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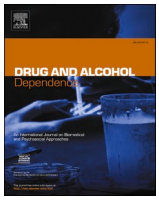

Person-centered patterns of substance use during the COVID-19 pandemic and their associations with COVID-related impacts on health and personal finances in young Black and White women

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ABSTRACT

Background: Population-level statistics on pandemic-related change in substance use can obscure patterns of use (e.g., polysubstance use) within individuals. This longitudinal study used a person-centered approach to identify subgroups with respect to patterns of substance use prior to and during the COVID-19 pandemic, and to examine profile correlates (e.g., socio-demographic characteristics), which can inform tailored intervention.
Methods: The two youngest age cohorts of the Pittsburgh Girls Study (n = 938; 59.1 % Black, 40.9 % White; mean age= 26.2 (SD= 0.8)), a longitudinal community sample, provided data on past year frequency of cigarette/e-cigarette use, binge drinking (>4 drinks per occasion), and cannabis use prior to and during the pandemic, and perceived change in use. Latent profile analysis identified subgroups. Profile correlates were examined (e.g., sociodemographics, COVID-19 infection status and reported exposure, COVID-19 impacts on psychological health and finances).
Results: Seven profiles were identified: "Low use", "Occasional binge drinking", "Cannabis use", "Cigarette/e-cigarette & binge drinking", "Occasional binge drinking & cannabis", "Binge drinking & cannabis", and "Polysubstance use". Black women were overrepresented in "Low use", which was associated with fewer pandemic effects on health. Profiles associated with more frequent binge drinking were more likely to report COVID-19 infection, whereas "Cannabis use" had lower reported infection prevalence. "Polysubstance use" had more COVID-related depression and income loss, on average, than "Low use".
Conclusions: Distinct subgroups representing single substance use, co-use, and polysubstance use prior to and during the pandemic were identified. The profiles show differential response to COVID-19 impacts, ranging from relative hardiness to specific needs to guide personalized treatment.

1. Introduction

At the start of the COVID-19 pandemic, public health experts predicted increases in substance use at the population level due to pandemic-related stress and "stay-at-home" mandates (Holmes et al., 2020; McKay and Asmundson, 2020; Mallet et al., 2021). Conversely, overall reductions in substance use also were predicted based on reduced access to and availability of certain substances (Rehm et al., 2020; Romm et al., 2022). Thus, both increases and decreases in substance use at the population level in response to the pandemic were predicted, with the direction of change dependent on specific substance.

In line with prediction, at the population-level, studies observed pandemic-related average increases in the use of tobacco products, alcohol, and cannabis (Bommele et al., 2020; Czeisler et al., 2020; Cousijn et al., 2021; Horigian et al., 2021; Manthey et al., 2021). In contrast, and in support of alternative prediction, other population-level studies found an overall decrease in the use of various substances (e.g., alcohol, cannabis) during the pandemic (Benschop et al., 2021). Mixed findings across studies may be explained, in part, by methodological factors (e.g., sample characteristics, dates of data collection).

Although population-level data are critical for determining regional trends in prevalence, they can obscure how subgroups of individuals differ in pandemic-related effects on substance use behavior (Benschop et al., 2021; Acuff et al., 2022). For example, some studies described

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population-level subgroups that perceived an increase, decrease, or no change in their substance use during the pandemic (Benschop et al., 2021; Leatherdale et al., 2021; Hicks et al., 2022). To better understand change in substance use at the individual level during the pandemic, a person-centered analytic approach (Spurk et al., 2020) has the advantage of examining use across multiple substances simultaneously, within the same person, in contrast to population-level, between-person studies. For example, a cross-sectional study of outpatients in opioid use disorder treatment identified three subgroups representing minimal substance use, opioid use, and polysubstance use, finding that the opioid use and polysubstance use subgroups increased substance use compared to the minimal use group during the pandemic (Jacka et al., 2021). Building on the results from a treatment sample, the current study would be the first use, to our knowledge, of a person-centered analytical method to examine substance use patterns during the pandemic in a community, rather than a treatment, sample. Identification of distinct profiles or subgroups, and their correlates (e.g., COVID-19 infection and exposure, report of depression) can inform more personalized intervention.

Patterns of substance use would be expected to differ in sociodemographic characteristics, COVID-19 infection and exposure, and impacts on psychological health and personal finances during the pandemic. As a key sociodemographic feature, this study focused on women, an understudied group (National Institutes of Health, 2019; Taslem Mourosi et al., 2022), whose rates of substance use are catching up to or matching that of men (Schulenberg et al., 2021). During the pandemic, young women endured disproportionate financial strain due to job/income loss and increased caregiving responsibilities (Wenham et al., 2020). Notably, sociodemographic characteristics of being female, young adult, and identifying as Black were each associated with increased alcohol consumption during the pandemic in a review of population-level studies (Acuff et al., 2022). This study examined these sociodemographic characteristics in relation to person-centered profiles of hazardous alcohol consumption (binge drinking: 4 + drinks per occasion for women), cigarette/e-cigarette (e-cig) use, and cannabis use during the pandemic.

In addition to sociodemographic characteristics, substance use may be associated with COVID-19 infection risk, with level of risk linked to specific substance used (Wang et al., 2021, 2022). For example, acute alcohol intoxication associated with binge drinking could reduce vigilance to infection risk and use of infection prevention behaviors [cf. (Madden and Clapp, 2019)]. Variability in COVID-19 infection risk across substances also needs to account for personal factors such as exposure to infected individuals both in and outside of the household (Wu et al., 2021), and use of infection prevention behaviors, such as mask-wearing (Oelsner, 2020). This study examined how person-level profiles of substance use during the pandemic were associated with COVID-19 infection status and use of infection prevention behaviors.

Pandemic-related impacts also extend to two major domains of daily life, psychological health and job/finances, both of which have been associated with changes in substance use. Systematic reviews indicate that psychological health conditions including depression and anxiety were associated with increased substance use during the pandemic (Roberts et al., 2021; Acuff et al., 2022). Further, pandemic-related income loss was associated with increases in alcohol use (Vanderbruggen et al., 2020; Acuff et al., 2022). These trends in the association of substance use with depression and anxiety, and job/income loss at the population-level may differ for various subgroups with distinct patterns of substance use during the pandemic.

This study used a person-centered approach to examine perceived change in cigarette/e-cig use, "binge drinking", and cannabis use during the pandemic, in the context of prior year use of these substances, as part of a longitudinal community-based study of Black and White women. Correlates of the identified profiles, which included sociodemographic characteristics (e.g., race, education), COVID-19 infection status and exposure, use of prevention behaviors, and COVID-19 impacts on psychological health and job/finances were examined. We hypothesized that profiles representing use of single substances (e.g., cannabis only), co-use (e.g., alcohol and cannabis), and polysubstance use would be identified. Further, we predicted that the polysubstance use profile would have greater likelihood of testing positive for COVID-19 infection, and be associated with lower adoption of preventive behaviors, and greater depression and loss of job/income relative to co-use and low/no-use profiles. Study findings can inform tailored intervention to address health disparities associated with risk for COVID-19 exposure and its intersection with commonly used substances among Black and White women.

2. Material and methods

2.1. Participants

The Pittsburgh Girls Study (PGS) (Hipwell et al., 2002; Keenan et al., 2010) used stratified, random household sampling, with over-sampling of households in low-income neighborhoods to identify eligible girls between ages 5–8 (N = 2450) to participate in a longitudinal study. The PGS included 4 age-based cohorts. In the two youngest cohorts, 1143 participants who identified as Black or White completed wave 1 at age 5 or age 6. At wave 20, 938 (82.1 %) of cohort 5 and 6 participants (59.1 % Black, 40.9% White; mean age = 26.2, [SD]= 0.8; range= 25–28]) provided data on items assessing the impact of the COVID-19 pandemic on substance use and comprised the analytic sample. Attrition analyses comparing those who did vs did not complete wave 20 indicated that Black (vs White) women were more likely to complete the assessment (85.1 % vs 78.0 %; $x^2(1) = 9.5$, $p = .002$), with no differences based on wave 1: household use of public assistance or caregiver level of education ($ps > 0.05$).

2.2. Procedure

The University's Human Subjects Research Protections Office approved study procedures. Participants provided informed consent prior to completing assessments and were compensated for participation. Wave 19 data were collected in 2019 (pre-COVID-19). Wave 20 data were collected from March 4, 2020 to December 31, 2021. Most (91.7 %) wave 20 assessments were completed in 2021.

2.3. Measurement

2.3.1. Frequency of and change in substance use

The Nicotine, Alcohol, and Drug Use measure (Pandina et al., 1984) assessed self-reported past year frequency of cigarette and e-cig use, binge drinking, and cannabis use in separate items (coded: 0 = none to 7 = daily). Frequency of e-cig use was not queried in Wave 19. At wave 20, frequency of cigarette and e-cig use was asked in two items, which were combined into one cigarette/e-cig use variable by taking the maximum value of the two items.

In wave 20, three items queried change in frequency of cigarette/e-cig use (cigarette and e-cigs in 1 item), binge drinking, and cannabis use ("Since mandated stay-at-home, started in March 2020, I have …") coded 0 = not consumed [substance] since March 2020, 1 = consumed less frequently, 2 = no change, and 3 = consumed more frequently.

2.3.2. Correlates of the substance use profiles

We examined nine correlates. Sociodemographic correlates included race (1 = White, 2 = Black), and highest education obtained as a proxy for socio-economic status (1 = GED or less, 2 = high school diploma, 3 = Associate Degree, 4 = Other Certificate, 5 = Bachelors, 6 = Masters, and 7 = PhD, MD, JD, or Doctorate).

COVID-19 exposure was assessed with three items. Participants reported personal COVID-19 exposure with the item "Has a healthcare provider ever told you that you have, or likely have, COVID-19" (0 = no;

1 = yes) (ECHO, 2020). Household exposure was assessed with, "How many people with whom you're living have been diagnosed (tested positive) for COVID-19? (number of people coded: 0–2, >3) (USC Center for Economic and Social Research, 2020). Exposure outside the home was assessed by asking, "How many people do you know personally (not living with you) who have been diagnosed with COVID-19?" (number of people coded 0–9, >10) (USC Center for Economic and Social Research, 2020).

Personal worry about infection was assessed with, "How worried are you that you will get sick from COVID-19?" rated 0 = not at all worried to 3 = very worried (Kaiser Family Foundation, 2020). COVID-19 preventive behaviors (Oelsner, 2020) were assessed with 15 items (e.g., social/ physical distancing) rated 0 = never to 4 = always, and summed to create a score (alpha=0.86).

Psychological health in response to the pandemic (Conway et al., 2020) was assessed with three items: "I have become depressed because of COVID-19", "COVID-19 has impacted my psychological health negatively", and "COVID-19 has NOT made me feel any worse than I did before" (reverse scored). The items were rated 1 = strongly disagree to 5 = strongly agree, and summed to create a psychological health score (alpha= 0.74). Job and financial impacts (CDC, 2020) were assessed with seven items (e.g., income or pay was reduced), rated 0 = no and 1 = yes; and summed to create a job/financial problems score (alpha= 0.90).

2.4. Data analysis

To identify distinct person-centered profiles of substance use and perceived change in substance use, we used repeated measures latent profile analysis (RM LPA) (Vermunt and Magidson, 2013). LPA generated subgroups of individuals who share a similar profile of substance use over time accommodating unequal spacing between assessments. The LPA model included 9 indicators: frequency of past year use at waves 19 and 20 of cigarette/e-cigs, binge drinking, and cannabis use (ordinal variables); and at wave 20, self-reported change in cigarette/e-cig use, binge drinking, and cannabis use (nominal variables). Preliminary analyses included additional prior waves of annual substance use data to examine trends in substance use prior to and during the pandemic (Jager and Keyes, 2021) to define the profiles. However, inclusion of additional prior waves did not add new information, and thus were not retained. The profiles represent self-reported frequency of past year substance use prior to and during the pandemic, in the context of perceived change in substance use during the pandemic for three commonly used substances. The final LPA model provided estimates of model parameters, such as probabilities of latent profile membership, and item response probabilities for each profile.

RM LPA analyses were run using Latent GOLD Version 6.0 (Vermunt and Magidson, 2013) using 1000 and 3000 random starts (Hipp and Bauer, 2006), testing the fit of 1–9 latent profiles. Each of the 9 profiles tested included the 9 indicators described above. Use of two different sets of random starts provided similar results regarding the best fitting model. Full-information maximum likelihood estimation accommodated missing data (Vermunt and Magidson, 2005). The best-fitting model was selected after considering fit indices (e.g., Bayesian Information Criterion [BIC], Akaike Information Criterion [AIC], Log-likelihood^2 [LL^2]; lower value= better fit (Henson et al., 2007; Spurk et al., 2020)), Vuong-Lo-Mendell-Rubin (VLMR) test (significant *p*-value suggests that an additional class significantly improves model fit), and avoiding profiles with low prevalence (e.g., <5 %) (Nylund-Gibson and Choi, 2018).

The adjusted three-step procedure (Bakk and Vermunt, 2016) was used to examine correlates of profile membership. The method corrects for classification error to minimize bias in estimation of associations between the profiles and the 9 correlates included (simultaneous entry) in the model. The year in which the participant completed the survey (2020 vs 2021) was included in preliminary analyses as a covariate, but was not statistically significant (p = .57) and excluded from the final model. For correlates that differed across the latent profiles overall (i.e., significant Wald test), pairwise comparisons between profiles were examined (p < .05). No adjustment for multiple comparisons of protected pair-wise comparisons was done, given the exploratory nature of the analyses (Leek et al., 2017).

3. Results

3.1. Substance use in the year prior to COVID-19 and during the pandemic

The total sample reported, on average, relatively low frequency (less than once per month) of cigarette/e-cig use, binge drinking, and cannabis use in the year prior to COVID-19 and during the pandemic (Table 1). Overall, since stay-at-home orders (March 2020), a minority (10.8 %) reported an increase in the frequency of using cigarettes/e-cigs, binge drinking (14.0 %), and using cannabis (17.4 %). Since the start of stay-at-home, a majority did not report cigarette/e-cig use (68.0 %), while 52.9 % did not use cannabis, and 44.4 % did not report binge drinking.

3.2. RM LPA model selection

Comparison of RM LPA models fitting 1–9 profiles indicated that the 7-profile model had the best fit based on BIC (Table 2). Although AIC, LL^2 and VLMR test indicated better model fit as the number of classes increased, the 8-profile (vs 7-profile) model had slightly higher classification errors (10.6 vs 11.4), and a low prevalence profile (4.2 %). Thus, the 7-profile model was selected after considering model fit indices and parsimony (i.e., the best fitting model that avoids including low prevalence profiles).

3.3. Latent profiles of substance use and pandemic-related change in use

The seven profiles (see Table 1) represent "Low use" (21.9 %), "Occasional binge drinking" (21.4 %), "Cannabis use" (7.4 %), "Occasional binge drinking & cannabis use" (8.6 %), "Binge drinking & cannabis use" (14.6 %), "Cigarette/e-cig use & binge drinking" (10.9 %), and "Polysubstance use" (15.2 %). The "Low use" profile had low probability of reporting use of any of the three substances.

Two profiles represented use of a single substance. The "Occasional binge drinking" profile reported, on average, binge drinking less than once per month, and low probability of using cigarettes/e-cigs or cannabis. A minority (9.6 %) in this profile were likely to report an increase in binge drinking, while 29.2 % reported binge drinking less often since stay-at-home started. The other single substance profile, "Cannabis use", reported, on average, monthly cannabis use in the year prior to COVID-19, and since the start of stay-at-home, cannabis use an average of twice per week. Roughly half (52.7 %) in the "Cannabis use" profile reported no change in frequency of cannabis use, while 38.0% reported an increase since stay-at-home.

Three profiles were characterized by use of two substances. Two profiles involved binge drinking and cannabis use, differing in the frequency of using both substances. "Occasional binge drinking & cannabis use", on average, reported binge drinking less than monthly in the year prior to COVID-19 and since the start of stay-at-home. Individuals in this profile were most likely to report no change (36.6 %) or decreased frequency of binge drinking (35.0 %) since stay-at-home began. Regarding cannabis use, individuals in this profile also reported use less than monthly at both assessments, with most (77.5 %) reporting no change in cannabis use since the start of stay-at-home. The second profile with both "Binge drinking & cannabis use" represented binge drinking 6–11 times per year prior to and since stay-at-home, with 30.6 % increasing binge drinking since stay-at-home and 46.8 % reporting no change. Regarding cannabis use, 52.8 % of individuals in this profile reported an

Table 1
Substance use descriptive statistics for the total sample (N = 938) and by latent profile type.

	Total Sample N = 938	Low use (Profile 1)	Occasional binge drinking (Profile 2)	Cannabis use (Profile 3)	Occasional binge drinking & cannabis (Profile 4)	Binge drinking & cannabis (Profile 5)	Cigarette/e-cig & binge drinking (Profile 6)	Polysubstance Use (Profile 7)
% of the sample in the profile	100.00 %	21.95 %	21.43 %	7.40 %	8.57 %	14.58 %	10.86 %	15.21 %
	Mean (SE)	Mean(SE)	Mean(SE)	Mean(SE)	Mean(SE)	Mean(SE)	Mean(SE)	Mean(SE)
Wave 19 Cigarette use	1.45 (0.08)	0.01(0.01)	0.88(0.16)	0.55(0.23)	0.51(0.22)	0.44(0.13)	3.73(0.33)	4.62(0.27)
W20 Cig/e-cig	1.42 (0.08)	0.00(0.00)	0.03(0.01)	0.00(0.01)	0.17(0.06)	0.07(0.03)	5.22(0.26)	5.43(0.21)
Cig/e-cig use	Est[SE]	Est[SE]	Est[SE]	Est[SE]	Est[SE]	Est[SE]	Est[SE]	Est[SE]
Did not use	.681	.999	.992(0.010)	.967	.351(0.076)	.916(0.031)	.101(0.034)	.020(0.015)
Used less	(0.016)	(0.005)	.000(0.001)	(0.025)	.187(0.048)	.000(0.001)	.191(0.041)	.162(0.033)
often	.064	.000	.007(0.009)	.032	.461(0.069)	.066(0.026)	.383(0.053)	.357(0.043)
No change	(0.008)	(0.000)	.000(0.001)	(0.023)	.000(0.004)	.018(0.016)	.325(0.051)	.461(0.045)
Use more	.147	.001		.000				
often	(0.012)	(0.005)		(0.003)				
	.108	.000		.001				
	(0.010)	(0.001)		(0.007)				
	Mean (SE)	Mean(SE)	Mean(SE)	Mean(SE)	Mean(SE)	Mean(SE)	Mean(SE)	Mean(SE)
W19 Binge drink	1.64 (0.06)	0.41(0.08)	1.93(0.14)	0.84(0.15)	1.53(0.21)	2.54(0.16)	1.90(0.19)	2.41(0.16)
W20 Binge drink	1.49 (0.06)	0.06(0.04)	1.60(0.14)	0.24(0.07)	1.58(0.22)	2.62(0.17)	1.82(0.19)	2.64(0.16)
Binge drink	Est[SE]	Est[SE]	Est[SE]	Est[SE]	Est[SE]	Est[SE]	Est[SE]	Est[SE]
Did not use	.444	.930	.366(0.044)	.836	.146(0.054)	.014(0.014)	.416(0.053)	.262(0.040)
Used less	(0.017)	(0.028)	.292(0.037)	(0.064)	.350(0.061)	.211(0.042)	.153(0.040)	.199(0.036)
often	.187	.034	.246(0.034)	.129	.366(0.061)	.468(0.048)	.185(0.042)	.336(0.042)
No change	(0.013)	(0.019)	.096(0.024)	(0.057)	.138(0.046)	.306(0.044)	.245(0.046)	.203(0.037)
Use more	.229	.025		.001				
often	(0.014)	(0.016)		(0.005)				
	.140	.010		.035				
	(0.012)	(0.011)		(0.032)				
	Mean (SE)	Mean(SE)	Mean(SE)	Mean(SE)	Mean(SE)	Mean(SE)	Mean(SE)	Mean(SE)
W19 Cannabis	1.84 (0.08)	0.03(0.02)	1.01(0.15)	3.61(0.40)	0.71(0.19)	3.69(0.27)	0.86(0.20)	4.29(0.25)
W20 Cannabis	1.88 (0.09)	0.02(0.01)	0.02(0.01)	5.22(0.36)	0.48(0.10)	4.60(0.25)	0.09(0.05)	5.00(0.24)
Cannabis	Est[SE]	Est[SE]	Est[SE]	Est[SE]	Est[SE]	Est[SE]	Est[SE]	Est[SE]
Did not use	.529	.961	.973(0.022)	.056	.001(0.014)	.023(0.016)	.841(0.052)	.065(0.023)
Used less	(0.017)	(0.018)	.000(0.001)	(0.034)	.220(0.052)	.020(0.014)	.012(0.013)	.111(0.028)
often	.043	.000	.016(0.020)	.036	.775(0.053)	.428(0.049)	.137(0.047)	.407(0.045)
No change	(0.007)	(0.000)	.011(0.009)	(0.028)	.001(0.004)	.528(0.049)	.010(0.015)	.416(0.045)
Use more	.255	.031		.527				
often	(0.015)	(0.015)		(0.070)				
	.174	.008		.380				
	(0.013)	(0.009)		(0.069)				

Notes: Cig= Cigarette; W= Wave; Est= Estimated probability of endorsement (reported to 3 decimal places because values are reported as percentages in text); SE= Standard Error; cig= cigarette; e-cig= e-cigarette; Binge drinking= consumption of 4 + drinks in a single occasion. Wave 19 = Year prior to COVID-19 pandemic (2019). Wave 20 = Data collection began March 2020, after the start of mandated stay-at-home. Frequency of use coded 0 =did not use in the past year, 1 = less than 5x in the past year, 2 = 6–11 times in the past year, 3 = about 1x/month, 4 = about 1x/week, 5 = a couple times per week, 6 = nearly every day, 7 = every day or more than once per day.

Table 2
Comparison of model fit, testing 1–9 class solutions.

clusters	LL	BIC (LL)	AIC (LL)	Npar	L^2	df	p-value	VLMR	p-value	Class.Err.	Entropy R^2
1	-6313.82	12,832.94	12,687.63	30	4805.473	908	7.10e-521			0.000	1.000
2	-5832.37	11,959.02	11,750.74	43	3842.580	895	7.50e-360	962.893	< 0.0001	0.049	0.837
3	-5616.71	11,616.66	11,345.41	56	3411.258	882	4.60E-293	431.322	< 0.0001	0.047	0.896
4	-5527.45	11,527.13	11,192.91	69	3232.749	869	3.00E-268	178.508	< 0.0001	0.068	0.864
5	-5457.34	11,475.88	11,078.69	82	3092.532	856	9.30E-250	140.217	< 0.0001	0.078	0.856
6	-5393.84	11,437.83	10,977.67	95	2965.517	843	1.70E-233	127.015	< 0.0001	0.091	0.860
7	-5336.67	**11,412.47**	10,889.35	108	2851.192	830	2.70E-219	114.325	< 0.0001	0.091	0.862
8	-5301.90	11,431.89	10,845.80	121	2781.638	817	4.50E-212	69.553	0.0001	0.089	0.866
9	-5268.20	11,453.47	10,804.40	134	2714.246	804	3.40E-205	67.392	0.0001	0.099	0.860

Notes: Bolded value=lowest BIC. LL=Log Likelihood, BIC=Bayesian Information Criterion, AIC=Akaike Information Criterion, N Par= Number of Parameters, L2 = Log Likelihood2, df=degrees of freedom, VLMR= Vuong-Lo-Mendell-Rubin Test, Class Err= Classification errors

increase in cannabis use since stay-at-home, while 42.8 % reported no change.

The third profile involving two substances, "Cigarette/e-cig use & binge drinking", represented cigarette/e-cig use roughly once per month in the year prior to COVID-19 and twice per week during the pandemic. Almost one-third (32.5 %) in this profile reported increasing cigarette/e-cig use since stay-at-home, while 38.3 % reported no change. Individuals in this profile reported binge drinking less than monthly at both assessments, with 24.5 % increasing binge drinking since stay-at-home started. A minority (15.3 %) decreased binge drinking.

Individuals in the "Polysubstance use" profile reported smoking 1–2 times per week, binge drinking 6–11 times per year, and using cannabis 1–2 times per week at both assessments. Since stay-at-home started, 46.1 % in this profile increased cigarette/e-cig use, and 41.6 % increased frequency of cannabis use. In contrast, a minority (20.3 %) increased binge drinking, while 33.6 % reported no change in binge drinking since stay-at-home.

3.4. Latent profile correlates

In the adjusted three-step procedure, seven of the nine correlates (simultaneous entry) were uniquely associated with the profiles (i.e., not statistically significant: number in the household tested positive for COVID-19; worry that you will get sick from COVID-19).

3.4.1. Sociodemographic characteristics

The profiles differed by race (multivariate Wald [df=6]= 34.3, $p <$ .01; Supplemental Table 1). Post-hoc paired comparisons indicated that the largest differences (Supplemental Table 2, $p <$ .001) involved the "Cigarette/e-cig use & binge drinking" profile, which included the lowest proportion of Black women (43.6 %), and the "Cannabis use" and "Binge drinking & cannabis use" profiles, in which Black women were overrepresented (76.5 % and 64.0 %, respectively; Table 3). Regarding highest education obtained, the profile with the lowest mean education level, "Polysubstance use" (mean= 2.7 [SD= 1.5]; 91.4 % high school grad or higher) differed from "Occasional binge drinking" (mean= 3.5 [SD= 1.5]; 98.3 % high school grad or higher) and "Occasional binge drinking & cannabis use" (mean= 3.8 [SD= 1.6]; 100 % high school grad or higher) ($ps < 0.001$).

3.4.2. COVID-19 exposure, preventive behaviors, and COVID-related impacts

In the total sample, 11.8 % reported being told by a healthcare provider that they have or likely have COVID-19 (Table 3). The two profiles with the lowest proportions reporting COVID-19 infection were "Cannabis use" (3.7 %) and "Polysubstance use" (6.7 %). Both had lower reported prevalence of COVID-19 infection compared to "Occasional binge drinking" (16.3 %), "Cigarette/e-cig use & binge drinking" (15.2 %), and "Occasional binge drinking & cannabis use" (17.7 %) profiles (Supplemental Table 2, $ps < 0.05$).

Regarding the number of people personally known outside the household diagnosed with COVID-19, the two profiles with the largest numbers were "Polysubstance use" (mean= 3.6 [SD= 3.5]) and "Binge drinking & cannabis use" (mean= 4.2 [SD= 3.5]), both of which differed from the profile with the lowest average number, "Low use" (mean= 2.8 [SD= 3.5]) (Supplemental Table 2, $ps < 0.05$).

COVID-19 preventive behaviors were, on average, highest in the "Low use" profile (mean= 47.5 [SD= 10.1]). Preventive behaviors in the "Low use" profile differed from the profile with the fewest preventive behaviors, "Polysubstance use" (mean= 43.5 [SD= 8.7]) (Supplemental Table 2, $p <$ .001). Although "Polysubstance use" reported using, on average, the fewest preventive behaviors, and the highest average number of people personally known outside the home diagnosed with COVID-19, this profile was not among those with the highest proportion reporting that they had or likely had COVID-19 infection.

Psychological health was most negatively affected in the "Polysubstance use" profile (mean= 10.3 [SD= 2.5]), which differed from the profile with the lowest impact, "Low use" (mean= 9.0 [SD= 2.6]) (Supplemental Table 2, $p <$ .001). Similarly, job/finances were most negatively affected in the "Polysubstance use" profile (mean= 2.5 [SD=2.5]), which differed from the profile with the lowest impact, "Low use" (mean= 1.1 [SD= 1.9]) (Supplemental Table 2, $p <$ .001).

4. Discussion

As hypothesized, person-centered profiles representing a single

Table 3
Profile correlates.

	Total sample (N = 938)	Low use (Profile 1)	Occasional binge drinking (Profile 2)	Cannabis use (Profile 3)	Occasional binge drinking & cannabis (Profile 4)	Binge drinking & cannabis (Profile 5)	Cigarette/e-cig & binge drinking (Profile 6)	Polysubstance Use (Profile 7)
	%	%	%	%	%	%	%	%
Race: Black	59.06	63.22	55.48	76.48	52.72	64.04	43.59	59.47
Told had COVID	11.83	9.52	16.34	3.70	17.67	12.22	15.23	6.69
	Mean (SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)
Education	3.28 (1.58)	3.19(1.50)	3.51(1.55)	3.26(1.59)	3.82(1.60)	3.74(1.51)	2.82(1.55)	2.69(1.55)
# Tested positive in household	0.13 (0.46)	0.12(0.45)	0.15(0.52)	0.13(0.49)	0.12(0.37)	0.10(0.39)	0.16(0.51)	0.13(0.45)
# people personally know with COVID outside home	3.29 (3.45)	2.76(3.47)	3.09(3.17)	2.91(3.06)	3.83(3.54)	4.22(3.46)	2.89(3.66)	3.65(3.53)
Worry that will get COVID	2.17 (0.98)	2.24(1.03)	2.09(0.95)	2.14(0.89)	2.15(0.99)	2.19(0.96)	2.09(0.96)	2.23(1.02)
COVID preventive behaviors	45.53 (10.12)	47.50 (10.13)	45.20(10.84)	45.57 (9.29)	45.88(10.46)	45.55(9.35)	44.38(11.24)	43.49(8.69)
Mental health negatively affected by COVID	9.62 (2.59)	9.00(2.58)	9.45 (2.42)	9.55 (2.63)	9.99(2.42)	10.12(2.82)	9.42(2.53)	10.27(2.50)
Job/ financial problems due to COVID	1.67 (2.28)	1.12(1.86)	1.50(2.20)	1.58(2.33)	1.36(2.36)	2.04(2.30)	1.82(2.30)	2.48(2.55)

Note: Education coded: 0 = no diploma or degree, 1 = GED, 2 = HS diploma, 3 = Associate degree or community college, 4 = other certificate of training, 5 = Bachelors, 6 = Masters, 7 = Doctorate, PhD, MD, JD; SD= standard deviation

substance (e.g., cannabis use), co-use of two substances (e.g., binge drinking and cannabis use), and polysubstance use were identified in an urban community sample of Black and White women. Notably, profiles representing single substance use included less than one-third of the sample, highlighting the importance of considering co-use of substances at the person level. An important caveat is that co-use in this study did not distinguish between simultaneous use (i.e., use on the same occasion) and co-use that occurred on different occasions (Skinner et al., 2022). Nevertheless, the profiles, defined primarily by type of substance used, rather than changes in use during the pandemic, indicate heterogeneity in COVID-19-related patterns of substance use, which differ in sociodemographic characteristics, self-reported COVID-19 infection and exposure, and COVID-19 impacts on psychological health and job/income loss.

Contrary to prediction, the "Polysubstance use" profile had relatively low self-reported COVID-19 infection prevalence (6.7 %). Further, among the profiles, the "Cannabis use" profile had the lowest self-reported COVID-19 infection prevalence (3.7 %). COVID-19 infection prevalence for these two profiles was lower relative to the overall sample (11.8 %). Notably, individuals in the "Polysubstance use" profile reported personally knowing a relatively high number of people diagnosed with COVID-19 outside the home and using relatively few preventive behaviors. By comparison, the "Cannabis use" profile did not report particularly high levels of exposure to COVID-19 in or outside the home or use of preventive behaviors. The low self-reported COVID-19 infection prevalence in these two profiles might reflect low rates of COVID-19 testing among women in these profiles.

Profiles with the highest self-reported prevalence of COVID-19 infection involved binge drinking: "Occasional binge drinking" (16.3%) and "Occasional binge drinking & cannabis use" (17.7 %). Greater risk for COVID-19 infection associated with high frequency of alcohol use is consistent with some prior research (Wang et al., 2021; Dai et al., 2022). However, little is known about patterns of substance co-use (e.g., binge drinking and other substance use) in risk for COVID-19 infection. Simultaneous use, particularly binge drinking, in combination with other substance use (e.g., cannabis) could increase disinhibition and risk for COVID-19 infection through, for example, reduced use of preventive behaviors such as social distancing.

As predicted, and similar to prior research (Jacka et al., 2021), individuals in the "Polysubstance use" (vs "Low use") profile were more likely to report pandemic-related psychological health and job/income loss. These results are in line with reviews indicating that increased substance use is associated with adverse pandemic-related impacts on mental health (Roberts et al., 2021; Acuff et al., 2022), and job/income loss (Vanderbruggen et al., 2020). By comparison, the "Low use" profile reported relatively few pandemic-related mental health problems and low job/income loss. Importantly, Black women were overrepresented in the "Low use" profile (63.2 %). The apparent hardiness of this subgroup to pandemic-related impacts stands in contrast to, but does not diminish, the overall burden of the pandemic on young Black women who, at the population-level, bear disproportionate pandemic-related strain on mental health and finances (Gould and Kassa 2020; Millett et al., 2020).

The identified profiles can inform tailored intervention to address disparities associated with risk for COVID-19 infection and its intersection with specific patterns of substance use (cigarette/e-cig, alcohol, cannabis), among young women to guide more personalized public health response. Specifically, women who report polysubstance use warrant intervention not only for substance use, but also would benefit from a range of services to address depression and anxiety, and job/income loss. The differential patterns of change across substances in some profiles highlight the importance of targeted intervention to meet specific needs.

Study limitations warrant comment. Results may not generalize to males, women who do not identify as Black or White, or other age groups. Analyses relied on self-report, and did not examine substance use quantity. E-cig frequency was not included in wave 19 cigarette frequency, resulting in possible underestimate of using this substance. The identified profiles are distinguished by type of substance use, rather than change in use, likely due to the number of substances studied simultaneously and limitations in sample size and characteristics. Processes that underlie changes in substance use were not examined. Given relatively low levels of substance use, substance-related problems and substance use disorder were not analyzed. Analyses of the two time points did not permit analysis of measurement error for the indicators examined. Wave 20 data were collected over an extended time frame (2020–2021), and the wave 20 past year time frame did not permit analyses of substance use in relation to regional changes in policies (e.g., stay-at-home periods). We examined self-report of COVID-19 test results from a health care provider.

5. Conclusions

This study identified subgroups with distinct patterns of pandemic-related substance use, which complement results at the population level. The profiles identified subgroups of women who show apparent hardiness to pandemic-related stress, as well as highlight specific pandemic-related needs to inform tailored intervention.

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Author contributions

TC (PI: DA012237 and COVID supplement to DA012237) designed and completed the analyses, and drafted the initial manuscript; AEH contributed to data collection and manuscript development; CS, AG and YJ contributed to manuscript development. All authors approved the final manuscript for submission.

Conflict of interest

The authors have no conflict of interest to declare.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.drugalcdep.2022.109620.

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