



RESEARCH ARTICLE

Longitudinal Emergence of Concurrent Mental Health and Substance Use Concerns in an Ontario School-Based Sample: The Research and Action for Teens Study

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Abstract

Objectives: This study characterizes patterns of mental health, substance use and their co-occurrence, and identifies developmental trajectories associated with progression from single to concurrent mental health and substance use concerns in an Ontario school-based population. It is a longitudinal extension of the Ontario Student Drug Use and Mental Health Survey, as part of the RAFT collaborative project. **Methods:** In this study, an Ontario-wide survey was administered to students across three biennial waves starting in grades 7-8 (ages 12-14). We explored how developmental patterns of externalizing, internalizing and co-occurring symptoms were differentially associated with late-adolescent (ages 17-19) problematic substance use. **Results:** On average, students exhibited early (ages 12-14) moderate risk of an internalizing and/or externalizing disorder and approached the low threshold for a diagnostic concern for substance use disorder at age 17-19. The pattern confirmed a potential pathway from early mental health concerns to later adolescent problematic substance use, with rates of co-occurrence increasing with age. Youth with early moderate-to high externalizing and co-occurring internalizing and externalizing symptomatology had the highest levels of problematic substance use, with scores indicating high likelihood of a substance use disorder diagnosis. **Conclusions:** Given the overall pattern of progression, early identification and referral of at-risk youth, especially youth with co-occurring mental health concerns, is of critical importance. Findings support the importance of integrated and co-located mental health and substance use services for youth to more effectively serve a diverse population of youth with varying levels of need.

Key Words: *longitudinal, mental health, substance use, school-based, adolescence*

Résumé

Objectifs: La présente étude caractérise les modèles de santé mentale, l'utilisation de substances et leur cooccurrence, et identifie les trajectoires développementales associées à la progression des problèmes isolés à concurrents de santé mentale et d'utilisation de substances dans une population scolaire de l'Ontario. Il s'agit d'une extension longitudinale du Sondage sur la consommation de drogues et la santé des élèves de l'Ontario, dans le cadre d'un projet RAFT de collaboration. **Méthodes:** Dans la présente étude, un sondage a été administré à l'échelle de l'Ontario à des élèves

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de trois vagues biennales commençant en 7^e et 8^e année (de 12 à 14 ans). Nous avons exploré comment les modèles développementaux d'externalisation, d'internalisation et les symptômes co-occurents étaient différemment associés au début tardif (de 17 à 19 ans) d'une utilisation de substances problématique. **Résultats:** En moyenne, les élèves montraient un risque modéré précoce (de 12 à 14 ans) d'un trouble d'internalisation et/ou d'externalisation et s'approchaient du seuil bas d'un problème diagnostique d'utilisation de substances entre 17 et 19 ans. Le modèle confirmait une trajectoire potentielle allant de problèmes précoces de santé mentale à l'apparition ultérieure d'une utilisation de substances problématique, avec des taux de cooccurrence augmentant avec l'âge. Les jeunes ayant une externalisation modérée à élevée et une symptomatologie d'internalisation et d'externalisation co-occurentes avaient les taux les plus élevés d'utilisation de substances problématique, leurs scores indiquant une probabilité élevée d'un diagnostic de trouble d'utilisation de substances. **Conclusions:** Étant donné le modèle de progression général, l'identification précoce et l'aiguillage d'un jeune à risque, surtout les jeunes présentant des problèmes de santé mentale co-occurents, sont d'une importance vitale. Les résultats appuient l'importance des services intégrés et en colocation de santé mentale et d'utilisation de substances pour les jeunes afin de servir plus efficacement une population de jeunes diversifiée dont les besoins sont de niveaux variés.

Mots clés: *longitudinal, santé mentale, utilisation de substances, adolescence en âge scolaire*

Adolescence is a critical period for the emergence of mental health and substance use concerns (Kessler et al., 2005). It is also a key period in terms of achieving developmental milestones, such as completing school, developing problem-solving skills, and achieving autonomy (Arnett, 2004; Wehmeyer & Shogren, 2017) – milestones that can be interrupted by substance use and mental health challenges. However, some 20-25% of youth have had a lifetime mental health disorder (Merikangas, He, Brody, et al., 2010; Merikangas, He, Burstein, et al., 2010). Trends indicate a recent increase in prevalence of youth mental health challenges (Collishaw, 2015; Gandhi et al., 2016; Mojtabai, Olfson, & Han, 2016), with a six month prevalence of any mental health disorder of nearly 22% in Ontario, Canada in the 2014 Ontario Child Health Study (Georgiades et al., 2019). Individuals with mental health disorders are two times more likely to have co-occurring substance use (SU) problems (Rush et al., 2008). More severe emotional and behavioral problems are more strongly associated with the development of an SU disorder (Armstrong & Costello, 2002; Roberts, Roberts, & Xing, 2007). Canadian youth ages 15-24 have the highest rates of SU disorders compared to any other age group (Pearson, Janz, & Ali, 2013).

Internalizing and externalizing disorders can interact in unique ways, acting as both risk and protective factors for SU in youth (Colder et al., 2013; Colder et al., 2014; Colder et al., 2017). The early presence of internalizing, externalizing and co-occurring internalizing-externalizing symptoms may reflect distinct trajectories, with the possibility of shared risk factors (Copeland et al., 2013; Kessler et al., 2005; Wolitzky-Taylor, Bobova, Zinbarg, Mineka, & Craske, 2012). Longitudinal studies have identified that co-occurring internalizing and externalizing symptoms are associated with higher rates of SU problems (Colder et al.,

2013; Colder et al., 2014; Colder et al., 2017), while a pooled review of studies further identified that co-occurrence was strongly associated with dependence (Chan, Dennis, & Funk, 2008). Concurrent mental health and substance use disorders (C-MHSU) are associated with poorer psychosocial, occupational, and educational outcomes (Catchpole & Brownlie, 2016; Henderson, Hawke, & Chaim, 2017; Lewinsohn, Rohde, & Seeley, 1995). Therefore, it is essential to develop a stronger evidence base to understand risk and developmental trajectories in the progression from a single disorder to C-MHSU in youth. Better understanding and prevention of youth mental health and/or substance use concerns have been identified as policy priorities in Canada (Mental Health Commission of Canada, 2012).

Only one-sixth of youth with a mental health disorder receive services for mental health concerns (Office of the Auditor General of Ontario, 2008). Low rates of service utilization have been explained by the difficulty in identifying and referring youth to appropriate services (Office of the Auditor General of Ontario, 2008), as youth with C-MHSU are often found in other service settings (e.g., criminal justice system, child welfare) (Henderson, Chaim, Hawke, & National Youth Screening Project, 2017). At high risk of being underserved, these youth tend not to receive specialized services (Chan, Godley, Godley, & Dennis, 2009; Priester et al., 2016; Waddell, McEwan, Shepherd, Offord, & Hua, 2005). For those with C-MHSU, this risk is potentially compounded by greater symptom severity, poorer prognosis and greater unmet needs (Crome & Bloor, 2005; Sterling, Weisner, Hinman, & Parthasarathy, 2010; Vida et al., 2009).

The Ontario Student Drug Use and Health Survey (OSDUHS, 1977-2017) is the longest Ontario-wide biennial cross-sectional cohort survey of youth (grades 7-12) (Boak, Hamilton, Adlaf, Henderson, & Mann, 2018). It provides

surveillance and monitoring of emerging trends in alcohol, drug, and mental health symptoms among school-based youth in Ontario. Cross-sectional OSDUHS findings of higher overlap between mental health and substance use (MHSU) concerns during mid-to-late adolescence is consistent with the broader literature (Armstrong & Costello, 2002; King, Gaines, Lambert, Summerfelt, & Bickman, 2000; Roberts et al., 2007). OSDUHS findings also show lower SU prevalence during early elementary school, with frequent and problematic SU peaking in later secondary school years for the majority of substances (Boak et al., 2018). Since adolescent SU can impact life-course trajectories during critical developmental stages (Jacobus et al., 2015; Kim-Cohen et al., 2003), it is a primary candidate for early intervention. However, there is an evidence gap regarding patterns of risk and developmental trajectories in school-based youth, which require longitudinal studies.

Some longitudinal studies have investigated developmental trajectories of C-MHSU (Goodwin, Fergusson, & Horwood, 2004; Pardini, White, & Stouthamer-Loeber, 2007). However, few have begun before the age of 16. This study utilizes the strengths of the OSDUHS, which starts at age 12-13, while addressing the identified research gap through a longitudinal extension (L-OSDUHS) as part of a larger Research and Action for Teens (RAFT) project (Henderson et al., 2019). In this L-OSDUHS report, we explore developmental trajectories of MHSU patterns most commonly found in cross-sectional OSDUHS reports (Boak et al., 2018; Boak, Hamilton, Adlaf, & Mann, 2017).

Objectives. 1) Explore how different developmental patterns of externalizing and/or internalizing symptoms are differentially associated with the emergence of problematic substance use; 2) Investigate whether these associations are accounted for by demographic, social, and school-related factors.

Methods

Sampling

The sampling and survey methodology of the L-OSDUHS are presented in Brownlie et al. (2018). Repeated measures data were collected starting in grade 7 or 8. Wave 1 data collection occurred from January 2011 to April 2011, Wave 2 from June 2012 to November 2014, and Wave 3 from April 2015 to February 2016. The 45-minute self-report survey was administered in paper-and-pencil format in classrooms at Wave 1 and 2. At Wave 3, data were collected online using FluidSurveys to maximize retention in the context of possible geographic moves during the transition to the post-secondary education and the workforce. Consent was

obtained at all waves and compensation was provided. This study was approved by the Research Ethics Board at the Centre for Addiction and Mental Health.

Participant attrition and removal. At Wave 1, 1291 participants were invited to complete the survey; 925 consented, but 138 were absent during the data collection period. In all, 787 (60.9%) participants completed the survey. Of Wave 1 participants, 401 (51.0%) completed Wave 2, and 499 (63.4%) completed Wave 3. Based on an algorithm and manual inspection of the demographic data, inconsistencies in information provided across each Wave were flagged and reviewed by the research team. Extremely high frequency responses with minimal variability were flagged for review as potential invalid data; five participants were identified as invalid responders based on this criterion. Twenty-two participants were removed from the study (Wave 1, $n = 765$; Wave 2, $n = 379$), with 14 additional participants removed at Wave 3 (Wave 3, $n = 463$), due to improbable extreme scores, or because static demographic variables were inconsistent across waves and/or 50%+ of their responses were missing.

Participant characteristics. Participants' mean ages were as follows: Wave 1 ($M=12.73$, $SD=0.67$, range: 11-15), Wave 2 ($M=14.62$, $SD=0.86$, range: 13-16), and Wave 3 ($M=17.12$, $SD=0.73$, range: 16-19). In all, 50.3% identified as male, 49.7% identified as female, and 63.1% (466) identified as Caucasian, which is similar to Ontario population rate (Statistics Canada, 2019). At Wave 1, 84.5% lived in a single home (as opposed to in multiple homes), and 78.0% lived with two parents. More than half reported that their mothers (75.5%) and fathers (69.8%) had completed post-secondary education, similar to Ontario population rates (Statistics Canada, 2019). The majority of participants were born in Canada (86.1%) and had one or more parents who were born in Canada (70.1%). Participation rates for Northern, Urban, Suburban and Rural regions at Wave 1 were as follows: Northern [23.4% (179)], Urban [32.3% (247)], Suburban [21.6% (165)], and Rural [22.7% (174)].

Measures

The Global Appraisal of Individual Needs-Short Screener (GAIN-SS) is a 20-item self-report screener that identifies risk for Internalizing, Externalizing, and Substance Use Disorders and Crime/Violence concerns. Items are rated based on recency of significant symptoms (0 = never to 5 = past month). Within each subscreener, endorsing 0 items in the past year indicates a low probability of a diagnosis meriting a thorough diagnostic assessment, 1 to 2 items indicates a moderate probability, and 3 or more items indicates a high probability (Dennis, Chan, & Funk, 2006). The GAIN-SS has been validated in youth with good sensitivity

(0.70) and specificity (0.90) (Dennis et al., 2006). In this study, the number of items endorsed on each subscreener was modeled. A participant was considered to likely meet criteria for C-MHSU with a score of three or greater on the Internalizing or Externalizing Disorder screener and one or greater on the Substance Use screener (Brownlie et al., 2018). A score of one or greater was used for SU as a conservative cut-off given the low prevalence of SU challenges at early ages of the longitudinal age range.

Alcohol Use Disorders Identification Test (AUDIT) is a 10-item measure of hazardous and harmful drinking (Saunders, Aasland, Babor, de la Fuente, & Grant, 1993). Scores range from 0-40, with a score of 8+ indicating dependence (Cogngrave, Hall, & Saunders, 1995). It has been validated in youth (Chung et al., 2000).

The CRAFFT Screening Test is a 6-item measure of drug problems designed for adolescents, with scores ranging from 0-6 (Knight et al., 1999). A score of 2+ indicates problematic drug use (Knight, Sherritt, Shrier, Harris, & Chang, 2002). Good validity and reliability has been demonstrated (Knight et al., 2002; Knight et al., 1999).

The Perceptions of Social Support-Family Subscale (PSS-FA) is a 20-item subscale of the Perceptions of Social Support Scale (Procidano & Heller, 1983). Yes/no items produce a total score ranging from 0-7, with higher scores reflecting more perceived social support. The PSS-FA has good reliability and validity (Gavazzi, Goettler, Solomon, & McKenry, 1994; Procidano & Heller, 1983).

Demographic questions and additional substance use and service utilization questions were drawn from the OSDUHS (Paglia-Boak et al., 2012). Demographic questions included age, sex, ethnicity, maternal and paternal education level, length of time lived in Canada, whether their parents were born in Canada, region of residence, and socioeconomic status (on a 1 to 10 scale, with 10 being the highest). Participants were asked about peer substance use (e.g., 5-point Likert scale: 'none of my friends use' to 'all of my friends use') and ease of access ('probably impossible' to 'very easy'). Participants were asked 5 questions about their connectedness to school, scored on a 4-point Likert scale, with scores ranging from 5-20. Lower scores reflected feeling more connected with their school.

Data Analyses

Latent class analysis (LCA). A repeated measures LCA (Lanza & Collins, 2006) was conducted using Mplus (Muthén & Muthén, 2012) to identify trajectories of youth GAIN-SS Internalizing Disorder and Externalizing Disorder trajectories (Dennis et al., 2006). Separate LCAs were run on Internalizing and Externalizing subscreeners, as both

are considered unique dimensions of common psychopathology (Cosgrove et al., 2011; Krueger, 1999; Krueger, Caspi, Moffitt, & Silva, 1998). For both LCAs, we assessed models with 2-5 classes, comparing multiple fit indices: Bayesian Information Criteria (BIC), Akaike Information Criteria (AIC), Vuong-Lo-Mendell-Rubin Likelihood Ratio Test (VLMR) and its adjusted version, and entropy (Akaike, 1974; Lo, Mendell, & Rubin, 2001; Nylund, Asparouhov, & Muthén, 2007). After identifying the best-fitting model, we used posterior probability scores to assign participants to both an Internalizing and an Externalizing group. We replicated the analyses separately for male and female participants to examine whether the latent classes were different by sex. Despite different class means by sex, the differences did not appear meaningful as the classes were interpretively and clinically the same as the classes with the entire sample combined; we therefore present the results for the full sample. Missing values were handled using Maximum Likelihood estimation under MAR (Missing at Random) assumption (Little & Rubin, 2002) and non-normality was addressed using Robust sandwich estimator of standard errors (Yuan & Bentler, 2000). There were no differences in age, sex, or ethnicity based on the number of survey waves the participants completed. Demographic differences between the resulting latent classes were analyzed using chi² tests or ANOVAs, with post-hoc tests for group differences.

Principal component analysis. The primary outcome variable was problematic substance use at Wave 3, produced by entering three measures of substance use at Wave 3 into a principal component analysis: AUDIT, CRAFFT, and GAIN-SS Substance Use. Reduced dimensionality provides a more comprehensive and robust measure, while minimizing redundancy in reporting (Tabachnick, Fidell, & Ullman, 2007). One component explained 75.1% of the total variance, supporting the use of the single component score. Missing values were handled by calculating the covariance matrix using pairwise observations. Bivariate correlations were used to explore sex, family, school, and substance influence variables, and association with the outcome variable.

Association between latent classes and substance use. We examined whether latent class membership predicted the substance use principal component at Wave 3. This was done using the 3-step approach developed by Vermunt (2010) and further explained in Asparouhov and Muthén (2014), implemented manually in Mplus. Although the entire model could be estimated in a single step, Vermunt (2010) argues that such an approach can become very complex and the outcomes may influence class definition, which makes it unpractical and difficult to interpret. A 3-step approach was therefore used. In the first step, the latent classes

are estimated separately using the indicators Internalizing-k and Externalizing-k. In the second, step classes are assigned to subjects according to the highest posterior probability of class membership. In the third step, class predictors and distal outcomes are added to the model, where classes are estimated using class membership indicators and accounting for measurement error. Two categorical latent class variables were created in the third step, specified as predicting the problematic substance use component score. By default, Mplus considers that the classes interact. To test the interaction, we applied constraints to the model and compared the nested, more restricted model that has only main effects of classes with the unrestricted model including the interaction. This test is an adjusted likelihood ratio Chi-square test described in Satorra and Bentler (2010). If the interaction is significant at alpha 0.05, we explore the nature of the interaction by looking at the interaction plot with confidence intervals. The model also included covariates: sex, perceived social-support (family), and school connectedness, selected since they are individual, contextual factors that contribute to variations in patterns of substance use behaviors (Poulin, Hand, Boudreau, & Santor, 2005; Wagner et al., 2010; Weatherson et al., 2018).

Results

Descriptive statistics. The average participant was at moderate risk of an internalizing or externalizing diagnosis at all waves (i.e., GAIN-SS scores of 1+). SU scores increased across waves. However, average scores at each wave were below threshold, indicating the average participant was unlikely to meet criteria for a substance use disorder. At Wave 3, over a quarter of the sample met C-MHSU criteria (see Table 1). C-MHSU status was not significantly associated with sex, age, maternal or paternal education, immigrant status, region of residence, or socioeconomic status. C-MHSU status was significantly more likely among participants who were not Caucasian, $\chi^2(1) = 4.521, p = .033, \phi = .12$ or who had at least one parent born in Canada, $\chi^2(1) = 5.519, p = .019, \phi = .13$

Table 2 presents the change in contextual factors over time and their relationship with Wave 3 SU. There was a decline in youths' perception of school connectedness, $F(2, 636) = 24.90, p < .001$ from Wave 1 to Wave 3, as well as a decline in perceived family support across all waves $F(2, 534) = 5.81, p = .0032$. There were significant increases in peer SU, and in the ease of access to cannabis and alcohol across waves (all $ps < .001$). Most of these contextual factors were correlated with SU at Wave 3. There was no significant association between Wave 3 SU and sex ($p = .498$).

Latent Class Analyses (LCA). For the Internalizing LCA, a 3-class model was retained. Both VLMR and adjusted-VLMR supported the 3-class model as a better fit than the 2-class model ($p < .0001$), and 4 or 5 classes were not a significant improvement. AIC and BIC, and entropy values further supported a 3-class model. The 4 and 5 class models were also less interpretable, as the new classes were very similar to existing classes. For the Externalizing LCA, a 3-class model was also retained. Indices of Externalizing model fit produced VLMR and adjusted VLMR values that favored 3 classes over 2 classes ($p < .0001$), but that suggested 4 classes were a better fit than 3, though with not as high significance ($p = 0.024$ and $p = 0.027$ respectively). The 3-class and 5-class models had comparable entropy scores (97% and 99%, respectively), indicating high classification certainty. AIC and BIC scores indicated a better fit for a 5-class model. Class interpretations revealed that the 4 and 5-class models could be collapsed into a 3-class model retaining similar trajectories, while optimizing parsimony, data interpretation, and model fit. Fit statistics are available as supplementary material.

The three classes retained for Internalizing and Externalizing produce the six classes illustrated in Figure 1. For each class, time-based comparisons of Internalizing, Externalizing, SU, and C-MHSU scores are presented in Table 3. The Low-to-Moderate Internalizing group had low internalizing scores at Wave 1, rising to a clinically relevant "moderate likelihood" level by Wave 3. The Moderate Internalizing group had clinically relevant internalizing scores at all three waves, rising across waves. The High Internalizing group was the highest risk group, with internalizing scores meeting the high likelihood threshold at Wave 1 and 3. The Low-to-Moderate Externalizing group had low externalizing scores at Wave 1, rising to a "moderate likelihood" clinically relevant level by Wave 3. The Moderate Externalizing group had clinically relevant Externalizing scores that declined. The High-to-Moderate Externalizing group had high likelihood scores for Externalizing at Wave 1, declining to "moderate likelihood". All groups, except the High-to-Moderate Externalizing Group, had a statistically significant increase in the percent of youth meeting criteria for C-MHSU across waves. Demographic characteristic across the latent classes for Internalizing and Externalizing are presented in Tables 4 and 5 respectively. For Internalizing disorder trajectories, females were more likely than males to be in the highest risk class. Having a father without a post-secondary education was also significantly associated with Internalizing risk. Lastly, a higher socioeconomic status was associated with being in the lowest risk Internalizing class. The remaining sociodemographic characteristics were not significantly associated with Internalizing class

Table 1. Student mental health, substance use, and concurrent mental health and substance use across waves among subjects who completed all three waves

	Wave 1	Wave 2	Wave 3	F/p or χ^2/p	$\eta p^2/ \phi$
GAIN-INT (n = 319)					
(M, SD)	1.54(1.55)	1.40(1.59)	2.39(1.79)	51.98/<.001 ^{1,2}	0.14
GAIN-EXT (n = 321)					
(M, SD)	1.18(1.33)	1.33(1.36)	1.70(1.38)	16.48/<.001 ^{1,2}	0.05
GAIN-SUD (n = 319)					
(M, SD)	0.10(0.46)	0.22(0.66)	0.80(1.25)	70.12/<.001 ^{1,2,3}	0.18
AUDIT (n = 313)					
(M, SD)	0.47(1.81)	1.23(2.64)	3.79(4.89)	110.50/<.001 ^{1,2,3}	0.26
CRAFFT (n = 316)					
(M, SD)	0.04(0.33)	0.22(0.73)	0.77(1.32)	69.10/<.001 ^{1,2}	0.18
C-MHSU (n = 321)					
% (n)	4.4% (14)	7.5% (24)	28.7% (92)	101.01/<.001 ^{1,2}	0.154

Note. F/p significance values from repeated measures ANOVA; ¹Significant pairwise difference between Wave 1 vs. Wave 3, ²Significant difference between Wave 2 and Wave 3; ³Significant difference between Wave 1 and Wave 2, Bonferroni correction, p = .025; χ^2/p significance tests for within-group comparisons using Cochran's Q test; ηp^2 partial eta square effect size for repeated measures ANOVA; ⁴ ϕ Phi effect size for comparisons of % C-MHSU at Wave 1 and Wave 3.

INT = Internalizing, EXT = Externalizing, SUD = Substance use, C-MHSU = concurrent mental health and substance use.

membership. For Externalizing, only socioeconomic status was associated with class membership, where a higher socioeconomic status was associated with being in the lowest Externalizing risk group.

Association with Substance Use. The three-class models were used to investigate SU differences at the third wave. There was a group interaction: the effect of Internalizing groups depended on which Externalizing group the individuals belong to ($\chi^2(4) = 16.5, p = 0.002$). We investigated the nature of the interaction using a profile plot with estimated marginal means of the SU principal component (Figure 2). The first Internalizing group (Low-to-moderate) shows average levels of SU regardless of Externalizing group membership (the principal component is around 0, Figure 2). Those in the moderate Internalizing group present higher levels of SU than the first group if they are also in the High-to-moderate Externalizing group. Those in the High Internalizing group have higher average SU, except for those in the Low-to-moderate Externalizing group, which has lower average SU; however, this is a very small group and should be interpreted with caution.

In the main effects model, SU generally increases from the first to third classes in both Internalizing and Externalizing (results not shown). The Low Externalizing group seems to have at least stable SU levels across Internalizing classes;

similarly, in the Low Internalizing group, SU seems to not be affected by Externalizing class. Belonging to either Low Internalizing or Low Externalizing classes seems to be protective against SU at a later age. Sex, perceived social support and school connectedness (all three waves) were then entered as covariates in the general linear model. Covariates did not impact the pattern of the results, suggesting that Internalizing and Externalizing profiles were predictive of problematic SU independent of covariates.

Discussion

This study characterized longitudinal patterns of mental health, substance use, and co-occurrence in an Ontario student population. Building on decades of cross-sectional OSDUHS findings (Boak et al., 2017) and youth literature (Chan et al., 2008; Colder et al., 2017; Cosgrove et al., 2011; Krueger et al., 1998), we adopted a theoretical framework that focused on exploring different trajectories of internalizing, externalizing and co-occurring internalizing and externalizing concerns and their progression towards later adolescent-onset problematic SU.

On average, students exhibited early and moderate clinical diagnostic risk for internalizing and externalizing disorders at all waves. At age 13-14, on average, youth were below the low threshold for SU diagnostic concern. By age 17-19,

on average, students almost met the moderate risk threshold. Early high internalizing disorder risk was associated with female sex, lower paternal education, having one or more parents born outside of Canada, and lower socioeconomic status; for moderate or high externalizing risk, the only sociodemographic association was lower socioeconomic status. There was a significant increase C-MHSU over time, with almost 30% meeting criteria by Wave 3, and with higher rates among participants who were not Caucasian and who had at least one parent who was born in Canada. This pattern confirms a potential pathway from early mental health concerns to later onset C-MHSU.

Consistent with previous literature (Chan et al., 2008), youth who endorsed early moderate-to-high externalizing symptoms had high problematic SU at ages 17-19. However, youth with early and high co-occurring internalizing and externalizing symptomatology reported the highest SU. Youth with early high internalizing but low externalizing symptoms had problematic SU that was not significantly different from youth with minimal mental health concerns. Internalizing concerns may serve a protective function against problematic SU in the relative absence of externalizing concerns. A protective internalizing effect has been previously theorized to be due to more risk-averse personalities and limited affiliation with deviant and substance using peers (Colder et al., 2013; Windle, 1993). However, this effect may vary depending on the types of substances used and may be specific to adolescent substance use (Colder et al., 2013)

The timing, severity and co-occurrence of mental health symptoms are critical factors in the progression towards problematic SU and C-MHSU. Previous literature has identified diagnostic co-occurrence, commonly between internalizing and externalizing

Table 2. Changes in contextual factors over time, including bivariate correlations with Wave 3 problematic substance use component score. Means and Non-parametric Spearman Rank Correlations were calculated including only participants present in all three waves

	Wave 1			Wave 2			Wave 3			partial η ²	
	M (SD)	r	p	M (SD)	r	p	M (SD)	r	p		
School connectedness (n = 319)	8.94 (2.58)	0.02	0.78	8.80 (2.53)	0.1	0.071	9.87 (2.95)	0.11	0.053	24.9 <0.001 ^{2,3}	0.07
Perceived family support (n = 268)	5.32 (1.70)	0.01	0.868	5.04 (1.85)	-0.09	0.142	4.91 (1.99)	-0.04	0.527	5.8 0.003 ²	0.02
Peer use of alcohol (n = 211)	1.41 (.69)	0.35	< .001	2.31 (1.16)	0.43	< .001	3.31 (1.33)	0.59	< .001	220.7 <0.001 ^{1,2,3}	0.51
Peer use of cannabis (n = 215)	1.18 (.53)	0.25	< .001	1.81 (1.03)	0.41	< .001	2.53 (1.22)	0.6	< .001	146.8 <0.001 ^{1,2,3}	0.41
Peer use of other substances (n = 172)	1.08 (.31)	0.11	0.167	1.31 (.75)	0.16	0.037	1.52 (.93)	0.33	< .001	21.4 <0.001 ^{1,2,3}	0.11
Access to cannabis (n = 178)	1.67 (1.21)	0.33	< .001	3.14 (1.52)	0.25	< .001	4.02 (1.23)	0.51	< .001	213.8 <0.001 ^{1,2,3}	0.55
Access to alcohol (n = 190)	2.67 (1.56)	0.29	< .001	3.58 (1.31)	0.29	< .001	4.37 (.95)	0.32	< .001	136.4 <0.001 ^{1,2,3}	0.42
(M, SD)	0.47(1.81)	1.23(2.64)	3.79(4.89)	110.50/<.0011,2,3	0.26						
CRAFFT (n = 316)											
(M, SD)	0.04(0.33)	0.22(0.73)	0.77(1.32)	69.10/<.0011,2	0.18						
C-MHSU (n = 321)											
% (n)	4.4% (14)	7.5% (24)	28.7% (92)	101.01/<.0011,2	0.154						

¹Significant pairwise difference between Wave 1 vs. Wave 2, ²Significant pairwise difference between Wave 1 vs. Wave 3, ³Significant pairwise difference between Wave 2 vs. Wave 3, Bonferroni correction, p=.025.

Table 3. Model estimated means and standard errors for internalizing and externalizing indicators in each latent class

Class	Description	Wave 1		Wave 2		Wave 3	
		M (SE)	C-MHSU (%)	M (SE)	C-MHSU (%)	M (SE)	C-MHSU (%)
Internalizing Group 1 (n = 441)	Low-to-moderate	0.32(0.02)	0.00	1.05(0.12)	5.60	1.90(0.05)	24.30
	(1,2)(1,3)(2,3)*						
	(1,2)(1,3)(2,3)**						
Internalizing Group 2 (n = 195)	Moderate	2.41(0.01)	6.20	1.71(0.17)	10.50	2.84(0.13)	33.30
	(1,2)(1,3)(2,3)*						
	(1,3)(2,3)**						
Internalizing Group 3 (n = 85)	High	4.25(0.02)	27.40	2.52(0.06)	13.00	3.08(0.31)	39.70
	(1,2)(1,3)(2,3)*						
	(2,3)**						
Externalizing Group 1 (n = 451)	Low-to-moderate	0.25(0.02)	1.10	1.04(0.10)	4.80	1.51(0.06)	26.60
	(1,2)(1,3)(2,3)*						
	(1,2)(1,3)(2,3)**						
Externalizing Group 2 (n = 219)	Moderate	2.40(0.03)	6.40	1.63(0.03)	12.70	1.72(0.07)	31.40
	(1,2)(1,3)*						
	(1,3)(2,3)**						
Externalizing Group 3 (n = 51)	High-to-moderate	4.23(0.08)	33.30	2.61(0.23)	15.80	2.14(0.19)	38.50
	(1,2)(1,3)*						

*Indicates the waves that are significantly different from each other in Internalizing or Externalizing score, after Bonferroni adjustment for pairwise comparison between waves. Linear Mixed Model with subjects and schools as random effects were used for this test. **Indicates the waves that are significantly different from each other in C-MHSU, after Bonferroni adjustment for pairwise comparison between waves. Generalized Linear Mixed Model with subject and schools as random effects were used for this test.

symptomology (Miller-Johnson, Lochman, Coie, Terry, & Hyman, 1998). Evidence suggests that co-occurrence is due to common genetic and environmental influences, where personality and temperament may also play a role (Cosgrove et al., 2011; Gjone & Stevenson, 1997). Co-occurrence may be associated with earlier onset, higher early environmental risk (Fanti & Henrich, 2010), and greater mental health symptom severity (Newman, Moffitt, Caspi, & Silva, 1998). Youth with “pure” externalizing and co-occurring internalizing and externalizing tend to exhibit more negative peer relations, delinquent behavior, and connections with deviant peers, which may contribute to SU onset and further perpetuate SU (Fanti & Henrich, 2010; Oland & Shaw, 2005). Externalizing disorders tend to have an earlier onset, while internalizing has its onset over the life course (Chan et al., 2008); therefore, later onset, more severe internalizing symptomology may play a stronger role in the development towards adult problematic substance use (Chan et al., 2008).

In the current study, there were some associations between demographic variables and mental health concerns, as well as concurrent disorder status. There was also a strong association between having substance-using peers, easier access to substances, and higher SU. Future research should explore how these variables, along with other risk and protective factors, mediate and/or moderate the pathway. Literature specifically focused on understanding risk and protective factors related to co-occurrence and SU is scarce (Chan et al., 2008).

There is a small but clinically concerning group of youth at ages 13-14 who endorsed C-MHSU. Due to the small group size, they may go unrepresented in school-based research. Concurrent disorders in this age group

Figure 1. Internalizing (left) and Externalizing (right) Trajectories for LCA three-class Internalizing and Externalizing models

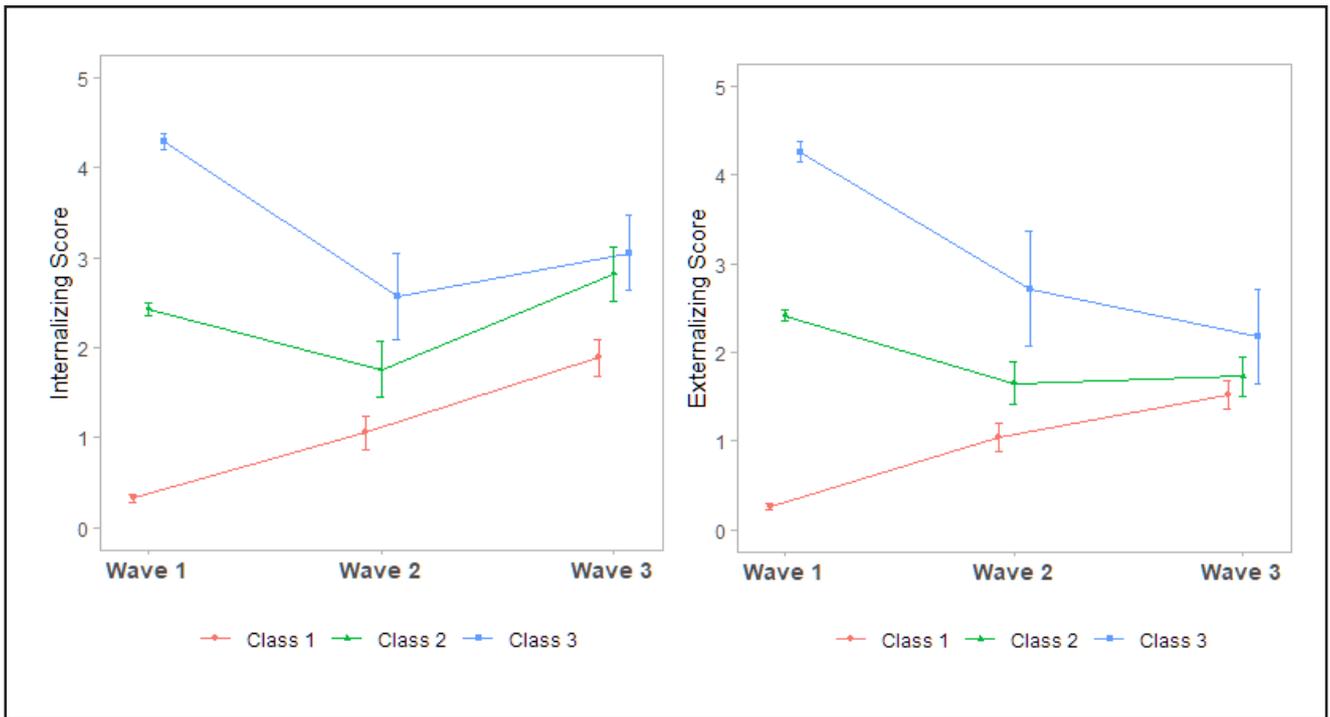


Figure 2. Problematic substance use component score for Internalizing-by-Externalizing class. The substance use score has a standard deviation = 1 so that a difference of 0.5 standard deviations is considered a moderate effect size (Cohen's d = 0.5)

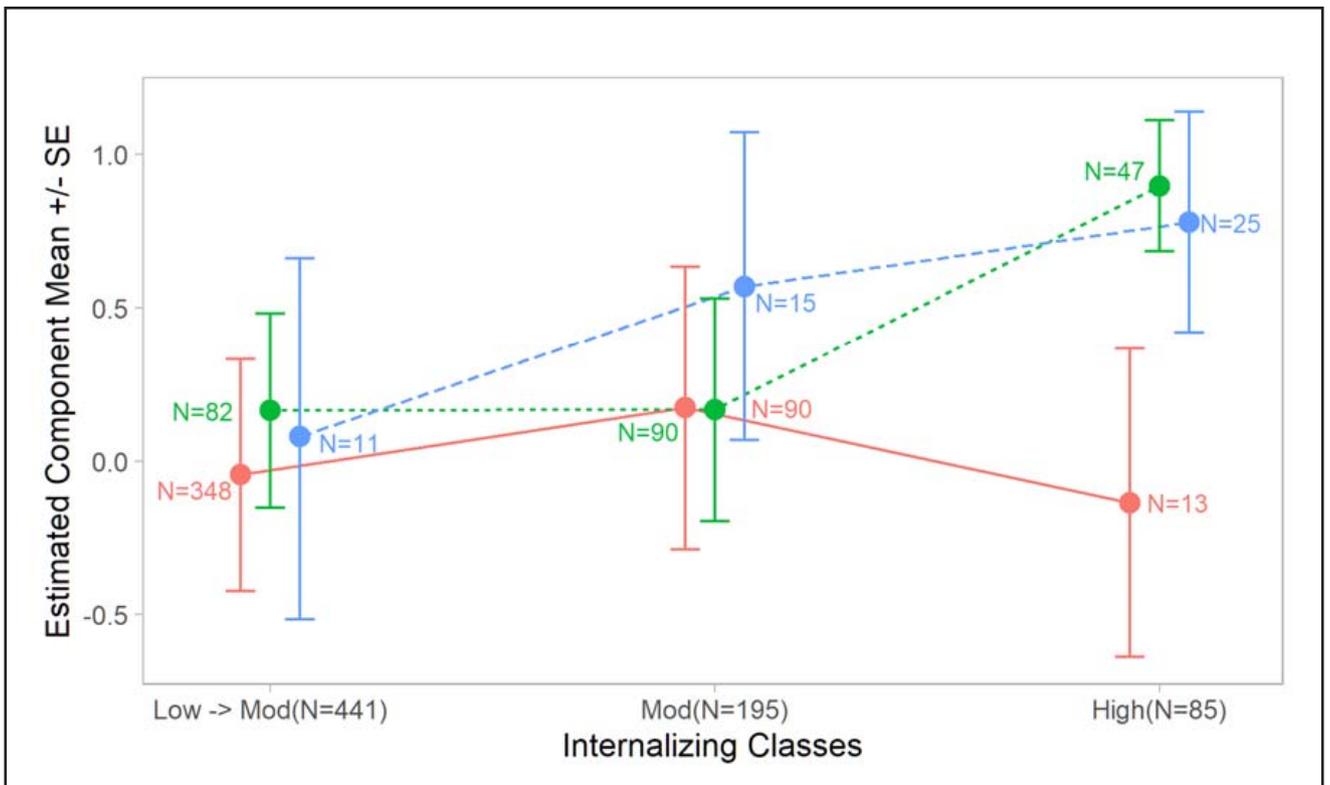


Table 4. Demographic characteristics by internalizing latent class

	Low-to-Moderate class	Moderate class	High class	Chi ² / F	p	Effect size ²
Sex – n (%)						
Male	247 (56.0)*	87 (44.6)*	33 (38.8)*	12.648	.002	.132
Female	194 (44.0)*	108 (55.4)*	52 (61.2)*			
Time 1 Age – M (SD)	12.68 (.66)	12.81 (.66)	12.76 (.63)	2.709	.067	.007
Ethnicity – n (%) ¹						
Caucasian	257 (63.8)	103 (57.5)	54 (65.9)	2.539	.281	.062
South or Southeast Asian	41 (10.2)	24 (13.4)	6 (7.3)			
South Asian		24 (6.0)	14 (7.8)	6 (7.3)		
Black	30 (7.4)	6 (3.4)	3 (3.7)			
Indigenous	4 (1.0)	2 (1.1)	3 (3.7)			
Multiple	34 (8.4)	20 (11.2)	8 (9.8)			
Another ethnicity	13 (3.2)	10 (5.6)	2 (2.4)			
Mother – post secondary education – n (%)	299 (77.9)	126 (72.8)	54 (72.0)	2.313	.315	.060
Father – post secondary education – n (%)	271 (73.6)*	110 (69.6)	37 (51.4)*	14.180	.001	.154
Born in Canada – n (%)	377 (86.7)	162 (84.4)	73 (86.9)	0.638	.727	.030
One or more parents born in Canada – n (%)	308 (70.3)	124 (64.2)	67 (78.8)*	6.145	.046	.093
Region – n (%)						
Northern	103 (23.4)	35 (17.9)	27 (31.8)	12.218	.057	.092
Urban	140 (31.7)	77 (39.5)	21 (24.7)			
Suburban	103 (23.4)	35 (17.9)	20 (23.5)			
Rural	95 (21.5)	48 (24.6)	17 (20.0)			
Socioeconomic status – M (SD)	7.29 (1.40)*	6.79 (1.54)	6.80 (1.70)	9.412	<.001	.026

¹Significance test conducted on Caucasian vs other due to sample sizes;

²Effect size: ϕ , Cramer's V, or η^2 as appropriate

*Post-hoc tests show significant differences at $p < .05$.

Table 5. Demographic characteristics by externalizing latent class

Class	Low-to-Moderate class	Moderate class	High class	Chi ² / F	p	Effect size ²
Sex – n (%)						
Male	224 (49.7)	110 (50.2)	33 (64.7)	4.203	.122	.076
Female	227 (50.3)	109 (49.8)	18 (35.3)			
Time 1 Age – M (SD)	12.69 (.65)	12.77 (.67)	12.84 (.73)	2.184	.133	.006
Ethnicity – n (%) ¹						
Caucasian	257 (61.2)	132 (66.7)	25 (54.3)	3.067	.216	.068
South or Southeast Asian	43 (10.2)	22 (11.1)	6 (13.0)			
South Asian		29 (6.9)	12 (6.1)	3 (6.5)		
Black	33 (7.9)	5 (2.5)	1 (2.2)			
Indigenous	3 (0.7)	3 (1.5)	3 (6.5)			
Multiple	42 (10.0)	15 (7.6)	5 (10.9)			
Another ethnicity	13 (3.1)	9 (4.5)	3 (6.5)			
Mother – post secondary education – n (%)	308 (77.6)	142 (72.4)	29 (74.4)	1.931	.381	.055
Father – post secondary education – n (%)	272 (71.6)	121 (68.0)	25 (62.5)	1.863	.394	.056
Born in Canada – n (%)	382 (85.8)	184 (85.6)	46 (90.2)	0.786	.675	.033
One or more parents born in Canada – n (%)	299 (66.7)	162 (74.7)	38 (74.5)	4.937	.085	.083
Region – n (%)						
Northern	89 (19.7)	61 (27.9)	15 (29.4)	9.367	.154	.081
Urban	160 (35.5)	61 (27.9)	17 (33.3)			
Suburban	102 (22.6)	45 (20.5)	11 (21.6)			
Rural	100 (22.2)	52 (23.7)	8 (15.7)			
Socioeconomic status – M (SD)	7.29 (1.42)*	6.76 (1.55)	6.82 (1.60)	10.199	<.001	.028

¹ Significance test conducted on Caucasian vs other due to sample sizes
² Effect size: ϕ , Cramer's V, or η^2 as appropriate
 *Post-hoc tests show significant differences at $p < .05$.

may represent a unique developmental pathway reflective of an underlying vulnerability to dependence and/or comorbid mental health disorders (Chambers, Taylor, & Potenza, 2003), and/or earlier and more severe exposure to negative developmental/environmental experiences (e.g. trauma) (Garner, Hunter, Smith, Smith, & Godley, 2014). Future researchers should target this population using longitudinal designs starting at an earlier age to better understand earlier time course and progression. Early identification and intervention for these high risk youth is essential, as they may have longer SU histories that span the entire developmental period, possibly resulting in more negative treatment and psychosocial outcomes (Ellickson, Martino, & Collins, 2004; Hawke, Wilkins, & Henderson, 2020; Silins et al., 2014).

The current findings highlight the critical importance of early identification of both mental health and substance use concerns. Given the pattern of progression, particularly for those with co-occurring concerns, early identification of any mental health or substance use concern holds the potential for addressing the concerns early and supporting a path to improved outcomes. Both mental health and SU services—especially services that address both—will be critical for these most vulnerable youth (Wiktorowicz, Abdulle, Di Pierdomenico, & Boamah, 2019). An emerging model of service delivery is the integrated youth service hub (i.e., a one-stop shop of youth service delivery that aims to address a wide variety of youth's needs) (Settipani et al., 2019). As integrated youth services continue to grow, it is critically important that they co-locate mental health and SU treatments, with special attention towards youth with early co-occurring mental health and SU concerns (Wiktorowicz et al., 2019).

Limitations

Self-report tools were used, which may not be reflective of a clinical diagnosis (Chan et al., 2008). In addition, the SU outcome did not distinguish between substances; the developmental pathway may vary by substance and the specific mental health concern (Colder et al., 2018; Colder et al., 2013). Future research should examine the reciprocal relationship between SU and internalizing, externalizing, and co-occurrence using a broader set of environmental factors (e.g., parental substance use), as well as individual factors (e.g., personality), and social factors (e.g., peer groups). Attrition should also be taken into account; youth with certain profiles may have been less likely to be retained over time. Replication and complementary studies are needed to address these issues.

Conclusion

Early onset externalizing and co-occurring internalizing and externalizing mental health concerns constitute a critical pathway leading to C-MHSU. Early risk identification, prevention and intervention efforts should start as early as elementary school to prevent cascading effects. Given that C-MHSU is increasingly prevalent over time and associated with poor prognosis and greater financial burden (Crome & Bloor, 2005; Urbanoski, Cairney, Bassani, & Rush, 2008; Vida et al., 2009), our findings bolster support for the call to government to allot more funding towards more early prevention and intervention efforts, as well as integrated mental health and substance use services that meet the diversity of youth needs.

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Conflicts of Interest

The authors have no financial relationships to disclose.

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