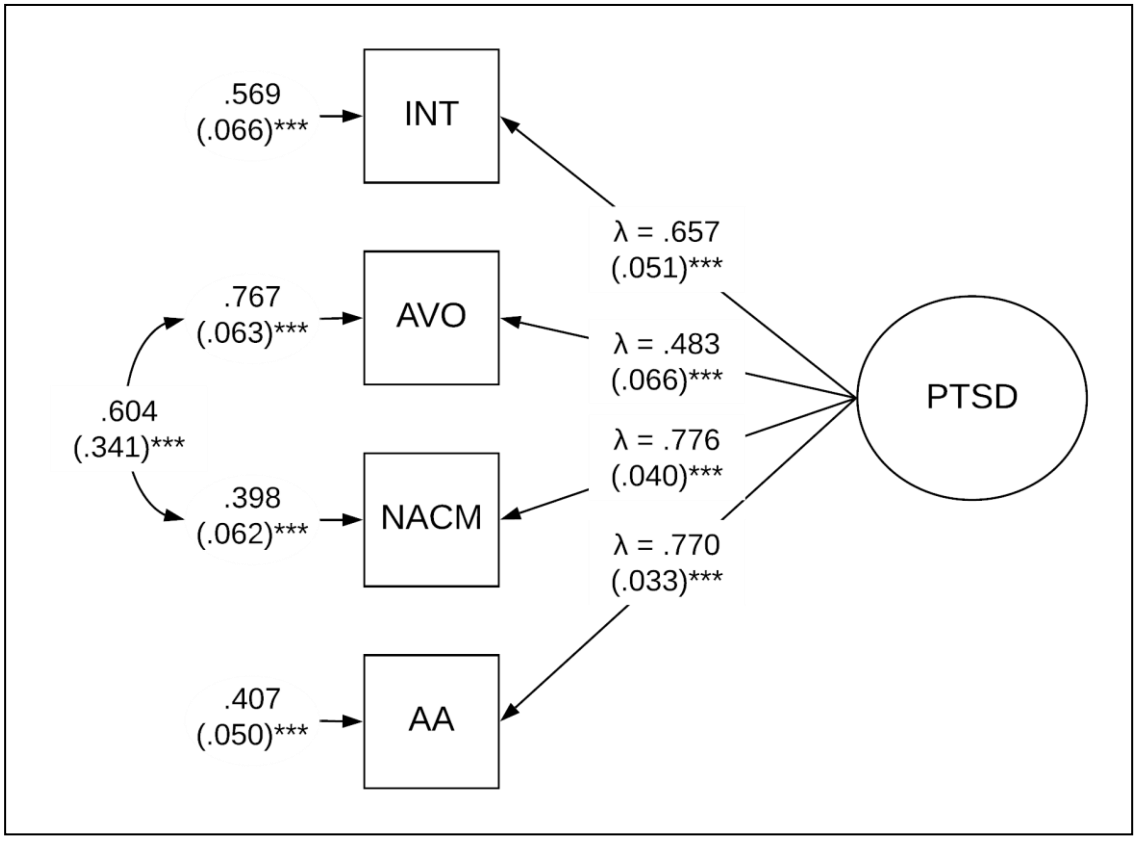

Figure S1. Latent PTSD Factor Measurement Model

All values are standardized. Standard error for residuals and covariances in parentheses. PTSD = PTSD latent factor, INT = Intrusions, AVO = Avoidance NACM = Negative Alterations in Cognition and Mood, AA = Alterations in Arousal. Model fit was adequate ($\chi^2(1, N = 334) = 10.57$, $p = .01$, TLI = .845, CFI = .974, RMSEA = .169 [95% CI = .088, .268], SRMR = 0.03). * $p < .05$; ** $p < .01$; *** $p < .001$

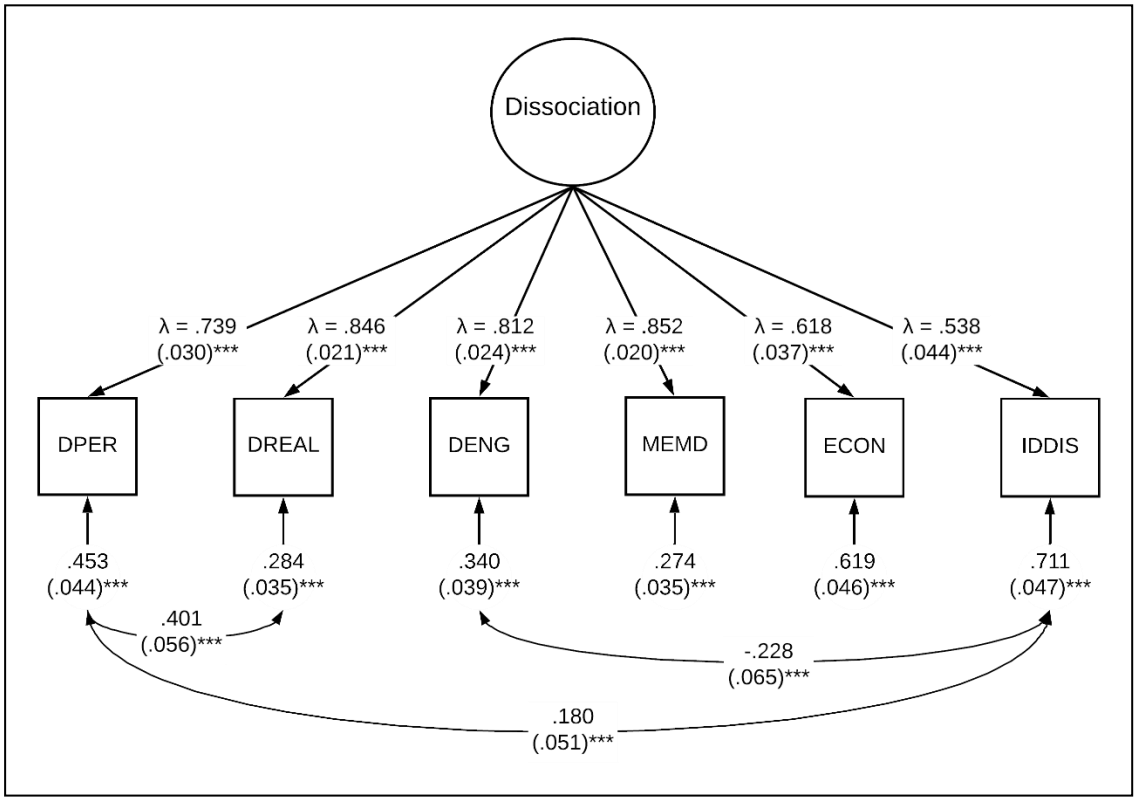

Figure S2. Latent Dissociation Measurement Model.

All values are standardized. Standard error for residuals and covariances in parentheses. DPER = Depersonalization, DREAL = Derealization, DENG = Disengagement, MEMD = Memory Disturbance, ECON = Emotional Constriction/Numbing, IDDIS = Identity Dissociation. Model fit was excellent ($\chi^2(6, N = 334) = 7.72$, $p > .05$, TLI = .996, CFI = .998, RMSEA = 0.03 [95% CI = .000, .081], SRMR = 0.01). * $p < .05$; ** $p < .01$; *** $p < .001$

3.3 Discussion

The paper presented in the current chapter is the first study to reveal the mediating role of dissociation in the relation between PTSD severity and alcohol-related problems among a sample of individuals seeking treatment for PTSD. Furthermore, using an SEM framework built upon Chapter 2 and added another layer to the analytical framework to capture and represent the complex associations between PTSD and substance-related problems with the addition of a mediator.

In this chapter, greater PTSD severity was associated with heightened dissociative symptoms and associated with greater alcohol-related problems via the mediating role of dissociation. Interestingly, when using an alternate model (via switching the predictor and mediators), greater dissociative symptoms were associated with heightened PTSD severity. However, greater PTSD severity did not significantly associate with alcohol-related problems. The lack of significant mediating effect by PTSD severity indicates a unique mediating role of dissociative symptomatology between PTSD severity and alcohol-related problems. In addition, examining the individual symptom clusters of PTSD further support the mediating role of dissociative symptoms between Intrusions, NACM, and Reactivity clusters with alcohol-related problems; the same mediating effects were not observed for the Avoidance symptom cluster. The present findings highlight the critical need to explore clinically dissociative symptomatology among treatment-seeking individuals with PTSD who endorse using alcohol. In addition, clinically targeting dissociative symptomatology can enhance treatment efficacy among individuals who present with more complex clinical presentations of PTSD due to their comorbid alcohol use.

The current chapter builds upon using SEM frameworks to analytically represent the complex associations between PTSD symptoms and substance-related problems. The significant associations seen between PTSD symptoms and alcohol-related problems with the addition of indirect associations via the mediating role of dissociation among another clinically severe sample adds to this notion that there is a unique connection between PTSD and substance use. With the addition of results presented in the current chapter to the previous chapter, a pattern of results has been established in clinically severe samples. However, whether these associations between PTSD and substance use-related problems exist in subclinical populations remains to be explored.

Chapter 4. Subclinical Healthcare Workers and Public Safety Personnel Sample

4.1 Introduction

Chapters 3 and 4 have established associations (direct and indirect) between PTSD and substance-related problems among two clinically severe samples: one with PTSD as a highly prevalent factor and the other as a primary focus. However, associations between PTSD symptoms and substance-related problems have not been explored among subclinical adult samples. Thus, the current chapter examines those associations among a trauma-exposed sample of healthcare workers (HCWs) and public safety personnel (PSP) during the height of the SARS-CoV-2 pandemic.

Among these occupations, exposures to criterion A traumas are widespread. However, there is not much literature exploring the outcomes of exposure to those traumas' pre-pandemic. The current literature points towards greater adverse outcomes for individuals in these occupations, such as depression, anxiety, stress, moral injury, substance use disorder, and PTSD (Carleton et al., 2018, 2019; Luftman et al., 2017; Raistrick et al., 2008; Robles et al., 2021; Saragih et al., 2021; Sendler et al., 2016; Young et al., 2021).

Given that the SARS-CoV-2 pandemic placed individuals in these occupations into a heightened level of chronic stress, the potential for developing or elevating the severity of PTSD and SUD has also drastically increased (Ballenger et al., 2011; Carmassi et al., 2020; Fjeldheim et al., 2014; Hall, 2020; Ménard & Arter, 2013; Mongeau-Pérusse et al., 2021; Pestana et al., 2022; Turna et al., 2021). Thus, examining the associations between PTSD and SUD symptoms among this sample is crucial to understanding whether these associations at a subclinical level even exist. If they do, how are they different from the associations observed among clinical samples. This study aimed to analyze the associations between PTSD symptoms and alcohol/cannabis/other substance use-related problems among a sample of HCWs and PSP.

Data were collected as a part of a more extensive study examining psychological and cognitive variables of interest among HCWs and PSP during the height of the pandemic (June 2021 – January 2022). HCWs and PSP were recruited from all over Canada. However, the majority of participants were from Ontario. Thus, the current sample represents a group of individuals who may experience symptoms of PTSD and/or SUD at a mostly subclinical level but is not the primary focus. Lastly, this study also used the same SEM framework presented in Chapters 2 and 3 to analyze the associations between PTSD and substance-related problems and the mediating roles of dissociation and emotion dysregulation in the relation between PTSD and substance-related problems.

The primary author of this study (HP) conceptualized the research question, developed the theoretical structural equation models, conducted the formal data analysis, and wrote the manuscript for publication.

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4.2 Associations between trauma and substance use among healthcare workers and public safety personnel during the SARS-CoV-2 (COVID-19) pandemic: the mediating roles of dissociation and emotion dysregulation

Patel, H., Easterbrook, B., D'Alessandro, A., Andrews, K., Hosseiny, F., Rodrigues, S., Malain, A., O'Connor, C., Schielke, H., McCabe, R. E., Nicholson, A. A., Lanius, R., & McKinnon, M. C. (submitted). Associations between trauma and substance use among healthcare workers and public safety personnel during the SARS-CoV-2 pandemic: the mediating roles of dissociation and emotion dysregulation. Submitted to the *European Journal of Psychotraumatology*.

ABSTRACT

Background: Given the highly stressful environment surrounding the SARS-CoV-2 pandemic, healthcare workers (HCW) and public safety personnel (PSP) are at an elevated risk for adverse psychological outcomes, including posttraumatic stress disorder (PTSD) and alcohol/substance use problems. As such, the study aimed to identify associations between PTSD severity, related dissociation and emotion dysregulation symptoms, and alcohol/substance use problems among HCWs and PSP. **Methods:** A subset of data (N = 498; HCWs = 299; PSP = 199) was extracted from a larger study examining psychological variables among Canadian HCWs and PSP during the pandemic. Structural equation modelling assessed associations between PTSD symptoms and alcohol/substance use-related problems with dissociation and emotion dysregulation as mediators. **Results:** Among HCWs, dissociation fully mediated the relation between PTSD and alcohol-related problems (indirect effect β=.133, p=.03) and emotion dysregulation partially mediated the relation between PTSD and substance-related problems (indirect effect β=.151, p=.046). In PSP, emotion dysregulation fully mediated the relation between PTSD and alcohol-related problems (indirect effects β=.184, p=.005). For substance-related problems among PSP, neither emotion dysregulation nor dissociation (ps >.05) had any effects. **Conclusion:** To our knowledge, this is the first study examining associations between PTSD severity and alcohol/substance use-related problems via mediating impacts of emotion dysregulation and dissociation among HCWs and PSP during the SARS-CoV-2 pandemic. These findings highlight dissociation and emotion dysregulation as important therapeutic targets for structured interventions aimed at reducing the burden of PTSD and/or SUD among

Canadian HCWs or PSP suffering from the adverse mental health impacts of the SARS-CoV-2 pandemic.

INTRODUCTION

Healthcare Workers (HCWs; e.g., nurses, physicians, personal support workers, and respiratory therapists) and Public Safety Personnel (PSP; e.g., paramedics, firefighters, police officers, and dispatchers) serve in high-stress occupations with elevated risk for trauma exposure (1–5). Critically, trauma exposure is inextricably linked to the development of posttraumatic stress disorder (PTSD) among these professions (1,2,6–8). Throughout the SARS-CoV-2 (COVID-19) pandemic, HCWs and PSP have faced an unprecedented risk of developing or further elevating their risk of adverse psychological outcomes such as depression, anxiety, PTSD, and alcohol/substance use (7–9). PTSD may develop following exposure to a traumatic event (10) and is a highly prevalent and functionally debilitating mental health disorder (11,12). Within the Diagnostic Statistical Manual for Mental Disorders-5th version (DSM-5), symptoms of PTSD are categorized into four clusters: intrusive thoughts and memories, avoidance behaviours, negative alterations in cognition and mood (NACM), and reactivity (10). Furthermore, ~30% of individuals with PTSD meet the criteria for the dissociative subtype which consists of the four symptom clusters with the addition of the depersonalization and derealization symptom clusters (10).

Emerging literature during the SARS-CoV-2 pandemic indicates that mental health concerns (including alcohol/substance use) have worsened for HCWs and PSP (7–9,13–17), with the number of healthcare visits by HCWs for mental health and substance use problems also increasing throughout (18). Based on a recent meta-analysis, the global prevalence rate of PTSD among HCWs during the pandemic is estimated to be 49% (7). In

Canada, 25% of intensive care unit HCWs endorsed symptoms consonant with probable PTSD (17). Furthermore, comparing mental health concerns among HCWs in Canada, Brazil, and the USA, Canadian HCWs reported the highest rates of anxiety, depression, and increased alcohol and cannabis use compared to their international counterparts (16). In a nationwide cohort study, Canadian HCWs reported increased alcohol consumption compared to pre-pandemic (15). To our knowledge, no literature has examined prevalence rates of PTSD and alcohol/substance use among Canadian PSP during the pandemic underscoring the need to further study this occupational group. However, pre-pandemic literature indicates 26.7% of Canadian PSP experience at least one mental health disorder during their lifetime and 5.9% of PSP met criteria for hazardous alcohol use (1) and that it is feasible to expect these rates would increase with the additional stressors of the SARS-CoV-2 pandemic. To date, the majority of literature examining PTSD and alcohol/substance use among HCWs during the pandemic has focused on prevalence rates. While important, prevalence rates do not provide insightful information as to how symptoms of PTSD and alcohol/substance-related problems are associated and impact each other, potentially informing treatment targets for intervention. Accordingly, little is known about the association between PTSD and alcohol/substance-related problems in these groups, as well as about psychological factors (e.g., dissociation, emotional dysregulation) that may mediate this relation, as has been shown in adult treatment-seeking samples (19,20).

Critically, there are other factors that may explain the association between PTSD symptoms and alcohol/substance-related problems, providing more nuanced therapeutic

targets for intervention. Factors such as dissociation (i.e., a form of psychological escape when physical escape is improbable; 21) and emotion dysregulation (i.e., difficulties in processing and healthily responding to emotional stimuli; 22) have been independently linked to PTSD (23,24) and Substance Use Disorders (SUDs; 25) pre-pandemic. Dissociation and emotion dysregulation that may be co-occurring with the symptoms of PTSD may drive individuals to use alcohol and non-alcohol substances to cope with their PTSD, as posited by the self-medication hypothesis (26). However, limited literature exists examining the role of these factors in explaining the associations between PTSD and SUD, with the focus primarily on clinical samples (19,20,27). By examining the role of these variables in the relation between PTSD and alcohol/substance-related problems among HCWs and PSP, the results may indicate potentially relevant clinical treatment targets that may be applicable to other adult treatment-seeking samples.

Given higher prevalence rates of PTSD and alcohol/substance use among HCWs and potentially PSP during the pandemic representing a high-risk population likely to develop PTSD and/or SUD (28), combined with prior literature indicating a high prevalence of comorbid PTSD+SUD in adult treatment-seeking samples (19,29–31), there is a crucial need to identify associations between PTSD and alcohol/substance-related problems among HCWs and PSP and examine mediating factors such as dissociation and emotion dysregulation that may help explain the associations. Accordingly, the purpose of the current study was to identify the global and symptom cluster level associations between PTSD and alcohol/substance use-related problems among samples of Canadian HCWs and PSP with data collected during the height of the pandemic. Furthermore, this study

examined the roles of underlying mechanisms (i.e., emotion dysregulation and dissociation) in assessing the associations between PTSD symptoms and alcohol/substance-related problems.

METHODS

Participants

Data was drawn from a larger study assessing psychological and cognitive functioning among HCWs and PSP from various provinces across Canada, the majority of whom were still actively working (HCWs = 96.%; PSP = 91.5%). Eligibility criteria included: 1) at least 18 years of age, 2) speak and read English, and 3) have provided healthcare or emergency services during the SARS-CoV-2 pandemic in Canada. Participants completed an online battery of self-report assessments during the SARS-CoV-2 pandemic (June 2021 – January 2022) via Research Electronic Data Capture (32). Participants provided written informed consent through e-signatures. Upon completion, participants could choose to be entered into a draw for a gift card. This study was approved by Hamilton Integrated Research Ethics Board (#12667).

In the present study, 633 HCWs and PSP consented to participate. Of this, one-hundred and thirty-three (n = 133) were removed due to insufficient survey completion (i.e., did not complete demographics and at least one full scale). This yielded a sample of N = 498 participants in the final working data set (two participants removed due to missing demographic data), in which there were HCWs (n = 299) and PSP (n = 199). Missing data were imputed using multiple imputation methods (described briefly in Data Analytic Plan and further in the Supplemental Materials).

Measures

A subset of measures from the larger study was included in the current study (described below). Demographics included age, biological sex at birth, and education.

Posttraumatic Stress Disorder Severity. PTSD severity in the past month was assessed using the Posttraumatic Stress Disorder Checklist for Diagnostic and Statistical Manual-5 (PCL-5; (33), a 20-item measure (range: 0-80) comprised of four clusters: Cluster B (Intrusive thoughts and memories; range = 0-20), Cluster C (Avoidance behaviours; range = 0-8), Cluster D (Negative Alterations in Cognition and Mood; range = 0-28), and Cluster E (Alterations in Arousal; range = 0-20). SEM was used to generate a latent factor of PTSD symptoms from the cluster scores (see Supplemental Materials).

Alcohol-Related Problems. Alcohol use frequency and alcohol-related problems experienced over the past 12 months were measured using the Alcohol Use Disorders Identification Test (AUDIT), a 10-item self-report screen (range: 0-40) assessing the frequency and severity of alcohol use (34). The AUDIT assesses both consumption of alcohol (three items) and problems related to alcohol consumption (seven items). As such, the AUDIT is referred to as assessing alcohol-related problems rather than consumption. The sum score on the AUDIT was included as an outcome variable in the mediation model.

Substance-Related Problems. Non-alcohol substance use (i.e., cannabis, illicit substances, prescription medication not used as prescribed, etc.) frequency and substance-related problems experienced over the past 12 months were measured using the Drug Use Disorders Identification Test (DUDIT). It is an 11-item self-report screen (range: 0-44) assessing the frequency and severity of substance use (35). Typically, the DUDIT is

referred to as assessing substance-related problems rather than consumption. The sum score on the DUDIT was included as an outcome variable in the mediation model.

Emotion Dysregulation. The Difficulties in Emotion Regulation Scale (DERS) is a 36-item (range: 36-180) self-report questionnaire assessing six facets of emotion regulation within the past month: (1) non-acceptance of emotional responses, (2) difficulty engaging in goal-directed behaviour, (3) impulse control difficulties, (4) lack of emotional awareness, (5) limited access to emotion regulation strategies, and (6) lack of emotional clarity (36). SEM was used to generate a latent factor of emotion dysregulation from the subscale scores (see Supplemental Materials).

Dissociative Symptomatology. The Multiscale Dissociation Inventory was used to assess dissociative symptoms within the past month (37). The MDI is a 30-item self-report questionnaire and measures six different types (range for each subscale: 5-25) of dissociative responses: (1) disengagement, (2) depersonalization, (3) derealization, (4) emotional constriction/numbing, (5) memory disturbance, and (6) identity dissociation. SEM was used to generate a latent factor of dissociative symptoms from the subscale scores (see Supplemental Materials).

Depression, Anxiety, and Stress. Symptoms of depression, anxiety, and stress over the past week were measured using the DASS-21 (38). The scale contains 21 items assessing depressive symptoms (seven items), anxiety symptoms (seven items), and stress symptoms (seven items). Three scores are generated from the scale, one for each category (range for each scale: 0-21). Subscale scores for Depression, Anxiety, and Stress were

included as covariates in the mediation model to account for PTSD symptom overlap with depression and anxiety (39) and account for occupational stress.

Childhood Adversity. The Adverse Childhood Experience Scale (ACES) is a 10-item self-report questionnaire (range: 0-10) used to assess the endorsement of adverse childhood experiences (40). A sum score on the ACES was used as a covariate in the mediation model to account for the impacts of childhood adversity on PTSD severity and substance use (41).

Data Analysis Plan

Prior to data analysis, missing data (~40% in HCWs; ~37% in PSP) were imputed using multiple imputation, a procedure for generating possible values for missing data via a series of regression analyses and an iterative, Bayesian algorithm to generate new estimates for each generated set of imputations (42,43). No systematic relationship between missing data was determined; missing data were assumed to be missing at random. Fully condition specification method was used to deal with missing data during imputation. All variables were included in each multiple imputation procedure. Only items that contributed to a total score for each scale were imputed; demographic data, yes/no responses, and other variables were not imputed but were used as predictors of missing values. Five imputed datasets were produced from imputation and pooled into a final imputed dataset. Total scores from the imputed dataset were compared to total scores from the original data set with missing values. No significant differences were found (see Supplemental Tables 1 and 2 for means and standard deviations of non-imputed and imputed datasets for HCWs and PSP).

Descriptive statistics and independent samples t-tests between HCWs and PSP were run among the study variables to inform whether group analyses should be conducted. There were significant differences among key variables (see Table 1). As such, separate analyses were conducted for HCWs and PSP. Structural equation modelling was implemented in MPlus Version 8.4 (44) using maximum likelihood estimation to assess the mediating effects of dissociation and emotion dysregulation on the association between PTSD severity and alcohol/substance-related problems. Before modelling, the alcohol-related problems measure (AUDIT sum score), substance-related problems measure (DUDIT sum score), and the identity dissociation subscale from the MDI were square-root transformed based on benchmarks of skewness >2 and kurtosis >7 (45). Following established conventions (46), an excellent-fitting model has a comparative fit index (CFI) and Tucker Lewis Index (TLI) ≥ 0.95, standardized root mean squared residual (SRMR) of ≤ 0.08, and a root mean square error of approximation (RMSEA) ≤ 0.06. Covariates for all models included age, sex, education, depressive symptoms, anxiety symptoms, stress, and childhood adversity.

Parallel mediation models were run for both HCWs and PSP and tested the direct effects of PTSD symptoms on alcohol- and substance-related problems as well as indirect effects via two mediators: dissociation and emotion dysregulation. In addition, a secondary set of models were run to assess the mediating roles of dissociation and emotion dysregulation on specific PTSD symptom clusters (see Supplemental Materials for Data Analytic Plan and Results). Initial models testing the direct effects of PTSD symptoms on

alcohol- and substance-related problems without the presence of the mediators can be found in supplemental materials.

RESULTS

Descriptive Statistics

The final sample consisted of two groups: HCWs (N = 299) and PSP (N = 199). Sample characteristics can be found in Table 1 and group testing results to indicate which variables of interest were different across the two groups.

Healthcare Workers

The parallel mediation model assessed the direct and indirect (mediated via dissociation or emotion dysregulation) effects of global PTSD symptoms on alcohol and substance-related problems (see Figure 1 and Table 2). The model accounted for 6.4% of the variance in alcohol-related problems (r^2=.064, p<.05) and 19.4% of the variance in substance-related problems (r^2=.194, p<.0001). Significant covariates in the model included age, education, childhood adversity, depressive, and anxiety symptoms. The direct path from PTSD to alcohol-related problems was significant (β=.212, p<.0001) prior to mediation. After mediation, the direct path was no longer significant (β=.094, p=.383). The indirect path from PTSD to alcohol-related problems was significant via dissociation (indirect effect β=.133, p<.05) whereas the indirect path via emotion dysregulation was not significant (indirect effect β=-.016, p=.835). Examining substance-related problems, the direct path from PTSD was not significant prior to the inclusion of mediators (β=.040, p=.492). With the inclusion of mediators, the indirect path via emotion dysregulation was

significant (indirect effect β=.151, p<.05), however, the indirect path via dissociation was not significant (indirect effect β=.096, p=.096).

Public Safety Personnel

The parallel mediation model assessing the direct and indirect (mediated via dissociation or emotion dysregulation) effects of global PTSD symptoms on alcohol- and substance-related problems (see Figure 2 and Table 3). The model accounted for 6.9% of the variance in alcohol-related problems (r^2=.069, p=.076) and 8.1% of the variance in substance-related problems (r^2=.081, p=.051). Significant covariates in the model included childhood adversity, depressive, anxiety, and stress symptoms. The direct path from PTSD to alcohol-related problems was not significant (β=.129, p=.071) prior to mediation. After mediation, the direct path was still not significant (β=-.077, p=.578). The indirect path from PTSD to alcohol-related problems was not significant via dissociation (indirect effect β=.015, p=.872) whereas the indirect path via emotion dysregulation was significant (indirect effect β=.184, p<.01). Examining substance-related problems, the direct path from PTSD was not significant prior to the inclusion of mediators (β=.136, p=.396). With the inclusion of mediators, the indirect paths via emotion dysregulation (indirect effect β=.109, p=.091) and dissociation (indirect effect β=-.011, p=.908) were not significant.

DISCUSSION

The current study aimed to identify the associations between PTSD symptoms and alcohol- and substance-related problems among HCWs and PSP during the SARS-CoV-2 pandemic. We found differential associations between PTSD and alcohol- and substance-related problems. Specifically, whereas PTSD symptoms were significantly associated with

alcohol-related problems among HCWs, PTSD symptoms were significantly associated with substance-related problems among PSP. Additional examination of putative underlying mechanisms such as dissociation and emotion dysregulation pointed towards the differential mediating roles of these factors in the relation between PTSD and alcohol- and substance-related problems in these two samples. Here, whereas dissociation significantly mediated the relation between PTSD and alcohol-related problems among HCWs, emotion dysregulation mediated the relation between PTSD and substance-related problems in this group. By contrast, among PSP, emotion dysregulation mediated the relation between PTSD and alcohol-related problems; there were no significant mediations for substance-related problems in this group.

The majority of the literature examining PTSD and alcohol/substance use among HCWs and PSP during the SARS-CoV-2 pandemic has focused on prevalence rates and frequency of use. Rates of probable PTSD seen in the current study (25-26%) are similar to rates previously published during the pandemic (7,17). In addition, alcohol- and substance use-related problems among our sample appear consistent with literature where relative increases in alcohol use and related problems are reported during the pandemic (9,15,16). No literature, to our knowledge, has examined how the symptoms of PTSD or SUD impact one another among HCWs and PSP during the pandemic.

Among current literature examining these associations during the pandemic, one study reported significant associations between PTSD symptoms and alcohol-related problems among a general PSP sample across the United States (47). Given similar low rates of alcohol-related problems and PTSD severity (47), symptom severity may be a

potential moderator of the associations between PTSD and alcohol-related problems. Although this hypothesis remains to be examined in follow-up studies, it is notable that Patel et al (2022) found a contrasting pattern of associations between PTSD and alcohol-related problems in a civilian sample with a high acuity of PTSD and dissociative symptoms. Here, dissociative symptoms fully mediated the relation between PTSD and alcohol-related problems in this inpatient sample undergoing treatment for PTSD and trauma-related disorders. Further research is needed in PSP samples presenting with high acuity of PTSD and dissociative symptoms to elucidate whether this pattern remains among more functionally impaired PSP.

In terms of examining symptom cluster associations between PTSD and alcohol- and substance-related problems, the majority of the extant literature was published prior to the SARS-CoV-2 pandemic. Similar to current results, significant associations between reactivity symptoms of PTSD and alcohol-related problems were seen among Red Cross workers following the September 11, 2001 attacks (48). Among police officers, avoidance symptoms of PTSD were associated with alcohol-related problems (49); however, the current study found no such association (see Supplemental Materials). Critically, the current sample amalgamates multiple PSP occupations, not only police officers. Future research is required to analyze the associations between PTSD and alcohol- and substance-related problems by specific occupation.

Among HCWs, there is no prior literature examining the global and symptom cluster associations between PTSD and substance-related problems prior or during the pandemic with the literature from during the SARS-CoV-2 pandemic focusing on

prevalence rate changes. The current results examining the associations between PTSD symptoms and alcohol- and substance-related problems among HCWs add to the relatively limited literature on prevalence rates during the pandemic (9,15,16). Furthermore, the significant mediating effects of emotion dysregulation and dissociation highlight them as potential treatment targets for structured interventions for HCWs struggling with PTSD and comorbid alcohol/substance-related problems during the pandemic.

Lastly, to our knowledge, this is the first study examining the mediating roles of underlying mechanisms (i.e., dissociation and emotion dysregulation) on the relations between PTSD symptoms and alcohol/substance-related problems. Prior literature examining the mediating role of dissociation has focused on adult treatment seeking clinical samples (19). Among a sample of individuals seeking treatment for PTSD, dissociation mediated the relation between PTSD symptoms and alcohol-related problems, consistent with current results among HCWs but not PSP. Though, important to note that the two samples between studies differ significantly as the current study was not treatment-seeking and rates of PTSD among this study were ~28% compared to 100% among the other study, and direct comparisons should be interpreted with caution. As for emotion dysregulation, no studies to date examine emotion dysregulation as a mediator between PTSD symptoms and alcohol-related problems among HCWs or PSP during the pandemic. Pre-pandemic literature suggests emotion dysregulation significantly mediates the relation between PTSD and impulsivity (20) among individuals using substances. Since emotion dysregulation was not a direct mediator between PTSD and SUD, drawing meaningful comparisons is difficult. A narrative review posits that emotion dysregulation may be a transdiagnostic

factor underlying PTSD and alcohol/substance-related problems via a combination of low distress tolerance and inability to effectively use goal-directed emotion regulation strategies (24) indicating that the role of emotion dysregulation should be explored further to define its utility as a clinical treatment target.

Limitations

In the present study, the results should be interpreted in the presence of a few limitations. This study used self-report assessments; while these assessments are widely used and psychometrically validated, they are not diagnostic interviews administered by a licensed clinician. Furthermore, data was cross-sectional during a portion of the pandemic, so comparing these results to pre-pandemic results should be done with caution. Another limitation was the use of imputation to account for missing data (~37 – 40%), though important to note that imputation has been used for alcohol/substance use measures previously (50). Lastly, within the current study, only underlying mechanisms of dissociation and emotion dysregulation were analyzed concerning PTSD and alcohol/substance-related problems. Other underlying mechanisms, such as impulsivity related to PTSD and substance use should be explored.

CONCLUSION

To our knowledge, this is the first study to analyze the associations between PTSD symptoms and substance-related problems during the SARS-CoV-2 pandemic among HCWs and builds upon the limited literature for PSP. These results build upon prior research among adult treatment-seeking clinically severe populations (19,31), indicating meaningful associations between PTSD and alcohol/substance-related problems regardless

of clinical severity. Uncovering associations between PTSD symptoms and alcohol/substance-related problems among HCWs and PSP can inform precise treatment targets for individuals of these occupations seeking treatment. Specifically, these results point towards emotion dysregulation and dissociation as potential key therapeutic targets among PSP and HCWs with co-morbid PTSD and alcohol/substance-related problems. Future directions include a longitudinal analysis of these associations following the end of the pandemic and exploring the mediating roles of other factors.

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FIGURES

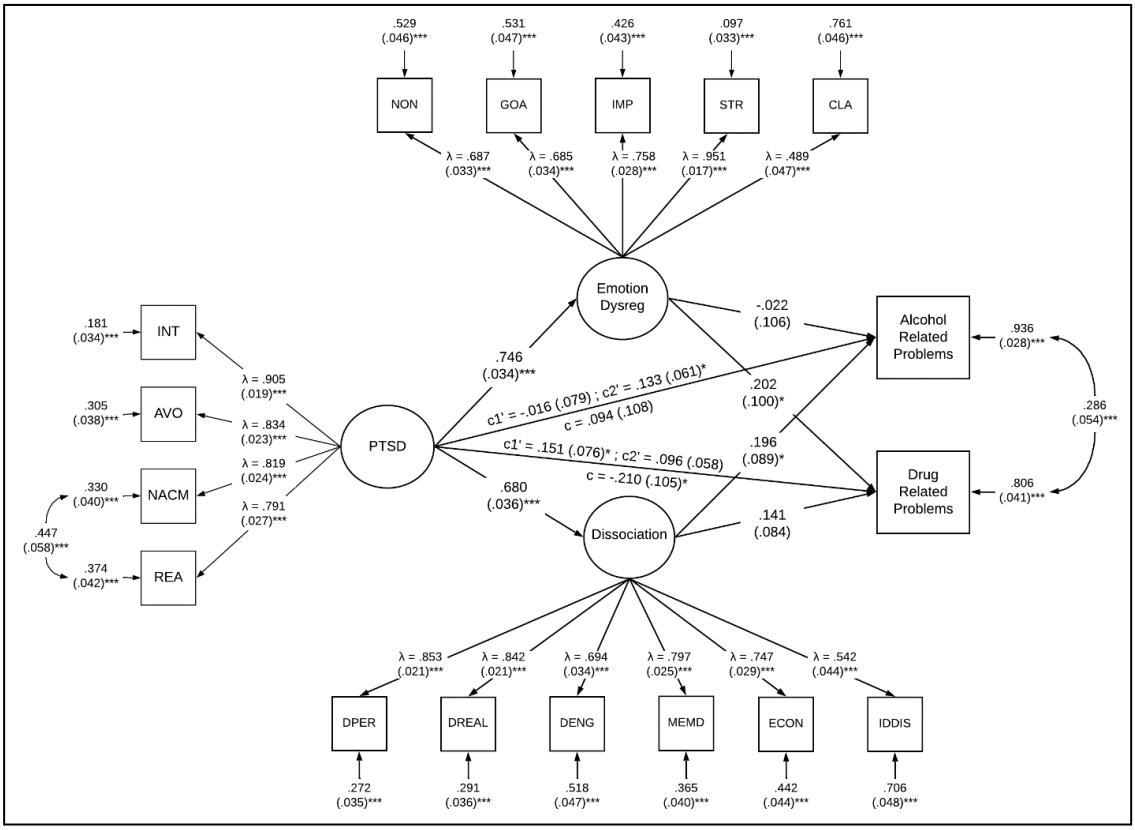

Figure 1. Parallel Mediation Model for HCWs. All values are standardized. Standard error for residuals and covariances in parentheses. PTSD = PTSD latent factor, INT = Intrusions, AVO = Avoidance, NACM = Negative Alterations in Cognition and Mood, REA = Reactivity, DPER = Depersonalization, DREAL = Derealization, DENG = Disengagement, MEMD = Memory Disturbance, ECON = Emotional Constriction/Numbing, IDDIS = Identity Dissociation, NON = Non-Acceptance of Emotional Responses, GOA = Difficulty Engaging in Goal-Directed Behaviour, IMP = Impulse Control Difficulties, STR = Lack of Access to Emotion Regulation Strategies, CLA = Lack of Emotional Clarity. Age, sex, education, childhood adversity, depressive symptoms, anxiety symptoms, and stress symptoms were controlled for. Model fit was

adequate ($\chi^2(209, N = 299) = 476.46$, $p < .0001$, TLI = .912, CFI = .927, RMSEA = 0.07 [95% CI = .058 - .073], SRMR = 0.06). * $p < .05$; ** $p < .01$; *** $p < .001$

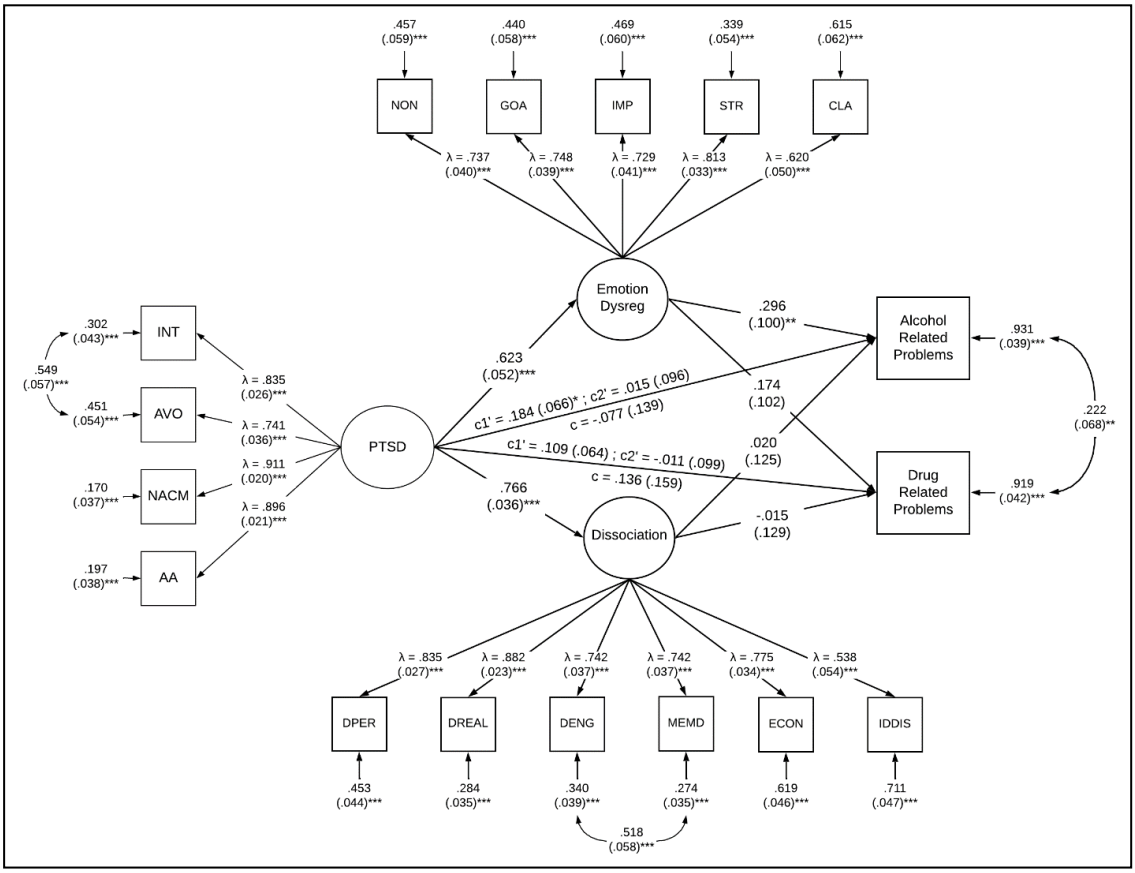

Figure 2. Parallel Mediation Model for PSP. All values are standardized. Standard error for residuals and covariances in parentheses. PTSD = PTSD latent factor, INT = Intrusions, AVO = Avoidance, NACM = Negative Alterations in Cognition and Mood, REA = Reactivity, DPER = Depersonalization, DREAL = Derealization, DENG = Disengagement, MEMD = Memory Disturbance, ECON = Emotional Constriction/Numbing, IDDIS = Identity Dissociation, NON = Non-Acceptance of Emotional Responses, GOA = Difficulty Engaging in Goal-Directed Behaviour, IMP = Impulse Control Difficulties, STR = Lack of Access to Emotion Regulation Strategies, CLA = Lack of Emotional Clarity Age, sex, education, childhood adversity, depressive symptoms, anxiety symptoms, and stress symptoms were controlled for. Model fit was adequate ($\chi^2(176, N = 199) = 403.36, p <$

.0001, TLI = .896, CFI = .913, RMSEA = 0.08 [95% CI = .070 - .091], SRMR = 0.07). * $p < .05$; ** $p < .01$; *** $p < .001$

TABLES

Table 1. Sample Characteristics for HCWs and PSP.

	HCWs (N = 299)	PSP (N = 199)	t/X^2	*p*
Demographics				
Age (%)				
20-29 years old	16.1	21.6		
30-39 years old	33.1	37.7		
40-49 years old	29.1	23.6	6.64	.249
50-59 years old	15.7	13.6		
60-69 years old	5.4	3.5		
70-79 years old	0.7	0		
Sex (% Female)	91.6%	39.7%	154.49	<.001
Race (%)				
African/Caribbean	0.02	0		
Caucasian	86.6	94.4		
East Asian	0.03	0.005		
Indigenous	0.02	0.03	6.69	.010
Latin American	0	0.01		
Pacific Islander	0	0		
South East Asian	0.02	0.01		
Other	0.05	0.01		
Education (%)				
Completed some college	2.3	10.1		
Completed college diploma	18.7	50.8		
Completed some university	5.7	12.1		
Completed Bachelor's university degree	45.2	24.6	119.68	<.001
Completed Master's/Graduate degree	21.4	1.0		
Completed Doctoral degree	5.4	0		
Other	1.3	1.5		
Childhood Adversity	3.11 (2.44)	2.76 (2.42)	1.614	.107
Psychiatric Symptoms				

Depression	14.45 (9.22)	13.13 (9.33)	1.56	.120
Anxiety	10.37 (7.30)	8.33 (7.07)	3.10	.002
Stress	18.73 (7.89)	16.69 (8.52)	2.74	.006
Provisional PTSD Diagnosis (%)	28.%	30%	.234	.629
Global PTSD Severity (PCL-5)	28.43 (15.27)	27.20 (17.26)	.819	.413
Intrusions	6.94 (4.27)	6.20 (4.57)	1.87	.062
Avoidance	3.10 (2.15)	2.72 (2.23)	1.93	.055
NACM	10.27 (6.05)	9.155 (6.58)	1.95	.052
Reactivity	8.12 (4.48)	9.13 (5.60)	-2.14	.033
Substance Use Symptoms				
Alcohol Related Problems (AUDIT)	3.92 (3.15)	6.16 (4.86)	-5.74	<.001
Substance Related Problems (DUDIT)	2.26 (3.45)	2.25 (2.98)	.045	.964
Cognitive and Emotional Variables				
Dissociative Symptoms (MDI)				
Depersonalization	7.93 (2.86)	7.74 (3.05)	.721	.471
Derealization	7.97 (2.76)	8.18 (2.99)	-.723	.470
Memory Disturbance	8.08 (2.71)	9.14 (3.64)	-3.49	<.001
Disengagement	11.94 (3.26)	12.05 (4.15)	-.291	.771
Emotional Constriction	9.70 (4.02)	10.53 (4.63)	-2.07	.040
Identity Dissociation	5.51 (1.10)	5.83 (1.55)	-2.49	.013
Emotion Dysregulation (DERS)	82.55 (19.69)	86.61 (20.73)	-2.21	.027
Non-Acceptance of Emotional Responses	13.92 (4.99)	14.85 (5.41)	-1.97	.049
Difficulty with Goal-Directed Behaviour	14.09 (4.17)	13.95 (4.21)	.375	.708
Impulse Control Difficulties	10.74 (3.87)	11.01 (3.84)	-.766	.444
Lack of Emotional Awareness	15.72 (4.30)	17.65 (5.14)	-4.37	<.001
Limited Access to Emotion Regulation Strategies	17.28 (6.06)	17.65 (5.89)	-.683	.495
Lack of Emotional Clarity	10.80 (3.29)	11.51 (3.59)	-2.28	.023

Note. All values reported are means (standard deviations) except for age, sex, race, education, and provisional posttraumatic stress disorder (PTSD) diagnosis where percentages are displayed. For age, sex, race, education, and provisional PTSD diagnosis, Chi-square tests were used to evaluate group differences; all other variables

used independent samples t-tests. Depression, Anxiety, and Stress variables are based on subscales of the Depression, Anxiety, Stress Scale-21. Provisional PTSD Diagnosis was based on a cut-off score of 33+ on Posttraumatic Checklist for DSM-5 (PCL-5). Global PTSD Severity is based on the sum score on PCL-5.

Table 2. All Direct and Indirect Paths from Parallel Mediation Model for HCWs.

Path	**β**	**S.E.**	***p***
PTSD → Alcohol-Related Problems (direct)	.094	.108	.383
PTSD → Drug-Related Problems (direct)	-.210	.105	.044
PTSD → Dissociation	.680	.036	< .0001
PTSD → Emotion Dysregulation	.746	.034	< .0001
Dissociation → Alcohol-Related Problems	.196	.089	.028
Dissociation → Drug-Related Problems	.141	.084	.093
Emotion Dysregulation → Alcohol-Related Problems	-.022	.106	.835
Emotion Dysregulation → Drug-Related Problems	.202	.100	.043
PTSD → Dissociation → Alcohol-Related Problems (indirect)	.133	.061	.030
PTSD → Dissociation → Drug-Related Problems (indirect)	.096	.058	.096
PTSD → Emotion Dysregulation → Alcohol-Related Problems (indirect)	-.016	.079	.835
PTSD → Emotion Dysregulation → Drug-Related Problems (indirect)	.151	.076	.046

Note: β (beta) represents the standardized co-efficient estimate; S.E. represents the standard error of the beta co-efficient estimate.

Table 3. All Direct and Indirect Paths from Parallel Mediation Model for PSP.

Path	**β**	**S.E.**	***p***
PTSD → Alcohol-Related Problems (direct)	-.077	.139	.578
PTSD → Drug-Related Problems (direct)	.136	.159	.391
PTSD → Dissociation	.766	.036	< .0001
PTSD → Emotion Dysregulation	.623	.052	< .0001
Dissociation → Alcohol-Related Problems	.020	.125	.872
Dissociation → Drug-Related Problems	-.015	.129	.908
Emotion Dysregulation → Alcohol-Related Problems	.296	.100	.003
Emotion Dysregulation → Drug-Related Problems	.174	.102	.086
PTSD → Dissociation → Alcohol-Related Problems (indirect)	.015	.096	.872
PTSD → Dissociation → Drug-Related Problems (indirect)	-.011	.099	.908
PTSD → Emotion Dysregulation → Alcohol-Related Problems (indirect)	.184	.066	.005
PTSD → Emotion Dysregulation → Drug-Related Problems (indirect)	.109	.064	.091

Note: β (beta) represents the standardized co-efficient estimate; S.E. represents the standard error of the beta co-efficient estimate.

SUPPLEMENTAL MATERIAL

Methods

Multiple Imputation Procedure

Missing data were addressed with multiple imputation using Statistical Package for Social Science (SPSS) software, version 27.0 (IBM, 2020). Unlike other techniques for dealing with missing data, multiple imputation preserves the estimates of the mean and standard deviation, even in cases of large amounts missing data, by accounting for uncertainty of the missing values through the creation of multiple, plausible imputed datasets and pooling the results of each. (Stern et al., 2009; Streiner, 2002). Multiple imputation is a sophisticated procedure for generating possible values for missing data via a series of regression analyses and an iterative, Bayesian algorithm to generate new estimates for each generated set of imputations (Enders, 2017). See van Ginkel et al., 2020 for a recent discussion of multiple imputation as a technique for dealing with missing data in applied scientific research.

In the present study, 633 healthcare workers and public safety personnel consented to participate. One-hundred and thirty-three (n=133) of these participants were removed due to insufficient survey completion (i.e., they did not complete the demographic form and at least one full scale), yielding n=500 participants in the working data set. For the multiple imputation procedure, healthcare workers (HCWs; n=300) and public safety personnel (PSP; n=200) were split into separate datasets to account for potential population differences between these related, yet distinct professional groups. Accordingly, healthcare worker data was imputed separately from public safety personnel data.

Among healthcare workers, 6.5% of variables (349 variables total) had missing data, 3.7% of cases (300 cases total) had missing data and 28.6% of values (104,700 values total) had missing data. Among public safety personnel, 11.1% of variables (289 variables total) had missing data, 25.5% of cases (200 cases total) had missing data and 24.9% of values (57800 values total) had missing data. Missingness in the data may be related to the length of the survey (approximately 50 to 60 minutes to complete), the personal nature of the mental health and functioning questionnaires and the populations completing the survey (i.e., trauma exposed group working on the frontlines of the COVID-19 pandemic). No systematic relationship between missing data was determined; missing data was assumed to be missing at random.

All variables were included in each multiple imputation procedure. Only items that contributed to a scale's total score were imputed; demographic data, yes/no responses and any other types of variables were not imputed but were used as predictors of missing values. Five imputed datasets were produced from imputation and pooled into a final, imputed dataset. Total scores from the imputed dataset were compared to total scores from the original data set with missing values and no meaningful differences were found.

Supplemental Table 1. Pre and Post Imputation Participant Characteristics for HCWs.

TOTAL N = 300	**Raw Data**				**Imputed Data**			
Scale	**N**	***M***	***SD***	***Mdn***	**N**	***M***	***SD***	***Mdn***
DASS-21 Depression	299	14.82	9.22	14	300	14.45	9.23	14
DASS-21 Anxiety	296	10.32	7.3	10	300	10.37	7.3	10
DASS-21 Stress	298	18.68	7.9	18	300	18.73	7.89	18
PCL-5	194	28.35	18.61	26	300	28.43	15.27	28
MDI Depersonalization	206	7.64	3.41	6	300	7.93	2.86	8
MDI Derealization	206	7.71	3.28	7	300	7.99	2.76	8
MDI Memory Disturbance	206	7.75	3.22	7	300	8.08	2.71	8
MDI Disengagement	206	11.74	3.95	11	300	11.94	3.26	12
MDI Emotional Constriction	206	9.48	4.86	8	300	9.7	4.02	9
MDI Identity Dissociation	206	5.4	1.32	5	300	5.51	1.1	5
ACES	203	2.24	2.38	1	300	3.11	2.44	2.44
DERS	181	81.8	24.64	76	300	82.55	19.69	83
AUDIT	178	3.59	3.91	2	300	3.92	3.15	4
DUDIT	178	1.75	4.29	0	300	2.26	3.45	2
CUDIT	182	1.75	3.85	0	300	2.06	3.11	1

Note. DASS-21 = Depression, Anxiety, Stress Scale-21; PCL-5 = Posttraumatic Stress Disorder Checklist for Diagnostic Statistical Manual-5; MDI = Multiscale Dissociation Inventory; ACES = Adverse Childhood Experiences Scale; DERS = Difficulties in Emotion Regulation Scale; AUDIT = Alcohol Use Disorder Identification Test; DUDIT = Drug Use Disorder Identification Test; CUDIT = Cannabis Use Disorder Identification Test

Supplemental Table 2. Pre and Post Imputation Participant Characteristics for PSP.

TOTAL N = 200	**Raw Data**				**Imputed Data**			
Scale	**N**	***M***	***SD***	***Mdn***	**N**	***M***	***SD***	***Mdn***
DASS-21 Depression	178	13.07	9.81	12	200	13.13	9.33	12
DASS-21 Anxiety	178	8.03	7.33	6	200	8.33	7.07	8
DASS-21 Stress	179	16.63	8.96	16	200	16.69	8.52	16
PCL-5	155	27.26	19.49	26	200	27.2	17.26	27
MDI Depersonalization	150	7.57	3.45	6	200	7.74	3.05	7
MDI Derealization	150	7.97	3.41	7	200	8.18	3	8
MDI Memory Disturbance	150	8.95	4.15	8	200	9.14	3.64	9
MDI Disengagement	150	11.97	4.74	11	200	12.05	4.15	12
MDI Emotional Constriction	150	10.37	5.3	9	200	10.53	4.63	10
MDI Identity Dissociation	150	5.67	1.73	5	200	5.83	1.55	5
ACES	143	2.06	2.27	1	200	2.76	2.42	2
DERS	125	84.38	23.87	84	200	86.61	20.73	88
AUDIT	128	5.67	5.87	4	200	6.16	4.86	5
DUDIT	128	1.9	3.35	0	200	2.25	2.98	2
CUDIT	129	2.12	3.86	0	200	2.41	3.2	2

Note. DASS-21 = Depression, Anxiety, Stress Scale-21; PCL-5 = Posttraumatic Stress Disorder Checklist for Diagnostic Statistical Manual-5; MDI = Multiscale Dissociation Inventory; ACES = Adverse Childhood Experiences Scale; DERS = Difficulties in Emotion Regulation Scale; AUDIT = Alcohol Use Disorder Identification Test; DUDIT = Drug Use Disorder Identification Test; CUDIT = Cannabis Use Disorder Identification Test

Data Analytic Plan

The following latent factors were used within the mediation models. First, a latent factor for PTSD was created using the four symptom cluster scores from the PCL-5: Intrusions (Cluster B), Avoidance (Cluster C), NACM (Cluster D), and Alterations in Arousal (Cluster E) (refer to supplemental figure 1 for measurement model). Second, a latent factor for dissociative symptomatology was created using the six subscales of dissociation on the MDI: Disengagement, Depersonalization, Derealization, Emotional Constriction/Numbing, Memory Disturbance, and Identity Dissociation (refer to supplemental figure 2 for measurement model). Third, a latent factor for emotional dysregulation was created using the six subscales of the DERS: (1) non-acceptance of emotional responses, (2) difficulty engaging in goal-directed behaviour, (3) impulse control difficulties, (4) lack of emotional awareness, (5) limited access to emotion regulation strategies, and (6) lack of emotional clarity (refer to supplemental figure 3 for measurement model). The lack of emotional awareness subscale was subsequently dropped from the measurement model due to low factor loading (beta = 0.2) compared to other subscales (beta = 0.5-0.8). For the secondary cluster models, the PTSD symptoms latent factor was replaced with the four subscales of the PCL-5 as independent variables: Intrusions, Avoidance, Negative Alterations in Cognition and Mood (NACM), and Reactivity.

Results

Table S3. Zero-order correlation matrix between all variables of interest in HCWs

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1. Age	-																								
2. Sex	.01	-																							
3. Education	-.18**	.01	-																						
4. AUDIT	-.02	-.04	-.12*	-																					
5. DUDIT	-.13*	-.12*	-.16**	.23**	-																				
6. Intrusions	.06	-.05	-.22**	.17**	.18**	-																			
7. Avoidance	.05	-.01	-.13*	.14*	.12*	.75**	-																		
8. NACM	.03	-.10	-.15**	.17**	.17**	.74**	.69**	-																	
9. Reactivity	.09	-.10	-.22**	.25**	.18**	.72**	.65**	.81**	-																
10. Depersonalization	-.06	-.12*	-.08	.23**	.17**	.42**	.40**	.52**	.51**	-															
11. Derealization	-.01	-.03	-.08	.19**	.23**	.49**	.40**	.53**	.52**	.73**	-														
12. Memory Disturbances	.08	-.08	-.06	.23**	.20**	.41**	.35**	.46**	.48**	.65**	.68**	-													
13. Disengagement	-.02	.00	-.07	.19**	.23**	.33**	.23**	.45**	.44**	.55**	.59**	.62**	-												
14. Emotional Constriction	-.01	-.11	-.03	.12*	.13*	.40**	.36**	.55**	.47**	.68**	.61**	.58**	.53**	-											
15. Identity Dissociation	.06	-.11	-.15*	.23**	.04	.25**	.25**	.28**	.38**	.52**	.44**	.46**	.33**	.35**	-										
16. Non-Acceptance	-.01	.01	-.10	.15**	.19**	.45**	.41**	.56**	.52**	.46**	.46**	.31**	.32**	.39**	.24**	-									
17. Goal Setting	-.12*	.04	.04	.15**	.13*	.30**	.27**	.44**	.42**	.28**	.34**	.25**	.31**	.22**	.14*	.44**	-								
18. Impulse Control	-.04	.06	-.08	.10	.10	.34**	.32**	.41**	.46**	.41**	.43**	.31**	.20**	.25**	.27**	.47**	.55**	-							
19. Emotional Awareness	-.04	-.09	.04	-.01	.12*	.13*	.13*	.22**	.21**	.28**	.22**	.22**	.21**	.38**	.13*	.33**	.13*	.13*	-						
20. Strategies	-.02	-.01	-.16**	.13*	.15**	.53**	.46**	.62**	.57**	.46**	.47**	.36**	.33**	.4**	.28**	.66**	.65**	.72**	.24**	-					
21. Emotional Clarity	-.11	-.13*	.02	.15**	.15*	.26**	.3**	.42**	.4**	.55**	.47**	.45**	.38**	.58**	.38**	.42**	.35**	.38**	.6**	.45**	-				
22. Depression	.02	-.06	-.15*	.09	.10	.44**	.37**	.57**	.48**	.38**	.34**	.30**	.31**	.42**	.2**	.41**	.27**	.3**	.18**	.47**	.34**	-			
23. Anxiety	-.10	-.02	-.24**	.08	.14*	.49**	.40**	.47**	.49**	.39**	.44**	.36**	.33**	.40**	.19**	.34**	.21**	.34**	.14*	.40**	.26**	.62**	-		
24. Stress	-.09	-.09	-.09	.05	.11*	.41**	.31**	.47**	.47**	.31**	.35**	.27**	.33**	.39**	.14*	.38**	.28**	.29**	.11	.38**	.27**	.67**	.65**	-	
25. Childhood Adversity	.00	.07	-.18**	.08	.21**	.26**	.24**	.31**	.31**	.16**	.22**	.19**	.19**	.16**	.16**	.23**	.15**	.17**	.01	.2**	.09	.05	.11*	.03	-

Note: ** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed).

Table S4. Zero-order correlation matrix between all variables of interest in PSP

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1. Age	--																								
2. Sex	-.21**	--																							
3. Education	-.095	.070	--																						
4. AUDIT	-.152*	-.025	-.003	--																					
5. DUDIT	-.129	-.024	.048	.185**	--																				
6. Intrusions	.060	.172*	-.037	.051	.032	--																			
7. Avoidance	.023	.190**	-.003	.088	.027	.822**	--																		
8. NACM	.040	.121	-.028	.111	.111	.756**	.698**	--																	
9. Reactivity	.033	.128	.007	.134	.112	.755**	.637**	.817**	--																
10. Depersonalization	-.083	.153*	.100	.102	.083	.483**	.472**	.563**	.500**	--															
11. Derealization	.009	.137	.052	.053	.147*	.555**	.484**	.607**	.585**	.746**	--														
12. Memory Disturbances	.032	.106	.110	.121	.083	.444**	.423**	.515**	.581**	.557**	.662**	--													
13. Disengagement	-.046	.150*	.121	.109	.074	.474**	.467**	.538**	.578**	.586**	.671**	.784**	--												
14. Emotional Constriction	.076	.050	.065	.093	-.009	.484**	.490**	.625**	.543**	.657**	.657**	.644**	.619**	--											
15. Identity Dissociation	-.068	-.007	-.025	.192**	.249**	.213**	.153*	.286**	.261**	.504**	.465**	.401**	.316**	.336**	--										
16. Non-Acceptance	-.145*	.221**	.034	.145*	.113	.326**	.264**	.363**	.361**	.235**	.346**	.275**	.387**	.267**	0.051	--									
17. Goal Setting	-.134	.159*	.130	.308**	.217**	.361**	.248**	.405**	.465**	.294**	.394**	.404**	.477**	.263**	.201**	.547**	--								
18. Impulse Control	-.120	.113	.030	.253**	.108	.232**	.179*	.303**	.363**	.231**	.341**	.284**	.275**	.193**	.250**	.476**	.581**	--							
19. Emotional Awareness	.005	-.054	-.122	.021	-.120	.216**	.200**	.264**	.240**	.102	.050	.150*	.103	.241**	.089	.248**	.090	.222**	--						
20. Strategies	-.079	.120	.015	.110	.143*	.399**	.355**	.509**	.409**	.361**	.378**	.241**	.352**	.334**	.212**	.629**	.606**	.582**	.297**	--					
21. Emotional Clarity	-.044	.033	-.062	.162*	.006	.321**	.279**	.431**	.416**	.266**	.332**	.330**	.305**	.403**	.227**	.487**	.421**	.512**	.636**	.476**	--				
22. Depression	.077	.101	.053	.101	.018	.529**	.480**	.682**	.560**	.393**	.452**	.284**	.370**	.448**	0.134	.407**	.408**	.330**	.206**	.558**	.379**	--			
23. Anxiety	-.014	.218**	.006	.025	.053	.575**	.459**	.535**	.567**	.422**	.529**	.481**	.491**	.430**	.223**	.329**	.387**	.329**	.098	.332**	.292**	.510**	--		
24. Stress	.072	.139	.023	.124	.096	.560**	.485**	.648**	.622**	.415**	.536**	.433**	.485**	.419**	.193**	.364**	.486**	.388**	.136	.420**	.417**	.744**	.650**	--	
25. Childhood Adversity	-.032	.089	.048	-.023	.057	.112	.065	.156*	.069	.229**	.274**	.187**	.180*	.222**	.156*	.197**	.060	.182**	.079	.194**	.226**	.190**	.184**	.173*	--

Note: ** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed).

Measurement Models

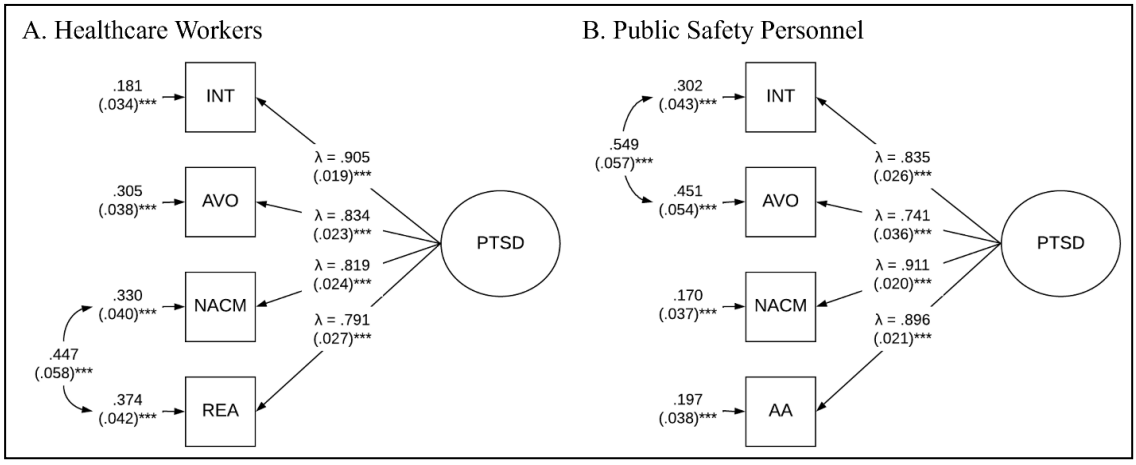

Figure S1. PTSD Measurement Models in HCWs and PSP.

All values are standardized. Standard error for residuals and covariances in parentheses. PTSD = PTSD latent factor, INT = Intrusions, AVO = Avoidance, NACM = Negative Alterations in Cognition and Mood, REA = Reactivity. Panel A represents measurement model for HCWs. The HCWs model fit was excellent ($\chi^2(1, N = 299) = 0.399$, $p > .05$, TLI = 1.00, CFI = 1.00, RMSEA = 0.00 [95% CI = .000 - .130], SRMR = 0.002). Panel B represents measurement model for PSP. The PSP model fit was adequate ($\chi^2(1, N = 199) = 6.248$, $p = .01$, TLI = .951, CFI = .992, RMSEA = 0.162 [95% CI = .060 - .293], SRMR = 0.01). * $p < .05$; ** $p < .01$; *** $p < .001$

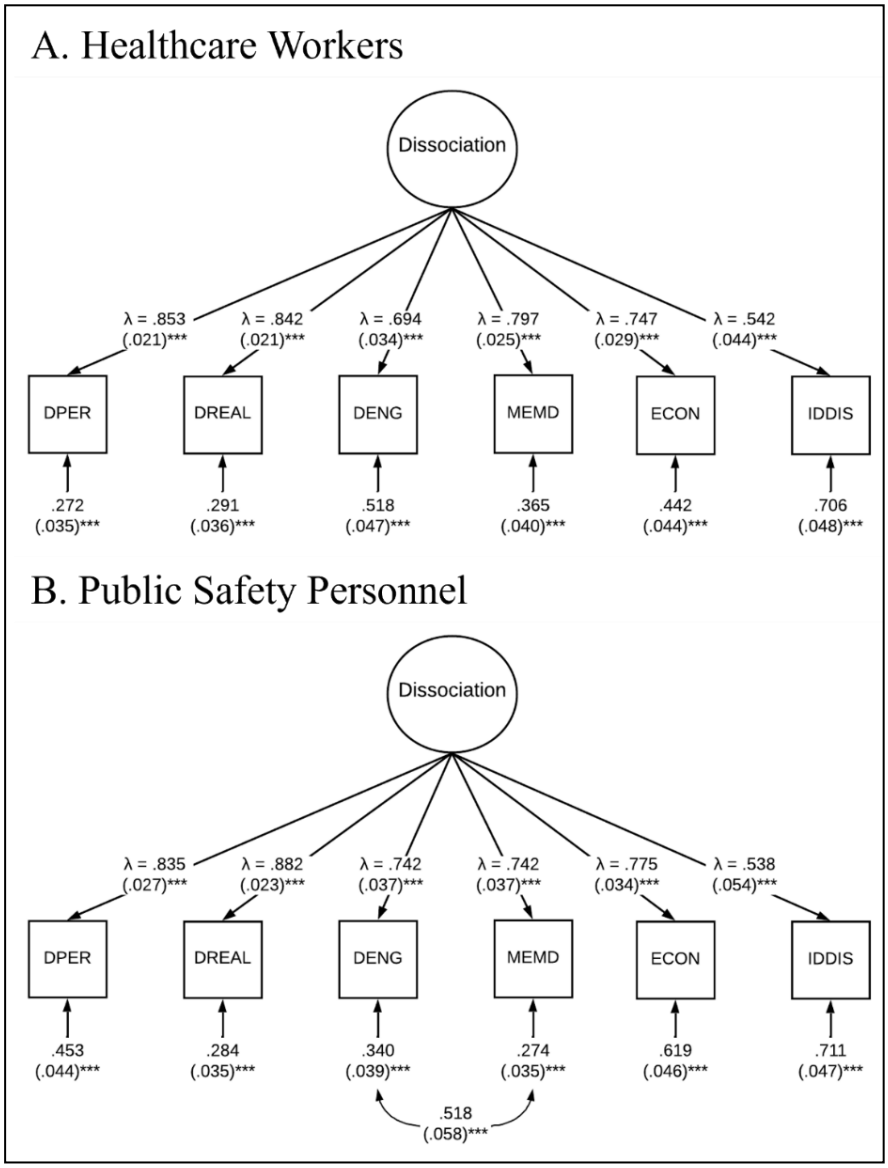

Figure S2. Dissociation Measurement Models in HCW and PSP.

All values are standardized. Standard error for residuals and covariances in parentheses. DPER = Depersonalization, DREAL = Derealization, DENG = Disengagement, MEMD = Memory Disturbances, ECON = Emotional Constriction, IDDIS = Identity Dissociation. Panel A represents measurement model for HCWs. The HCWs model fit was excellent ($\chi^2(9, N = 299) = 32.04$, $p < .001$, TLI = .958, CFI = .975, RMSEA = .092 [95% CI = .059 -

.128], SRMR = 0.03). Panel B represents measurement model for PSP. The PSP model fit was adequate ($\chi^2(8, N = 199) = 27.48$, $p < .001$, TLI = .949, CFI = .973, RMSEA = 0.110 [95% CI = .067 - .157], SRMR = 0.03). * $p < .05$; ** $p < .01$; *** $p < .001$

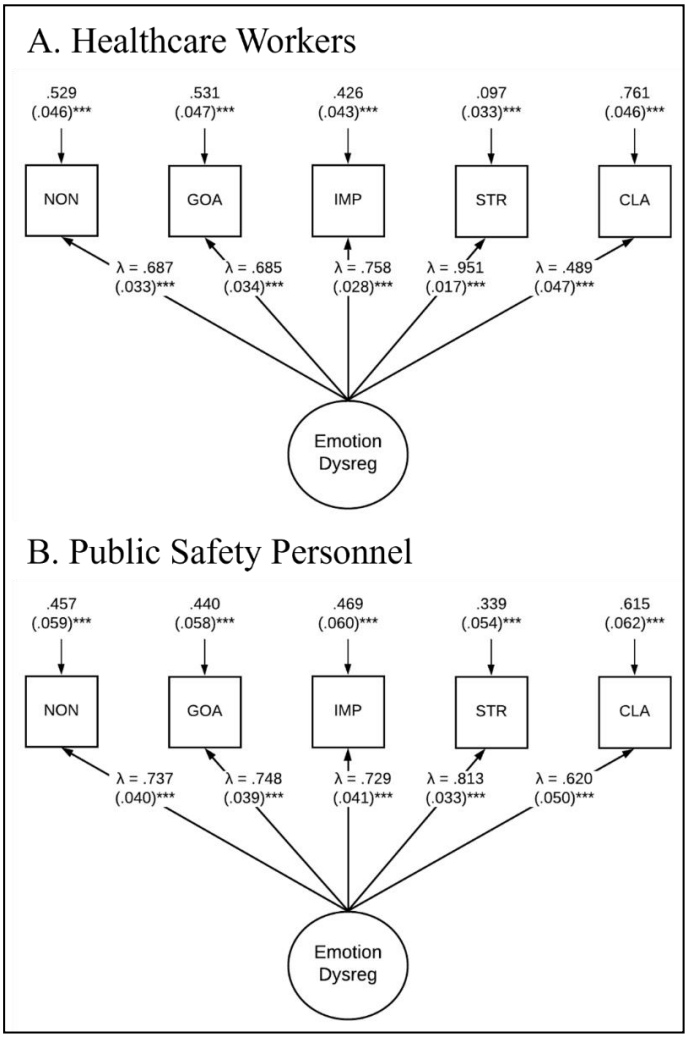

Figure S3. Emotion Dysregulation Measurement Models in HCWs and PSP.

All values are standardized. Standard error for residuals and covariances in parentheses. NON = Non-Acceptance of Emotional Responses, GOA = Difficulty Engaging in Goal-Directed Behaviour, IMP = Impulse Control Difficulties, STR = Lack of Access to Emotion Regulation Strategies, CLA = Lack of Emotional Clarity. The HCWs model fit was excellent ($\chi^2(8, N = 299) = 27.90$, $p < .001$, TLI = .952, CFI = .974, RMSEA = .091 [95% CI = .056 - .129], SRMR = 0.04). Panel B represents measurement model for PSP. The PSP

model fit was excellent ($\chi^2(5, N = 199) = 12.24$, $p < .05$, TLI = .963, CFI = .982, RMSEA = 0.085 [95% CI = .023 - .147], SRMR = 0.03). * $p < .05$; ** $p < .01$; *** $p < .001$

Initial HCWs PTSD and Substance Use Model

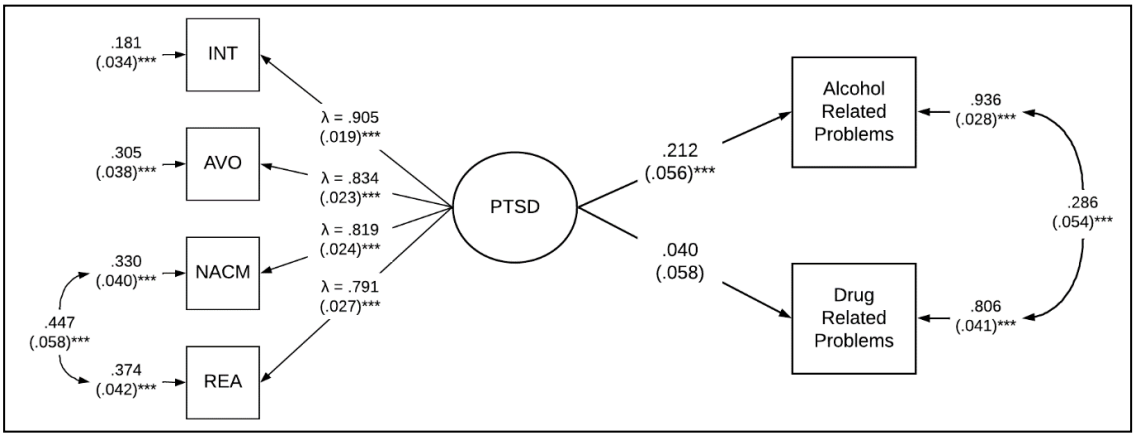

Figure S4. Associations between PTSD and Alcohol and Drug Related Problems among HCWs. All values are standardized. Standard error for residuals and covariances in parentheses. PTSD = PTSD latent factor, INT = Intrusions, AVO = Avoidance, NACM = Negative Alterations in Cognition and Mood, REA = Reactivity. Age, sex, education, childhood adversity, depressive symptoms, anxiety symptoms, and stress symptoms were controlled for. Model fit was excellent ($\chi^2(33, N = 299) = 64.43$, $p < .0001$, TLI = .962, CFI = .976, RMSEA = 0.056 [95% CI = .035 - .077], SRMR = 0.04). * $p < .05$; ** $p < .01$; *** $p < .001$

Initial PSP PTSD and Substance Use Model

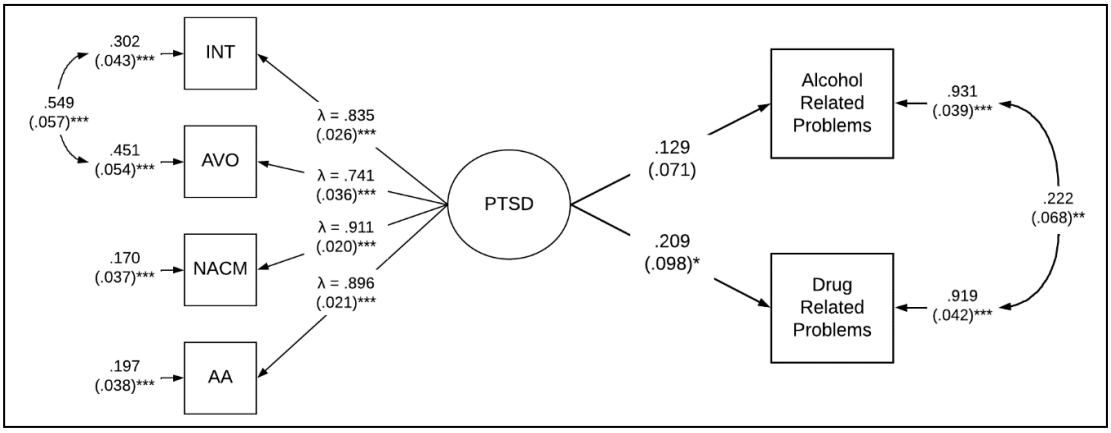

Figure S5. Associations between PTSD and Alcohol and Drug Related Problems among PSP. All values are standardized. Standard error for residuals and covariances in parentheses. PTSD = PTSD latent factor, INT = Intrusions, AVO = Avoidance, NACM = Negative Alterations in Cognition and Mood, REA = Reactivity. Age, sex, education, childhood adversity, depressive symptoms, anxiety symptoms, and stress symptoms were controlled for. Model fit was excellent ($\chi^2(36, N = 199) = 57.66$, $p < .05$, TLI = .972, CFI = .980, RMSEA = 0.055 [95% CI = .026 - .081], SRMR = 0.05). * $p < .05$; ** $p < .01$; *** $p < .001$

HCWs Secondary Cluster Model

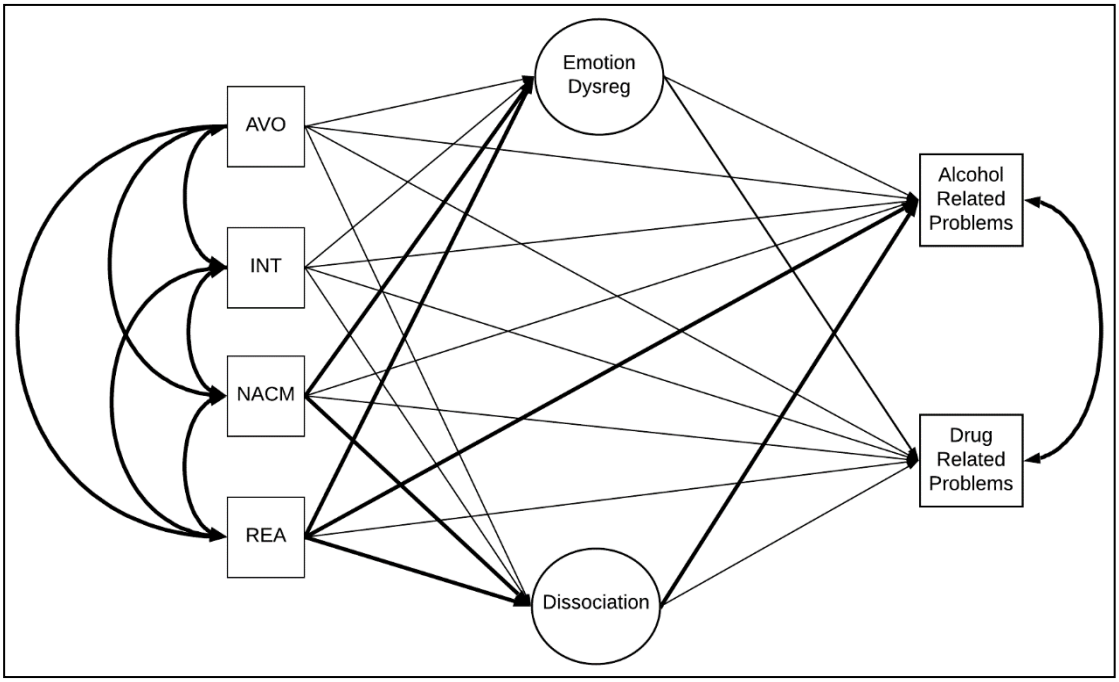

Figure S6. Parallel Mediation Model with PTSD Symptom Clusters among HCWs.

All values are standardized. Standard error for residuals and covariances in parentheses. PTSD = PTSD latent factor, INT = Intrusions, AVO = Avoidance, NACM = Negative Alterations in Cognition and Mood, REA = Reactivity. Age, sex, education, childhood adversity, depressive symptoms, anxiety symptoms, and stress symptoms were controlled for. Model fit was poor ($\chi^2(178, N = 299) = 425.42$, $p < .00001$, TLI = .883, CFI = .910, RMSEA = 0.068 [95% CI = .060 - .076], SRMR = 0.06). * $p < .05$; ** $p < .01$; *** $p < .001$

The secondary cluster model evaluated the direct and indirect (mediated via dissociation or emotion dysregulation) paths from each of the four PTSD symptoms clusters to alcohol and

drug use related problems. Overall, the model accounted for 8.3% of the variance in alcohol use related problems (r^2 = .083, p < .05) and 9.2% of the variance in drug use related problems (r^2 = .092, p < .05). Prior to mediation, the direct paths from the four PTSD symptoms clusters to alcohol-related problems were as follows: Intrusions (β = .018, p > .05), Avoidance (β = -.098, p > .05), NACM (β = -.056, p > .05), and Reactivity (β = .267, p = .007). Following mediation, the direct paths to alcohol-related problems were not significant for any of the clusters (βs = -.254 - .171, ps > .05). The indirect paths from the PTSD symptom clusters to alcohol-related problems via dissociation (βs = .000 - .005, ps > .05) were not significant. However, the indirect path from NACM to alcohol related problems via emotion dysregulation was significant (indirect effect β = .101, p < .05) but the indirect paths for the other symptom clusters were not (βs = -.031 - .076, ps > .05). Prior to mediation, the direct paths from the four PTSD symptoms clusters to drug use related problems were as follows: Intrusions (β = .000, p > .05), Avoidance (β = -.019, p > .05), NACM (β = -.049, p > .05), and Reactivity (β = .117, p > .05). Following mediation, the direct paths to drug use related problems were not significant for any of the clusters (βs = -.109 - .086, ps > .05). The indirect paths from the PTSD symptom clusters to drug use related problems via dissociation (βs = .000 - .004, ps > .05) and emotion dysregulation (βs = -.016 - .051, ps > .05) were not significant.

PSP Secondary Cluster Model

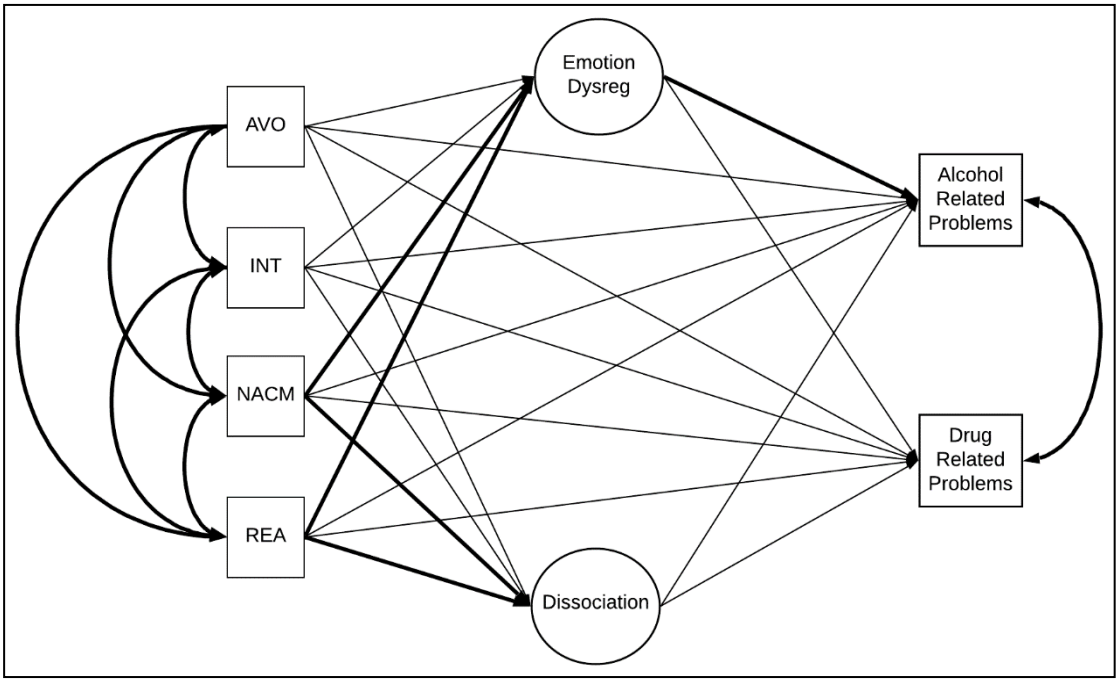

Figure S7. Parallel Mediation Model with PTSD Symptom Clusters among PSP.

All values are standardized. Standard error for residuals and covariances in parentheses. PTSD = PTSD latent factor, INT = Intrusions, AVO = Avoidance, NACM = Negative Alterations in Cognition and Mood, REA = Reactivity. Age, sex, education, childhood adversity, depressive symptoms, anxiety symptoms, and stress symptoms were controlled for. Model fit was poor ($\chi^2(153, N = 199) = 371.40$, $p < .00001$, TLI = .848, CFI = .881, RMSEA = 0.084 [95% CI = .074 - .095], SRMR = 0.076). * $p < .05$; ** $p < .01$; *** $p < .001$

The secondary cluster model evaluated the direct and indirect (mediated via dissociation or emotion dysregulation) paths from each of the four PTSD symptoms clusters to alcohol and

drug use related problems. Overall, the model accounted for 8.5% of the variance in alcohol use related problems (r^2 = .085, $p < .05$) and 8.7% of the variance in drug use related problems (r^2 = .087, $p < .05$). Prior to mediation, the direct paths from the four PTSD symptoms clusters to alcohol-related problems were as follows: Intrusions (β = -.212, $p > .05$), Avoidance (β = .128, $p > .05$), NACM (β = .048, $p > .05$), and Reactivity (β = .175, $p > .05$). Following mediation, the direct paths to alcohol-related problems were significant for Reactivity only (β = .259, $p < .01$), but not the others (β's = -.147 - .016, ps > .05). However, the indirect paths from the PTSD symptom clusters to alcohol-related problems via dissociation (βs = -.007 - .056, ps > .05) and emotion dysregulation (βs = .005 - .000, ps > .05) were not significant. Prior to mediation, the direct paths from the four PTSD symptoms clusters to drug use related problems were as follows: Intrusions (β = -.099, $p > .05$), Avoidance (β = .068, $p > .05$), NACM (β = .006, $p > .05$), and Reactivity (β = .110, $p > .05$). Following mediation, the direct paths to drug use related problems were not significant for any of the clusters (β's = -.180 - .023, ps > .05). The indirect paths from the PTSD symptom clusters to drug use related problems via dissociation (βs = -.005 - .043, ps > .05) and emotion dysregulation (βs = -.003 - .089, ps > .05) were not significant.

4.3 Discussion

To date, the paper discussed in the current chapter is the first to examine the associations between PTSD and substance use-related problems among a sample of HCWs and builds upon prior literature on PSP. Furthermore, this paper also replicated and built upon the SEM frameworks presented in the previous chapters with the addition of two mediators operating in parallel to understand the mediating roles of multiple variables simultaneously.

In this chapter, among HCWs, PTSD symptoms were significantly associated with alcohol-related problems. Furthermore, dissociation significantly mediated the relation between PTSD and alcohol-related problems when examining underlying mechanisms such as dissociation and emotion dysregulation. Emotion dysregulation mediated the relation between PTSD and drug-related problems among HCWs. While among PSP, PTSD symptoms were significantly associated with drug-related problems. Among PSP, emotion dysregulation mediated the relation between PTSD and alcohol-related problems, whereas there were no significant mediations for drug-related problems. These results build upon prior research among clinically severe populations (see Chapters 2 and 3), indicating a meaningful association between PTSD and substance use across clinical and subclinical populations. Uncovering these associations between PTSD symptoms and substance-related problems among HCWs and PSP can inform precise treatment targets for individuals of these occupations seeking treatment for their PTSD and/or SUD.

The current chapter builds upon a pattern of results established among clinically severe samples with similar findings. Thus, the previous chapters and the current one all

suggest the presence of a unique connection between PTSD and substance use-related problems that are present across clinical and subclinical populations. In addition, the utilization of similar SEM frameworks building upon one another allows for the direct comparison and interpretation of results (see Chapter 5 for general discussion).

Chapter 5. General Discussion

5.1 Patterns of Associations across Samples

The overarching purpose of this dissertation was to explore the associations between PTSD symptoms and alcohol/cannabis/substance use problems among three samples of differing clinical severity.

In Chapter 2, significant associations between global PTSD symptoms and cannabis use-related problems and illicit substance use-related problems were observed. Furthermore, among the specific symptom clusters of PTSD, the Reactivity (a.k.a., Alterations in Arousal) cluster was significantly associated with cannabis and illicit substance use-related problems. In addition, specific to cannabis use-related problems, the Avoidance cluster was significantly associated.

In Chapter 3, greater PTSD severity was associated with heightened dissociative symptoms and associated with greater alcohol-related problems via the mediating role of dissociation. In addition, individual symptom clusters of Intrusions, NACM, and Reactivity were indirectly associated (via dissociation) with alcohol-related problems; the same mediating effects were not observed for the Avoidance symptom cluster.

In Chapter 4, among HCWs, PTSD symptoms were significantly associated with alcohol-related problems. Furthermore, dissociation significantly mediated the relation between PTSD and alcohol-related problems. Emotion dysregulation mediated the relation between PTSD and drug-related problems among HCWs. Examining PTSD symptom

clusters, the indirect path from NACM to alcohol-related problems via emotion dysregulation was significant. While among PSP, PTSD symptoms were significantly associated with drug-related problems. Emotion dysregulation mediated the relation between PTSD and alcohol-related problems, whereas there were no significant mediations for drug-related problems. For PTSD symptom clusters, following mediation, the direct paths to alcohol-related problems were still significant for Reactivity.

Connecting the three studies, a pattern of results is established among three samples of differing clinical severity: (1) associations between global PTSD symptoms and alcohol/cannabis/illicit substance use problems are observed across clinically severe and subclinical samples; (2) among the PTSD symptom clusters, Reactivity, NACM, and Avoidance show direct or indirect associations with alcohol/cannabis/illicit substance use problems; and (3) specifically, Reactivity seems to be the most frequently associated cluster with substance-related problems. The results from the PTSD symptom clusters indicate that different aspects of PTSD may be more closely linked to comorbid substance-related problems. As such, understanding those associations has critical implications for developing treatment targets for efficacious intervention. Lastly, underlying factors such as dissociation and emotion dysregulation influence the relation between PTSD and alcohol/cannabis/illicit substance use problems. Across both chapters where dissociation was included in the analyses, it significantly mediated the relation between PTSD symptoms and alcohol-related problems, indicating a unique mechanism present in clinically severe and subclinical samples.

The models presented in all three chapters were contextualized within the self-medication hypothesis, which posits that individuals use substances to cope with their psychiatric symptoms, in this case, PTSD (Khantzian, 1985, 1997). Furthermore, the hypothesis posits that non-substance use-related psychiatric symptoms precede substance use and its associated outcomes. As such, PTSD symptoms were the predicting factors within all models. However, given the cross-sectional data used within all studies, the possibility of other hypotheses explaining the etiology of comorbid PTSD+SUD (Hien et al., 2021; María-Ríos & Morrow, 2020) cannot be eliminated.

5.2 Clinical Implications

All results presented have important clinical implications. For the first category of results, global PTSD symptoms are significantly associated with alcohol/cannabis/substance use problems across the three samples. This shows an intrinsic connection between PTSD and SUDs (inclusive of alcohol use disorder) beyond that of other comorbid presentations, a common belief in the literature given the high rates of comorbid PTSD and SUD compared to other psychiatric comorbidities (María-Ríos & Morrow, 2020). One potential reason for this could be the activation of the shared neural circuitry involved in PTSD and SUD (Hien et al., 2021; María-Ríos & Morrow, 2020). As such, the need to analyze the associations between PTSD and SUD (even at the level of self-reported symptoms) is critical in order to develop effective treatment targets for treating comorbid PTSD and SUD (Babor et al., 2008; Back et al., 2000; Driessen et al., 2008; Hakobyan et al., 2020; Karapareddy, 2019; Pietrzak et al., 2011; Stinson et al., 2005).

Among the specific PTSD symptom clusters, the Reactivity cluster was most frequently associated with substance-related problems among the three samples. As such, it may be an essential target during treatment. The Reactivity cluster comprises symptoms related to hypervigilance, irritability, reckless behaviours, and trouble with sleep and concentration (American Psychological Association, 2013). To speculate, the reckless behaviour symptom may be driving the association between PTSD symptoms and SUD, as a recent network analysis of individual symptoms among veterans in Ireland showed that the reckless behaviour symptom among PTSD and not being able to stop drinking and the number of drinks among alcohol-related problems were the most closely correlated among all the symptoms (McGlinchey et al., 2021). While it cannot be definitively stated that reckless behaviour was the main driving force behind the association between PTSD and substance-related problems, it may be a pivotal symptom to target during treatment. Important to note that the sample from McGlinchey et al. (2021) comprised solely of Northern Ireland military veterans, the samples in the three studies presented were much more diverse in terms of occupation and exposures to trauma. As such, the comparisons made should be interpreted with caution. Furthermore, given the different occupations and exposures to trauma across the results presented, it may be possible that different symptoms may play this key role based on the type of trauma that individuals were exposed to. In conclusion, given that individual symptoms were not analyzed, all the individual symptoms in the Reactivity cluster should be targeted during treatment in order to reduce the severity of Reactivity symptom cluster, which may in turn, reduce the association between PTSD and substance-related problems, as seen in the three samples presented here.

The second important category of results pertains to the role of underlying mechanisms such as dissociation. The results across the latter two chapters indicate that dissociation is a potential risk factor for developing substance-related problems among individuals with PTSD. Dissociation significantly mediated the relation between PTSD symptoms and alcohol-related problems among clinically severe and subclinical samples. This was supported by the significant mediation of relations between specific PTSD symptom clusters (i.e., Reactivity) and alcohol-related problems via dissociation. Interesting to note that the studies presented incorporated six different facets of dissociation, not just trauma-related dissociation, which is typically comprised of depersonalization and derealization (Briere et al., 2005). This approach is consistent with prior literature examining associations between dissociation and alcohol-related problems (Craparo et al., 2014; Evren et al., 2011; Najavits & Walsh, 2012; Schäfer et al., 2010; Zdankiewicz-Ścigała & Ścigała, 2018). In addition, other facets of dissociation, such as emotional constriction/numbing, disengagement, memory disturbances, and identity dissociation, were also incorporated. While individual symptoms were not analyzed within the studies, dissociative symptoms other than trauma-related dissociation play a role in mediating the relation between PTSD and substance-related problems. As such, dissociative symptoms in their entirety may also be an important treatment target, and the presence of dissociation symptoms should be examined and monitored by the treatment provider on an ongoing basis during treatment (Brand et al., 2019). As part of treatment, having patients understand and recognize dissociation as a method of escape from inescapable stress may help individuals identify their coping mechanisms for PTSD

symptoms, extrapolate those ideologies to substance use, and acknowledge that it may play a similar role.

Lastly, one of the most important clinical implications arising from Chapter 4 is the importance of intervening at earlier stages when the symptoms of PTSD and SUD are starting to be associated with one another to prevent the comorbid condition from getting worse. According to the failing cascade model, similar neuroadaptations underlie the comorbidity of PTSD and opioid use disorder (OUD) via exposure to acute and chronic stress for both disorders (Elman & Borsook, 2019). It is hypothesized that exposure to trauma and the use of opioids begins with some shared and independent processes for both disorders. As PTSD develops, continued opioid use and related problems emerge; there is cross-sensitization of aberrant learning where prior use of opioids sensitizes an individual to subsequent opioid use and the stress response involved in PTSD. As such, they begin to interact with one another, leading to the development of comorbid PTSD+SUD. This model lays out a theoretical framework to explain the comorbidity between PTSD and SUD, specifically, OUD. Given that the sample of HCWs and PSP did not endorse high rates of PTSD like samples in the previous two chapters, it is feasible to assume that the HCWs and PSP are on the route to developing comorbid PTSD+SUD. With that in mind, the presence of significant associations between PTSD symptoms and substance-related problems among HCWs and PSP indicates that even among cognitively high functioning and resilient samples, associations between PTSD and substance-related problems are still seen.

5.3 General Limitations

The presented results and their interpretations should be made in the context of their limitations. First, all three studies used self-report cross-sectional data, not semi-structured diagnostic interviews by a trained clinician. The symptoms and severity of psychiatric disorders reported are not one hundred percent diagnostically accurate. However, all three studies used psychometrically valid and widely used scales to assess psychiatric symptoms. Furthermore, confirmatory factor analysis was used for the scales assessing PTSD, dissociation, and emotion dysregulation by creating latent variables for analysis in SEM. A second limitation is the use of pre-intervention data only. All three studies used data from participants prior to the start of treatment. How these associations may be different following treatment still has to be evaluated. Third, while dissociation and emotion dysregulation were examined as underlying factors in the association between PTSD and SUD, all possible mechanisms were not explored. It is possible that other factors, such as impulsivity, may also have significant mediating effects on the association between PTSD and SUD (Amlung et al., 2019; Morris et al., 2020; Weiss et al., 2012, 2013). Fourth, all models presented were contextualized within the self-medication hypothesis, given early life stressors in combination with current PTSD severity and alcohol/substance use, which posits that individuals with PTSD use substances to cope with their symptoms (Khantzian, 1997). However, this is not the only hypothesis to explain the etiology of comorbid PTSD-SUD (Hien et al., 2021; María-Ríos & Morrow, 2020). When interpreting the results, one should consider that other hypotheses may be a better fit for specific samples and types of traumas. Evidence from population-level longitudinal cohort studies is needed to tease

apart the etiology between PTSD and SUD among individuals who develop comorbid PTSD+SUD.

5.4 Future Directions

While the body of work presented in this dissertation significantly contributes to the current literature, there are still some future directions that can and should be explored based on the current findings. One central avenue to continue exploring is the longitudinal examination of these associations between PTSD and substance-related problems. First, at the longitudinal level, these associations should be explored among individuals as they are starting to develop symptoms of both disorders. Additionally, these associations should also be examined during and after treatment to evaluate the effectiveness of current treatment methods in reducing the associations between PTSD and SUD. Second, to address the self-report nature of the data analyzed within the presented studies, neuroimaging methodologies (i.e., functional magnetic resonance imaging) should be implemented to study the neural correlates of these symptom associations among individuals presenting with comorbid PTSD and SUD. These results would allow for two significant areas of support: (1) the confirmation of the involvement of specific brain regions involved in the behavioural symptoms seen in the self-report data, and (2) the identification of novel brain regions and their corresponding cognitive functions in the involvement in the associations between PTSD and SUD symptoms.

5.5 Conclusion

In conclusion, the current studies add to the limited body of literature examining the associations between PTSD symptoms and substance use-related problems amongst three samples with differing clinical severity and presentation. Furthermore, the studies presented used multivariate statistics to represent the complex interactions between symptoms amongst comorbid PTSD-SUD analytically. Therefore, analyzing symptom level associations within this analytical framework has the potential to elucidate effective clinical treatment targets for individuals seeking treatment for comorbid PTSD-SUD.

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