

Post-Substance Use Treatment Trajectories of Adolescent Substance Use Disorders: Examining
the Moderating Roles of Mental Health and Social Support

by

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A dissertation accepted and approved in partial fulfillment of the

requirements for the degree of

Doctor of Philosophy

in Counseling Psychology

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Spring 2025

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DISSERTATION ABSTRACT

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Title: Post-Substance Use Treatment Trajectories of Adolescent Substance Use Disorders:
Examining the Moderating Roles of Mental Health and Social Support

Adolescents with substance use disorders (SUDs) represent a vulnerable clinical population for whom substance use treatment and continuing care are essential. Despite increased treatment receipt, rates of returning to use and substance-related consequences following treatment remain high. Consistent with a social-ecological model of development, notable risk and protective factors that may impact the recovery process and trajectory of outcomes include the presence and severity of co-occurring mental health conditions, and adolescents' perceived level of social support. To better understand the potential influence of social support and mental health on adolescents' post-substance use treatment outcomes, this study examined the unique and interactive effects of mental health symptoms and social support on trajectories of SUD symptoms and alcohol and drug-related consequences. This dissertation study draws data from an existing longitudinal study of 294 adolescents who were recruited from substance use treatment facilities in the U.S. Participants reported their symptoms of major depressive disorder (MDD), generalized anxiety disorder (GAD), and post-traumatic stress disorder (PTSD), as well as their perceived level of social support, from community members at treatment discharge, i.e., baseline data collection. Using latent growth curve modeling, outcomes of alcohol and drug use disorder symptoms, and alcohol and drug-related consequences were measured at baseline, 6- , and 12-month follow-up periods. The results provided no evidence of a significant interaction between mental health symptoms and social support. Mental health

symptoms were significant predictors of baseline levels of alcohol use disorder (AUD) and drug use disorder (DUD) symptoms, such that reporting more MDD and GAD symptoms at treatment exit was also associated with reporting more AUD and DUD symptoms. Results also suggested that reporting more PTSD symptoms was associated with both greater initial AUD symptoms and a negative rate of change over time. Substantial heterogeneity in these trajectories was also noted. Given limited prior research on post-treatment experiences among adolescents in recovery from SUDs, this dissertation provides valuable preliminary evidence that youth exiting substance use treatment experience co-occurring mental health symptoms that may predict the rate of change of SUD symptoms after treatment. Study limitations, future directions, and clinical and research implications are discussed.

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ACKNOWLEDGMENTS

As I reflect on my academic journey, I am filled with immense gratitude for the numerous people in my life, near and far, who have helped me reach this professional milestone. First and foremost, I wish to thank my advisor, Dr. Emily Tanner-Smith. Since I arrived at the UO as a master's student, still figuring out my path forward, you have provided countless hours of mentorship, grace, professional advice, and consultation as I've navigated academia. Thank you for always treating me as a valued team member and scholar, and for teaching me how to conduct sound research. I'm so lucky to have such a strong female mentor. I also wish to thank the members of my dissertation committee: Dr. Jessica Cronic, Dr. Wendy Hadley, Dr. Maria Schweer-Collins, and Dr. Alayna Park. Thank you for pushing me to present my research in a manner that destigmatizes addiction and mental health, and to think critically about the clinical implications and limitations of this work. A special thank you to Dr. Schweer-Collins for being a role model to me throughout graduate school.

This achievement has only been possible thanks to the support and encouragement of many friends and family members. Thank you first to my family for instilling in me the value of education. Dad, you taught me to be kind, genuine, and selfless. Mom, you always encouraged me to reach for the highest peaks in my scholarship. And to my little brother, Trent – your authenticity and heart inspire me every day. I wish to thank my grandparents for their relentless support over the years, without which I would not have made it to the finish line. Thank you to my chosen family, Jeff and Ellen, for helping raise me. Thank you to extended family on both sides who have visited me in Oregon and Texas, and for reminding me to always make time for family and fun v. fun. I'd like to thank my cohort for supporting, challenging, and sustaining me through this program. A special thank you to Wyatt and Reid – you are two of the most

incredible clinicians – and humans – I’ve ever known, and I’m better for learning alongside you over the last five years. Thank you, Jaclyn, Angie, and Lauren for your friendship – you are equally brilliant, thoughtful, and fun. To my childhood best friend, Sydney, with whom I completed this doctorate alongside and miles apart, thank you for keeping me motivated and accountable. Thank you to my college bestie, Lindsey, for sticking with me as we focused on our careers – your work ethic amazes and inspires me. Thank you, Fernanda, Olivia, and Cloe – I’m so lucky to know you. Thank you, Alexa, Nikki, and Gretchen for 10+ years of friendship.

I’d like to thank all my colleagues and supervisors who have supported me during my time at UO and at UT Austin where I first fell in love with research. Thank you to Chris Loan for sharing code and answering a million questions – your statistical prowess is unmatched. Thank you to my wonderful collaborators and mentors, Drs. Tiffany Brown and Emily Hennessy. Thank you, Drs. Anne Marie Mauricio, Jean Kjellstrand, Atika Khurana, Shaina Trevino, Kaitlin O’Brien, Jon Pedroza, Anna Cahn, and Amelia Stanton. Thank you, Dr. Kendall Thornton.

I’d like to thank and acknowledge my loved ones who are no longer with me at the end of this journey. To my friend and “big,” the late Bryn Howard, thank you for years of friendship and inspiration as an incredible woman in STEM. I wish you could be here to celebrate this milestone with me. And to my late grandmother, Sandra Nichols, thank you for helping me find my voice. You were a fierce and outspoken advocate for public health and you loved us all so deeply. I wish I could have known you better and had you with me longer. To all those I’ve lost, I am forever grateful for your memory and your lasting impacts.

Lastly, I am so grateful for my fur baby, Ruth, who reminds me to be patient and that daily walks are a necessity. You have given me back all the love I have for you tenfold, and then some.

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CHAPTER I

INTRODUCTION

Prevalence and Impacts of Adolescent Substance Use

Adolescent substance use, including both alcohol and drug use, remains a significant public health concern in the United States. Among the 133.1 million individuals who report currently using alcohol aged 12 or older in 2021 in the United States, 4.6 million were adolescents ages 12-17 (Center for Behavioral Health Statistics and Quality, 2022). Outside single drinking episodes, 3.8% (995,000 adolescents) who reported past-year alcohol use also engaged in risky patterns of use, including past month binge drinking and heavy alcohol use (0.4%). In terms of past-year drug use, in 2021, an estimated 3.66 million (or 14.1%) adolescents reported using illicit drugs (e.g., cannabis, cocaine, inhalants), with rates increasing with age: 6.0% of adolescents aged 12-13 (544,000), 12.3% of adolescents 14-15 (1.04 million), and 24.3% of adolescents 16-17 years (2.08 million). Cannabis was the most commonly used illicit drug reported among adolescents (10.5% or 2.7 million adolescents) in 2021, followed by misused prescription medications (3.3% or 851,000).

Notably, the national average rate of past-year alcohol use among U.S. adolescents has steadily declined since 1975, and the rate of illicit drug use has remained relatively stable. However, substance-related risks, including overdose deaths, have increased drastically in the past several years (Miech et al., 2023), warranting further study and targeted intervention efforts for adolescents who use drugs and alcohol. While substance use and other risk behaviors during adolescence – a developmental period of normative experimentation and exploration – raise concerns for many, it is important to recognize that substance use behaviors are not always maladaptive nor associated with negative consequences (Aaron Ginzler et al., 2003; Dennis &

Scott, 2007; Hart, 2017). Rather, examining the topic of adolescent substance use warrants honest and candid discourse about the potential harms of substance use, harm reduction approaches, and recognition of the various factors that account for a substantial proportion of addictions (Cook & Fletcher, 2011; Grifell & Hart, 2018; Skrzynski & Creswell, 2020).

Substance Use Disorders during Adolescence

In contrast to experimental or singular occurrences of substance use, a substance use disorder (SUD) represents a pervasive pattern of substance use associated with both intrapersonal and interpersonal consequences, as well as impairments in functioning. Rates of SUDs among adolescents ages 12-17, as measured by the Diagnostic and Statistical Manual, 5th edition (DSM-5; American Psychiatric Association [APA], 2013), were reported at 2.2 million (8.5%) in 2021 (Center for Behavioral Health Statistics and Quality, 2022). The percentage of people aged 12 or older with an SUD was highest among young adults aged 18 to 25 (25.6% or 8.6 million people). This statistic is noteworthy because adolescence is the developmental period when substance use is typically initiated, and early substance use initiation is often associated with an increased likelihood of developing an SUD in early adulthood (Chassin et al., 2002; Compton et al., 2007; Grant et al., 2001; Hogue et al., 2018). Persistent and risky patterns of substance use during adolescence can have more significant impacts on the maturing and malleable developing brain compared to the same behaviors in adulthood (Arain et al., 2013; Thorpe et al., 2020). These findings highlight the importance of halting the progression of early SUD symptoms and related consequences during adolescence by way of preventive interventions and/or targeted treatment efforts.

In this regard, 82,000 U.S. adolescents received treatment at some formal treatment facility (e.g., inpatient, outpatient) for illicit drug or alcohol use concerns (0.3%) in 2021. The

majority of adolescents who sought treatment did so for both illicit drug and alcohol use problems, as opposed to only illicit drugs (3.1%) or only alcohol use (3.6%; Center for Behavioral Health Statistics and Quality, 2022), illustrating the importance of addressing polysubstance use in treatment among adolescents. To this end, researchers have aimed to identify effective methods for the treatment of SUD that are developmentally tailored for adolescents. Consistently, cognitive behavioral and family-focused therapy approaches have emerged as the most effective methods for treating adolescent SUDs (Fadus et al., 2019; Hernandez et al., 2015; Hogue et al., 2018; Tanner-Smith et al., 2013; Winters et al., 2014; 2018). Cognitive behavioral approaches (e.g., cognitive-behavioral therapy [CBT]) for treating adolescent SUDs generally emphasize and promote learning from environmental cues and encompass a wide range of approaches and skills, including refusal skills, impulse and cognitive control, and challenging automatic and/or negative thoughts (Kaminer et al., 2002; Tripodi et al., 2010; Waldron & Kaminer, 2004). On the other hand, family-focused interventions tend to identify and target relevant and proximal risk factors within the family system such as communication and problem solving (Winters et al., 2014). A review of treatment modalities for adolescent substance use identified that interventions that included families had average effect sizes two to nine times larger than adolescent-only programs (Hernandez et al., 2015), supporting the notion that SUD treatment for adolescents should consider the larger ecological contexts in which these youth are embedded.

Continuing Care Supports and Post-substance Use Treatment Challenges

Despite the availability of these noted effective treatment options and increased treatment receipt among adolescents, rates of relapse¹ and substance-related consequences following substance use treatment remain high, particularly during the first year after treatment (Chung & Maisto, 2006; Godley et al., 2004; Ramo et al., 2012; Winters et al., 2018). Adolescents with SUD histories who have recently completed substance use treatment represent a vulnerable clinical population with greater risks for discontinuing their education (Breslau et al., 2011; King et al., 2006), experiencing other mental and behavioral health challenges (Chan et al., 2008; Chung & Maisto, 2006; Tanner-Smith et al., 2019), and challenges navigating familial dynamics, including conflict and/or living with family members who also experience substance use challenges (Rusby et al., 2018; Tanner-Smith et al., 2018; Yule et al., 2013).

The year following substance use treatment completion is indeed a critical period in the recovery from SUDs among youth. Recovery in this paper is defined as a process of change through which individuals attempt to improve their health and well-being while abstaining from or lessening their substance use, or by using substances in less risky ways (Substance Abuse & Mental Health Services Administration [SAMHSA], 2012). With growing recognition that SUDs can be a chronic and relapsing condition for many individuals, rather than an acute disorder (Kampman & Jarvis, 2015), many recent research and policy efforts have shifted focus on addressing SUDs along a continuum of care, including bolstering recovery supports following substance use treatment (Stanojlović & Davidson, 2021; Volkow & Morales, 2015). This shift in perspective on addiction has largely been driven by efforts to reduce stigma associated with

¹ While the term relapse is commonly used in the literature to reflect returning to substance use after a period of abstinence, it lacks a unified operationalization (Moe et al., 2022) and can be shame-inducing or imply “failure” for individuals in recovery from SUDs. While dissertation will use the term “relapse” in conjunction with other terms such as “returns to use” to reflect prior empirical findings, other less stigmatizing terms include “slips” or “lapses” to indicate reusing substances after a period of abstinence.

substance use, address high rates of returning to substance use following treatment, and encourage engagement with treatment and continuing care supports.

To this end, the holistic treatment of adolescent SUD should be approached on a continuum of care, which includes early preventive interventions, targeted treatments based on sound assessment practices, and continuing care supports following treatment (Center for Substance Abuse Treatment, 2006; Passetti et al., 2016; Stanojlović & Davidson, 2021). The goals of substance use recovery differ for every individual, and therefore the “best” continuing care options may vary from person to person. Consistently noted examples of continuing care supports include engagement with peer and community sober networks, psychoeducation and check-ins with family members, self-help meetings (e.g., Alcoholics and Narcotics Anonymous), and school-based supports (e.g., recovery high schools; Finch et al., 2014; Fisher, 2014; McKay et al., 2009; Passetti et al., 2016). Regardless of the recovery supports sought out, an overarching theme for best practices in the continuity of care among adolescents includes taking an ecological and developmentally informed approach that accounts for both individual-level risk and protective factors (e.g., mental health status), as well as interpersonal considerations (e.g., social supports of family and friends).

Notable individual-level factors relevant to the recovery process that impact youth include the presence and severity of other mental health conditions such as depression and anxiety, which commonly co-occur with adolescent SUDs (Chan et al., 2008; Deas & Brown, 2006). Compared to the general population of U.S. adolescents (i.e., those without clinical diagnoses), adolescents with SUD histories have a greater likelihood of experiencing comorbid mental health conditions (Godley et al., 2014; Lubman et al., 2007). Furthermore, co-occurring mental health diagnoses among adolescents with a primary diagnosis of SUD may worsen risk

outcomes compared to youth with singular diagnoses (Deas & Brown, 2006; Diamond et al., 2006; Shane et al., 2003). For instance, adolescents with SUD and co-occurring depression and anxiety disorders have demonstrated more severe substance use problems (Grella et al., 2001; Rowe et al., 2004; Shane et al., 2003), while those with comorbid PTSD have reported worse quality of life and engagement in risky health behaviors (Lubman et al., 2007). It is likely then that the presence of comorbid mental health conditions may carry additional challenges for adolescents in recovery from SUDs and could impact their trajectories following substance use treatment.

In addition to individual-level factors like mental health, prior empirical and theoretical research suggests that environmental and social contexts (e.g., peer and family relationships) are also critical factors in promoting recovery among adolescents (Fisher, 2014; Passetti et al., 2016; Winters et al., 2018). In fact, research has demonstrated that social support networks following treatment may be even more important than pre- or during-treatment variables such as substance use severity (Broome et al., 2002; Hernandez et al., 2015; Latimer et al., 2000; Winters et al., 2014). Given the salience of peers and family as agents of socialization during adolescence, social factors are even more critical to the recovery process compared to adults. For instance, adolescents are more likely to return to use as a result of social pressures when compared to adults with SUD histories (Trocchio et al., 2013). Additionally, adolescents most likely to maintain treatment gains were those who avoided substance-using friends or family and who felt supported by their community members to maintain abstinence (Broome et al., 2002), highlighting the salient influence of the social environment on adolescent post-substance use treatment experiences and outcomes.

The presentations of and experiences associated with adolescent SUDs are multifaceted and complex, which are further complicated by the interaction with mental health conditions, and accordingly, treatment and recovery implications. For adolescents with SUD histories, the existence of another mental health condition may increase the risk for worse outcomes following treatment (Anderson, 2007; Cornelius et al., 2004; Rowe, 2004; Shane et al., 2003; Tomlinson et al., 2004). However, the presence of supportive family, friends, and community members may provide a buffering effect on these potential risks. Despite increased research efforts to understand and address adolescent SUDs, there is still a paucity of research on the ways that social support and mental health conditions may interact to impact adolescent SUDs and substance-related consequences along the continuum of care. Thus, researchers and practitioners alike are limited in informing continuing care supports following substance use treatment. Given the various factors in adolescents' recovery environment that can promote or hinder well-being and treatment gains, it is paramount to better understand post-substance use treatment experiences among adolescents and the heterogeneity therein.

Current Study

The current study therefore sought to better understand the post-substance use treatment risk and protective factors that influence SUD symptoms and risks among adolescents in recovery from SUDs. This study aimed to inform comprehensive and holistic assessment of adolescents' risks and supports upon substance use treatment discharge. Having a better understanding of risk and protective factors at treatment discharge, as well as the ways that they interact to impact subsequent SUD symptoms among adolescents, would better enable practitioners to provide recommendations and support to those most at risk. On the other hand, identifying adolescents with more protective factors that theoretically may mitigate risks

following treatment could help inform treatment supports at the outset of SUD treatment.

Further, this information could inform the development of effective continuing care supports that address these various ecological risk considerations to sustain and promote treatment gains and general well-being among youth with SUD histories.

The current study aimed to a) model the average 12-month trajectories of adolescents' drug use disorder, alcohol use disorder, and substance-related consequences following substance use treatment, b) investigate whether mental health diagnoses of major depressive disorder (MDD), post-traumatic stress disorder (PTSD), and generalized anxiety disorder (GAD), as well as social support independently predict trajectories, and c) examine whether adolescents' perceived level of social support moderates the relationship between mental health and post-substance use treatment trajectories. The next chapter provides a summary of prior theory and research on trajectories of adolescent outcomes following substance use treatment, as well as the influences of mental health and social support on these trajectories.

CHAPTER II

LITERATURE REVIEW

Post-substance Use Treatment Trajectories

Even after receiving treatment for SUDs, adolescents commonly return to use following treatment, and the benefits of substance use treatment are often not maintained after the first year of exiting treatment. Some research has found that more than half of adolescents return to pre-treatment levels of use within 6 months following treatment (Cornelius et al., 2003). There are many reasons why adolescents may return to use after substance use treatment, but through a developmentally informed lens and consideration of the larger ecology, the onset of mental health conditions and the influences in the social environment appear to be particularly influential in either mitigating or increasing risk (e.g., experiencing anxiety or isolation, peer pressure to use drugs or alcohol, level of familial support). Compared to adults, adolescents have been found to be more likely to relapse following substance use treatment when they were trying to enhance a positive emotional state in a social setting or in the presence of triggers/cues (e.g., with peers), whereas adults were more likely to relapse during negative affective states (e.g., coping with frustration or depression; Ramo & Brown, 2008). These findings highlight the need to study the unique experiences and challenges faced by adolescents following receipt of substance use treatment.

In an effort to understand the nature of the change in substance use behaviors over time, several prior research studies have examined different latent trajectories of adolescents after substance use treatment. Although studies have varied in the number of latent trajectories identified (Campbell, 2016; Chung et al., 2003; 2005; Godley et al., 2004), they generally identify classes of adolescents who are abstinent, low/stable, or increasing their substance use

over time. Importantly, prior studies have documented substantial heterogeneity in these relapse trajectories and have noted substantial unexplained variance in these trajectory outcomes (Godley et al., 2004; 2005). This suggests that there are likely other important factors that may help explain heterogeneity in post-substance use treatment trajectories.

To this end, substance use treatment sites may be an opportune place to assess adolescents for various modifiable risk and protective factors, such as comorbid mental health conditions and levels of social support and positive relationships. Identifying moderators of these post-substance use treatment trajectories could help identify for whom and under what contexts various recovery supports for adolescents and their families may be most beneficial, and at the same time encourage practitioners to conduct comprehensive and holistic assessment of various risk and protective factors at treatment discharge.

Social-Ecological Model

Adolescent substance use is a complex health phenomenon most appropriately understood through a developmentally informed and multi-faceted framework. In this light, the social-ecological model (Bronfenbrenner, 1979) provides a comprehensive conceptual framework through which to understand and identify relevant risk and protective factors for post-substance use treatment outcomes among youth. This model posits that human development is shaped by bidirectional interactions between an individual (e.g., intrapersonal factors such as biology and personality) and several ecological systems: the microsystem (e.g., peers and family), mesosystem (interactions between microsystems), exosystem (e.g., access to local resources), macrosystem (e.g., state and national policies), and chronosystem (e.g., changes across time and historical context).

Particularly salient modifiable factors for adolescent outcomes are those more proximal ecological systems, including individual characteristics (e.g., mental health, substance use history) and microsystemic (e.g., peer/family substance use history, levels of social support, general influence of family/peers) factors. Extending from the social-ecological model, prior empirical research has found strong evidence for ecological factors predictive of substance use and other related behaviors across diverse samples of adolescents (Arthur et al., 2002; Bränström et al., 2008; Cleveland et al., 2008; Hemphill et al., 2011; Nichols et al., 2021). Among individual-level predictors, mental health concerns (e.g., anxiety and depression; Diamond et al., 2006; Edlund et al., 2015; Kenneson et al., 2013; Young et al., 2012) and post-traumatic stress (Diamond et al., 2006; McCauley et al., 2010; Kenneson et al., 2013; Steinbuchel et al., 2009) have been associated with increased likelihood of adolescents' self-reports of SUD and substance-related consequences. On the other hand, social influences including supportive relationships with peers and family members have been linked to improved adolescent substance use outcomes (Ennett et al., 2008; Yap et al., 2017). In particular, social support has been identified as a key protective factor in the recovery process for adolescents (Hennessy et al., 2019; Stevens et al., 2015).

The social-ecological model outlines interconnected individual and social factors that shape an individual's health behaviors like substance use. The social-ecological lens allows for examination of both risk and protective factors for SUD symptoms following treatment and has been shown in prior research to be related to substance use treatment outcomes (Connell et al., 2010; Elkington et al., 2011; Maina et al., 2021; Raynor, 2013). This model can be flexibly applied and adapted to many different contexts and behavioral outcomes utilizing any level(s) of an individual's ecology. The social-ecological model therefore offers a useful framework for

identifying developmentally appropriate risk and protective factors for adolescent SUD challenges following substance use treatment. Given the influence and importance of proximal ecological contexts, the current study focuses on the individual-level risk factor of mental health conditions and the microsystemic construct of social support, to examine their potential interactive effects on post-substance use treatment SUD trajectories among adolescents.

Adolescent Mental Health

Mental health conditions are prevalent among adolescents, and many disorders such as depression and anxiety tend to first emerge during adolescence (Rapee et al., 2019). In 2021, the most common mental health concerns and noted reasons for seeking therapy among adolescents ages 12-17 included depression, feeling tense and afraid (i.e., anxiety), thoughts and attempts of suicide, and problems with their home or family (Center for Behavioral Health Statistics and Quality, 2022). However, research consistently demonstrates that among adolescents with SUDs, other mental health conditions commonly co-occur with SUD, namely major depressive disorder (MDD), post-traumatic stress disorder (PTSD), and generalized anxiety disorder (GAD; Basedow et al., 2020; Chan et al., 2008; Deas & Brown, 2006). Studies in a variety of treatment settings have estimated that approximately 55–88% of adolescents with an SUD as their primary mental health diagnosis, have at least one comorbid mental health disorder, and often report more than one (Armstrong & Costello, 2002; Chan et al., 2008; Diamond et al., 2006; Grella et al., 2004; Lubman et al., 2007; Wu et al., 2011). These prevalence rates suggest that it is likely that adolescents being treated for SUDs may also have one or more co-occurring mental health conditions that warrant attention.

Moreover, the presence of co-occurring mental health diagnoses among adolescents with SUDs has been associated with poorer prognosis following substance use treatment compared to

youth with singular diagnoses (Deas & Brown, 2006; Godley et al., 2014; Shane et al., 2003; Tomlinson et al., 2004). Specifically, research indicates that, compared to adolescents with singular SUD diagnosis histories, those with additional, co-occurring mental health conditions are at increased risk of returning to substance use within one year following substance use treatment (Anderson, 2007; Campbell et al., 2016; Cornelius et al., 2003; Hsieh et al., 1998; Shane et al., 2003), worse withdrawal symptoms and treatment prognosis (Tomlinson et al., 2004), higher severity of substance use problems (Grella et al., 2001; Rowe et al., 2001; Shane et al., 2003), poorer social functioning (Anderson et al., 2008), and engagement in risky health behaviors (e.g., unprotected sex; Lubman et al., 2007). Consistent with the social-ecological model of development, these empirical findings implicate mental health status as a key individual-level risk factor for post-substance use treatment outcomes among adolescents with SUD histories.

Another important reason to study mental health as a predictor of post-substance use treatment trajectories is that this risk factor may differentially predict initial (i.e., baseline) levels of substance use disorder symptoms versus change over time (Joe et al., 2014; Shane et al., 2003). Some research suggests that mental health symptoms may only affect initial levels of substance use (Brunelle et al., 2013), whereas other studies have found that mental health levels may influence the post-treatment trajectories (i.e., intra-individual change) of substance use (Becker et al., 2011; Campbell et al., 2016). Specifically, Brunelle et al. (2013) found that the severity of mental health problems was associated with greater baseline drug use severity, but decreases in drug use occurred between treatment entry and three months, then maintained improvement through six months post-treatment. Other research conversely found that a depression diagnosis did not predict baseline substance use, but did significantly predict the

change in frequency of substance use over time (Becker et al., 2011; Campbell et al., 2016), such that, on average, anxiety and depression scores were significantly lower over time among adolescents who abstained from cannabis use post-treatment compared to those who continued to use in a stable or increasing manner (Campbell et al., 2016). Taken together, this suggests that adolescents' mental health may help explain some of the variability in post-substance use treatment outcome trajectories. Given this inconsistency in the literature, it is therefore important to examine how and whether the presence of other mental health conditions may act as a risk factor of initial substance use and/or the overall rates of change in substance use following treatment.

Adolescent Social Support

One potential protective factor relevant to adolescent SUD that may bolster the recovery process and post-treatment outcomes is social support, defined here as the perception that one is cared for and valued by others in their social network (Earnshaw et al., 2019). Social support may come from family members, friends, teachers, and/or community members, and can include emotional comfort, information-seeking, advice, and/or assistance with obligations related to the recovery process (Earnshaw et al., 2019; Kelly & Urbanoski, 2012). Many adolescents endorse having supportive relationships and trusted others in their microsystem. Among a national sample of U.S. adolescents, 93.5% reported they had someone to talk with about their problems (23.5 million; Center for Behavioral Health Statistics and Quality, 2022), an important component of social support.

Social support has been identified in the empirical literature as a salient protective factor in terms of promoting mental and behavioral health and overall well-being (Cheng et al., 2014; Dobkin et al., 2002) and may therefore mitigate the risks of relapse and substance-related

consequences following substance use treatment. Social support in relation to SUD recovery is particularly important directly following treatment discharge when risk for returning to use is highest. Having and perceiving high levels of social support after substance use treatment has been proposed to improve self-efficacy to initiate changes, sustain treatment gains, and/or resist triggers to return to substance use (Ilgen et al 2005; Jason et al., 2007; Litt et al 2003).

There is a small but growing body of research evidence underscoring the importance of social and environmental influences on adolescents' post-treatment recovery, including interpersonal relationships and supports (Brown et al., 2001). For instance, having non-substance using social supports in one's social networks may be predictive of post-treatment abstinence (Broome et al., 2002; Latimer et al., 2000; McCrady, 2004; Richter et al., 1991), and having supportive and positive relationships with parents and peers can be particularly beneficial for post-substance recovery (Jason et al., 2007; Passetti et al., 2016; Winters et al., 2018). Some research has found that living with others who are currently using substances puts adolescents at elevated risk of relapse after substance use treatment (Broome et al., 2002), underscoring the critical importance of the post-treatment environment for either promoting or hindering SUD recovery.

Importantly, this research suggests that not only the presence of supportive persons, but the perceived level of social support (e.g., emotional reassurance, assistance) likely buffers the potentially harmful experiences of SUD and risk post-treatment. Research has indicated that greater levels of social support are associated with increasingly positive outcomes (e.g., decreases in SUD severity over time, increased mental health; Dobkin et al., 2002; Godley et al., 2005; Warren et al., 2007), whereas lower levels of perceived social support at treatment intake are associated with higher severity of alcohol and drug use disorder over time (Dobkin et al.,

2002). Similar findings have been reported between baseline social supports and 12-month outcomes, such that greater levels of social support were associated with fewer substance-related problems among youth (Godley et al., 2005). Thus, there is compelling empirical evidence and theoretical grounding pointing to the importance of the post-substance use treatment social environment, including supportive relationships and general social support in terms of sustaining SUD treatment gains.

Interactions between Mental Health and Social Support

From a social ecological perspective, it is plausible that the positive influence of social supports and the potential risk posed by co-occurring mental health conditions may interact to influence adolescents' post-treatment outcomes. Greater levels of social support may be particularly important for sustaining recovery among adolescents with co-occurring mental health conditions, such as depression, anxiety, and PTSD (Maina et al., 2021). For instance, some research has found that among high-risk samples of adolescents, the positive effects of social support were not enough to buffer the negative impacts of PTSD experienced by youth (Pinto et al., 2017). However, this research was conducted among youth with singular PTSD diagnoses, not among those with co-occurring SUDs.

To date, I am aware of no research that has examined the interaction between social support and mental health on post-substance use treatment outcomes among adolescents. A recent meta-analysis (Bachrach & Chung, 2021) identified only one study that examined the potential moderating effect of social support *during* SUD treatment among adolescents (Shelef et al., 2005), and several that have examined the moderating role of mental health, but no studies that examined post-substance use treatment recovery with both of these constructs. Given the preponderance of comorbid health conditions with SUDs, adolescents with multiple disorders

appear to be at greater risk for returning to use and experiencing negative health and behavioral outcomes. Therefore, social support may be a critical protective factor in this population.

Critical Gaps in the Evidence Base

Although the research base on adolescent treatment outcomes and trajectories is growing, there remain critical gaps in knowledge that warrant further study. First, although empirical literature largely supports the important role of other mental health conditions on SUD treatment outcomes among adolescents (Anderson et al., 2008; Bachrach & Chung, 2021; Hsieh et al., 1998; Joe et al., 2014; Shane et al., 2003), there have been mixed findings regarding the impacts of mental health on post-substance use treatment trajectories. The conflicting evidence is likely due, in part, to the complexity of this relationship across different outcome measurements (e.g., relapse versus SUD symptomology), and the specific mental health diagnoses studied (e.g., depression vs. anxiety; Bachrach & Chung, 2021; Hussong et al., 2017). For instance, whereas one study reported that the presence of co-occurring depression with SUD did not predict post-substance use treatment relapse (Cornelius et al., 2003), others have found that beginning treatment *without* co-occurring disorders may be associated with less risk of relapse (Anderson et al. 2007), or that co-occurring depressive symptoms and trauma history may only relate to post-substance use treatment relapse through their impact on initial substance use frequency (Anderberg et al., 2021). This suggests that the specific substance use outcome measure studied is a key consideration in terms of understanding the post-substance use treatment experience.

Research also suggests that while mental health conditions such as depression and PTSD may independently predict trajectories of substance use, these associations do not hold when considering other important factors, suggesting there are likely other moderators that impact symptom trajectories (e.g., Anderberg et al., 2021). Understanding how different mental health

diagnoses might affect adolescents' post-treatment substance use trajectories could therefore provide helpful information for clinicians who might be assessing these disorders throughout treatment. Relatedly, compared to other mental health disorders like anxiety, depression, and conduct disorder (Roberts et al., 2022), or studying mental health in adult populations (Gil-Rivas et al., 2009; Najavits et al., 2006), few studies have examined the impacts of PTSD diagnoses on SUD treatment outcomes. Research suggests that adolescents with co-occurring PTSD and SUD had high rates of histories of suicide attempts, self-harm, and experiencing various forms of abuse (Chasser, 2016). The evidence base surrounding the impact of PTSD on SUD trajectories following substance use treatment is sparse, despite many adolescents reporting trauma experiences by this age. This represents an important gap in the literature given the noted impact of trauma on challenges later in life and the use of substances to cope with PTSD symptoms (Haller & Chassin, 2014).

A second gap in the evidence base is that prior studies focused on treatment moderators have often focused on non-modifiable characteristics of adolescents (e.g., gender, race/ethnicity) and have failed to study the potential buffering effect of the social environment (Bachrach & Chung, 2021). Although most research has focused on early stages of substance use prevention and the role of parents and peers in substance initiation and development of SUD (e.g., Bauman & Ennett, 1994; Chassin & Handley, 2006), few studies have looked at the protective role in post-treatment trajectories among youth with SUD histories. This represents a critical gap in knowledge given the socializing influence of parents and peers, among others.

A third considerable gap in the literature base is the timing of data collection for measuring post-treatment substance use. Most prior studies examining adolescents' post-treatment outcomes assess SUD and mental health symptomology at treatment intake, but do not

examine factors such as mental health and social support at treatment discharge (e.g., Anderson et al., 2007; Brunelle et al., 2013; Joe et al., 2014). Although there are practical reasons for this gap in the literature (e.g., treatment drop-out, resource allocation), the lack of consistent measurement of risk and protective factors like mental health and social support at treatment discharge prevents the synthesis of information that can subsequently inform the assessment of symptomology at treatment end that may impact post-treatment outcomes and continuing care efforts.

Finally, there is a general paucity of adolescent-focused research examining heterogeneity in post-substance use treatment trajectories, thus limiting the conclusions that can be drawn to date (e.g., Bachrach & Chung, 2021). Indeed, the majority of research studies on this topic have focused on adult trajectories after treatment (e.g., Brook et al., 2016; Kline-Simon et al., 2017; López-Castro et al., 2015; Mefodeva et al., 2022; Najavits et al 2006; Stull et al., 2019). In sum, the lack of assessment at treatment discharge, inconsistent measurement of outcome variables, and paucity of adolescent-focused research (including the potential impact of PTSD on SUD risk following treatment for adolescents) represent significant gaps in the knowledge base that this study aims to address.

Study Aims

The present study addressed some of these gaps in the literature and to extend the knowledge base in a number of ways. First, prior research generally supports the conclusion that mental health and social support are both likely to influence post-treatment substance use outcomes among adolescents, but no studies to date have examined the interaction between mental health and social support in predicting post-treatment SUD trajectories. Examining the interconnected influence of both factors would provide a more nuanced understanding of the

roles that each play on the potential changes in SUD rates following substance use treatment.

Second, this study aimed to expand the evidence base regarding the moderating impact of mental health on adolescent SUDs by examining the impact of co-occurring mental health conditions on post-substance use treatment SUD symptoms.

Given the various factors in adolescents' recovery environment that can promote or hinder well-being and treatment gains, it is paramount to better understand post-substance use treatment experiences among adolescents. This study therefore examined the potential moderating effects of mental health conditions (MDD, PTSD, and GAD symptoms) and social support (from family, peers, community) on trajectories of changes in SUD symptoms and alcohol and drug-related consequences (hereafter referred to as "AOD consequences") among adolescents with SUD histories who have recently been discharged from SUD treatment. This study used latent growth curve modeling (LGCM) to observe intra- and inter-individual changes over time to address the following research aims:

Aim 1

Examine the average 12-month trajectory of alcohol use disorder (AUD) symptoms, drug use disorder (DUD) symptoms, and AOD consequence outcomes among adolescents after discharge from SUD treatment.

Hypothesis 1. I hypothesize that adolescents will experience significant changes over time in each outcome between baseline and 12 months post-treatment, as well as significant variability in the trajectories.

Aim 2

Aim 2a. Test whether baseline symptoms of MDD, PTSD, and GAD (i.e., mental health symptoms at substance use treatment discharge) are associated with adolescents' post-treatment trajectories.

Aim 2b. Test whether baseline levels of perceived social support are associated with adolescents' post-treatment trajectories.

Hypothesis 2a. I hypothesize that baseline mental health symptoms will be associated with an overall positive SUD trajectory, indicating a positive slope value of (i.e., increase in levels of) SUD symptoms and AOD consequences.

Hypothesis 2b. I hypothesize that baseline social support will be associated with an overall negative SUD trajectory, indicating a negative slope value of (i.e., decrease in levels of) SUD symptoms and AOD consequences.

Aim 3

Investigate whether the associations between mental health (MDD, PTSD, and GAD symptoms) and adolescents' post-treatment trajectories vary depending on baseline levels of perceived social support.

Hypothesis 3. I hypothesize that mental health symptoms and social support will have a significant interaction effect that will impact SUD and AOD consequences trajectories, such that greater levels of social support will mitigate the potential risk posed by co-occurring mental health conditions.

CHAPTER III

METHOD

Sample and Procedures

The sample in the current study was from a longitudinal parent study examining the effects of recovery high school (RHS) attendance among high school aged youth with SUD histories who had received substance use treatment (Finch et al., 2018). Adolescent participants and caregivers were recruited from several SUD treatment facilities ($n = 149$ adolescents) or RHSs ($n = 145$ adolescents) in predominately urban and suburban areas in Minnesota, Texas, or Wisconsin and then longitudinally assessed after discharge from treatment (i.e., baseline data collection period) at 3-month, 6-month, and 12-month follow-up periods. Adolescents and their parents joined the study on a rolling admission status such that the baseline timepoint represents a different time in the year for each individual in the study. A total of 323 parents consented to participate in the study and 294 adolescents assented to participate and were enrolled in the study at the baseline data collection period. Only adolescent data were of interest in the current study. Of the 294 adolescents enrolled in the parent study, 71.4% of adolescents ($n = 210$) provided data at the 12-month follow-up. This study only used data from the baseline, 6-, and 12-month follow-ups, collected between 2011 and 2016.

Measures

Outcomes

AOD Consequences. The outcome of interest for AOD consequences was measured using the Personal Consequences of Drugs and Alcohol Scale (PEI; Winters & Henly, 1989); this was a self-report measure to identify problems associated with drug use that asks adolescents to think back to when they were using drugs at their heaviest. In the parent study, the PEI

administered was a four-item summative scale that assessed consequences resulting from alcohol and drug use. Each item assessed how often an adolescent has experienced a consequence with the following scale: *Never* (1), *Once or twice* (2), *Sometimes* (3), or *Often* (4). Higher scores correspond to greater levels of AOD consequences. The range of scores was 4-16. An example item is, “How often have you... Sold personal things like your clothes or jewelry to get or pay for drugs/alcohol?” The scale demonstrated reasonable internal consistency in this sample ($\alpha = .77$). This scale demonstrated good psychometric properties and is well documented with clinical and non-clinical (i.e., community) samples (Winters & Henly, 1989; Winters et al., 1993).

Notably, the PEI does not measure severity of consequences related to legal/health consequences, but rather measures constructs of substance seeking behaviors and substance use motivations. For consistency with the measurement name, I will continue to refer to this outcome as AOD consequences and make note of this construct further in the discussion section.

Alcohol Use Disorder Symptoms. AUD symptoms were assessed in the parent study via the Mini International Neuropsychiatric Interview, Structured Clinical Interview (M.I.N.I.)—a brief structured diagnostic interview for major Axis I psychiatric disorders in DSM-IV (APA, 1994) and ICD-10 (Sheehan et al. 1999). All questions were adolescent self-reported from DSM-IV diagnostic criteria. This outcome was a sum score of the number of AUD symptoms (of abuse or dependence) endorsed by adolescents, with higher scores indicating more symptoms of AUD. The range was 0-13. An example question is, “During the past 3 months, did you continue to drink even though your drinking caused problems with your family or other people?”

Drug Use Disorder Symptoms. DUD symptoms were also assessed via the M.I.N.I. This outcome was a sum score of the number of DUD symptoms (of abuse or dependence) endorsed by adolescents in relation to their most heavily used drug. Specific drugs assessed

included cannabis, cocaine, opioids, and hallucinogens. Higher scores indicated more symptoms of DUD endorsed by adolescents, and the range of symptoms was 0-13. An example diagnostic question is, “Did you find that you needed to use more [drug] to get the same effect that you did when you first started taking it?”

Predictors

Mental Health Symptoms. Symptoms of major depressive disorder (MDD), post-traumatic stress disorder (PTSD), and generalized anxiety disorder (GAD) were independently assessed as predictors of each outcome. Symptoms of each diagnostic category were assessed via the M.I.N.I. (Sheehan et al., 1999). Each predictor variable represented a symptom severity score for each condition (MDD, PTSD, or GAD), with higher scores indicating the presence of more symptoms. The range of symptoms for MDD was 0-9. A sample diagnostic question for MDD is, “Did you feel tired or without energy almost every day?” The range for PTSD symptoms was 0-16. A sample question assessing for a diagnosis of PTSD is, “Have you re-experienced the event in a distressing way (such as through dreams, intense recollections, flashbacks, or physical reactions)?” The range for GAD symptoms was 0-9. A sample question for GAD is, “Do you find it difficult to control the worries or do they interfere with your ability to focus on what you are doing?” All symptoms were measured at the baseline assessment period when adolescents were discharged from SUD treatment and at each follow-up. However, for the purposes of the current study, only baseline levels of mental health (i.e., measured at the time of treatment discharge) were analyzed.

These measures of mental health were chosen for the current study because a) the M.I.N.I. may be less prone to reporter bias given that it is a structured brief interview delivered by a trained interviewer and b) it is adolescent-reported (rather than parent-reported), thereby

providing a more accurate and objective measure of symptomology (e.g., De Los Reyes et al., 2015). It is also important to note that these measures of mental health represent only symptom of disorders and do not reflect clinical diagnoses of each disorder. Additionally, the timing of the mental health measurements do not necessarily align with the diagnostic measurement windows for each disorder. For example, MDD symptoms need only be present for at least 2 weeks, while GAD symptoms must be present for at least 6 months to meet diagnostic criteria for this disorder and PTSD symptoms must be present for more than a month.

Social Support. The measure of social support represents a latent variable, based on 14 items derived from The How I Feel About Myself and High School Questionnaire (HSQ; McLellan & Steward, 2015) and Community Activities and Support Scale (CAS; Bobek et al., 2009; Zaff et al., 2010).

The HSQ is a measure of youth well-being in the school context that takes into account the quality of relationships and level of supportiveness of peers and adults at school. The HSQ contains eight items to which adolescents respond on a 4-point Likert type scale (1 = *Strongly disagree*, 2 = *Disagree*, 3 = *Agree*, or 4 = *Strongly agree*). Higher scores indicated higher levels of perceived social support. An example item is, “There is someone I can talk to if I need to.” This scale demonstrated good internal consistency in the current sample ($\alpha = .79$).

The CAS contains six items that measure adolescents’ perceived support from caregivers and adults in their community. Adolescents were instructed to rate their level of agreement to each statement, using a 5-point Likert style scale (1 = *Strongly disagree*, 2 = *Disagree*, 3 = *Neither agree nor disagree*, 4 = *Agree*, 5 = *Strongly agree*). An example item is, “My teachers really care about me.” This scale showed good internal consistency in the present study ($\alpha = .76$).

The latent construct of social support seemed appropriate because the 14 items derived from these two scales are all highly correlated, conceptually aligned with the theoretical construct of social support, and demonstrate good internal consistency in the current sample ($\alpha = .78$).

Covariates

The following binary variables were included in all models as covariates: adolescent self-reported sex assigned at birth (male/female), adolescent age (reported in years at baseline data collection), adolescent self-reported race (White/non-White), whether an adolescent had ever participated in mental health treatment (measured at baseline; yes/no), and RHS involvement at baseline (yes/no). These covariates were chosen to adjust for potentially important confounding influences according to prior research and theory.

Analysis Plan

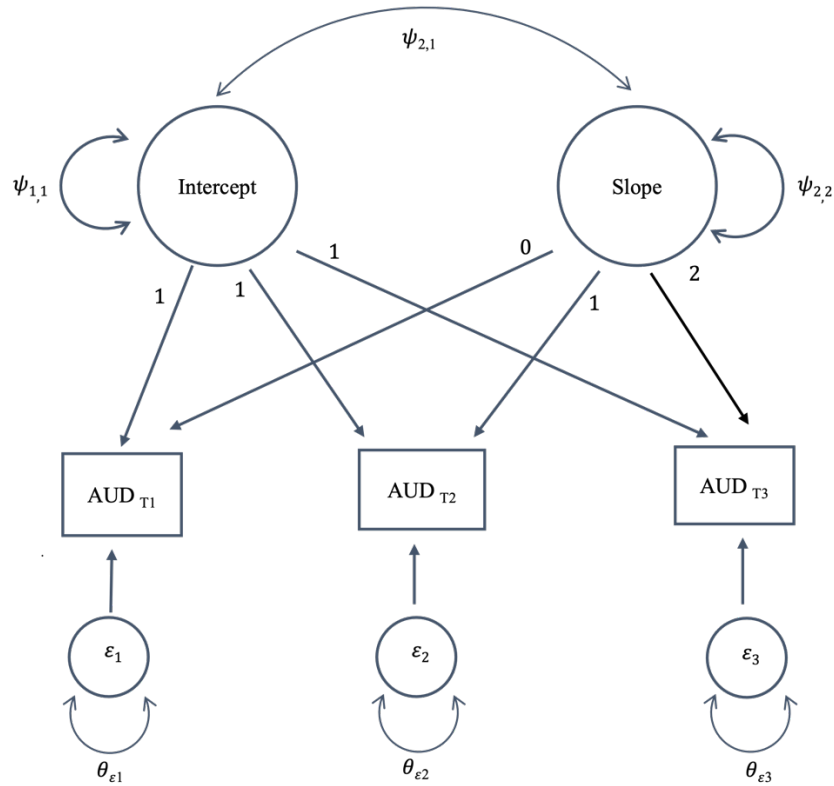
I used linear latent growth curve modeling (LGCM; Duncan & Duncan, 2009) to estimate the intra-individual change in SUD diagnoses and AOD consequences over 12 months post-substance use treatment, and to examine whether social support and mental health were associated with mean levels of SUD symptoms and AOD consequences (i.e., intercept) and changes in SUD symptoms and AOD consequences over time (i.e., slope). This modeling approach is appropriate for examining longitudinal trajectories, and potential predictors of those trajectories. More specifically, I estimated separate linear growth models for each of the three outcome variables of interest using data at three timepoints: baseline (T1), 6-month follow-up (T2), and 12-month follow-up timepoint (T3). Parameters in each model were computed with maximum likelihood (ML) estimation.

The benefits of LGCM include its flexibility in modeling complex data structures and its ability to handle partially missing data, unequally non-normally distributed data, and complex nonlinear-shaped trajectories that may be difficult or impossible to address using other traditional approaches (e.g., hierarchical linear modeling, repeated measures ANOVA; Curran et al., 2010; Muthén & Curran, 1997). Additionally, more traditional longitudinal approaches often only analyze mean changes and treat differences among individuals as “error variance”; LGCM, however, can provide valuable information about changes in outcomes and allow for examination of heterogeneity in growth trajectories of outcomes (Duncan & Duncan, 2009). Given recommendations to utilize LGCM with sample sizes of at least 100 and with at least three timepoints (Curran et al., 2010), LGCM was appropriate for addressing the aims of this study with the current analytic sample. Below, I outline the model specifications for each of the three study aims.

Aim 1

The first analysis estimated the mean trajectory of SUD symptoms and AOD consequences for the 294 adolescent participants over the 12-month follow-up period. This analysis entailed estimating unconditional linear growth curve models for each outcome estimated as a function of time with no other predictors or control variables (see Figure 1 for an example). This resulted in three unconditional models with random intercepts and slopes to estimate baseline differences in each outcome as well as intra-individual changes over time. The estimates of interest included the intercept and slope, the variance of both the intercept and slope, and the covariance between the intercept and slope.

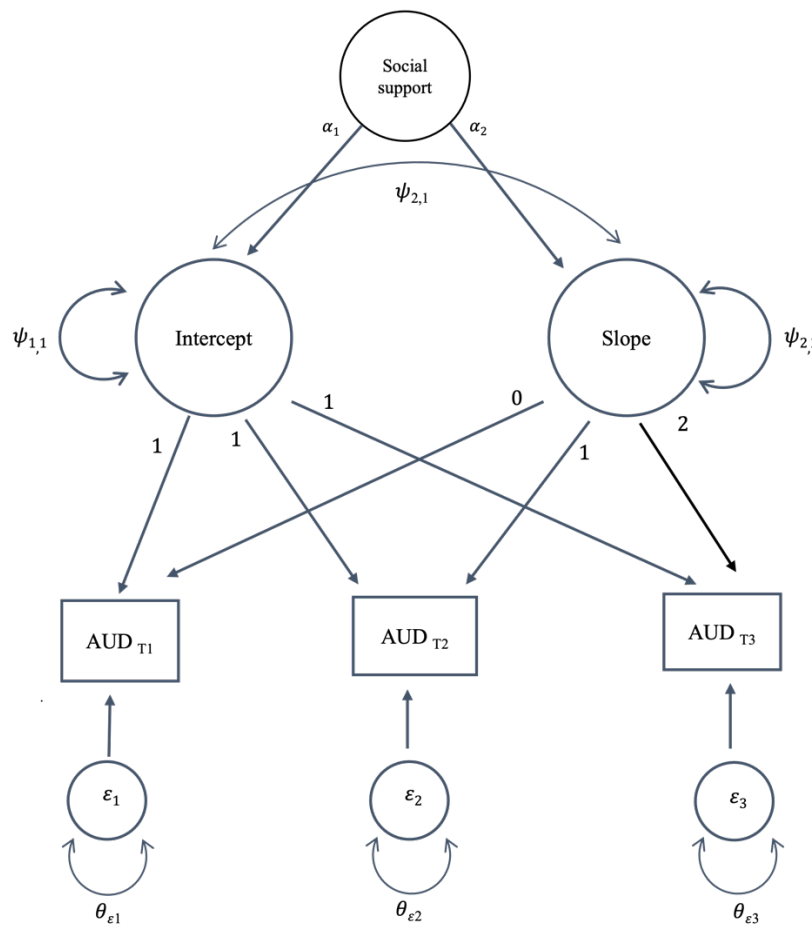
Figure 1. Conceptual Model Unconditional Model with AUD Symptoms Outcome



Aim 2

To address the second aim, I built separate conditional models for each of the three outcomes of interest, which included the time-invariant predictor variables of interest: mental health symptoms and social support. I assessed whether each predictor individually predicted the mean level of SUD symptoms and AOD consequences at each timepoint (the intercept), and the rate of change in SUD symptoms, and AOD consequences (the slope). These conditional models also controlled for participant sex, age, race, RHS involvement, and current treatment status (all included as fixed effects), which were identified from the literature as potentially important confounders. This resulted in estimating a total of six conditional models. Figure 2 depicts a conditional model with social support as a predictor of AUD.

Figure 2. Conditional Model with AUD Symptoms Outcome and Social Support Predictor



Note. Covariates excluded for simplicity.

Aim 3

To address the third research aim, I estimated conditional models that included multiplicative interactions terms between social support and mental health symptoms; these models examined whether social support moderated the association between mental health symptoms and adolescents' post-treatment trajectories. A total of nine conditional models with an interaction term examined the potential moderating impact of social support (a latent construct) on mental health conditions (manifest variables; see Figure 3 for an example).

Interaction effects were probed and interpreted based on both the intercept and the slope to study changes in SUD symptoms and AOD consequences over time as well as mean differences in SUD symptoms and AOD consequences. The equation for the intercept with the interaction term is as follows:

$$\alpha_i = \mu_\alpha + \gamma_1 Z_{1i} + \gamma_2 Z_{2i} + \gamma_3 Z_{1i} Z_{2i} + \xi_{\alpha i}.$$

and the equation of the slope is:

$$\beta_i = \mu_\beta + \gamma_4 Z_{1i} + \gamma_5 Z_{2i} + \gamma_6 Z_{1i} Z_{2i} + \xi_{\beta i}.$$

Where β_i represents the slope of an individual as a function of time, α_i represents the average value the intercept for individual i , (μ) represents the average value of the slope and intercept, plus the presence of independent predictors ($\gamma_5 Z_{2i}$) and an interaction term ($\gamma_6 Z_{1i} Z_{2i}$). Both unstandardized and standardized regression coefficients and model estimates were calculated and reported. Figure 1 represents a conceptual model to illustrate this interaction and proposed relationship between variables.

Model fit at each stage of model building was assessed using the root mean square error of approximation (RMSEA), comparative fit index (CFI), standardized root mean squared residual (SRMR), and the chi-square test statistic (Bentler, 1990; Brown & Cudeck, 1993; Hu & Bentler, 1999). Goodness of fit indices have been widely documented and previously used strict rules of thumb (e.g., Hu & Bentler, 1999) have been cautioned against in favor of viewing a range of values and using information from each source to come to an informed conclusion is recommended (Iacobucci, 2010; Kenny, 2015; Kenny et al., 2015). The SRMR value represents an absolute measure of fit, therefore not penalizing model complexity; a value less than .08 is generally considered a good fit (Hu & Bentler, 1999) and was used as the model fit indicator for the current study. The RMSEA statistic penalizes models based on sample size, and therefore a

range of “acceptable values” was reviewed to evaluate model fit. An RMSEA value less than 0.10 is generally considered “acceptable,” and a “good” value is anything less than 0.08 (Browne & Cudeck, 1992; Hu & Bentler, 1999). An advantage of using RMSEA to evaluate fitness is its ability for a confidence interval to be calculated (MacCallum et al, 1996), therefore providing a range of “certainty” of its value. The CFI statistic measures the deviation from the “null” model. A CFI value above 0.95 have been commonly deemed “good” fit but there is no cutoff to represent “bad” model fit. Based on prior literature, a CFI value greater 0.90 is considered adequate and was therefore used as the indicator of fit for the current study (Iacobucci, 2010; McDonald & Ho, 2002). Finally, the SRMR value reflects the difference between the observed and predicted correlations across model variables; an SRMR value less than 0.08 is considered “good,” and therefore used as the indicator of goodness of fit in the present study. Consistent with recommendations that caution against overinterpreting fit indices and given that fit measures often disagree with one another, models where the RMSEA value is greater than .1 *and* other indicators of model fit are outside the prespecified values were not interpreted but were discussed in the limitations sections and reported in full in the appendix.

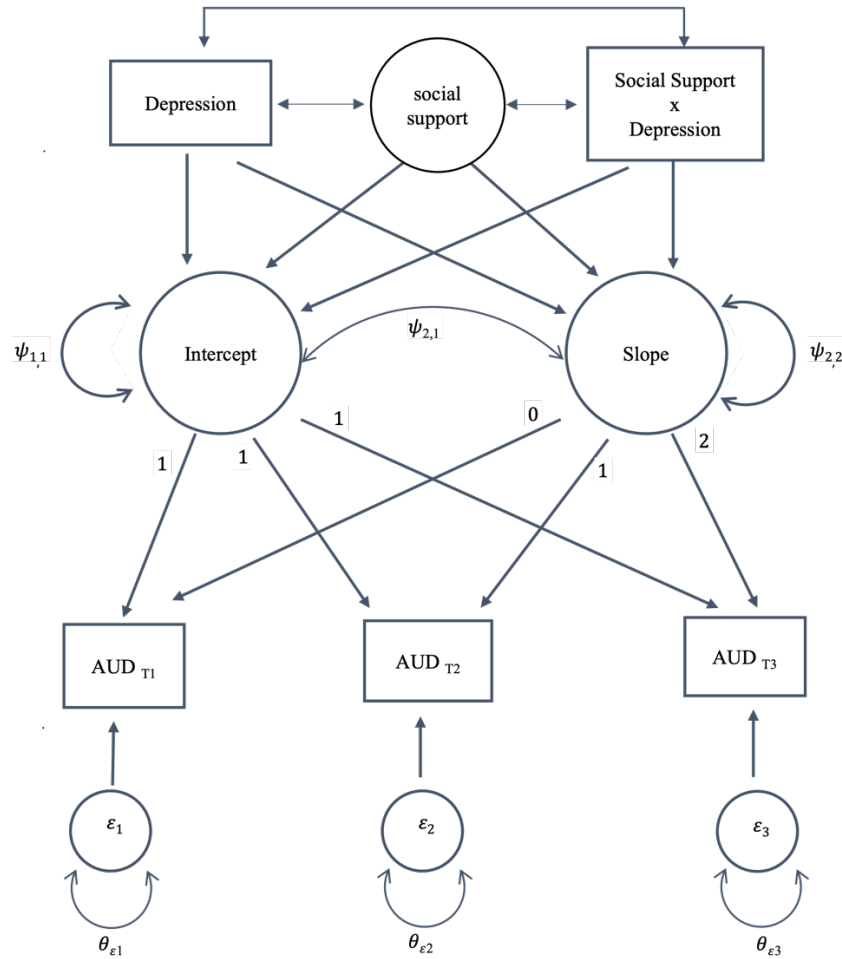
Models were modified until appropriate model fit was established; I relied on prior theory and research, and consultation with my advisor, to inform modifications needed to improve model fit. All analyses were conducted in RStudio (Version 2023.03.0+386); linear growth models were conducted using the lavaan (Rosseel, 2012) and semTools (Jorgensen et al., 2022) packages.

Missing Data

Missing data were handled using full information maximum likelihood (FIML; Graham et al., 1996; McNeish, 2017) and included all key study variables and covariates. Research

suggests that utilizing FIML to handle missing time-invariant data in LGCM is best practice (Cheung, 2007) under missing completely at random (MCAR) assumptions.

Figure 3. Conditional Model with AUD Outcome and Interaction Between Predictors



Note. Covariates excluded for simplicity.

CHAPTER IV

RESULTS

Preliminary Analyses

Pearson's bivariate correlations, means, standard deviations, and ranges are presented for key study variables in Table 1. Inspection of the bivariate correlations revealed that outcome variables were significantly and positively correlated. Mental health symptoms were generally significantly positively associated with baseline levels of each outcome, but not with 6- and 12-month outcomes. Social support was significantly, positively associated with baseline levels of each outcome variable, as well as significantly negatively associated with baseline GAD symptoms.

Sample demographics are shown in Table 2. Adolescents in the current sample were, on average 16 years old ($SD = 1.1$), majority White (72%), and nearly half were female sex (45%). A large proportion of adolescents reported having a parent with substance use concerns (62%). The modal household yearly income reported by parents was more than \$40,000 and up to \$75,000 (30.4% or 83 of 273 total parent responses), followed by more than \$100,000 (28.2%), and the modal parental education reported was a 4-year college degree (30.5% of 275 total parent responses).

Adolescents also reported their heaviest used drug, not including alcohol, which informed the measurement of DUD symptoms. The most common drug used by adolescents in the sample was cannabis, reported by 69% of the sample, followed by narcotics (9%), and polydrug use (not including alcohol; 7.5%). In addition to an SUD, a majority of the sample reported other mental health comorbidity at baseline. Specifically, based on the number of symptoms reported on the M.I.N.I., 75% of adolescents met diagnostic criteria for MDD, while 62% met criteria for GAD,

and 28% met criteria for PTSD. It is again important to note that these do not represent clinical disorders diagnosed by a licensed practitioner, but nonetheless represent the number and cluster of symptoms that would technically meet diagnostic criteria for each. Other mental health symptoms were prevalent, including 25% of the sample who met diagnostic criteria for attention-deficit/hyperactivity disorder (ADHD; 25%) noting an average of 1.3 symptoms ($SD = 0.8$). A large portion of adolescents also reported suicidal ideation (66%). The majority of adolescents also reported having received some form of other mental health treatment (that was specifically *not* for an SUD) at baseline (89%).

All variables were assessed for univariate normality via values of skewness and kurtosis, as well as visualization of frequency distributions. Most met conditions for normality, with values of skew and kurtosis falling within ± 1 and ± 2 , respectively. However, as might be expected of count measures, the following variables were significantly positively skewed: AOD consequences at 6 and 12 months (skew > 1 , kurtosis > 2), AUD symptoms at 6 and 12 months (skew > 1 , kurtosis > 2), and DUD symptoms at 6 and 12 months (skew > 1 , kurtosis > 2). Given the robustness of growth modeling in SEM to handle non-normally distributed data, no corrections were applied prior to running the models.

Table 1. Correlations, Means, and Standard Deviations of Key Model Variables

Variable Name	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Baseline AOD consequences	-												
2. AOD consequences 6 months	.15*	-											
3. AOD consequences 12 months	.12*	.41*	-										
4. Baseline AUD symptoms	.43*	.08	.08	-									
5. AUD symptoms 6 months	.00	.47*	.25*	.22*	-								
6. AUD symptoms 12 months	.06	.30*	.48*	.15*	.47*	-							
7. Baseline DUD symptoms	.38*	.07	.06	.33*	.02	.00	-						
8. DUD symptoms 6 months	.00	.57*	.33*	-.02	.39*	.22*	.11	-					
9. DUD symptoms 12 months	.04	.34*	.60*	-.02	.25*	.47*	.19*	.48*	-				
10. Baseline MDD symptoms	.14*	.01	.04	.21*	.04	.05	.27*	-.04	.03	-			
11. Baseline PTSD symptoms	.18*	-.04	.09	.29*	-.02	.04	.13*	-.04	-.05	.34*	-		
12. Baseline GAD symptoms	.10	-.01	.04	.19*	.00	.00	.24*	-.04	.08	.52*	.24*	-	
13. Baseline social support ^a	.03	-.08	0.00	.12*	.12	.12*	.04	-.04	.09	-.15*	-.15*	-.13*	-
<i>n</i>	284	294	294	294	294	294	294	294	294	294	293	294	283
<i>M</i>	9.27	5.94	5.85	4.28	0.68	0.90	7.49	2.13	2.85	6.06	3.71	5.07	0.99
<i>SD</i>	3.51	2.72	2.86	3.69	2.09	2.29	2.77	2.87	3.42	3.38	5.55	3.78	0.14
Range	4-16	4-16	4-16	0-11	0-13	0-11	0-11	0-12	0-13	0-9	0-16	0-9	0.56-1.40

Note. Pearson correlations are reported. Range refers to the minimum and maximum observed values, *n* = number of observations.

^aSocial support was presented as a sum score and standardized to describe and present the relations with other study variables (social support is modeled as a latent variable in the growth models). **p* < .05.

Table 2. Baseline Demographic and Clinical Variables

Variable	N (%) / Range
Age (years) $M = 16.32$, $SD = 1.09$	13-19
Female sex	132 (44.90)
Race	
White	212 (72.10)
Hispanic	30 (10.20)
Black	27 (9.20)
Asian	10 (3.40)
Native American	9 (3.10)
Other	6 (2.0)
Mental Health Treatment Status	261 (88.80)
RHS Status (baseline)	148 (50.30)
Parent with AOD	183 (62.20)
Drug of choice ¹	
Cannabis	201 (68.80)
Narcotics	26 (8.90)
Polysubstance	22 (7.50)
Stimulants	12 (4.10)
Cocaine	11 (3.80)
Hallucinogens	10 (3.40)
Over the counter	4 (1.40)
Tranquilizers	3 (1.00)
Miscellaneous	3 (1.00)
Inhalants	0 (0.00)
Substance use diagnoses	
Alcohol dependence	145 (49.32)
Alcohol abuse	184 (62.59)
Drug dependence	247 (84.01)
Drug abuse	271 (92.18)
Co-occurring mental health disorders	
MDD	220 (74.80)
PTSD	83 (28.20)
GAD	182 (61.90)

Note. N=294. All clinical disorders, including substance abuse and dependence, were measured via the M.I.N.I. Suicidal ideation pertained to any suicide risk per DSM-IV criteria. Zero participants reported inhalant use and is not reported with other drugs of choice. Parent with AOD pertains to biological parents with alcohol or drug problems.

¹ $n = 292$ (drug of choice).

Analysis of Missingness

Data were not missing for demographic information collected at baseline. There were minimal missing data at the 6- and 12-month follow-up timepoints for several model variables, resulting in a range of 0.35 - 1.41% missingness across social support indicators, and 0.35% missing data in PTSD symptoms. Little's MCAR Test of Missingness (Little & Rubin, 1989) was conducted for variables used in the growth models, including covariates and individual indicators of the latent variable of social support. The MCAR hypothesis was rejected, indicating that data were not missing completely at random. The number of missing data patterns identified was 2, and none of these missing data patterns raised concerns about the data being missing not at random. Sensitivity analyses were performed to examine whether missingness in any of the outcome variables was associated with predictor variables, which provided no evidence of any relations between variables with missing data; thus, it seemed reasonable to assume the missing data were missing at random. Due to the robustness of FIML for handling data missing at random, and given recommendations in prior empirical literature (Xiao & Bulut, 2020), missing data were therefore handled using FIML in each growth model (as opposed to using additional strategies like multiple imputation prior to model specification and fitting). I used FIML to handle missingness on endogenous variables across LGCM models. However, due to the complexity of the interaction terms used (between a latent and observed variable) in the interaction models, FIML was also used to handle missingness on exogenous variables (Rosseel, 2012).

Model Specification and Fit

For the latent variable of social support, factor loadings were significant for all indicators ($p < .01$). The standardized factor loadings ranged from .089 – .876 as shown in Appendix A

(Table S1). Distributions of outcome variables and relations between study variables were visually inspected to check that statistical assumptions were met. Each growth model was estimated using the ML estimator and a mean covariance structure was specified for each model. Due to complexity in the models specifying the interaction terms, and resulting challenges in obtaining model convergence, robust standard errors were calculated and reported using the maximum likelihood with robust standard errors (MLR) estimator. To provide more information about the degree of certainty in the RMSEA measure (Kenny, 2015), 90% confidence intervals are provided in Table 3.

Overall, models adequately fit the data and thus the parameter estimates were interpretable. Due to high collinearity between items 1 and 2 of the HSQ, these items were specified to covary in each model. This change did not significantly change model fit, nor the parameter estimates or interpretation of the models. For ease of interpretation, the unstandardized coefficients (*b*) are presented below for each model, whereas both the standardized (including β) and unstandardized estimates are presented in Tables 4 and 5.

Main Study Analyses

Aim 1 Results: To address this aim, I estimated three separate LGCMs to examine the average 12-month trajectory of AOD consequences, AUD symptoms, and DUD symptoms among adolescents after discharge from SUD treatment. These unconditional models were specified with no predictor variables included and residual variances were constrained to be equal in order for the models to converge. However, these models were poorly fit and therefore not interpretable (see Table 3). A visual depiction of the trajectories can be found for each outcome (see Figures 4, 5, 6). In summary, the results indicated general decreases in AOD consequences, AUD symptoms, and DUD symptoms after treatment exit, although it is likely

unreasonable to model a simple, unconditional trajectory for these substance use outcomes (given the poor model fit).

Table 3. Model Fit Statistics for Growth Models

Model description	Model name	χ^2	<i>df</i>	CFI	RMSEA	[90% CI]	SRMR
Unconditional growth models with no predictors ^a							
AOD Consequences	Model 1.1	34.81**	3	.000	.267	[.234, .301]	.313
AUD Symptoms	Model 1.2	61.17**	3	.000	.257	[.229, .286]	.395
DUD Symptoms	Model 1.3	107.26**	3	.000	.344	[.306, .383]	.355
Conditional growth models with single predictors ^b							
AOD Consequences							
MDD symptoms	Model 2.1a	94.14**	49	.910	.056	[.044, .077]	.059
PTSD symptoms	Model 2.1b	101.03**	49	.892	.060	[.050, .082]	.060
GAD symptoms	Model 2.1c	83.10**	49	.926	.049	[.037, .072]	.056
Social support	Model 2.1d	437.41**	187	.785	.067	[.059, .076]	.070
AUD Symptoms							
MDD symptoms	Model 2.2a	109.77**	9	.889	.065	[.049, .081]	.063
PTSD symptoms	Model 2.2b	48.10**	11	.797	.107	[.077, .139]	.054
GAD symptoms	Model 2.2c	36.16**	9	.842	.101	[.068, .137]	.048
Social support	Model 2.2d	490.71**	188	.747	.074	[.066, .082]	.070
DUD Symptoms							
MDD symptoms	Model 2.3a	33.30**	9	.882	.096	[.062, .132]	.046
PTSD symptoms	Model 2.3b	27.46**	9	.884	.084	[.049, .120]	.041
GAD symptoms	Model 2.3c	35.75**	9	.847	.101	[.067, .136]	.047
Social support	Model 2.3d	496.94**	188	.742	.075	[.067, .083]	.071
Conditional growth models interaction terms ^{a,b}							
AOD Consequences							
MDD x Social support	Model 3.1ad	1177.48**	598	.711	.057	[.053, .062]	.072
PTSD x Social support	Model 3.1bd	1017.42**	598	.760	.049	[.045, .054]	.054
GAD x Social support	Model 3.1cd	1062.02**	598	.751	.051	[.047, .056]	.069
AUD Symptoms							
MDD x Social support	Model 3.2ad	1212.85**	602	.702	.059	[.054, .063]	.072
PTSD x Social support	Model 3.2bd	1082.48**	602	.736	.052	[.048, .057]	.069
GAD x Social support	Model 3.2cd	1095.27**	602	.739	.053	[.048, .058]	.069
DUD Symptoms							
MDD x Social support	Model 3.3ad	1209.03**	602	.702	.059	[.054, .063]	.072
PTSD x Social support	Model 3.3bd	1055.61**	602	.747	.051	[.046, .055]	.068
GAD x Social support	Model 3.3cd	1069.70**	598	.749	.052	[.047, .057]	.068

Note. ^aUnconditional and interaction models were estimated with MLR, providing robust standard errors, robust CFI estimates, robust RMSEA estimates for model convergence and interpretation. ^bConditional models included covariates. χ^2 = chi-squared, *df* = degrees of freedom (for chi-squared test statistic), CI = confidence interval. **p* < .05; ***p* < .01.

Figure 4. Trajectory of AOD Consequences

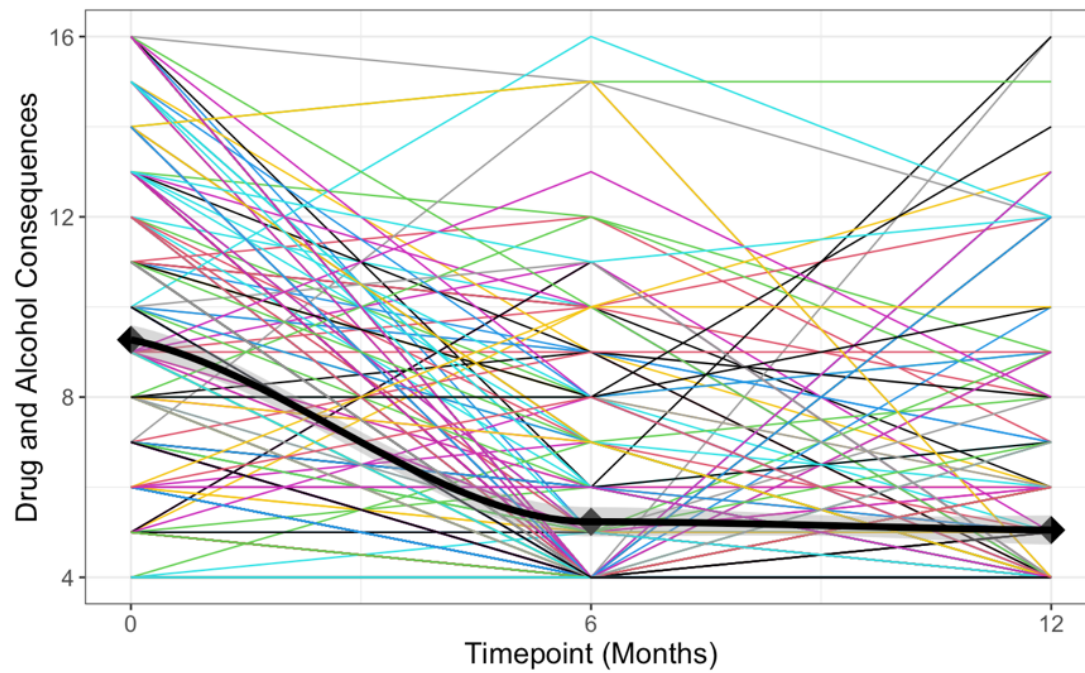


Figure 5. Trajectory of AUD Symptoms

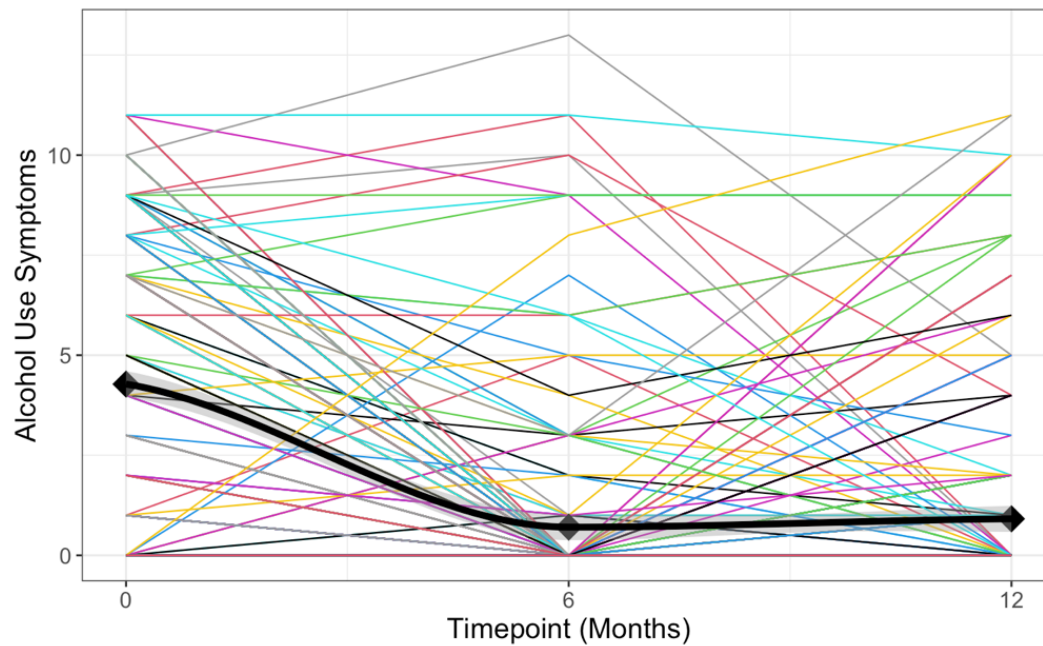
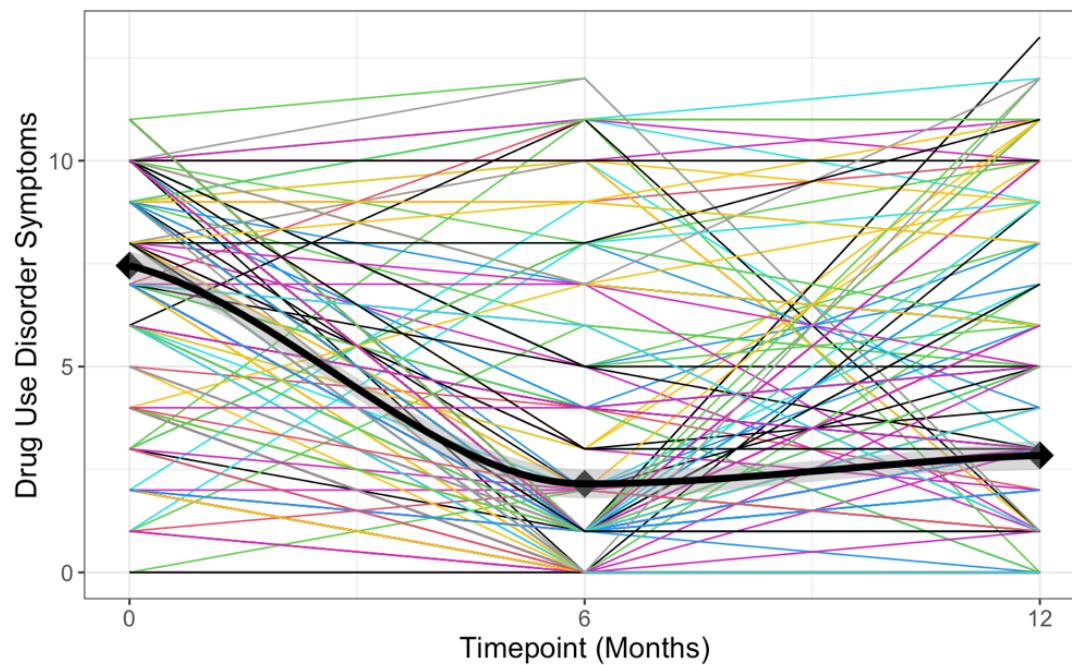


Figure 6. Trajectory of DUD Symptoms



Aim 2 Results: To address this aim, I estimated 12 separate LGCMs to examine whether baseline symptoms of MDD, PTSD, and GAD, as well as social support were associated with adolescents' 12-month post-treatment trajectories of AOD consequences, AUD symptoms, and DUD symptoms. These results are presented in Table 4.

Predicting AOD Consequences. The model with MDD predicting AOD consequences adequately fit the data (Model 2.1a; CFI = .910, RMSEA = .056, SRMR = .059). MDD symptoms were not a statistically significant predictor of the intercept ($b = 0.10$, $SE = 0.05$, $p = .052$) or the slope ($b = -0.03$, $SE = 0.03$, $p = .573$). There was no significant covariance between intercept and slope, nor significant variance of intercept or slope. The variance of MDD symptoms was significant ($\Psi = 11.38$, $SE = 0.94$, $p = .000$); as well as AOD consequences at each timepoint.

The model of PTSD symptoms and AOD consequences adequately fit the data (Model 2.1b; CFI = .892, RMSEA = .060, SRMR = .060). There was no evidence that PTSD symptoms predicted the intercept ($b = 0.06$, $SE = 0.03$, $p = .024$) or slope ($b = -0.01$, $SE = 0.02$, $p = .388$). There was no evidence of significant covariance between intercept and slope. The intercept variance was not statistically significant, nor the variance in the slope. There was significant variance in PTSD symptoms, as well as AOD consequences at each timepoint (see Table 4).

The GAD predictor model adequately fit the data (Model 2.1c; CFI = .926, RMSEA = .049, SRMR = .056). There was no evidence that GAD symptoms significantly predicted the intercept ($b = 0.04$, $SE = 0.05$, $p = .172$) or slope ($b = -0.01$, $SE = 0.03$, $p = .527$). There was no statistically significant covariance between intercept and slope. Neither the variance of the intercept or the slope was statistically significant. The variance in GAD symptoms was statistically significant, as well as AOD consequences at each timepoint.

Finally, the model testing the linear relation between social support and AOD consequences adequately fit the data (Model 2.1d; CFI = .788, RMSEA = .067, SRMR = .071). Social support was not a statistically significant predictor of the intercept ($b = -0.76$, $SE = 0.81$, $p = .582$). There was no significant covariance between slope and intercept. There was significant variance of social support, $\Psi = 0.06$, $SE = 0.02$, $p = .001$, as well as AOD consequences at each timepoint. The variance of the intercept was not statistically significant, nor that of the slope (see Table 4).

In summary, the results indicated that including mental health predictors did explain more of the variance in trajectories in AOD consequences compared to an unconditional model with no predictors. However, there was no evidence that mental health symptoms, nor social

support, predicted the average level of AOD consequences at treatment exit nor the change over time in AOD consequences after SUD treatment.

Predicting AUD Symptoms. The next set of models contained singular predictors of AUD symptoms at each timepoint and change over time in AUD symptoms.

The model with MDD predicting AUD symptoms adequately fit the data (Model 2.2a; CFI = .889, RMSEA = .065, SRMR = .063). Baseline MDD symptoms significantly predicted the intercept ($b = 0.11$, $SE = 0.05$, $p = .045$), but there was no evidence that symptoms predicted the slope ($b = -0.03$, $SE = 0.03$, $p = .307$). In other words, having more MDD symptoms at treatment exit was associated with also reporting greater levels of AUD symptoms. The covariance between intercept and slope was not statistically significant. There was significant variance in the intercept ($\Psi = 1.77$, $SE = 0.78$, $p = .02$) but not the slope. There was significant variance in baseline levels of MDD as well as AUD symptoms at each timepoint.

The PTSD model predicting AUD symptoms was poorly fit to the data, and therefore interpreted with caution (Model 2.2b; CFI = .797, RMSEA = .107, SRMR = .054). Baseline PTSD symptoms significantly predicted the intercept ($b = 0.08$, $SE = 0.03$, $p = .016$), as well as the slope ($b = -0.04$, $SE = 0.02$, $p = .048$). This finding suggests that greater levels of PTSD symptoms at treatment exit were associated with a slower linear decrease in AUD symptoms over time (compared to those with lower levels of PTSD symptoms), as well as a greater number of initial AUD symptoms at treatment exit. There was no evidence that the intercept and slope significantly covaried, thus no evidence that the initial level of PTSD symptoms was associated with the rate of change over time in AUD symptoms. There was significant variance in the intercept ($\Psi = 1.76$, $SE = 0.78$, $p = .025$) but not the slope.

The GAD model was also a poor fit to the data and should therefore be interpreted with caution (Model 2.2c; CFI = .842, RMSEA = .101, SRMR = .048). This model showed no evidence that baseline GAD predicted the intercept ($b = 0.08$, $SE = 0.05$, $p = .094$) nor the slope ($b = -.045$, $SE = .028$, $p = .113$). The variance was statistically significant for the intercept ($\Psi = 1.80$, $SE = 0.79$, $p = .022$) but not the slope.

Finally, the social support model predicting AUD symptoms was adequately fit to the data (Model 2.2d; CFI = .747, RMSEA = .074, SRMR = .070). There was no evidence that the intercept was predicted by social support ($b = 0.90$, $SE = 0.83$, $p = .275$) nor the slope ($b = 0.07$, $SE = 0.50$, $p = .887$). The covariance between intercept and slope was not statistically significant. There was significant variance of the intercept ($\Psi = 1.82$, $SE = 0.79$, $p = .021$) but not the slope ($\Psi = 0.43$, $SE = 0.43$, $p = .318$). There was also significant variance of social support at baseline, $\Psi = 0.06$, $SE = 0.02$, $p = .003$, and the outcome at each timepoint.

In summary, the results indicated that including mental health predictors and other relevant covariates improved model fit (compared to the unconditional growth models estimated for aim 1). Baseline MDD and PTSD separately predicted the intercept, suggesting that greater symptoms of each were associated with a greater number of AUD symptoms at treatment exit. Additionally, PTSD symptoms predicted the slope, suggesting that having more PTSD symptoms at treatment exit was associated with a slower rate of decrease in AUD symptoms following treatment. There was substantial variability found in AUD symptoms at each timepoint, however, suggesting that the experiences of adolescents varied significantly and there are likely other variables that could account for the average level of AUD symptoms following treatment exit.

Predicting DUD Symptoms. The final set of models include single predictors of the intercept and slope of DUD symptoms. The MDD model was poorly fit to the data but still interpretable (Model 2.3a; CFI = .882, RMSEA = .096, SRMR = .046). Baseline levels of MDD symptoms significantly predicted the intercept ($b = 0.18$, $SE = 0.05$, $p = .000$), as well as the slope ($b = -0.08$, $SE = 0.04$, $p = .038$). This finding indicated that reporting more symptoms of MDD at treatment exit was associated with more symptoms of DUD at baseline as well as a slower rate of decrease from 0-12 months after treatment exit. There was no significant covariance between intercept and slope, signaling that no evidence that baseline levels of MDD were associated with the rate of change over time in DUD symptoms. The outcome variances were statistically significant at each timepoint. There was also significant variance in MDD symptoms at baseline ($\Psi = 11.38$, $SE = 0.94$, $p = .000$). There was no evidence of significant variance in the intercept or slope.

The PTSD model adequately fit the data (Model 2.3b; CFI = .884, RMSEA = .084, SRMR = .041). There was no evidence that baseline PTSD symptoms were a statistically significantly predictor of the intercept ($b = 0.05$, $SE = 0.03$, $p = .079$) or slope ($b = -0.04$, $SE = 0.02$, $p = .075$). There was no significant covariance between intercept and slope, nor significant variance of slope or intercept. There was significant variance in PTSD symptoms ($\Psi = 30.76$, $SE = 2.54$, $p = .000$) as well as DUD symptoms at each timepoint.

The GAD model was a poor fit to the data and should be interpreted with caution (Model 2.3c; CFI = .847, RMSEA = .101, SRMR = .047). Baseline GAD symptoms significantly predicted the intercept value ($b = 0.12$, $SE = 0.04$, $p = .003$), suggesting that as the number of GAD symptoms increase, so do the number of DUD symptoms at treatment exit. However, there was no evidence that GAD symptoms predicted the slope ($b = -0.04$, $SE = 0.03$, $p = .254$). There

was no significant covariance between the intercept and slope. There was also no significant variance in the slope or the intercept. There was significant variance in GAD symptoms ($\Psi = 14.19$, $SE = 1.17$, $p = .000$), and each timepoint for DUD symptoms.

The final model with social support predicting DUD symptoms adequately fit the data (Model 2.3d; $CFI = .742$, $RMSEA = .075$, $SRMR = .071$). This model provided no evidence that social support predicted the intercept ($b = -0.44$, $SE = 0.70$, $p = .525$) or slope ($b = 0.49$, $SE = 0.56$, $p = .381$). The intercept and slope did not significantly covary, but there was significant variance in each timepoint for DUD symptoms, as well as baseline levels of social support ($\Psi = 0.05$, $SE = 0.02$, $p = .003$).

In summary, the results indicated that mental health symptoms of GAD and MDD predicted baseline symptoms of DUD at treatment exit, even after accounting for adolescent's demographic characteristics and RHS status and mental health treatment history. Additionally, MDD symptoms predicted the slope, such that having a higher number of MDD symptoms at treatment exit was associated with a slower decline in the number of DUD symptoms 12 months after treatment. Finally, there was no evidence that social support nor PTSD symptoms were associated with DUD symptoms at baseline or the rate of change in symptoms over time.

Table 4. Growth Models with Single Predictors

Model Description	AOD Consequences			AUD Symptoms			DUD Symptoms		
Model Parameters	Unstandardized Estimate	Std Estimate	SE ^a	Unstandardized Estimate	Std Estimate	SE ^a	Unstandardized Estimate	Std Estimate	SE ^a
MDD Model									
Regression results									
Intercept	0.10	0.25	0.05	0.11*	0.25	0.05	0.18**	0.90	0.05
Slope	-0.03	-0.12	0.03	-0.03	-0.15	0.03	-0.08*	-0.24	0.04
I/S covariance	0.12	0.13	0.51	-0.18	-0.20	0.48	0.86	4.90	0.51
Variance									
Intercept	0.94	0.56	0.87	1.77*	0.84	0.78	0.03	0.08	0.78
Slope	0.48	0.64	0.45	0.43	0.74	0.43	0.93	0.81	0.54
Predictor	11.38**	1.00	0.94	11.38**	1.00	0.94	11.38**	1.00	0.94
Baseline	9.91**	0.85	1.22	10.93**	0.84	1.21	6.88**	0.94	0.99
6 months	4.11**	0.70	0.46	2.47**	0.56	0.33	5.54**	0.66	0.59
12 months	2.10**	0.39	0.76	2.33**	0.44	0.67	4.19**	0.36	1.20
PTSD Model									
Regression results									
Intercept	0.06	0.23	0.03	0.08*	0.29	0.03	0.05	0.58	0.03
Slope	-0.01	-0.08	0.02	-0.04*	-0.28	0.02	-0.04	-0.21	0.02
I/S covariance	0.04	0.05	0.51	-0.14	-0.17	0.48	0.94	6.68	0.52
Variance									
Intercept	0.99	0.57	0.87	1.76*	0.83	0.78	0.02	0.12	0.81
Slope	0.54	0.66	0.45	0.38	0.68	0.43	0.84	0.80	0.55
Predictor	31.17**	1.00	2.62	30.75**	1.00	2.54	30.76**	1.00	2.54
Baseline	9.77**	0.85	1.22	10.74**	0.84	1.20	7.28**	0.97	1.02
6 months	4.17**	0.70	0.46	2.50**	0.56	0.34	5.41**	0.66	0.58
12 months	2.00**	0.37	0.77	2.41**	0.46	0.68	4.28**	0.36	1.19
GAD Model									

Table 4. Continued

Regression results									
Intercept	0.04	0.12	0.05	0.08	0.20	0.05	0.12**	0.68	0.04
Slope	-0.01	-0.04	0.03	-0.05	-0.23	0.03	-0.04	-0.13	0.03
I/S covariance	0.09	0.13	0.51	-0.15	-0.18	0.48	0.79	2.28	0.51
Variance									
Intercept	0.98	0.59	0.87	1.80*	0.86	0.79	0.12	0.29	0.81
Slope	0.47	0.64	0.45	0.39	0.70	0.43	0.99	0.84	0.55
Predictor	14.20**	1.00	1.19	14.19**	1.00	1.17	14.19**	1.00	1.17
Baseline	10.01**	0.86	1.22	10.93**	0.84	1.21	6.92**	0.94	1.01
6 months	4.08**	0.70	0.45	2.46**	0.56	0.33	5.55**	0.66	0.59
12 months	2.12**	0.39	0.76	2.39**	0.45	0.67	4.09**	0.35	1.20
Social Support Model									
Regression results									
Intercept	-0.76	-0.15	0.81	0.90	0.15	0.83	-0.44	-0.29	0.70
Slope	0.06	0.02	0.50	0.07	0.02	0.50	0.49	0.11	0.56
I/S covariance	0.16	0.27	0.51	0.42	0.59	0.07	0.93	10.96	0.52
Variance									
Intercept	0.90	0.59	0.86	1.82*	0.87	0.79	0.01	0.06	0.82
Slope	0.41	0.61	0.46	0.43	0.75	0.43	0.87	0.83	0.55
Predictor	0.06**	1.00	0.02	0.06**	1.00	0.02	0.05**	1.00	0.02
Baseline	10.14**	0.86	1.23	11.01**	0.84	1.21	7.40**	0.98	1.03
6 months	4.02**	0.70	0.45	2.45**	0.56	0.33	5.41**	0.66	0.58
12 months	2.24**	0.41	0.76	2.33**	0.44	0.67	4.17**	0.36	1.19

Note. Std = standardized, Est = estimate, SE = standard error. ^aStandard errors correspond to unstandardized estimates. Unstandardized (*b*) and standardized (β) estimates are presented in this table for regression analyses. The standardized estimate represents the completely standardized solution in which both latent and observed variables are standardized. Each model also includes covariates. * $p < .05$; ** $p < .01$

Aim 3 Results: To address this aim, I estimated linear growth models to examine whether mental health symptoms and adolescents' post-treatment trajectories of each outcome varied depending on baseline levels of perceived social support. These final models tested whether an interaction exists between mental health symptoms and social support on three separate outcomes, totaling 9 growth curve models.

Predicting AOD Consequences. The first model tested the interaction between MDD and social support on AOD consequences, which was adequately fit to the data (Model 3.1ad; CFI = .711, RMSEA = .057, SRMR = .072). There was no evidence that social support or MDD symptoms predicted the intercept or slope, and there was no significant interaction effect on the AOD consequences intercept or slope (see Table 5).

The model with PTSD and social support predicting AOD consequences was adequately fit to the data (Model 3.1bd; CFI = .771, RMSEA = .049, SRMR = .068). There was no evidence of a main effect of social support or PTSD symptoms on the intercept or slope, nor evidence of a significant interaction effect on the AOD consequences intercept or slope (see Table 5).

The interaction model with GAD and social support was adequately fit to the data (Model 3.1cd; CFI = .761, RMSEA = .051, SRMR = .069). There was no evidence that social support or GAD symptoms predicted the slope or intercept (i.e., no main effects), nor was there evidence that the interaction between GAD symptoms and social support predicted the intercept or slope (see Table 5).

In summary, the results provided no evidence of significant interactions between social support and mental health symptoms on AOD consequences. In other words, there was no evidence that mental health symptoms or social support significantly predicted initial levels of AOD consequences at treatment exit, nor the change in AOD consequences after treatment exit;

and there was no evidence that the social support moderated the effect of mental health symptoms on adolescents' AOD symptoms at or after treatment exit.

Predicting AUD Symptoms. The interaction model between MDD and social support was adequately fit to the data (Model 3.2ad; CFI = .718, RMSEA = .059, SRMR = .072). There was a significant effect of MDD symptoms on the intercept ($b = 0.13$, $SE = 0.06$, $p = .022$) but not slope ($b = -0.04$, $SE = 0.04$, $p = .321$). In other words, having a higher number of MDD symptoms, regardless of the level of social support, was associated with having more AUD symptoms at treatment exit. There was no evidence that social support significantly predicted the intercept or slope, and there was no statistically significant interaction between the two indicators (for the slope or intercept). Social support and MDD symptoms significantly covaried in the model ($\Psi = -0.14$, $SE = 0.06$, $p = .022$) such that greater levels of MDD symptoms were associated with lower social support and vice versa.

The interaction model between PTSD and social support was adequately fit to the data (Model 3.2bd; CFI = .749, RMSEA = .052, SRMR = .069). The number of PTSD symptoms significantly predicted the intercept ($b = 0.09$, $SE = .04$, $p = .026$) but not the slope ($b = -0.04$, $SE = 0.02$, $p = .054$). In other words, more PTSD symptoms at baseline was associated with a greater number of AUD symptoms. There was no significant main effect of social support on the intercept or slope, nor was there a significant interaction between the two variables. Additionally, social support and PTSD symptoms covaried significantly ($\Psi = -0.22$, $SE = 0.09$, $p = .009$) such that higher PTSD symptoms was associated with lower levels of social support. There was no evidence of significant variance in the intercept or slope.

The final interaction model between GAD and social support was adequately fit to the data (Model 3.2cd; CFI = .750, RMSEA = .053, SRMR = .069). There was no evidence that

social support or GAD symptoms significantly predicted the intercept or slope, and there was no statistically significant interaction between the two variables. Social support and GAD symptoms significantly covaried ($\Psi = -0.16$, $SE = 0.07$, $p = .037$), such that increasing GAD symptoms was correlated with lower reported social support.

In summary, the results indicated that there was no evidence of an interaction between mental health symptoms and social support. Baseline PTSD and MDD symptoms were positively associated with the number of AUD symptoms at baseline, such that having more symptoms of PTSD or MDD was associated with reporting more AUD symptoms at treatment exit. There was no evidence, however, that GAD symptoms or social support predicted baseline levels of AUD symptoms. There was no evidence that mental health symptoms or social support predicted the rate of change in AUD symptoms following treatment exit.

Predicting DUD Symptoms. The interaction model with MDD and social support was adequately fit to the data (Model 3.3ad; CFI = .702, RMSEA = .059, SRMR = .072). There was a significant main effect of MDD symptoms on the intercept ($b = 0.18$, $SE = 0.05$, $p = .000$), indicating that even considering the potential influence of social support, treatment influences and demographics, more MDD symptoms at baseline were associated with more symptoms of DUD at treatment exit. However, there was no evidence of this association with the slope ($b = -0.07$, $SE = 0.04$, $p = .078$). There was also no evidence of a significant effect of social support on the intercept or slope, nor a significant interaction effect. MDD symptoms and social support significantly and negatively covaried ($\Psi = -0.14$, $SE = 0.06$, $p = .021$).

The interaction model of PTSD and social support was adequately fit to the data (Model 3.3bd; CFI = .758, RMSEA = .051, SRMR = .068). There was no evidence of a significant main effect of social support or PTSD symptoms, nor the interaction between the two on the intercept

or slope (see Table 5). The covariance between intercept and slope was statistically significant ($\Psi = 0.95$, $SE = 0.42$, $p = .023$), suggesting that the initial level of symptoms (at treatment exit) was indicative of the rate at which symptoms change following treatment.

The final model included the interaction between GAD symptoms and social support, which was adequately fit to the data (Model 3.3cd; CFI = .759, RMSEA = .052, SRMR = .068). Baseline GAD symptoms significantly predicted the intercept ($b = 0.12$, $SE = 0.04$, $p = .008$) but not the slope ($b = -0.03$, $SE = 0.04$, $p = .374$). There was no evidence of a significant interaction effect between social support and GAD symptoms on the intercept or slope, nor a main effect of social support. There was significant covariance between social support and GAD symptoms ($\Psi = -0.16$, $SE = 0.07$, $p = .028$), indicating that social support and anxiety symptoms were negatively correlated with one another. There was no evidence of significant variance of the intercept or slope (see Table 5).

In summary, the results indicated that even after controlling for the influence of social support on DUD symptoms at baseline and the change over time, mental health symptoms generally were positively associated with baseline levels of DUD symptoms; however, there was no evidence that mental health predicted change over time in DUD symptoms after treatment exit. There was also no evidence of an interaction effect between mental health and social support, but in each model the level of social support was significantly, negatively correlated with mental health symptoms at baseline, suggesting an inverse relationship between the two variables.

Table 5. Growth Models with Interaction Terms

Model Description	AOD Consequences			AUD Symptoms			DUD Symptoms		
Model Parameters	Unstandardized Est	Std Est	SE ^a	Unstandardized Est	Std Est	SE ^a	Unstandardized Est	Std Est	SE ^a
MDD Model									
Regression results									
Intercept									
Social support	-0.60	-0.11	0.83	1.09	0.18	0.85	0.03	0.01	0.65
Mental health	0.10	0.25	0.05	0.13*	0.31	0.06	0.18**	0.93	0.05
Interaction	-0.04	-0.04	0.16	-0.22	-0.17	0.17	-0.10	-0.17	0.14
Slope									
Social support	0.12	0.04	0.56	0.04	0.01	0.61	0.25	0.06	0.63
Mental health	-0.03	-0.11	0.03	-0.04	-0.16	0.04	-0.07	-0.22	0.04
Interaction	-0.05	-0.07	0.09	0.11	0.16	0.11	-0.03	-0.37	0.12
I/S covariance	0.15	0.24	0.68	-0.16	-0.19	0.52	0.85*	6.60	0.42
SS/MH covariance	-0.13*	-0.17	0.06	-0.14*	-0.17	0.06	-0.14*	-0.17	0.06
Variance									
Intercept	0.88	0.55	0.97	1.63	0.78	0.89	0.02	0.04	0.71
Slope	0.43	0.62	0.67	0.44	0.73	0.51	0.95	0.83	0.54
Interaction	1.27**	1.00	0.43	1.27**	1.00	0.43	1.26**	1.00	0.43
Social Support	0.06**	1.00	0.02	0.06**	1.00	0.02	0.06**	1.00	0.02
Mental Health	11.10**	1.00	0.74	11.10**	1.00	0.74	11.10**	1.00	0.74
Baseline	10.02**	0.86	1.23	10.91**	0.84	1.07	6.89**	0.94	0.97
6 months	3.98**	0.69	0.67	2.49**	0.56	0.64	5.55**	0.66	0.92
12 months	2.27**	0.41	1.47	2.27**	0.43	1.07	4.12**	0.35	1.66
PTSD Model									
Regression results									
Intercept									
Social support	-0.61	-0.11	0.85	1.38	0.22	0.91	-0.24	-0.14	0.68
Mental health	0.06	0.24	0.03	0.09*	0.33	0.04	0.05	0.64	0.37
Interaction	0.15	0.14	0.15	0.01	0.01	0.17	0.02	0.07	0.11
Slope									
Social support	0.21	0.06	0.57	-0.12	-0.03	0.59	0.32	0.07	0.62
Mental health	-0.01	-0.06	0.02	-0.04	-0.28	0.02	-0.03	-0.18	0.02
Interaction	-0.02	-0.03	0.10	-0.07	-0.10	0.12	0.03	0.04	0.11
I/S covariance	0.11	0.16	0.65	-0.18	-0.21	0.54	0.95*	130.65	0.42

Table 5. Continued

SS/MH covariance	-0.22	-0.17	0.08	-0.22**	-0.18	0.09	-0.22*	-0.17	0.08
Variance									
Intercept	0.88	0.54	0.98	1.66	0.79	0.95	-0.00	-0.00	0.73
Slope	0.50	0.66	0.63	0.46	0.71	0.51	0.83	0.82	0.52
Interaction	1.40*	1.00	0.70	1.42*	1.00	0.71	1.41*	1.00	0.70
Social Support	0.05**	1.00	0.02	0.05**	1.00	0.02	0.05**	1.00	0.02
Mental Health	30.83**	1.00	2.27	30.37**	1.00	2.26	30.38**	1.00	2.26
Baseline	9.94**	0.86	1.24	10.55**	0.83	1.13	7.32**	0.98	1.00
6 months	4.04**	0.69	0.67	2.59**	0.57	0.67	5.41**	0.66	0.90
12 months	2.13**	0.38	1.41	2.24**	0.43	1.06	4.25**	0.36	1.61
GAD Model									
Regression results									
Intercept									
Social support	-0.66	-0.13	0.80	1.23	0.20	0.83	-0.05	-0.02	0.66
Mental health	0.04	0.13	0.05	0.09	0.24	0.05	0.12**	0.69	0.04
Interaction	-0.10	-0.07	0.20	-0.10	-0.07	0.22	-0.10	-0.15	0.17
Slope									
Social support	0.17	0.05	0.55	-0.11	-0.03	0.58	0.37	0.08	0.62
Mental health	-0.01	-0.06	0.03	-0.05	-0.23	0.03	-0.03	-0.11	0.04
Interaction	-0.04	-0.04	0.13	0.03	0.04	0.15	0.01	0.00	0.15
I/S covariance	0.13	0.20	0.68	-0.16	-0.19	0.53	0.79	2.46	0.43
SS/MH covariance	-0.16	-0.18	0.07	-0.17	-0.18	0.07	-0.16*	-0.18	0.07
Variance									
Intercept	0.91	0.57	0.98	1.71	0.83	0.58	0.10	0.25	0.74
Slope	0.45	0.63	0.66	0.41	0.72	0.52	1.01	0.84	0.54
Interaction	0.85**	1.00	0.33	0.86**	1.00	0.31	0.86**	1.00	0.32
Social Support	0.06**	1.00	0.02	0.06**	1.00	0.02	0.06**	1.00	0.02
Mental Health	14.02**	1.00	0.47	14.09**	1.00	0.45	14.02**	1.00	0.45
Baseline	10.08**	0.87	1.24	10.87**	0.84	1.08	6.94**	0.95	0.99
6 months	3.97**	0.69	0.67	2.49**	0.56	0.65	5.57**	0.66	0.92
12 months	2.23**	0.40	1.44	2.34*	0.44	1.08	3.98**	0.34	1.67

Note. Std = standardized, Est = estimate, SE = standard error. ^aStandard errors correspond to unstandardized estimates.

Unstandardized (*b*) and standardized (β) estimates are presented in this table for regression analyses. The standardized estimate represents the completely standardized solution in which both latent and observed variables are standardized. Each model also includes covariates. * $p < .05$; ** $p < .01$

CHAPTER V

DISCUSSION

Using an existing longitudinal dataset, this study examined the post-substance use treatment risk and protective factors that influence changes in AUD and DUD symptoms, as well as AOD consequences, among adolescents in recovery from SUDs. Specifically, I modeled the average 12-month trajectories of AOD consequences, AUD symptoms, and DUD symptoms following substance use treatment among a sample of 294 adolescents with SUD histories. I also modeled the interaction between social support and each cluster of mental health symptoms. The results provided no evidence of an interaction effect between social support and mental health symptoms on any outcomes, nor evidence that social support was associated with initial levels or the rate of change in substance use outcomes after treatment exit. There were no significant findings related to AOD consequences, which may indicate that this construct was less clinically meaningful for adolescents in their post-treatment recovery period (in relation to mental health and other relevant psychosocial factors). Additionally, although this outcome was related to “consequences” of drug and alcohol use, this construct more closely resembles a construct related to substance seeking behaviors and motivations for continued use. This may also explain this null finding and is further discussed as a limitation.

In general, results from each set of models indicated substantial heterogeneity in the initial levels (at treatment exit) and 12-month trajectories (after treatment exit) of the outcome variables. Some mental health symptoms were significant predictors of baseline levels of AUD and DUD symptoms, even after controlling for the impact of social support, such that having more mental health symptoms at treatment exit was associated with also reporting more SUD symptoms.

Regarding aim 1, none of the unconditional models that estimated an average linear trajectory and included no predictor variables were interpretable due to poor model fit. This finding suggests that it may be unrealistic to model an unconditional growth trajectory of substance use outcomes given the heterogeneity in experiences and characteristics among adolescents in recovery from SUDs. In line with the social-ecological model, there are likely a host of potential social risk and protective factors, as well as individual differences like age and race, that impact adolescents' outcomes following treatment, and it is therefore unlikely that one linear trajectory is sufficient to capture adolescents' post-treatment experience (Connell et al., 2010; Elkington et al., 2011; Maina et al., 2021; Raynor, 2013; Trucco et al., 2020). Indeed, visual inspection of the trajectories suggests that although adolescents experienced overall, average decreases in outcomes following treatment, individual trajectories over the 12-month follow-up period were clearly heterogeneous.

Regarding aim 2, which modeled the independent effects of mental health and social support on the initial levels and rate of change over time of each outcome, there were several unique associations between mental health symptoms and AUD and DUD symptom outcomes. The findings suggested that having more depressive symptoms at treatment exit only predicted initial levels of AUD symptoms (not the rate of change over time), whereas symptoms of GAD significantly predicted only initial levels of DUD symptoms at treatment exit. These findings are consistent with prior research indicating the co-occurrence of depression and anxiety disorders with SUDs (Grella et al., 2001; Rowe et al., 2004; Shane et al., 2003; Wolitzky-Taylor et al., 2012), and that other mental health symptoms predict baseline levels of SUD symptoms, but not the rate of change over time (Brunelle et al., 2013). These findings also indicate a potential

unique and differential influence of depression versus anxiety symptoms in predicting the severity of symptoms in AUD versus DUD.

There were two findings suggestive of a relationship between baseline levels of mental health symptoms and the change over time in symptoms of SUD. First, baseline levels of depressive symptoms were associated with a slower rate of change (i.e., less improvement) in DUD symptoms over time following treatment, which is somewhat in contrast with hypothesis 2. However, this finding is consistent with prior research that indicates mood and anxiety symptoms predict the general rate of change in substance use following treatment (Becker et al., 2011; Campbell et al., 2016). Additionally, I found that adolescents with more PTSD symptoms at treatment exit experienced a slower rate of decrease over time in AUD symptoms. This is consistent with prior research that PTSD symptoms at SUD treatment exit may influence post-treatment trajectories of AUD symptoms (Kenneson et al., 2013; McCauley et al., 2010; Steinbuechel et al., 2009). Other research highlights how adolescents with trauma histories tend to have more severe substance use problems at treatment admission, which in turn may impact their specific treatment needs (Grella et al., 2004) and the way they respond to SUD treatment (Grella & Joshi, 2003). Together, these findings suggest that the rate at which adolescents' SUD symptoms resolve may vary based on the intensity of PTSD symptoms, as well as depressive symptoms. Overall, these results indicate a need for treatment of comorbid conditions to address both SUDs and other mental health conditions (Bishop et al., 2017; Fitzpatrick et al., 2020).

Contrary to my hypothesis for aim 3, there was no evidence of a significant interaction between social support and mental symptoms on any outcomes. This null finding might reflect a Type II error due to low statistical power and complexity in estimating the models that examined these interactions. Additionally, given that the results provide no evidence that social support is

associated with any substance use outcomes, this may also signal that my latent construct of social support did not accurately or fully reflect the type of social support that adolescents perceive in their post-treatment experience. Specifically, there may be better ways to capture the nuances of social support, such as utilizing measures that capture various types of support from peers versus family members, or measures that are specific to recovery-based support. The implications of these findings are discussed in greater detail in the following sections.

Theoretical and Clinical Implications

An overarching implication of my dissertation results is the unique and differential impacts of certain mental health symptoms (GAD vs. MDD) on alcohol use versus other drug use patterns. These findings have important clinical implications that are noteworthy. First, although depression and anxiety commonly co-occur and can be effectively treated with similar approaches (e.g., CBT; Carpenter et al., 2018; García-Escalera et al., 2016), these findings provide important insight into the ways that symptoms of depression versus anxiety may differentially impact the changes in DUD symptoms following treatment. Depression and anxiety are commonly collapsed into one category of “internalizing disorders” because they tend to co-occur and share similar behavioral characteristics (e.g., appearing withdrawn, irritable, isolated; Zahn–Waxler et al., 2000), but this does not mean that they have equal effects on post-treatment substance use trajectories. Second, it is important to note that cannabis was the most commonly reported drug used among adolescents in the sample (consistent with prior research; Goldstick et al., 2021). Although it is unclear whether cannabis use disorder was the treatment target for these adolescents, adolescents engaging in cannabis or other drug use who also have high levels of depression at treatment exit may experience a slower rate of decline in DUD symptoms after treatment. Clinicians working with youth in SUD treatment settings with similar characteristics

should therefore carefully assess the severity in depression symptoms and cannabis use, as well as differentiate symptoms of depression and anxiety disorders. Further, understanding the nature of the specific SUD for which adolescents are being treated is important in order to provide targeted clinical support, which may in fact have an impact on the rate of change in alcohol or drug use symptoms over time following treatment.

Third, depressive and trauma symptoms were associated with a slower decrease in symptoms of DUD and AUD, respectively, following treatment. On one hand, this signals a unique relationship between these mental health symptoms and their rate of change over time after receiving treatment for SUD, signaling that practitioners providing treatment and assessing for symptoms throughout treatment should attend to these nuances. On the other hand, these findings suggest that adolescents still experienced an overall, beneficial decline in symptoms regardless of the level of mental health severity when exiting treatment, albeit slower than others with lower symptom counts of depression and PTSD. This finding may be most relevant for other caregivers in adolescents' lives such as parents and teachers, or other mental health providers that interact with these youth after SUD treatment. Specifically, it should be kept in mind that although adolescents are exiting treatment with elevated symptoms associated with mental health and SUD, these are likely to decrease slowly within the first year after treatment. This study did not, however, account for additional variables that may also explain the links between PTSD and MDD and the changes in SUD. For instance, it could be the case that adolescents who exhibit more severe mental health symptoms are likely to receive continuing care, which in turn promotes the decrease in SUD symptoms. Indeed, recent research identified several moderators that impact post-treatment experiences among adolescents with PTSD, including level of parental involvement and functioning, as well as the nature of treatment and

the trauma itself (Danzi and La Greca, 2021). Additionally, adolescents' experiences following treatment may vary based on the ways their symptoms manifest (e.g., behaviorally, cognitively, emotionally), which could influence their level of post-treatment support, or lack thereof (Zalsman et al., 2006). Taken together, these findings suggest that careful assessment and differential diagnosis of mood and trauma-related symptoms, as well as their co-occurrence with symptoms and severity of DUD versus AUD, is important for promoting post-treatment continuing care.

Fourth, somewhat surprising were the null findings regarding the influence of social support on any of the outcomes. This finding contrasts the literature base which generally has found a significant protective influence of social supports in the lives of adolescents, particularly those in recovery from SUDs (Dobkin et al., 2002; Godley et al., 2005; Hennessy et al., 2019; Warren et al., 2007). As noted above, one potential explanation for this null finding concerns the latent measure of social support, which may not have accurately reflected the significant influence of peers and families among adolescents in recovery from an SUD. And prior research has found that general social support from friends (but not substance-specific support from friends and family) may predict decreases in alcohol use (Groh et al., 2007), while other research suggests that adolescents who avoid substance-using peers are more likely to maintain their SUD treatment goals (Broome et al., 2002; Trocchio et al., 2013).

What may be more clinically meaningful and beneficial for future studies to consider is the various aspects or types of social support experienced by adolescents, in line with theories that delineate between emotional, instrumental, informational, and appraisal components of support (Kerres Malecki et al., 2002; Tardy, 1985). Prior empirical research suggests that different functions of social support, mental health, and substance use are important to explicate

in order to understand the nuances of their unique relations (Rubio et al., 2020), and in fact, this way of conceptualizing social support aligns with recovery capital theory (Hennessy, 2017; Hennessy et al., 2019). Specifically, various types of social supports may be relevant to measure clearly, including mutual aid groups (e.g., 12-step), familial support specifically for adolescent SUD recovery (e.g., Hogue et al., 2008), and peer groups that also value recovery goals (McCrary, 2004). Recent recovery capital research that has focused on the unique aspects of adolescent recovery (versus adults) identified important social components that emphasize the changes that occur in the recovery process. Specifically, adolescents may experience changes in their social networks throughout both treatment and continuing care, and their sources of support may shift to include those with shared substance use histories and attitudes about substances (Hennessy et al., 2019; Jurinsky et al., 2023). For instance, having non-substance using social supports in one's social networks may be particularly beneficial for adolescents whose goal is abstinence after treatment (Broome et al., 2002; Latimer et al., 2000; McCrary, 2004).

The recovery literature base also provides support for the changing and variable landscape of adolescents' recovery environments post-treatment. For example, qualitative research has studied how youth's perceptions of recovery may vary significantly from one to another – youth may not view SUD challenges as being chronic or needing continued support after a period of treatment (Gonzales et al., 2012). This may suggest that adolescents lack the tools and/or underappreciate the level of commitment to recovery-focused changes they need to make to maintain their treatment goals. In other research, adolescents noted that the most important aspects in their post-treatment recovery included making changes in their usual activities, changing their drug use behaviors, and making environmental changes (such as trying to connect with non-substance using peers), whereas therapy and clinical support were noted as

least important (Gonzales et al., 2013). Additionally, youth expressed a desire for continued substance use education and harm reduction options (vs. abstinence only recovery) and learning coping skills to manage stress (Gonzales et al. 2013). Taken together, these connections to recovery capital suggest that there are likely time-varying factors related to the social environment that need to be assessed following treatment and studied in future investigations.

Strengths, Limitations, and Future Directions

This study adds to the evidence base regarding adolescent substance use, mental health, and treatment/continuing care supports in several important ways. This study identified that mental health symptoms of MDD, PTSD, and GAD uniquely and independently predicted baseline levels of AUD and DUD symptoms at treatment discharge. The findings from this study suggest that in some cases, leaving treatment with increased mental health symptoms predicts severity in DUD and AUD symptoms and a slower decline in DUD and AUD symptoms after treatment. Overall, adolescents nonetheless experienced declines in symptoms over time. These findings also suggest that there are unique differences in the relation between mental health and specific SUD symptoms measured at treatment end. These associations held after controlling for the potential confounding influence of adolescents' age, race, sex assigned at birth, RHS status, and treatment history.

An additional contribution of this study is the emphasis on better understanding modifiable and salient characteristics of adolescents with SUD histories. Specifically, this study identified that overall, adolescents reported positive social support at treatment discharge, though this was not necessarily associated with average levels of SUD symptoms or consequences, nor changes in these characteristics over time. Overall, the rate of change over time was not significant for most outcomes, but the variability in baseline levels of symptoms and the overall

trajectories was substantial. This points to the presence of other variables not accounted for in the present study that may increase risk for some adolescents and decrease risk over time for others.

A third contribution to the literature base is the timing of the baseline data collection period, which occurred at discharge from substance use treatment. Due to various clinical factors such as leaving treatment early, lack of treatment exit/transition resources, etc., most of the research base has focused on intake levels of mental health and substance use symptoms. The present study provides evidence that the levels of symptomology at treatment exit may be just as important in understanding the levels of SUD and AOD consequences, which adolescents then carry into the post-treatment continuing care environment. The reason this is noteworthy is that this may fall on other stakeholders, such as parents, teachers, peers, and mental health therapists to address, rather than during SUD treatment. Clearly, adolescents are leaving SUD treatment with significant levels of MDD, PTSD, and GAD symptoms, as well as AUD and DUD symptoms.

Despite the contributions and strengths of this dissertation, it is not without limitations. First, this study relied on secondary data collected previously for the purposes of studying the effects of RHSs. This study is therefore reliant on the available measures; variables included in the parent study may not wholly capture each construct of my study aims. For instance, the latent construct of social support was not measured using an existing, well-established scale of social support. This measure of social support did not account for the potential influence of substance-using peers and/or family members, which could be suggestive of post-treatment abstinence (Broome et al., 2002; Latimer et al., 2000; McCrady, 2004; Richter et al., 1991). Adolescents in this sample have significant family histories of AODs, as well as peers that may align or not with their recovery goals and may hold attitudes favorable to substance use, even after treatment.

Additionally, the AOD consequences outcome may not have reflected diagnostic or clinical substance-related consequences such as interpersonal consequences (e.g., losing friends) or intrapersonal consequences related to withdrawal or negative feelings toward oneself. In sum, future research is warranted using measures that specifically reflect social support related to their substance use and recovery (rather than more general types of social support), as well as consequences of substances that align with common clinical experiences among those with SUDs, which may be more beneficial in understanding their impact on the changing rates of SUD symptoms over time.

Related to limitations of secondary data analysis, this study focused on mental health symptoms assessed via criteria from the DSM-IV, which is now outdated and does not accurately reflect the current conceptualization of these diagnoses. For example, AUD and DUD diagnoses in the DSM-5 (APA, 2013) now represent a continuum of symptoms of mild, moderate, and severe, compared to a dichotomous diagnosis of “abuse” or “dependence” as in the DSM-IV. It is also likely that participants have co-occurring conditions that were not fully accounted for in the present study. Future research would benefit from having a clear picture of the constellation of mental health symptoms and diagnoses, as well as treatment experiences that may influence post-treatment experiences. Additionally, there are several other mental health variables that are often comorbid with SUD symptoms in adolescents, including ADHD (Molinero & Hinckley, 2023; van Emmerik-van Oortmersse et al., 2012), as well as other externalizing disorders that may be critical to include and understand in future predictive modeling.

A third limitation is the racially and socioeconomically homogenous nature of the sample. Therefore, the findings are limited in their generalizability beyond White, middle-class families with adolescents with SUD histories. Similarly, although this dataset is novel and

clinically relevant, the relatively small sample size ($N = 294$) limited the complexity of the growth models that could be estimated and led to computational issues of poor model fit for a few of the models. Future research would benefit from examining these associations using a larger, more racially and culturally diverse sample.

A fourth important limitation relates to the methodological approach using linear growth modeling. Specifically, a linear fit may not have been the most appropriate for the nature of the data, reflective of relatively poor model fit. The fit indices were often discrepant, and while this is often expected and commonplace when using SEM, the implications of model misfits are not well understood. Further, a good-fitting model may also not necessarily reflect the best theoretical model. These methodological constraints limit the confidence with which the results can be interpreted, and therefore, future research is needed to replicate the findings and test similar model structures, as well as other types of analytical designs (e.g., multilevel modeling).

Relatedly, the results clearly indicated substantial variability in the post-treatment trajectories that are likely due to a variety of factors not accounted for in the current study, and an average, linear trajectory is likely inappropriate given the diversity in their experiences. However, due to lack of data and utilizing only three timepoints, modeling other types of growth (quadratic or S shaped) was not feasible. Potential directions for future research include investigating latent profile or group-based trajectory analyses, which would allow researchers to parse heterogeneity in patterns across and within characteristics, domains, and processes of recovery. In general, examining other types of growth trajectories, such as quadratic growth, may lead to a more nuanced understanding of changes in these outcomes over time. Additionally, future research would benefit from studying longer follow-up periods after treatment. While there are reasons why this may not be feasible (resources, staying in contact, burden to

participants and research/clinical personnel), visual inspection of the trajectories suggested an uptick in both AOD consequences and AUD and DUD symptoms by the 12-month follow-up.

Finally, I may not have adequately accounted for all potential confounders of the relationships of interest. Consistent with the social-ecological model, there are several spheres of influence in adolescents' lives that are important to consider, particularly within the interpersonal sphere. For instance, this study did not account for other potential influences of parents, peers, and school/community (beyond examining social support). Related to the individual sphere of influence, this study only observed mental health at treatment exit, not the potential change over time. Although I controlled for lifetime receipt of mental health treatment at baseline, it is likely that adolescents experienced changes in their mental health symptomology over the course of the study follow-up period, which may have a substantial impact on the likelihood that AUD or DUD symptoms change after treatment (e.g., Campbell et al., 2016). Future research may consider investigating the influence of time varying variables of interest given the change over time in predictor variables. Additionally, this study did not include broader spheres of influence such as community norms surrounding substance use, access to treatment or access/availability of drugs and alcohol, nor local/state policies surrounding substance use, all of which are important considerations. Given the salient influence of peers and larger social determinants of health, particularly for youth in recovery, future research efforts may benefit from the inclusion of other potential confounding variables within the social sphere of influence and societal/community level when examining the heterogeneity in recovery experiences post-treatment.

Conclusion

Adolescents with SUD histories who have completed substance use treatment are a unique clinical population that warrant effective treatment approaches and continuing care following treatment. Compared to the adult literature base, the evidence surrounding adolescents' post-substance use treatment trajectories, as well as potential moderators of these heterogeneous trajectories, is limited. In sum, results from this dissertation suggest that having more mental health symptoms at treatment exit is associated with also reporting a greater number of AUD and DUD symptoms. Furthermore, these symptoms of SUD appear to decrease at a slower rate among youth reporting more symptoms of PTSD and depression. On the whole, findings from this dissertation provide support for the need for integrated treatment for SUDs and co-occurring mental health disorders, which may ultimately help youth experience quicker reductions over time in alcohol and drug use symptoms after treatment. Given the many ways that adolescents change over time in terms of their individual development and their environment (e.g., friend groups, familial relationships, school), it is most likely that there are dynamic, time varying factors that would be important to account for in future research.

Importantly, given the nascent nature of this research and the need for replication to further evaluate model fit, the findings must be considered suggestive and interpreted with caution. Nonetheless, the current study adds to a small but growing evidence base regarding the challenges and supports of adolescents with SUD histories who have undergone substance use treatment. Understanding the levels of social support and mental health symptoms reported by adolescents at treatment discharge may inform future assessment of treatment discharge procedures to better understand potential risk and protective factors following treatment. This study provides insight into the unique impacts of mental health symptoms on symptoms of AUD and DUD, as well as the various individual trajectories of adolescents over the course of the year

following SUD treatment. Adolescents in recovery from SUDs clearly have varied and dynamic experiences following substance use treatment, which are likely impacted by a variety of social-ecological factors, only some of which could be accounted for in the present study.

Understanding substance use and other mental health recovery on a continuum of care is essential to support their recovery, maintain treatment goals, and ultimately contribute to their overall wellness.

APPENDIX A

Table S1. Factor Loadings of Latent Variable

Variable name	Item content	Standardized Estimate	SE	<i>p</i>	Variance	Variance SE
HSQ1	<i>I make friends easily</i>	0.31	-	-	0.34*	0.03
HSQ2	<i>Other kids seem to like me</i>	0.21	0.18	.004	0.21*	0.02
HSQ3	<i>I feel free to talk with friends about my problems</i>	0.27	0.26	.001	0.35*	0.03
HSQ4	<i>It's hard for me to tell anyone how I am feeling</i>	0.34	0.35	.000	0.50*	0.04
HSQ5	<i>There are people who care about what happens to me</i>	0.27	0.21	.001	0.24*	0.02
HSQ6	<i>People treat me fairly</i>	0.44	0.28	.000	0.22*	0.02
HSQ7	<i>There is someone I can talk to if I need to</i>	0.32	0.23	.000	0.23*	0.02
HSQ8	<i>It's stupid to trust other people</i>	0.34	0.35	.000	0.48*	0.04
CAS1	<i>Adults in my town or city listen to what I have to say</i>	0.79	0.93	.000	0.42*	0.05
CAS2	<i>Adults in my town or city make me feel important</i>	0.82	0.97	.000	0.38*	0.05
CAS3	<i>In my town or city, I feel like I matter to people</i>	0.69	0.87	.000	0.66*	0.07
CAS4	<i>In my neighborhood, there are lots of people who care about me</i>	0.55	0.67	.000	0.76*	0.07
CAS5	<i>If one of my neighbors saw me do something wrong, he or she would tell one of my parents</i>	0.27	0.51	.001	1.28*	0.11
CAS6	<i>My teachers really care about me</i>	0.47	0.66	.000	1.03*	0.09

Note. The standardized estimates represent latent estimates of the fully standardized solution.

HSQ = The How I Feel About Myself and High School Questionnaire; CAS = Community Activities and Support Scale.

**p* < .001

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