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CLINICAL PSYCHOLOGY | RESEARCH ARTICLE

A multinational study of psychosocial stressors and symptoms associated with increased substance use during the early wave of the COVID-19 Pandemic: The role of polysubstance use

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Abstract: We launched a multinational study to examine changes in substance use during the early phase of the pandemic and to identify factors related to these changes, with a specific focus on the effect of polysubstance use in increasing nicotine, alcohol, and cannabis use. This study was conducted using an online survey in English and seven other languages. The survey included measures focusing on substance use, psychological symptoms, stress, and other health and psychosocial measures. A total sample of 2907 participants was included. The results showed that higher levels of perceived social isolation, depression, and anxiety during the pandemic were associated with increases in nicotine use. Increased alcohol use was associated with feelings of uncertainty and increased depression and anxiety symptoms. Polysubstance use was associated with increases in use of cannabis and alcohol during the pandemic; co-use of cannabis and alcohol increased chances for escalating alcohol use; and increases in cannabis use were influenced by the number rather than the types of substances being used. These

ABOUT THE AUTHOR

The reported research was conducted by our research team from the Stress and Resilience Research Laboratories (SRRL) at the University of Minnesota Medical School. The research was conducted in collaboration with colleagues from the University of Monastir, Tunisia, the University of Frankfurt, Germany, and from other universities in Spain, Italy, Germany, Russia, China, and India. Research programs, including funded research, conducted within the SRRL seek to identify psychophysiological, neurobiological, and behavioral mechanisms mediating and moderating effects of stress on addictive behaviors and chronic diseases. Our approach is transdisciplinary and our collaborators include experts in multiple fields of medicine, physiology, pharmacology, and behavioral sciences. Since 1997, these laboratories have served the global community in furthering the discussion surrounding addiction and stress in an effort to address obstacles to recovery and to destigmatize addictive diseases.

PUBLIC INTEREST STATEMENT

The COVID-19 pandemic has had deleterious effects on economies, societies, and health. The pandemic and related life stress have impacted mental health, addictive behaviors, and substances use. This study aimed to examine changes in substance use during the early phase of the pandemic and to identify factors related to these changes, with a specific focus on the effect of polysubstance use in increasing nicotine, alcohol, and cannabis use. Results showed the effect of psychosocial stressors in increasing substance use and highlighted the role of pre-COVID polysubstance use status in substance use increases during the pandemic. Findings of the study can be used to guide post-pandemic interventions aiming to address health effects of the pandemic and to reduce the impact of future pandemics on vulnerable and at-risk groups.

results demonstrate a link between COVID-19 related psychological distress and increased substance use during the first wave of the pandemic. They also point-out the contribution of pre-COVID polysubstance use in increases in substance use during COVID-19.

Subjects: Psychological Science; Health Psychology; Mental Health; Addictions and Substance Use; Mental Health; Behavioral Medicine

Keywords: COVID-19; psychosocial stress; depressive and anxiety symptoms; substance use; polysubstance use

1. Introduction

The emergence of the new coronavirus, SARS-CoV-2, at the end of 2019 led to rapid spread of the Coronavirus Disease 2019 (COVID-19), reaching pandemic levels within weeks and affecting countries worldwide (Baloch et al., 2020; Coronavirus: the first three months as it happened, 2020). To curtail the virus, many governments enforced preventive measures of self-isolation and nationwide lockdowns; in April 2020, about one third of world's population was living with government-mandated restrictions on movement due to COVID-19 (Katharina, 2020). The impacts of both the disease and the preventive public health measures intended to mitigate its spread have impacted mental health (Brooks et al., 2020; Galea et al., 2020; Rajkumar, 2020) as well as substance use and addictive behaviors in many countries (Ali et al., 2021; Bakaloudi et al., *In Press*; Benschop et al., 2021; Bommele et al., 2020; Chodkiewicz et al., 2020; Czeisler et al., 2020; Farhoudian et al., 2020; Lechner et al., 2020; Rolland et al., 2020; Siddiqi et al., 2021; Stanton et al., 2020; Sun et al., 2020).

Although substance use may increase to cope with negative states (Cooper et al., 2015; Cox & Klinger, 2004), researchers have also acknowledged that several pandemic-related factors, such as decreased availability of substances and increased financial barriers (Chodkiewicz et al., 2020; Rehm et al., 2020), may decrease substance use. Recent research into changing patterns of substance use during the COVID-19 pandemic have shown a mix of no change, increases, and decreases in substance use across study periods, populations, countries, and epidemiological situations (Ali et al., 2021; Bakaloudi et al., *In Press*; Benschop et al., 2021; Bommele et al., 2020; Czeisler et al., 2020; Farhoudian et al., 2020; Gendall et al., 2021; Lechner et al., 2020; Rolland et al., 2020; Siddiqi et al., 2021; Stanton et al., 2020; Sun et al., 2020; Van Laar et al., 2020), though most of these studies found increases in substance use (Ali et al., 2021; Bakaloudi et al., *In Press*; Benschop et al., 2021; Gendall et al., 2021; Rolland et al., 2020; Stanton et al., 2020; Van Laar et al., 2020).

In the context of the ongoing COVID-19 pandemic and related life stress, identifying factors associated with increased consumption of substances is important to inform and target interventions to mitigate consequences of such use on health and on quality of life in the future (National Institute on Drug Abuse, 2020; Centers for Disease Control and Prevention, 2021; Health risks and benefits of alcohol consumption, 2000; Rehm, 2011; Rehm & Parry, 2009; Testino, 2020; Vardavas & Nikitara, 2020; Wang et al., 2021). Therefore, the purpose of this study was to identify correlates of increased substance use during the COVID-19 pandemic, with a focus on the three most commonly used substances worldwide: alcohol, nicotine, and cannabis (Winstock, 2021). While previous studies have examined correlates of use, most have focused on use of individual substances without consideration of patterns of use among polysubstance users (Benschop et al., 2021; Gendall et al., 2021; Knell et al., 2020; Luk et al., 2021; Reynolds et al., 2021). Thus, in addition to identifying sociodemographic characteristics as well as emotional and psychological symptoms associated with increased substance use, we sought to expand previous studies by examining the effect of polysubstance use in increasing nicotine, alcohol, and cannabis use.

Based on previous literature, we predicted that increased levels of psychological and other stress-related measures would be associated with increased substance use during the pandemic. We also

predicted that users of multiple substances would be more likely than single-substance users to increase their levels of use during COVID-19. Among polysubstance users, we expected that increases in use of one substance would be positively associated with increases in use of other substances.

2. Methods

2.1. Participants & procedures

A convenience sample of adults aged 18 years or older were recruited to participate in a cross-sectional, online survey hosted on the Qualtrics © platform between March 31st and May 15th, 2020. In addition to an English language version, 7 other translated versions of the survey (Arabic, Chinese, French, German, Italian, Russian, European Spanish) were available online. Recruitment messages were distributed in each of the 8 survey languages. Participants were recruited internationally via social media (social posts and paid advertisements on Facebook and Twitter that targeted individuals in various countries) and email announcements in professional and international organizations (e.g., American Psychosomatic Society, Society for Research on Nicotine and Tobacco, National Institutes of Health, Africa and Middle East Congress on Addiction, the University of Minnesota, and other universities outside of the USA). The survey landing page consisted of a consent form; individuals had to indicate that they were aged 18 years or older and they had to provide consent in order to participate. The survey took approximately 15 minutes to complete, and no compensation was offered. All protocol and procedures were approved by the Institutional Review Board at the University of Minnesota.

3. Measures

Socio-demographics characteristics. Participants responded to questions regarding their age, sex, highest level of education completed, marital status, employment status, country of residence and nature of residence (urban/rural residence). These items were translated from English to the other survey languages by native speakers of each language and then verified by experts.

Other predictors. Participants reported to what extent they have felt uncertain, stressed, socially isolated, and socially supported in the time since COVID-19 began spreading. The response scales ranged from 0 to 5 (0 = not at all; 1 = slightly; 2 = somewhat; 3 = moderately; 4 = quite a bit; 5 = a lot). They were also asked about their average sleep quality (perceived restfulness) during the pandemic; response scales ranged from 0 to 3 (0 = not at all; 1 = somewhat; 2 = moderately; 3 = very much). All of these items were translated from English to the other survey languages by native speakers of each language and then verified by experts. Depression and anxiety symptoms during the pandemic were collected using the 4-items Patient Health Questionnaire (PHQ-4; Kroenke et al., 2009) and psychological resilience was assessed using the Brief Resilience Scale (BRS), with higher scores indicating greater resilience (Smith et al., 2008). When available, existing translations of these two measures were used (Chmitorz et al., 2018; Jacobs & Horsch, 2019; Löwe et al., 2010; Patient Health Questionnaire screeners; Rodríguez-Rey et al., 2016); in addition, native speakers of each language translated the questions and experts verified the final items. Based on their role in increasing substance use (Asmundson et al., 2020; Frone, 2008; Wu et al., 2018), other health and societal stressors were assessed; participants were asked about chronic health conditions and reported if the COVID-19 pandemic had caused reduced working hours or job loss.

Substance use outcomes. Participants were asked about their nicotine, cannabis, and alcohol use, including perceived changes in their use compared to before the coronavirus began spreading. Response options included a decrease of $\geq 25\%$, an increase of $\geq 25\%$, no change in use, and no use during the last 6 months. Native speakers of each language translated these items from English; and experts verified the translations.

4. Statistical analyses

Only participants who used at least one substance (nicotine, cannabis, or alcohol) were included in this study.

Analyses were performed using Statistical Package for the Social Sciences (SPSS) version 23.0. First, we examined descriptive statistics for all variables, including the number and percentage of respondents (n , %) for categorical variables and the means and standard deviations ($M \pm SD$) for quantitative variables. Then, chi-square goodness of fit tests were used to test whether increases in use were more frequent than decreases in use for each substance. To explore potential factors associated with increases in use for each type of substance, we dichotomized each substance use outcome variable by combining responses indicating no change in substance use with responses indicating decreases in substance use to form a single category (coded 0) versus increases in substance use (coded 1). Next, for each substance, we used bivariate logistic regressions to identify factors related to increases in use of the substance ($p < .25$); the resulting factors were entered as a block of potential predictors in multivariable logistic regression that implemented stepwise backward selection to retain factors at a significance level of 0.05. Pearson correlations were used to investigate the relationships between increases in use for each substance among polysubstance users; then, correlations were compared between users of two substances vs users of three substances using transformations to Fisher Z scores.

5. Results

A total sample of 2907 participants from 83 different countries used at least one substance and were then included in this analysis. Their ages ranged from 18 to 95 years ($M = 38.7$, $SD = 14.3$). Table 1 summarizes the main sample characteristics. The countries that were most represented (identified by $>5\%$ of the sample) included the USA ($n = 1589$), Germany ($n = 239$), Canada ($n = 166$), and Tunisia ($n = 144$). Most participants used the English language version of the survey ($n = 1999$), followed by German ($n = 268$), European Spanish ($n = 175$), and Arabic ($n = 164$).

The results showed that among those who reported using nicotine in the last 6 months ($n = 801$), 19.7% reported increases in use, 34.1% reported decreases, and 46.2% reported no changes in use during the pandemic. Among those who reported using alcohol in the last 6 months ($n = 2516$), 20.0% reported increases in use, 22.0% reported decreases, and 58.0% reported no changes in use during the pandemic. Among those who reported using cannabis in the last 6 months ($n = 447$), 28.6% reported increases in use, 24.6% reported decreases, and 46.8% reported no changes in use during the pandemic. Chi-square goodness of fit tests showed that decreases were more likely than increases among nicotine users who changed their consumption ($p < 0.001$) and no significant differences between increases and decreases emerged among alcohol and cannabis users who changed their consumption.

Raw (bivariate) and adjusted (multivariate) analyses of the factors associated with increases in use for each substance are summarized in Table 2. Based on results from the multivariable logistic regression models, respondents who reported increasing their nicotine use were more likely to be employed, to have no loss in employment nor work hours due to COVID-19, to have higher levels of perceived social isolation, and to have more depression and anxiety symptoms. Participants who reported increasing their use of alcohol were more likely to be employed, to be younger in age, to have post-secondary education, to use cannabis, to have higher levels of perceived uncertainty, and to have more depression and anxiety symptoms. Younger age, higher levels of perceived stress and using a larger number of substances were associated with increased cannabis use during the pandemic.

To examine associations of increased use across multiple substances, we conducted Pearson's correlations between increased use of each substance among polysubstance users (see, Table 3). Polysubstance users were clustered into two categories, those who used two substances and those who used three substances. Increased nicotine use, increased alcohol use, and increased cannabis use were mutually correlated among users of two substances and users of three substances, without a significant difference in correlations between the two groups.

Table 1. Main characteristics of the study participants

Characteristic (# of valid responses)	N (%)	M (SD)
Sex (n = 2899)		
Male	870 (30)	
Female	2023 (69.8)	
Other	6 (0.2)	
Marital status (n = 2879)		
Never married	1219 (42.3)	
Married	1387 (48.2)	
Married but separated	41 (1.4)	
Divorced and not remarried	207 (7.2)	
Widowed and not remarried	25 (0.9)	
Education level (n = 2880)		
Primary school	18 (0.6)	
Secondary school	354 (12.3)	
Post-secondary/Tertiary school	2508 (87.1)	
Current employment status (n = 2866)		
Employed (full- or part-time)	1964 (68.5)	
Student	471 (16.4)	
Retired	156 (5.4)	
Unemployed	275 (9.6)	
Rural or urban nature of residence ^a (n = 2872)		
Urban area	1880 (65.5)	
Urban cluster	769 (26.8)	
Rural area	223 (7.8)	
Has a chronic health condition ^b (n = 2877)	931 (32.4)	
Lost job or work hours were reduced ^c (n = 2638)	607 (23.0)	
Age (n = 2907)		38.7 (14.3)
Perceived stress during the pandemic (n = 2859)		3.1 (1.4)
Perceived uncertainty (n = 2859)		3.0 (1.6)
Depression and anxiety symptoms (PHQ-4 ^d) (n = 2781)		4.4 (3.4)
Perceived social isolation (n = 2858)		2.3 (1.7)
Perceived social support (n = 2858)		2.9 (1.4)
Resilience (BRS ^e) (n = 2539)		3.4 (0.8)
Sleep quality (n = 2546)		1.5 (0.9)

All percentages were calculated as percent of valid responses for the variable in question. M = Mean; SD = standard deviation. ^a Urban area: Population more than 50,000; Urban cluster: Population between 2500 and 50,000; Rural area: Population less than 2500; ^b Responded “yes” to the dichotomous item “Do you have any chronic mental or physical health conditions?”. ^c Responded “yes” to the dichotomous item “I lost my job or my hours were significantly reduced because of the coronavirus”. ^d Depression and anxiety symptoms measured using PHQ-4 (4-item Patient Health Questionnaire (Kroenke et al., 2009)). ^e Resilience measured using BRS (Brief Resilience Scale; (Smith et al., 2008))

Table 2. Factors associated with increases in substance use during the early wave of the COVID-19 pandemic: Results of the bivariate and multivariate regressions

	Increase in nicotine use (multivariate n = 554)		Increase in alcohol use (multivariate n = 2190)		Increase in cannabis use (multivariate n = 400)	
	OR (95%CI)	aOR (95%CI)	OR (95%CI)	aOR (95%CI)	OR (95%CI)	aOR (95%CI)
Age	0.99 (0.97; 1.00) *		0.98 (0.97; 0.98)***	0.98 (0.97; 0.99)***	0.97 (0.96; 0.99)**	0.98 (0.96; 0.99)**
Sex (Male vs Female)	0.70 (0.51; 1.03) *		0.85 (0.67; 1.07) *		0.98 (0.64; 1.51)	
Marital status ^a	0.74 (0.52; 1.06) *		0.92 (0.75; 1.12)		0.58 (0.36; 0.95)**	
Education level ^b	0.90 (0.59; 1.36)		1.38 (0.98; 1.94) *	1.77(1.18; 2.67)**	1.17 (0.69; 2.03)	
Employment status ^c	1.5 (1.02; 2.21)**	1.67 (1.04; 2.69)**	1.2 (0.96; 1.48) *	1.40 (1.09; 1.80)**	1.01 (0.66; 1.53)	
Nature of residence						
Urban ^d	1.35 (0.66; 2.74)		1.09 (0.73; 1.64)		1.38 (0.62; 3.03)	
Urban cluster ^d	1.57 (0.74; 3.31) *		1.39 (0.91; 2.12) *		1.05 (0.44; 2.53)	
Chronic health condition (Yes vs No)	1.37 (0.97; 2.01) *		1.21 (0.99; 1.50) *		1.4 (0.92; 2.12) *	
COVID-19 impact on employment ^e	0.56 (0.35; 0.88)**	0.45 (0.27; 0.76)**	1.11 (0.87; 1.41)		1.64(1.03; 2.6)**	
Perceived stress	1.22 (1.08; 1.38)***		1.24 (1.15; 1.33)***		1.18 (1.02; 1.36)**	1.20 (1.02; 1.40)**
Perceived uncertainty	1.20 (1.08; 1.34)***		1.27 (1.19; 1.36)***	1.16 (1.07; 1.26)***	1.05 (0.92; 1.20)	
Perceived social isolation	1.18 (1.07; 1.31)***	1.19 (1.05; 1.35)**	1.16 (1.10; 1.24)***		1.13 (0.99; 1.28)**	
Perceived social support	0.96 (0.85; 1.08)		0.92 (0.85; 0.98)**		0.96 (0.83; 1.12)	
Depression and anxiety symptoms ^f	1.10 (1.05; 1.16)***	1.10 (1.03; 1.16)**	1.1 (1.07; 1.13)***	1.06 (1.02; 1.10)**	1.07 (1.01; 1.13)**	
Resilience ^g	0.85 (0.65; 1.09) *		0.87 (0.77; 0.99)**		0.86 (0.64; 1.14)	
Sleep quality	0.72 (0.58; 0.90)**		0.80 (0.71; 0.90)***		1.01 (0.79; 1.29)	
Number of substances used	1.22 (0.96; 1.55) *		1.38 (1.18; 1.61)***		1.44 (1.01; 2.07)**	1.61 (1.08; 2.39)**
Nicotine use during the last 6 months			1.03 (0.80; 1.33)		1.45 (0.96; 2.19) *	

(Continued)

Table 2. (Continued)

	Increase in nicotine use (multivariate n = 554)		Increase in alcohol use (multivariate n = 2190)		Increase in cannabis use (multivariate n = 400)	
	OR (95%CI)	aOR (95%CI)	OR (95%CI)	aOR (95%CI)	OR (95%CI)	aOR (95%CI)
Alcohol use during the last 6 months	1.14 (0.80; 1.64)				1.30 (0.71; 2.38)	
Cannabis use during the last 6 months	1.5 (1.03; 2.25)**		2.14 (1.68; 2.73)***	1.82 (1.39; 2.39)***		

Notes. OR = Crude Odds Ratio. aOR = Adjusted Odds Ratio. 95%CI = 95% Confidence Interval. Bold typeface indicates $p \leq .05$. ^a Married vs (not married, married but separated, widowed and not remarried, or divorced and not remarried); ^b Post-secondary/ Tertiary school vs primary or secondary school; ^c Employed vs (unemployed, student, or retired); ^d urban area or urban cluster vs rural area; ^e Responded “yes” vs “no” to the dichotomous item “I lost my job or my hours were significantly reduced because of the coronavirus”; ^f Depression and anxiety symptoms measured using PHQ-4 (Kroenke et al., 2009).^g Resilience measured using BRS (Smith et al., 2008)

* $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$

Table 3. Correlations between increased substances use among polysubstance users and comparison for correlations according to the number of substances used (2 vs. 3 substances)
a. Correlations among polysubstance users

	Increase in nicotine use	Increase in alcohol use	Increase in cannabis use
Increase in nicotine use	1	0.22** (n = 428)	0.22** (n = 187)
Increase in alcohol use		1	0.24** (n = 381)
Increase in cannabis use			1
b. Correlations among users of 2 substances			
	Increase in nicotine use	Increase in alcohol use	Increase in cannabis use
Increase in nicotine use	1	0.20** (n = 276)	0.25 (n = 35)
Increase in alcohol use		1	0.16* (n = 229)
Increase in cannabis use			1
c. Correlations among users of 3 substances			
	Increase in nicotine use	Increase in alcohol use	Increase in cannabis use
Increase in nicotine use	1	0.21** (n = 152)	.21** (n = 152)
Increase in alcohol use		1	.35** (n = 152)
Increase in cannabis use			1
d. Comparison for correlation among users of 2 substances vs. among users of 3 substances			
	Increase in nicotine use	Increase in alcohol use	Increase in cannabis use
Increase in nicotine use		-0.17 (0.86) †	0.24 (0.81) †
Increase in alcohol use			-1.95 (0.05) †
Increase in cannabis use			

* = significant at $p < .05$ 2-tailed; ** = significant at $p < .01$ 2-tailed

† Test statistic (2-tailed p) for r -to- Z comparison for correlation among users of 2 substances vs. among users of 3 substances

6. Discussion

This study found that feelings of isolation as well as depression and anxiety symptoms during the pandemic were associated with increased nicotine use. In addition, feelings of uncertainty and increased levels of depression and anxiety during the pandemic were associated with increased alcohol use. Moreover, being a user of multiple substances was associated with increased use of cannabis and alcohol during the pandemic. Co-use of cannabis and alcohol increased chances for escalating alcohol use during the pandemic, while increased cannabis use was associated with the number, rather than the type, of substances being used.

Our findings that feelings of loneliness and depression/anxiety symptoms were associated with increases in nicotine use are consistent with recent research documenting that these experiences play a role in promoting nicotine use both prior to (Dyal & Valente, 2015; Fluharty et al., 2017) and during the COVID-19 pandemic (Gendall et al., 2021; Knell et al., 2020; Luk et al., 2021; Reynolds et al., 2021). Our results also identified employment status and having experienced COVID-19 related reductions in work hours or job loss as factors associated with increased substance use in this sample. These employment-related factors had the strongest relationships with increased nicotine use and suggest that increases in nicotine use may be facilitated by one's finances and/or by work-related stress. Previous studies indicate that stress may cause individuals to crave nicotine (Childs & de Wit, 2010) and increasing use of nicotine may serve as a means of coping (Park & Iacocca, 2014).

Our study showed that experiencing higher levels of stress during the pandemic was associated with increases in cannabis use during the pandemic. This observation extends pre-pandemic

literature noting that stress can trigger and maintain cannabis use (al'Absi & Allen, 2021; Hyman & Sinha, 2009). One novel finding of this study is that increases in cannabis use were predicted in a dose-response manner by the number of other substances that respondents co-used. That is, we observed that increases in cannabis use were more likely if one other substance (alcohol or nicotine) was being used, and the likelihood of increased cannabis use increased even higher if two other substances (both alcohol and nicotine) were being used. For each additional substance co-used, there were 60% higher odds of reporting an increase in cannabis use during the pandemic.

Within this study, depression/anxiety symptoms, uncertainty, and age were associated with increased alcohol use during the pandemic. This is consistent with the hypothesis that negative affective states drive some individuals to consume alcohol as a means of coping with their distress (Cox & Klinger, 2004; Gorka et al., 2012; Kraemer et al., 2015). Being employed was another factor associated with increased alcohol use in this sample, suggesting that finances or work-related stress may contribute to increased alcohol consumption (Frone, 2016; Neupert et al., 2017). One novel finding in this study is the observation that cannabis use during the last six months was the strongest predictor of respondents' increased alcohol use during the pandemic; indeed, co-using cannabis was associated with 86% higher odds of increased alcohol use. We note that this finding was unique to cannabis co-use; nicotine co-use was not significantly related to increases in alcohol consumption.

Interestingly, our analysis of the role of co-use of other substances with increases in nicotine use during the pandemic did not yield significant results. This was possibly related to the smaller sample of cannabis-nicotine users in the study, which may be partially explained by the fact that some users of co-administered cannabis and tobacco products, such as blunts, may not consider themselves tobacco smokers (Lee et al., 2010) and, therefore, may not think to report increases in their tobacco use even if they increased consumption of co-administered cannabis and tobacco products. We note that the literature indicates that co-use of cannabis and tobacco increases dependence for both substances (Panlilio et al., 2013). Notwithstanding this null finding related to substance co-use predicting nicotine use, we did find that co-use of both nicotine and alcohol was associated with increases in cannabis use (through the effect of the number of substances co-used).

Our study has several implications. The consistency of the findings related to risk factors associated with increases in substance use highlights a potential need to provide alternative means of coping with experiences such as depression/anxiety symptoms, perceived stress, and lack of employment to prevent increases in substance use within a subset of the population. In addition, our observation of increased use of alcohol among cannabis co-users indicates the potential importance of considering co-use in future intervention efforts, particularly in light of both the high prevalence of alcohol and cannabis co-use and the association of this co-use with higher levels of alcohol consumption (Metrik et al., 2018; Yurasek et al., 2017). Furthermore, many studies have found that co-use of cannabis and alcohol is associated with poorer treatment responses for both substances (Mojarrad et al., 2014; Subbaraman et al., 2017).

Notwithstanding the strengths of this study, we note some limitations inherent in the study design. Although this study included a multinational sample, the sample was not designed to be representative; about half of the participants were from the USA and three of the top represented countries are currently classified as high income by the World Bank (The World Bank Group, 2022). Future studies are needed to examine whether risk factors for increasing substance use vary systematically between high and middle/low income regions. In addition, data collection utilized self-reports rather than objective measures of substance use; future studies may benefit from including biological measures of substance use. While stress and negative affect related to the COVID-19 pandemic may promote substance use, the opposite may also be possible—continuing use of these substances may increase risk for elevated perceived stress and depression/anxiety symptoms. To better assess the directionality of effects, future research would need to address these questions using prospective research designs that carefully track changes in stress, mood,

and substance use patterns. In addition, this study examined use of the three most commonly used substances worldwide (Winstock, 2021); however, future research should consider additional substances that were not assessed in this study. Nevertheless, the current study provides novel and important findings that capture factors associated with increased substance use during the early escalation period of the pandemic, characterized by heightened concerns and uncertainty. It has the additional strength of including a multinational sample, identifying risk factors that predict increases in substance use across different regions of the world. Future studies can build on this study by including larger samples from different regions of the world to examine whether predictors of increased substance use vary systematically by region.

In conclusion, the results of this study demonstrate significant burdens associated with the early wave of the pandemic and point to potential long-term consequences of the pandemic on substance use and mental health. Integrating routine brief screenings for feelings of depression and anxiety as well as for changes in quantities and types of substances used may help clinicians identify at-risk individuals. The links between polysubstance use with higher likelihoods of increased use of alcohol and cannabis point-out the need to pay careful attention to co-use of multiple substances when identifying at-risk groups and when developing potential interventions. Recovery efforts post-pandemic must consider the need to build multinational efforts to address substance use and related mental health effects of COVID-19.

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The datasets generated and analyzed for this study are available from the corresponding author on reasonable request.

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