Investigating substance use as a coping strategy among adolescent psychiatric inpatients: A comparative analysis before and during the COVID-19 pandemic

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Abstract

Background: The COVID-19 pandemic was accompanied by significant changes in daily life, which impacted mental health and substance use behavior. Among adolescents, studies of COVID-related changes in rates of substance use yielded mixed findings. While studies of large U.S. samples found no significant increases in adolescent substance use during COVID-19, studies of youth with psychiatric symptoms suggest that some adolescents used substances to cope with negative affect during COVID-19. The current study compared rates of past-year substance use among adolescent psychiatric inpatients before and during COVID-19. Motives for coping with changes due to COVID-19 were assessed and evaluated in relation to correlates associated with psychiatric acuity (e.g., suicidal thoughts), and rate of past-year substance use.

Methods: This cross-sectional chart review study analyzed hospital intake data of psychiatrically hospitalized adolescents before and during COVID-19. Count models assessed if the number of past-year days of alcohol and cannabis use was higher among adolescents (n=491, 11-18 years, 61% female) hospitalized between 3/14/20 to 4/5/21 ("COVID-19") versus 8/30/2019 to 3/13/20 ("pre-COVID). For a subsample of inpatients admitted during COVID-19 (n=124; 75% female), we evaluated psychiatric correlates of endorsing alcohol, cannabis, or e-cigarettes to cope with COVID-19 changes/rules. Finally, we tested if past-year days of alcohol or cannabis use were greater for adolescents reporting they used that substance to cope with COVID-19.

Results: Adolescents admitted during COVID-19 reported significantly more past-year alcohol and cannabis use days than adolescents admitted pre-COVID. Adolescents endorsed using alcohol (19%), cannabis (33%), and e-cigarettes/vaping (25%) to cope with COVID-19. E-cigarette/vaping to cope during COVID-19 was significantly related to lifetime suicide attempt.

Endorsing alcohol or cannabis to cope with COVID-19 was associated with a significantly greater number of past-year use days for each respective substance.

Conclusion: Adolescents admitted to a psychiatric inpatient unit during COVID-19 had a higher rate of substance use than adolescents admitted pre-COVID. Using substances to cope was linked to psychiatric correlates (suicide attempt, impairment). Substance use patterns among psychiatrically vulnerable adolescents may be distinct from adolescents whose substance use is linked to other, non-coping motivations, and have important implications from preventing compounding negative outcomes among these youth.

Keywords: cannabis; alcohol; e-cigarettes; adolescents; mental health; COVID-19 pandemic; suicide

Background

The coronavirus disease 2019 (COVID-19) pandemic caused monumental shifts in the day-to-day lives and well-being of people across the globe. A growing body of evidence documents mental and behavioral changes stemming from the pandemic. Over 40% of U.S. adults who completed a United States (U.S.) Center for Disease Control (CDC) survey in June 2020 reported at least one negative behavioral/mental health condition, with trends indicating increasing rates of anxiety, depression, suicidal ideation, and substance use during the pandemic (1). Adolescents have also been vulnerable to the negative mental health effects of COVID-19 as demonstrated by remarkably high rates of depression and anxiety among youth during the pandemic (2, 3) and notable increases in symptoms compared to pre-pandemic estimates (4). In the U.S., concerns about potential rising rates of adolescent substance use emerged from recognition that the pandemic exacerbated pre-existing risk factors for substance use—already an adolescent public health problem—including stress, social isolation, boredom, trauma exposure, and other mental health factors (5); these factors could increase self-medication or coping-related use (6). Simultaneously, systems that may prevent or buffer risk for substance use (e.g., families, schools, social networks, mental health care) were under strain, resulting in decreased support which may have disproportionately impacted adolescents at heightened risk for mental and behavioral health concerns (5).

Somewhat surprisingly, emerging evidence on trends in adolescent substance use pre- and post-pandemic have yielded mixed findings. Notably, the Monitoring the Future (MTF) study, comprised of a U.S. representative sample of 8th, 10th, and 12th grade adolescents, did not find any changes in binge-drinking or cannabis use during the pandemic, and the prevalence of nicotine vaping decreased (7). The Adolescent Brain Cognitive Development (ABCD) Study,

another large U.S. sample that at the time was comprised of community youth aged 10-14, found a significant decrease in past 30-day alcohol use and a significant increase in past 30-day nicotine and prescription drug misuse during vs. pre-pandemic (8). A large (n = >7,000) sample of U.S. 13-17 year old adolescents found rates of all substances decreased in 2020 compared to 2018-2019 (9). Similarly, one Canadian study found that the occurrence of adolescent substance use declined during COVID-19 (10), whereas another found that while the percentage of adolescents engaging in any use decreased in the early weeks of the pandemic, the frequency of both alcohol and cannabis use increased (11). International reviews have also resulted in mixed findings. Two studies found overall declines or unchanged patterns in youth substance use (12, 13), whereas another earlier review noted a higher frequency of using alcohol and cannabis during the pandemic (2).

Given the complexity of studying adolescent substance use, many factors might confound results and complicate the interpretation of findings, including the locations of studies, differences in measurement and substances included, and characteristics of the populations sampled (9). Notably, several studies identified different characteristics (e.g., stress, mood symptoms, reasons for substance use) that may influence differential patterns of substance use before and during COVID-19 (14). For example, rates of social substance use may have decreased due to limited social contact (13), especially during the first year of the pandemic. These socially-driven effects may be reflected in large population-based samples of youth such as the MTF or ABCD cohorts.

Conversely, pandemic-related social isolation and mental health stressors could increase other motivating factors for use, such as coping-related use. The negative affect pathway theory proposes that substances are used as a form of coping with negative feelings; therefore,

experiencing negative affect and/or stress may pose risk for substance misuse (15-18). Consistent with this theory, 13.3% of the aforementioned adults surveyed by the CDC reported starting or increasing substance use as a means of coping with COVID-19 stress or emotions (1). Moreover, adults in that sample receiving treatment for psychiatric diagnoses had higher rates of initiating/escalating substance use than adults in the full sample not receiving treatment (i.e., a comparison group presumably with lower rates of psychiatric concerns). Adolescents in the ABCD Study who reported elevated stress and symptoms of negative affect during the pandemic, as well as those who had pre-existing internalizing and externalizing symptoms, were more likely to report substance use (8). Internalizing models of adolescent substance use propose that adolescents with internalizing conditions (e.g., depression, anxiety) are more likely to develop motives to use substances as a means of coping with tension and stress (15). In turn, these coping motives increase risk for engagement in substance use. Interestingly, although Acuff and colleagues (2022) found no changes in alcohol use in their overall sample during the COVID-19 pandemic, individuals with depression increased their consumption of alcohol. Similarly, another study found that early in the pandemic, more adolescents reported using substances alone than with friends, and solitary substance use was linked to increased COVID-19 fears and depressive symptoms (11). These findings suggest that individuals with internalizing conditions may engage in greater substance use during COVID-19 pandemic due to heightened levels of coping motivated use. Thus, substance use patterns among psychiatrically vulnerable adolescents may be distinct from adolescents whose substance use is linked to other, non-coping motivations.

Temperamental (e.g., disinhibition) and environmental (e.g., access to and affiliations with peers who use substances) characteristics of youth with externalizing conditions increase their susceptibility for substance use (19, 20). Taken together with findings from research on

internalizing disorders, these data suggest that adolescents presenting to acute psychiatric settings for internalizing or externalizing concerns (or possibly both) may be a group vulnerable to increases in substance use during the pandemic.

Limited research in the U.S. has explored rates of substance use before and during the pandemic among psychiatrically hospitalized adolescent populations. One study that compared rates of discharge diagnoses across two six-month periods before and during the pandemic found that the rate of substance use disorders (SUD) increased from 17% to 30%, and notably, there were no differences in rates of other diagnoses (21). Similarly, a large study compared SUD visits in inpatient and emergency departments at a children's hospital and found that the median number of SUD visits increased by over 14% during the first summer of COVID-19, compared to pre-COVID (22). These findings support the theory that psychiatrically vulnerable adolescents may be at risk for increased substance use during the pandemic; however, more research is needed to better understand patterns in use of different substances, factors influencing use, and links between substance use and other clinical concerns associated with acute hospitalization (e.g., suicidal thoughts or behaviors (23). Increased rates of substance use among this group can have severe consequences, as use of substances like cannabis, alcohol, and e-cigarettes have all been linked to suicide (23-28). Therefore, the goals of the current study were to assess in psychiatrically hospitalized youth: 1) rates of alcohol and cannabis use before and during the COVID-19 pandemic, 2) motivation to engage in substance use to cope with COVID-19-related stressors and links with psychiatric correlates of acute hospitalization, and 3) whether endorsing a motive of coping is associated with greater past-year days of substance use. We hypothesized the following: (a) adolescents hospitalized during COVID-19 would report a significantly greater number of substance use days compared to adolescents hospitalized before COVID-19; (b)

adolescents would indicate they used substances to cope with changes and stressors due to COVID-19, and that this motive would be linked to psychiatric correlates associated with the need for hospitalization; and (c) adolescents indicating a coping motive would report a higher past-year rate of substance use than adolescents without a coping motive.

Methods

Procedures

Data collection procedures occurred as part of standard intake protocol to an adolescent inpatient unit at a psychiatric hospital in the Northeast United States. During the admission process, adolescents were administered a substance use screening tool by hospital nursing staff. Adolescents subsequently completed a psychological assessment battery including self-report measures about mental health. This battery was administered by psychology staff who were available to answer questions and support survey completion. The study was conducted as a retroactive chart review that was approved by the hospital's Institutional Review Board and for which informed consent was waived.

Sample

The current study consists of adolescents (ages 11-18) hospitalized before and during the COVID-19 pandemic: defined as between 8/30/2019 and 04/5/2021. Race and ethnicity for the sample were as follows: 30.34% Hispanic; 5.39% American Indian or Alaskan Native; 3.41% Asian; 13.46% Black or African American; 11.67% Hispanic Black; 15.80% Hispanic White; 53.32% Non-Hispanic White; 1.26% Native Hawaiian or other Pacific Islander; 13.29% Other (rates total above 100% because adolescents could select more than one option). The full sample (n=491) consisted of adolescents hospitalized between 09/3/2019 and 04/5/2021 who completed a substance use screening measure that was included in their electronic health record (described

below). A subset of adolescents (n=124) hospitalized between 12/16/2020 and 04/05/2021 completed a specific set of questions regarding their use of drugs to cope with COVID-19 (described below). If adolescents had more than one admission during the time frame, data from their initial visit were used.

Measurement

Past 12-month substance use days. The CRAFFT (study objectives 1 & 3; (29)) is an interview-based screening assessment administered upon hospital admission to identify substance use and related risk behaviors among adolescents. Screening questions using yes/no responses evaluated alcohol use and cannabis use within the past 12 months. If adolescents endorsed previous use, they were asked to report days of use of each substance within the past 12 months (range: 0-365).

Substance Use Coping During COVID-19. A single item was included to assess substance use as a coping method during the COVID-19 pandemic (study objectives 2 & 3). The item was administered from 12/16/2020 to 4/05/2021. Youth were asked, "Before coming to the hospital, how much were you doing the following things to cope with COVID-19 (coronavirus) and the changes and rules put in place as a result of the virus?". Responses for "using drugs, alcohol, or vaping" ranged from 1 (Not at all) to 5 (Very Often). If youth selected a response of 2 (Rarely) or greater, they were administered an additional item which asked "Check off any substance(s) you used to cope". Response options were: marijuana (including marijuana vaping), alcohol, E-cigarettes or vaping (e.g., JUUL), and other drugs. Because only five adolescents endorsed "other drugs", this option was not included in analyses. Responses were binarized such that any endorsement of using substances to cope with COVID-19 was coded as 1, and "Not at all" was coded as 0.

Emotion Regulation. The Difficulties in Emotion Regulation Scale-Short Form (DERS-SF; study objective 2; (30)) is an 18-item self-report measure of emotion regulation across six domains: perceived limited access to emotion regulation strategies, nonacceptance of emotional responses, impulse control difficulties during distress, difficulties in engaging in goal-directed behavior during distress, emotional awareness, and lack of emotional clarity. Items had Likert-type responses ranging from 1 (Almost never) to 5 (Almost always) and responses were summed for a total score (possible range: 18-90), with higher scores indicating more difficulty regulation emotions.

Suicidal Ideation. The Suicidal Ideation Questionnaire-Junior (SIQ-JR; study objective 2; (31)) is a 15-item self-report assessment of suicidal ideation. The frequency and severity of suicidal ideation were evaluated using Likert-type items with responses ranging from 0 (I've never had this thought) to 6 (Almost every day). A total score consisted of summed responses, with higher scores indicating a greater severity of suicidal ideation (possible range: 0-90).

Suicide Attempt. Lifetime suicide attempts were evaluated using a single item adapted from the Self-Injurious Thoughts and Behaviors Interview (SITBI; study objective 2; (32)). Adolescents were asked, "Have you ever made an actual suicide attempt, where you were trying to kill yourself, even just a little?". Responses were coded as a dichotomous variable: (yes [1], no [0]).

Internalizing and Externalizing Symptoms .The Youth Pediatric Symptom Checklist (PSC-Y 17; study objective 2; (33)) is a 17-item measure that evaluates internalizing symptoms, externalizing symptoms, and attention difficulties using Likert-type items. Response options were "Never" (0), "Sometimes" (1), and "Often" (2). Items were summed to create only internalizing and externalizing scales (possible ranges: 0-10 for internalizing, 0-14 for externalizing), with higher scores indicating a greater amount of that domain.

Adverse Childhood Experiences (ACEs). Adverse and/or traumatic life events during childhood were assessed using the 19-item Adverse Childhood Experiences Adolescent Self-Report Questionnaire (ACE-Q; study objective 2; (34)). Youth read 19 statements and indicated how many items they have experienced. Example items are "Your parents or guardians are separated or divorced" and "A household member swore at, insulted, humiliated, or put you down in a way that scared you OR a household member acted in a way that made you afraid that you might be physically hurt". A total count of items experienced was used in this study (possible range: 0-19).

Psychosocial Impairment. The Work and Social Adjustment Scale for Youth (WSASY; study objective 2; (35)) is a 5-item measure that assesses adolescent psychosocial impairment due to emotional and/or behavioral concerns (e.g., chores, spending time with friends, family). Responses were obtained on a Likert-type scale ranging from 0 (Not at all impaired) to 8 (Very severely impaired). Responses were summed for a total score, with higher scores indicating greater adolescent impairment (possible range: 0-40).

Statistical Analyses

Analyses were conducted in R (4.1.3) using the following packages: tidyverse, gtsummary, easystats, pscl, MASS, haven, sjPlot (36-44). As expected, the distributions of days of alcohol and cannabis use were skewed with high kurtosis due to a large number of zero responses. Therefore, count models (details below) were used to account for this distribution, identified by using model fit comparisons and tests to evaluate dispersion.

The first study objective evaluated whether adolescents reported greater past 12-month alcohol and cannabis use days during COVID-19 (3/14/2020 to 4/5/2021) compared to before COVID-19 (8/30/2019-03/13/2020). Demographic variables significantly related to substance

use (age and sex) were included in the models as covariates. We fit a zero-inflated negative-binomial model to predict alcohol use days according to COVID-19 timeframe, controlling for age. We fit a negative-binomial model (estimated using maximum likelihood) to predict cannabis use days according to COVID-19 timeframe, controlling for age and sex.

The second study objective evaluated how using substances to cope with COVID-19 was associated with psychiatric correlates relevant to acute psychiatric hospitalization (e.g., internalizing, externalizing, emotion regulation, psychosocial impairment, ACEs, suicidal ideation, and lifetime suicide attempt). We used *t*-tests for group differences of continuous variables, and we present these results with the test *p*-value as well as a *p*-value corrected for multiple comparisons. A three-step hierarchical logistic regression was used to evaluate whether using substances to cope (alcohol, cannabis, e-cigarettes) was linked to a lifetime history of suicide attempt, beyond the contribution of other psychiatric correlates associated with hospitalization. In the first step, we entered age and sex. In the second step, we added variables measuring psychiatric correlates associated with hospitalization (e.g., emotion regulation, psychosocial impairment). In the third step, we added alcohol, cannabis, and e-cigarette use to cope with COVID-19. R^2 Tjur is reported as a measure of effect size for logistic regression; it indicates the proportion of variance in lifetime suicide attempt explained by the variables in each step of the model.

Third, to test whether adolescents who indicated that they used alcohol or cannabis to cope with COVID-19 reported greater past-year days of alcohol or cannabis, we conducted negative-binomial regressions (zero-inflated for cannabis use) predicting days of use from endorsement of using to cope, including age as a covariate (for alcohol, n=110, and for cannabis,

n=107). In these analyses, we only included adolescents who reported one or more days of past-year use for that respective substance if they indicated they used it to cope with COVID-19.

Results

Objective 1: Historical comparison of alcohol and cannabis use days before and during COVID-19

Descriptive analyses. The sample for the first study objective consisted of 491 adolescents (M_{age} = 15.02 [SD = 1.77]; 61% female) hospitalized between 8/30/2019 and 4/2/2021 (see Table 1). Univariate analyses that determined which covariates to include (described above) indicated age was positively related to cannabis and alcohol use days, and that sex was significantly related to cannabis use days (males had more days).

Main analyses. Adolescents admitted during COVID-19 reported significantly more days using alcohol and cannabis in the 12 months prior to admission relative to adolescents admitted before COVID-19 (Table 1 for number of days; Table 2 for model results). For alcohol, the number of days of use for adolescents admitted during COVID-19 was 2.90 times the number of days reported pre-pandemic; pandemic status had no effect on the extent of zero-inflation (amount of non-users greater than would be expected in a standard negative-binomial model). For cannabis, the number of days reported of use during COVID-19 was 2.28 times the number of days reported pre-pandemic. For both substances, older youth also reported significantly more days of use; for alcohol, older age also was associated with less zero-inflation, reflecting an increased proportion of older youth reporting any use.

Objective 2: Links between using substances to cope with COVID-19 and psychiatric correlates of acute hospitalization.

Descriptive analyses. Adolescents who reported on using substances to cope (n=124) were on average 15.22 years old (SD = 1.74), and 75% reported female biological sex. The following percentages of youth endorsed using substances to cope with COVID-19 and the changes and rules put in place as a result of the virus: 41% reported any extent of using drugs, alcohol, or vaping to cope with COVID-19; 33% reported using cannabis to cope; 19% alcohol; 25% e-cigarette; and 4% "other drugs". Additionally, 65% of these youth endorsed a lifetime history of suicide attempt.

Main analyses. Using alcohol to cope with COVID-19 was significantly associated with more ACEs and psychosocial impairment (Table 3). Using cannabis to cope with COVID-19 was linked to significantly more ACEs (Table 3). Using e-cigarettes to cope was not significantly associated with any psychiatric correlates of hospitalization (Table 3).

When evaluating whether endorsing substance use to cope during COVID-19 was linked to a lifetime history of suicide attempt, controlling for age and sex, endorsing e-cigarette/vaping was significant, beyond the contribution of other psychiatric correlates associated with hospitalization (see Table 4).

Objective 3: Testing whether adolescents endorsing substance use to cope with COVID-19 report greater past-12 month use days.

Finally, we tested whether endorsing the use of alcohol or cannabis to cope with COVID-19 was associated with a greater number of use days of that substance in the prior year, compared to adolescents who denied using that substance to cope with COVID-19, controlling for age. Endorsing alcohol to cope with COVID-19 was associated with a significantly greater number of past-year alcohol days (M = 67.93 [SD = 94.23] vs. M = 1.56 [SD = 7.50]), and the same was true for cannabis (see Table 5; M = 122.22 [SD = 123.79] vs. M = 3.11 [SD =21.42]).

Older youth also reported significantly more days of alcohol use. Endorsing the use of cannabis to cope with COVID-19 had no effect on the extent of zero-inflation, suggesting minimal impact on rates of abstinence.

Discussion

In this study, we examined rates of substance use amongst adolescent inpatients before and during COVID-19, evaluated links between a motive to cope with COVID-19 stress and psychiatric correlates of hospitalization, and investigated frequency of substance use associated with this coping motive. Although prior literature indicated that some youth reported greater use of substances (e.g., alcohol, cannabis) during COVID-19, findings depended on how and among whom this was assessed. Among both adolescents and adults, research suggests links between psychiatric symptoms and greater rates of substance use (1, 8). Using substances to cope is associated with risk for developing substance use disorder symptoms, and this coping mechanism is likely to be especially risky for youth with severe psychopathology, as substance use can impact psychiatric care and prognosis (45, 46)

The first study objective was to examine if the number of days of alcohol and cannabis use differed for adolescents hospitalized before COVID-19 compared to adolescents hospitalized during COVID-19. Results indicated that the number of days of both alcohol use and cannabis use adolescents reported in the year prior to their admission was significantly higher among youth admitted during the pandemic, relative to before. These findings suggest that the onset of the pandemic was a critical juncture for this vulnerable group, such that pandemic-related changes may have resulted in increased substance use. However, it is also possible that higher-acuity adolescents were admitted to inpatient psychiatric units during this time, and they happened to have higher rates of substance use. The pattern of higher rates of past-year substance

use reported during COVID-19 is not consistent with findings from a recent systematic review of studies of substance use among typically developing youth, which found that the prevalence of youth alcohol, cannabis, tobacco, and e-cigarette/vaping largely declined during the pandemic (12). One potential explanation for these discrepant findings is that public health restrictions did not serve the same preventative benefit across typically developing youth and youth with severe psychopathology included in the current study. That is, for many typically developing youth, public health restrictions associated with COVID-19 (e.g., lockdowns, homeschooling) may have limited exposure to potential risk factors for youth substance use, such as unsupervised contact with peers, time spent outside of the home, and access to substances. It is possible that exposure to these risk factors did not change, or may have increased, for youth with severe emotional and behavioral disorders. Another potential explanation is that youth with severe psychopathology were more motivated to seek substances during this period relative to their peers. Relatedly, youth with psychopathology who were at high risk for substance use may have had less access during COVID-19 to important supports including mental health professionals and school-based caregivers who, under normal circumstances, may help mitigate stress and perceived need for substance-related coping.

Our second study goal was to evaluate adolescents' motivation to use substances to cope with COVID-19-related stressors and whether this motive was associated with psychiatric correlates of hospitalization. We found 41% of youth surveyed indicated they used substances to cope with COVID-19, which varied by substance: 33% endorsed cannabis to cope; 19% alcohol; and 25% e-cigarettes. Other studies have also found links between substance use and coping with stressors caused by COVID-19. For example, a large sample of typically developing older adolescents reported that 15.7% endorsed cannabis use, 8.9% increased vaping (relative to 2019),

and 8.2% increased drinking to cope with COVID-specific stressors in Fall 2020 (47). Among a large sample of adults surveyed by the CDC during COVID-19, 13.3% reported starting or increasing substance use to cope with stress and emotions from the pandemic (1). Use of substances to cope among youth with severe psychopathology is especially risky, as this coping mechanism has the potential to exacerbate current psychiatric symptoms and to increase the likelihood of developing substance-related problems (48)

With regard to identifying psychiatric correlates of hospitalization associated with using substances to cope with COVID-19, we found that having a lifetime history of a suicide attempt was associated with the use of e-cigarettes to cope. These findings align with a growing body of literature documenting links between vaping nicotine and mental health. For example, a scoping review of the literature found that e-cigarette use was associated with depression, suicidal ideation and suicide attempt, and that suicide attempts were significantly higher among e-cigarette users compared to non-users (49). One explanation for this association is that impulsive personality traits are common to both e-cigarette usage and suicidality (50). Additionally, we found that a greater number of ACEs was associated with using both alcohol and cannabis to cope, which is consistent with a robust body of research (51-54). To illustrate, the initial study on ACEs found that individuals reporting four or more experiences of childhood adversity had significantly greater risk of developing substance use problems (54). Because many of these studies linking ACEs to substance misuse are conducted in adult samples, which rely on retrospective recall about childhood, a benefit of the present study is that it documents this phenomenon in adolescence, which is less studied (53) and has the advantage of less time having lapsed since childhood. Our finding of greater psychosocial impairment linked to using alcohol to cope with COVID-19 has less-clear implications given the cross-sectional nature of our study.

That is, adolescents experiencing greater psychosocial impairment due to their emotional/behavioral concerns may have used alcohol to cope, or alternatively using alcohol to cope during COVID-19 may have resulted in greater psychosocial impairment. It is well-established that the co-occurrence of alcohol misuse and depressive symptoms contributes to greater impairment than either condition alone (55), and the same is true for anxiety (56). Future studies with a design that can disentangle the temporal sequence of this link are needed.

Finally, we evaluated whether adolescents endorsing using a substance to cope with COVID-19 reported greater past-year use of that substance. Our results showed that reporting using alcohol and cannabis to cope with COVID-19 stressors was associated with significantly greater past-year use days for each respective substance, potentially providing insight into how coping motives during adolescence are associated with greater likelihood to develop a use disorder (48). That is, research on the development of SUDs indicates that early initiation of substance use (i.e., prior to age 18), habitual use, and negative reinforcement that may accompany habitual substance use (e.g., reduction in an aversive experience like stress) contribute to the development of SUD (57-59). It is important to note that not all adolescents endorsed a motive of coping with COVID-19 for substance use, which may reflect either other reasons for their use (e.g., sensation-seeking, coping with non-COVID-19 related psychiatric symptoms) and/or their lack of awareness of why they use substances. Given the importance of understanding the function of behavior to target interventions, considering other motivating reasons for using substances during this time is informative.

There are several treatment implications from these findings. Although adolescents recognized their need to cope with changes and stress associated with the pandemic, which is an important first step towards problem-solving, the coping strategies they chose may have more

negative than positive consequences long-term. There is a need to provide alternative, healthy coping strategies for youth managing both severe psychopathology and the stressors associated with COVID-19. While these results are specific to COVID-19, which is an evolving landscape, these findings signal a need to provide alternative coping strategies during high stress times to reduce the likelihood that youth rely on substances to cope. Interventions that redirect youth from substance use to healthier coping strategies can serve several protective purposes by simultaneously increasing emotional awareness, decreasing risky behavior, and increasing adaptive strategies (e.g., psychological coping strategies, exercise, positive interpersonal support). Related yet outside the scope of the current study, caregiver substance use behaviors (e.g., modeling), monitoring, and attitudes toward adolescent substance use are other important targets for incorporation into adolescent treatment, especially within the pandemic context when many families were confined to their homes. Additionally, it is clear from these findings that substance use screening remains a critical tool for identifying youth at greater risk for harm during a mental health crisis. This is because use of substances can exacerbate psychiatric symptoms and place vulnerable youth at increased risk for the development of future problems, and thus preventing maladaptive coping strategies like substance misuse is vital. Moreover, because treatment for adolescent substance use disorders either alone or in conjunction with psychiatric disorders is not easily accessible, does not yet have a high success rate of changing behavior over time, and is associated with a high rate of relapse, it is crucial to identify substance use and risk factors early to prevent problematic use (60, 61).

This study should be interpreted in light of its limitations, including its cross-sectional design and use of primarily self-report measures. The timeframe of data collection presents some challenges to interpreting the findings because the use of substances to cope (Goal 2) was not

assessed until over eight months after the onset of the pandemic, and we are unable to investigate time effects and potential changes within the course of the pandemic due to the sample size. Relatedly, we acknowledge the small sample size and multiple comparisons is a limitation; nonetheless, we provided corrected p-values, effect sizes, means, and standard deviations by group for transparency (Table 3). Given the novelty of these data and the importance of gaining insight to psychiatric correlates of acute hospitalization that may be associated with even greater vulnerability to negative outcomes like attempted suicide and substance use disorders, we believe providing this detailed information may be beneficial for those working with adolescents experiencing major life disruptions. Another limitation is that some data was missing given that some adolescents in the inpatient setting declined or were unable to complete all measures. While the COVID-19 measures developed for this study have high face validity, they have not been validated and substance use related coping was based on a single item. In addition, although we employed a validated self-report measure of trauma, the ACE-Q is simply a count of the number of potentially traumatic experiences and does not indicate the specific type or extent of trauma experienced. It is also possible that differences observed from before the pandemic to after its onset reflect overall increases in psychiatric symptoms during that time. Finally, we did not assess parental behavior, which may have provided insight with regard to the amount of monitoring as a potential explanation for some adolescent behaviors, as well as whether parents may have modeled substance use as a coping mechanism to adolescents (62). Regardless, the results of this study suggest the importance of assessing substance use related to the pandemic in adolescent psychiatric patients.

Conclusions

Substance use among youth admitted for psychiatric hospitalization may have a negative impact on the course of care and prognosis. The goals of this study were to compare substance use rates among youth within an inpatient psychiatric hospital before and during COVID-19, to explore the degree to which substances were used to cope with COVID-19 and their link to psychiatric correlates associated with acute hospitalization, and to evaluate rates of substance use when used to cope. Results indicated that youth admitted during COVID-19 endorsed greater past-year substance use relative to youth admitted before COVID-19. Moreover, a subset of youth reported they used substances to cope with COVID-19, which was linked to greater psychosocial impairment, ACEs, lifetime history of suicide attempt, and higher rate of substance use. These findings underscore the importance of screening for substance use during youth mental health crises, as this information can inform service in emergency contexts and targeted intervention may buffer against the well-documented negative effects of substance use on psychiatric symptoms during adolescent development.

Declarations

- Ethics approval and consent to participate
    - The study was conducted as a retrospective chart review, for which informed consent/assent was waived, that was approved by the hospital's institutional review board (IRB # 879582).
- Consent for publication
    - Not applicable
- Availability of data and materials
    - Data from the current study are not available because of the sensitive nature of the content and because neither parental or adolescent consent was obtained to release the data.
- Competing interests
    - The authors declare that they have no competing interests
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- Authors' contributions

- ST designed the study, analyzed and interpreted the data, and contributed to writing and editing the manuscript. ET contributed to study design and was a major contributor in writing the manuscript. JP contributed to data analysis, interpretation, and manuscript editing. LM and SM were major contributors in writing the manuscript. MM organized and pre-processed the data prior to analyses and contributed to manuscript writing. SR prepared and edited tables, references, and contributed to manuscript editing. JW contributed to study design, data collection, and manuscript writing/editing. All authors read and approved the final manuscript.

- Acknowledgements
  - Not applicable

List of abbreviations

-Coronavirus disease 2019 (COVID-19)

-United States (U.S.)

-Center for Disease Control (CDC)

-Adolescent Brain Cognitive Development (ABCD)

-Monitoring the Future (MTF)

-substance use disorders (SUD)

-CRAFFT (Car, Relax, Alone, Forget, Friends, Trouble Screening Test)

-The Suicidal Ideation Questionnaire-Junior (SIQ-JR)

-The Difficulties in Emotion Regulation Scale- Short Form (DERS-SF)

-Self-Injurious Thoughts and Behaviors Interview (SITBI)

-Youth Pediatric Symptom Checklist (PSC-Y 17)

-Adverse Childhood Experiences (ACEs)

-The Work and Social Adjustment Scale for Youth (WSASY)

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Table 1. Age, sex, and days of past-year alcohol and cannabis use before and during COVID-19.

Variable	*n*	Pre-COVID-19 *n*=208			COVID-19 *n*=283		
		M (SD)	Reported Range	*n* (%)	M (SD)	Reported Range	*n* (%)
Age	491	14.82 (1.85)	11 – 18 years		15.16 (1.71)	11 – 18 years	
Sex	491						
Female				120 (58%)			178 (63%)
Male				88 (42%)			105 (37%)
Alcohol	491	2.13 (9.46)	0 – 100 days		9.29 (36.55)	0 - 335 days	
Cannabis	473	27.85 (80.26)	0 – 365 days		46.61 (98.11)	0 – 365 days	
Missing				9 (4.33%)			9 (3.18%)

Note. Age and sex did not differ pre-COVID-19 versus COVID-19.

Table 2. Negative binomial models evaluating differences in past-year substance use days before and during COVID-19.

	Alcohol (n=491)				**Cannabis (n=473)**			
Predictors	*Estimate*	*Std. Error*	*z-value*	*p*	*Estimate*	*Std. Error*	*z-value*	*p*
Intercept	-5.03	2.47	**-2.04**	0.042	-4.83	1.48	**-3.27**	**0.001**
COVID-19	1.06	0.43	**2.48**	0.013	0.82	0.34	**2.44**	**0.015**
Age	0.40	0.15	**2.58**	0.010	0.47	0.09	**5.04**	**<.001**
Sex					0.40	0.34	1.18	0.237
Zero-Inflation Estimates								
Intercept	20.84	8.75	**2.38**	0.017				
COVID-19	-1.81	1.15	-1.58	0.115				
Age	-1.46	0.64	**-2.27**	0.023				

Note. This table presents results for negative binomial models (zero-inflated for alcohol only) evaluating differences in past-year alcohol and cannabis use days before and during COVID-19.

Table 3. Descriptive statistics and comparisons by group for endorsing substances to cope with COVID-19 (yes/no).

Variable	No M (SD)	Yes M (SD)	*t*	*p*	Cohen's *d*	95% CI	*q*-Value
Alcohol Use to Cope							
	n=100	n=24					
Internalizing	6.39 (2.76)	7.67 (2.84)	-1.99	0.055	-0.46	[-0.91, -0.01]	0.082
Externalizing	3.94 (2.76)	3.21 (2.69)	1.19	0.2	0.27	[-0.18, 0.71]	0.241
Suicidal Ideation	37.08 (26.28)	49.50 (27.56)	-2.00	0.054	-0.47	[-0.92, -0.02]	0.082
Adverse Childhood Experiences	5.86 (4.00)	7.67 (3.71)	-2.11	0.042	-0.46	[-0.91, -0.01]	0.082
Psychosocial Impairment	18.74 (10.45)	24.12 (11.03)	-2.17	0.037	-0.51	[-1.0, -0.06]	0.082
Emotion Regulation	51.38 (15.00)	56.29 (16.74)	-1.32	0.2	-0.32	[-0.77, 0.13]	0.237
Cannabis Use to Cope							
	n=83	n=41					
Internalizing	6.64 (2.79)	6.63 (2.87)	0.008	>0.9	0.00	[-0.37, 0.38]	0.990
Externalizing	3.94 (2.77)	3.51 (2.72)	0.818	0.4	0.16	[-0.22, 0.53]	0.990
Suicidal Ideation	39.75 (25.77)	38.95 (29.30)	0.148	0.9	0.03	[-0.34, 0.40]	0.990
Adverse Childhood Experiences	5.65 (3.92)	7.34 (3.95)	-2.25	0.027	-0.43	[-0.81, -0.05]	0.164
Psychosocial Impairment	19.41 (10.17)	20.54 (11.89)	-0.520	0.6	-0.10	[-0.48, 0.27]	0.990
Emotion Regulation	52.45 (14.23)	52.10 (17.73)	0.110	>0.9	0.02	[-0.35, 0.40]	0.990
E-Cigarettes Use to Cope							
	n=93	n=31					
Internalizing	6.51 (2.73)	7.03 (3.03)	-0.859	0.4	-0.19	[-0.59, 0.22]	0.473
Externalizing	3.61 (2.82)	4.35 (2.47)	-1.40	0.2	-0.27	[-0.68, 0.14]	0.252

Suicidal Ideation	37.40 (26.64)	45.74 (27.03)	-1.49	0.14	-0.31	[-0.72, 0.10]	0.252
Adverse Childhood Experiences	5.88 (4.10)	7.19 (3.55)	-1.71	0.092	-0.33	[-0.74, 0.08]	0.252
Psychosocial Impairment	19.41 (10.56)	20.90 (11.35)	-0.646	0.5	-0.14	[-0.55, 0.27]	0.521
Emotion Regulation	50.90 (14.41)	56.61 (17.64)	-1.63	0.11	-0.37	[-0.78, 0.04]	0.252

Note. This table presents means and standard deviations by group for response to using substances to cope with COVID-19 and comparison of psychiatric correlates of hospitalization. *q*-Value is the false discovery rate correction for multiple testing. These constructs were measured as follows: Internalizing/Externalizing = Pediatric Symptom Checklist-17; Suicidal Ideation = Suicidal Ideation Questionnaire – Junior; Adverse Childhood Adverse Experiences = Adverse Childhood Experiences Questionnaire; Impairment = Work and Social Adjustment Scale for Youth; Emotion Regulation = Difficulties in Emotional Regulation – Short Form.

Table 4. Hierarchical logistic regression predicting lifetime suicide attempt (n = 124).

Variables	Step 1			Step 2			Step 3		
	Odds Ratios	CI	*p*	Odds Ratios	CI	*p*	Odds Ratios	CI	*p*
Intercept	2.25	0.08 – 64.31	0.631	0.41	0.00 – 40.07	0.701	1.41	0.01 – 226.13	0.894
Age	0.94	0.76 – 1.17	0.595	0.92	0.71 – 1.19	0.547	0.85	0.63 – 1.14	0.295
Sex	2.52	1.09 – 5.87	**0.031**	2.26	0.85 – 6.08	0.101	1.97	0.71 – 5.55	0.191
Emotion Regulation				1.01	0.96 – 1.06	0.776	1.00	0.94 – 1.06	0.951
Psychosocial Impairment				1.04	0.99 – 1.11	0.117	1.07	1.01 – 1.14	**0.037**
Internalizing				1.13	0.89 – 1.43	0.316	1.16	0.91 – 1.49	0.236
Externalizing				0.92	0.77 – 1.10	0.367	0.88	0.72 – 1.06	0.193
Adverse Childhood Experiences				1.08	0.97 – 1.21	0.186	1.06	0.94 – 1.19	0.357
Cannabis to Cope							0.94	0.27 – 3.31	0.918
Alcohol to Cope							0.39	0.07 – 2.02	0.263
E-Cigarettes to Cope							9.74	2.22 – 53.40	**0.005**
R^2 Tjur		0.040			0.187			0.257	

Note. Presented here are the results of a hierarchical logistic regression predicting lifetime suicide attempt from psychiatric correlates of acute hospitalization and using substances to cope with COVID-19. *q*-Value is the false discovery rate correction for multiple testing. These constructs were measured as follows: History of Suicide Attempt = Single Item Adapted from Self-Injurious Thoughts and Behaviors Interview; Internalizing/Externalizing = Pediatric Symptom Checklist-17; Adverse Childhood Adverse Experiences = Adverse Childhood Experiences Questionnaire; Impairment = Work and Social Adjustment Scale for Youth; Emotion Regulation = Difficulties in Emotional Regulation – Short Form.

Table 5. Negative binomial models evaluating differences in past-year substance use days based on coping motive.

	Alcohol (n=110)				**Cannabis (n=107)**			
Predictors	*Estimate*	*Std. Error*	*z-value*	*p*	*Estimate*	*Std. Error*	*z-value*	*p*
Intercept	-10.13	2.73	**-3.71**	**<.001**				
Alcohol to Cope	4.17	0.78	**5.38**	**<.001**				
Age	0.65	0.17	**3.71**	**<.001**				
Intercept					0.28	2.52	0.11	0.913
Cannabis to Cope					1.60	0.57	**2.81**	**0.005**
Age					0.18	0.15	1.25	0.213
Zero-Inflation Estimates								
Intercept					3.28	3.52	0.93	0.352
Cannabis to Cope					-21.71	3352.01	-0.01	0.995
Age					-0.08	0.23	-0.34	0.737

Note. Presented here are the results of two negative binomial regression models evaluating differences in past-year alcohol and cannabis use days based on whether adolescent endorsed using substance to cope with COVID-19