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Patterns of substance use and associations with mental health and interpersonal violence among adolescents

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ABSTRACT

Objective: To identify patterns of adolescent substance use and associated behavioral health characteristics among adolescents.

Methods: We conducted a cross-sectional study of 167,504 adolescents aged 13–17 who were screened for substance use, mental health symptoms, and interpersonal violence during well-check visits in a large healthcare system in California from 2021 to 2022. We conducted latent class analysis to identify patterns of substance use from four substance use behaviors (past-year alcohol, cannabis, other substance, and close friends' use). We calculated the prevalence of depressive symptoms, suicidal ideation, bullying, physical abuse by an adult, sexual violence, and intimate partner violence for each substance use class compared to those with no reported substance use behaviors and estimated adjusted prevalence ratios using modified Poisson regression.

Results: In total, 29,288 (17 %) adolescents reported ≥ 1 substance use characteristic. From those, we identified five latent classes with different patterns of substance use: *substance use among close friends* (37 %), *alcohol use* (21 %), *polysubstance use* (20 %), *cannabis use and some polysubstance use* (18 %), and *other substance use* (5 %). All classes had higher adjusted prevalence of mental health and interpersonal violence outcomes compared to those with no substance use characteristics, with the greatest differences being among the *polysubstance use* class.

Conclusions: The high prevalence of mental health and interpersonal violence outcomes among adolescents with substance use, even among those who only report close friends' substance use, highlights the need for routine screening during well-check visits. Comprehensive routine social and behavioral health screening among adolescents is vital for early identification and intervention.

1. Introduction

Substance use is prevalent among adolescents and has long-term adverse health consequences, including the development of substance use disorders (SUDs) in adulthood (Chen et al., 2009; Grant & Dawson, 1997; McCabe et al., 2007). The majority of adults with a SUD report substance use initiation during adolescence (Substance Abuse Mental Health Services Administration, & Office of the Surgeon General, 2016). Although adolescent substance use has decreased over the past few decades, with decreases occurring during the COVID-19 pandemic (Miech et al., 2024), use of alcohol, cannabis, and other drugs remains common. National data from 2023 of self-reported past-year use among 8th, 10th,

and 12th graders indicate that 30.0 % used alcohol, 18.0 % used cannabis, 17.2 % vaped nicotine, and 5.6 % used any illicit drug other than cannabis (Miech et al., 2024). While studies of adolescent substance use typically focus on single substances, polysubstance use is common and has an increased risk for health and behavioral problems (Chen et al., 2009; Connor et al., 2014; Grant & Dawson, 1997; McCabe et al., 2007; Moss et al., 2014). For example, adolescents who use multiple substances are more likely to have severe mental health problems and engage in risky sexual behaviors compared to those who use few to no substances (Connor et al., 2014; Halladay et al., 2020; Moss et al., 2014).

To better understand patterns of substance use among adolescents,

studies have used person-centered approaches like latent class analysis (LCA) (Tomczyk et al., 2016). Prior studies have found distinct subgroups of adolescents with unique patterns of substance use, for example: no/low use of any substances, predominately alcohol use, cannabis use in combination with either alcohol use or tobacco use, and polysubstance use (i.e., use of more than one substance) (Tomczyk et al., 2016). Some LCA studies also analyzed the association between substance use patterns and risk factors, such as peer and parental substance use, academic performance, and mental health. However, there is high heterogeneity in the choice of factors (Halladay et al., 2020; Tomczyk et al., 2016). Peer substance use is a key risk factor for adolescent substance and polysubstance use, as there is a perceived established social norm and peer approval of using substances (Tomczyk et al., 2016; Trucco, 2020). Peer substance use is typically included as a correlate of adolescent substance use classes but not as a variable in LCA models, which could inform distinct classes. Peer substance use may also be associated with mental health and interpersonal violence, given the association of substance use, mental health, and violence and the clustering of mental health and violence perpetration and victimization within adolescent peer groups (Alho et al., 2024; Mullet et al., 2024).

Adolescent substance use, mental health problems, and interpersonal violence experiences (e.g., bullying, physical abuse, and intimate partner violence) are intersecting issues that often co-occur (Cole et al., 2019; Halladay et al., 2020; Hulvershorn et al., 2015; Nawi et al., 2021; Parker & Bradshaw, 2015; Zhu et al., 2022). Adolescents commonly experience various forms of interpersonal violence. About 22 % of adolescents report past-year bullying, 25 % report lifetime physical abuse, 11 % report past-year sexual violence, and 14 % report past-year physical or sexual intimate partner violence (IPV; physical, psychological, or sexual abuse or aggression by a current or former intimate or romantic partner) (Breiding et al., 2015; Clayton et al., 2023; Swedo et al., 2023). Psychological IPV (e.g., emotional abuse, coercion) is the most common form of IPV, and estimates of lifetime prevalence are as high as 60 % among adolescents, although it is not as widely assessed as physical or sexual IPV (Taylor & Mumford, 2016; Ybarra et al., 2016). Adolescents who experience interpersonal violence may use substances to cope with the accompanying adverse physical and mental health effects (Piolanti et al., 2023; Valdebenito et al., 2015). Although the associations between substance use, interpersonal violence, and mental health have been established, the relationship between different patterns of substance use among adolescents and experiences of the individual forms of violence warrant further investigation.

In this study, we conducted LCA using data from a large, integrated healthcare delivery system to identify patterns of individual and peer substance use and further understand how the patterns are associated with mental health and experiences of interpersonal violence.

2. Methods

2.1. Sample and Setting

Kaiser Permanente Northern California (KPNC) is an integrated healthcare delivery system that provides healthcare to ~ 4.6 million members, with a sociodemographic profile generally similar to the insured California population (Gordon, 2020). KPNC systematically screens adolescents aged 13–17 for mental health and substance use via a confidential well-check questionnaire administered at well-child visits. The questionnaire includes items on nutrition, physical activity, body image, safety, mental health, substance use, and sexual health. Pediatricians privately review and confirm responses to sensitive questions, which are included in adolescents' electronic health records (EHR).

All KPNC adolescents who completed a well-check questionnaire from January 1, 2021 to December 31, 2022 at a standard well-child visit (N = 168,467 adolescents, N = 200,975 questionnaires) were eligible for inclusion. Records missing a response to all four questions about past-year substance use characteristics (N = 1,347 questionnaires,

0.7 %) were excluded. We included the most recent record for adolescents who completed more than one questionnaire during the study period (N = 32,124 questionnaires excluded, 16 %). The KPNC Institutional Review Board approved this study and waived informed consent.

2.2. Exposures

Self-reported past-year substance use was the study exposure. Latent classes were formed using past-year substance use characteristics (1) "Do your close friends drink alcohol or get high?" (2) "During the past year, did you drink alcohol?" (3) "During the past year, did you use marijuana?" (4) "During the past year, did you use any other substance to get high, calm down, or stay awake?".

2.3. Outcomes

Study outcomes were mental health symptoms and interpersonal violence experiences ascertained from the well-check questionnaire. Mental health outcomes included depressive symptoms and suicidal ideation experienced in the past two weeks. Depressive symptoms were based on the Patient Health Questionnaire 2 (PHQ-2), a validated questionnaire that assessed the frequency of: 1) having little interest or pleasure in doing things and 2) feeling down, depressed, or hopeless (Kroenke et al., 2003). Each response uses a 4-point Likert scale (0 = not at all, 1 = several days, 2 = more than half the days, and 3 = nearly all days). The PHQ-2 scale ranges from 0 to 6 and scores ≥ 3 indicate a positive screen for depressive symptoms. Suicidal ideation was based on endorsing yes to the yes/no question: "Have you thought seriously about killing yourself, made a plan, or tried to kill yourself?" Interpersonal violence outcomes included lifetime experiences of bullying (bullied or threatened online, by text, or in person; yes/no), physical abuse by an adult (hit, slapped, kicked, shoved by an adult; yes/no), sexual violence (forced or pressured to have sex or be involved in unwanted sexual activities; yes/no), emotional IPV (dated someone who put you down or made you feel like you cannot do anything right; yes/no), and physical IPV (dated someone who physically hurt you or made you feel afraid; yes/no).

2.4. Covariates

We abstracted all covariate data from the EHR. We identified age at well-child visit, sex, race, ethnicity, and census-based neighborhood deprivation index (NDI, categorized into quartiles using the distribution from the overall KPNC population in 2021) (Messer et al., 2006).

2.5. Statistical analysis

We conducted LCA to identify patterns of substance use among adolescents. LCA determines discrete classes in which individuals will have most similar response patterns to each other that are also notably distinct from response patterns of individuals within other classes (Berlin et al., 2014). In this study, individuals' response patterns to a set of four indicators were used to determine the probability of latent class membership: (1) substance use among close friends, (2) alcohol use, (3) cannabis use, and (4) other substance use within the past year.

We fit six LCA models among the subset of adolescents reporting at least one of the four substance use characteristics. We added a class during each model iteration. starting with two classes and ending with seven classes We compared the decreases in likelihood ratio statistic (G^2), Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC) values, and increases in entropy values between subsequent model iterations (i.e. between models specifying 3 vs. 4 classes, 4 vs. 5 classes, etc.) (Lanza et al., 2015; Sinha et al., 2021). When determining the best fit model, we considered these model fit statistics as well as the interpretability of the latent classes, informed by input from KPNC clinical leaders.

We used posterior probabilities from the best fitting LCA model to categorize adolescents into their substance use experience latent class. We compared sociodemographic characteristics and prevalence of mental health and interpersonal violence outcomes across latent classes. We estimated associations between latent classes and behavioral health outcomes using modified Poisson regression with robust standard errors, unadjusted and adjusted for race and ethnicity, age, sex, and NDI. Regression models excluded participants with missing data, resulting in varying sample sizes by outcome. Adolescents reporting no substance use (and thus excluded from the LCA model) were specified as the reference group. We reported the adjusted prevalence ratios (aPRs) and 95 % confidence intervals (CIs). We used SAS 9.4 for all analysis.

3. Results

3.1. Study population

During the study period, 167,504 adolescents completed all substance use-related fields in the well-child questionnaire. Of these, 29,288 adolescents (17.5 %) reported ≥ 1 substance use characteristic. Overall, 9.6 % of participants reported depressive symptoms, 2.3 % suicidal ideation, 8.2 % bullying, 1.5 % experienced physical abuse by an adult, 1.6 % experienced sexual violence, 4.7 % experienced emotional IPV, and 0.9 % experienced physical IPV. See Table 1 for the sample characteristics.

We compared LCA model fit indices with each increase in the number of classes specified in the model. Among competing models specifying 2 to 7 classes, we further assessed notable decreases in G^2, AIC, and BIC values and increases in entropy values when comparing results for 3 vs. 4 latent classes and 4 vs. 5 latent classes. Optimal combination of model fit and interpretability of latent classes pointed to a 5-class model as the best fit, suggesting the following labels: (1) *substance use among close friends* (n = 10,860, 37.3 % of all adolescents reporting substance use), (2) *alcohol use* (n = 5,979, 20.5 %), (3) *polysubstance use* (n = 5,782, 19.9 %), (4) *cannabis use and some polysubstance use* (n = 5,219, 17.9 %), and (5) *other substance use* (n = 1,448, 5.0 %). The latent class labelling reflects the probability of endorsing the substance use characteristic, with the highest probability of an endorsement taking precedent. For example, the *polysubstance use* class was characterized by the equally high probability (>90 %) of endorsing cannabis and alcohol use, and close friends' substance use; and the *cannabis use and some polysubstance use* class was characterized by the 100 % probability of endorsing cannabis use and lower probabilities of endorsing close friends' substance use (48.3 %), alcohol use (41.6 %), and other substance use (17.1 %). See Fig. 1 for item-response probabilities within each class.

Differences were found in sociodemographic characteristics of substance use latent classes (Table 1). The average age at well-child visits was lowest among the *no substance use* class (14.8 ± 1.3 years) and highest among the *polysubstance use* class (16.0 ± 1.0 years). Females were more common than males in the *substance use among close friends* class (55.4 % vs. 44.6 %) and *polysubstance use* (53.8 % vs. 46.1 %) classes, and less common than males in the *other substance use* class (44.7 % vs. 55.2 %). Substance use characteristics varied by race and ethnicity, with the highest proportions of non-Hispanic Black adolescents (12.5 %) and Hispanic adolescents (33.4 %) in the *cannabis use and some polysubstance use* class, non-Hispanic White adolescents in the *polysubstance use* class (46.4 %), and Asian or Pacific Islander adolescents in the *no substance use* class (22.4 %).

Mental health.

The unadjusted prevalence of depressive symptoms and suicidal ideation was highest among the *polysubstance use* class (26 % and 9 %, respectively; Fig. 2). Adjusting for sociodemographic characteristics, the prevalence of depressive symptoms in the *polysubstance use* class was 3.41 times that of adolescents reporting *no substance use* (aPR = 3.41, 95 % CI: 3.24, 3.58). Prevalence of depressive symptoms was also higher in the remaining four classes compared to adolescents reporting *no*

substance use (*substance use among close friends,* aPR = 2.08, 95 % CI: 1.98, 2.18; *alcohol use,* aPR = 2.12, 95 % CI: 1.99, 2.26; *cannabis use and some polysubstance use,* aPR = 3.01, 95 % CI: 2.85, 3.17; *other substance use,* aPR = 3.06, 95 % CI: 2.79, 3.37). Similarly, suicidal ideation was more prevalent in all five latent classes compared to the *no substance use* class (*polysubstance use* aPR = 7.18, 95 % CI: 6.49, 7.94; *other substance use* aPR = 6.17, 95 % CI: 5.19, 7.32; *cannabis use and some polysubstance use* aPR = 5.15, 95 % CI: 4.61, 5.77; *alcohol use* aPR = 3.85, 95 % CI: 3.40, 4.35; *substance use among close friends* aPR = 3.42, 95 % CI: 3.11, 3.76; Table 2).

3.2. Interpersonal violence

The unadjusted prevalence of bullying was highest in the *other substance use* (18.8 %), and *polysubstance use* classes (18.0 %; Fig. 2). Compared to the *no substance use* class, the adjusted prevalence of bullying was highest among the *polysubstance use* class (aPR = 3.25, 95 % CI: 3.07, 3.45), followed by *cannabis use and some polysubstance use* (aPR = 2.67, 95 % CI: 2.50, 2.85), *other substance use* (aPR = 2.92, 95 % CI: 2.63, 3.25), *substance use among close friends* (aPR = 2.38, 95 % CI: 2.26, 2.50), and *alcohol use* (aPR = 2.21, 95 % CI: 2.06, 2.36; Table 2).

We found a low prevalence of physical abuse by an adult across all classes, ranging from 5.3 % (*polysubstance use*) to 1 % (*no substance use*; Fig. 2). Compared to the *no substance use* class, the adjusted prevalence of physical abuse by an adult was higher across all substance use classes, particularly among the *polysubstance use* class (aPR = 6.05, 95 % CI: 5.30, 6.90; Table 2).

While the overall prevalence of sexual violence (1.6 %) was low, the prevalence among all five substance use latent classes was higher, ranging from 3.7 % (*substance use among close friends*) to 12.2 % (*polysubstance use*; Fig. 2). Compared to the *no substance use* class, the adjusted prevalence of sexual violence was highest among the *polysubstance use* class (aPR = 14.01, 95 % CI: 12.60, 15.60) and lowest among the *substance use among close friends* class (aPR = 4.65, 95 % CI: 4.13, 5.25; Table 2).

Emotional IPV was more prevalent than physical IPV among all classes (Fig. 2). The highest prevalence was among the *polysubstance use* class (22.5 % vs. 5.4 %) and the lowest was among the *substance use among close friends* class (11.0 % vs. 1.8 %). Compared to the *no substance use* class, the adjusted prevalence of emotional IPV ranged from aPR = 3.72, 95 % CI: 3.49, 3.97 (*substance use among close friends*) to aPR = 7.43, 95 % CI: 6.98, 7.91 (*polysubstance use*), and physical IPV ranged from aPR = 3.76, 95 % CI: 3.19, 4.44 (*substance use among close friends*) to aPR = 10.58, 95 % CI: 9.11, 12.30 (*polysubstance use*; Table 2).

4. Discussion

The current study adds to the literature by examining latent classes of substance use characteristics among adolescents and their associations with mental health and experiences of interpersonal violence. Consistent with prior research, the majority of adolescents reported no substance use, and the largest class that reported any substance use was those who used alcohol, followed by classes containing cannabis use and other substance use (Silveira et al., 2019; Tomczyk et al., 2016). The largest class of substance use characteristics was the *substance use among close friends*, in which adolescents largely abstained from substances themselves. While other studies assessed peer substance use as a risk factor for adolescent substance use (Tomczyk et al., 2016; Trucco, 2020), this study uniquely identified that close friends' substance use, even in the absence of one's own use, is associated with adverse mental health and experiences of bullying, physical abuse by an adult, sexual violence, and physical and emotional IPV among adolescents. Out of the five classes of substance use characteristics, *polysubstance use* consistently had the strongest association with all adverse outcomes (e.g., depressive symptoms, suicidal ideation, and all forms of interpersonal violence). This finding supports prior literature indicating that adolescents who use

Table 1
Sociodemographic Characteristics and Mental Health and Interpersonal Violence Outcomes, Stratified by Substance Use Latent Class.

Characteristics	Overall	No substance use	Substance use among close friends	Alcohol use	Polysubstance use	Cannabis use and some polysubstance use	Other substance use	P-Value	Effect Size
N	(N = 167,504)	(N = 138,216)	(N = 10,860)	(N = 5,979)	(N = 5,782)	(N = 5,219)	(N = 1,448)		
Age									
Mean (SD)	14.9 (1.3)	14.8 (1.3)	15.4 (1.2)	15.7 (1.2)	16.0 (1.0)	15.7 (1.2)	15.0 (1.3)	<0.001	0.06
Sex								<0.001	0.03
Female	82,229 (49.1)	66,894 (48.4)	6,014 (55.4)	3,029 (50.7)	3,113 (53.8)	2,532 (48.5)	647 (44.7)		
Male	85,241 (50.9)	71,303 (51.6)	4,843 (44.6)	2,946 (49.3)	2,666 (46.1)	2,684 (51.4)	799 (55.2)		
Other or unknown	34 (0.0)	19 (0.0)	3 (0.0)	4 (0.1)	3 (0.1)	3 (0.1)	2 (0.1)		
Neighborhood deprivation, quartile								<0.001	0.03
1st (least deprivation)	41,997 (25.1)	34,747 (25.1)	2,336 (21.5)	1,833 (30.7)	1,738 (30.1)	989 (18.9)	354 (24.4)		
2nd	48,685 (29.1)	40,080 (29.0)	3,148 (29.0)	1,790 (29.9)	1,760 (30.4)	1,496 (28.7)	411 (28.4)		
3rd	43,518 (26.0)	36,068 (26.1)	2,894 (26.6)	1,419 (23.7)	1,331 (23.0)	1,429 (27.4)	377 (26.0)		
4th (most deprivation)	33,272 (19.9)	27,294 (19.7)	2,479 (22.8)	937 (15.7)	952 (16.5)	1,304 (25.0)	306 (21.1)		
Missing	32 (0.0)	27 (0.0)	3 (0.0)	0 (0.0)	1 (0.0)	1 (0.0)	0 (0.0)		
Race and ethnicity								<0.001	0.07
Asian or Pacific Islander	34,334 (20.5)	30,905 (22.4)	1,464 (13.5)	872 (14.6)	500 (8.6)	392 (7.5)	201 (13.9)		
Non-Hispanic Black	12,172 (7.3)	9,560 (6.9)	1,187 (10.9)	241 (4.0)	401 (6.9)	653 (12.5)	130 (9.0)		
Hispanic	47,320 (28.3)	38,744 (28.0)	3,394 (31.3)	1,570 (26.3)	1,443 (25.0)	1,742 (33.4)	427 (29.5)		
Multiple, other, or unknown	21,509 (12.8)	17,922 (13.0)	1,337 (12.3)	6,92 (11.6)	758 (13.1)	609 (11.7)	191 (13.2)		
Non-Hispanic White	52,169 (31.1)	41,085 (29.7)	3,478 (32.0)	2,604 (43.6)	2,680 (46.4)	1,823 (34.9)	499 (34.5)		
Mental health									
Depression								<0.001	0.12
Yes	16,161 (9.6)	10,450 (7.6)	1,791 (16.5)	926 (15.5)	1,472 (25.5)	1,198 (23.0)	324 (22.4)		
No	150,113 (89.6)	126,876 (91.8)	8,936 (82.3)	4,992 (83.5)	4,253 (73.6)	3,966 (76.0)	1,090 (75.3)		
Missing	1,230 (0.7)	890 (0.6)	133 (1.2)	61 (1.0)	57 (1.0)	55 (1.1)	34 (2.3)		
Suicidal ideation								<0.001	0.10
Yes	3,871 (2.3)	2,080 (1.5)	537 (4.9)	284 (4.7)	498 (8.6)	350 (6.7)	122 (8.4)		
No	160,649 (95.9)	134,119 (97.0)	9,982 (91.9)	5,527 (92.4)	5,064 (87.6)	4,711 (90.3)	1,246 (86.0)		
Missing	2,984 (1.8)	2017 (1.5)	341 (3.1)	168 (2.8)	220 (3.8)	158 (3.0)	80 (5.5)		
Interpersonal violence									
Bullying								<0.001	0.09
Yes	13,652 (8.2)	9107 (6.6)	1,639 (15.1)	771 (12.9)	1,043 (18.0)	820 (15.7)	272 (18.8)		
No	136,595 (81.5)	115,265 (83.4)	8,110 (74.7)	4,565 (76.4)	3,923 (67.8)	3,726 (71.4)	1,006 (69.5)		
Missing	17,257 (10.3)	13,844 (10.0)	1,111 (10.2)	643 (10.8)	816 (14.1)	673 (12.9)	170 (11.7)		
Physical abuse by an adult								<0.001	0.07
Yes	2,452 (1.5)	1,414 (1.0)	276 (2.5)	163 (2.7)	306 (5.3)	224 (4.3)	69 (4.8)		
No	144,411 (86.2)	120,096 (86.9)	9,271 (85.4)	5,052 (84.5)	4,565 (79.0)	4,240 (81.2)	1,187 (82.0)		
Missing	20,641 (12.3)	16,706 (12.1)	1,313 (12.1)	764 (12.8)	911 (15.8)	755 (14.5)	192 (13.3)		
Sexual violence								<0.001	0.15
Yes	2710 (1.6)	890 (0.6)	397 (3.7)	254 (4.2)	706 (12.2)	394 (7.5)	69 (4.8)		
No	163,772 (97.8)	136,727 (98.9)	10,270 (94.6)	5,679 (95.0)	4,976 (86.1)	4,780 (91.6)	1,340 (92.5)		
Missing	1,022 (0.6)	599 (0.4)	193 (1.8)	46 (0.8)	100 (1.7)	45 (0.9)	39 (2.7)		

Table 1 (*continued*)

Characteristics	Overall	No substance use	Substance use among close friends	Alcohol use	Polysubstance use	Cannabis use and some polysubstance use	Other substance use	P-Value	Effect Size
Emotional intimate partner violence								**<0.001**	0.17
Yes	7,923 (4.7)	3,642 (2.6)	1,196 (11.0)	672 (11.2)	1,302 (22.5)	939 (18.0)	172 (11.9)		
No	158,754 (94.8)	134,121 (97.0)	9,478 (87.3)	5,267 (88.1)	4,404 (76.2)	4,241 (81.3)	1,243 (85.8)		
Missing	827 (0.5)	453 (0.3)	186 (1.7)	40 (0.7)	76 (1.3)	39 (0.7)	33 (2.3)		
Physical intimate partner violence								**<0.001**	0.10
Yes	1,437 (0.9)	569 (0.4)	197 (1.8)	120 (2.0)	314 (5.4)	193 (3.7)	44 (3.0)		
No	165,204 (98.6)	137,191 (99.3)	10,470 (96.4)	5,811 (97.2)	5,373 (92.9)	4,991 (95.6)	1,368 (94.5)		
Missing	863 (0.5)	456 (0.3)	193 (1.8)	48 (0.8)	95 (1.6)	35 (0.7)	36 (2.5)		

Notes. Mental health and interpersonal violence outcomes were based on self-reports during well-child visits.
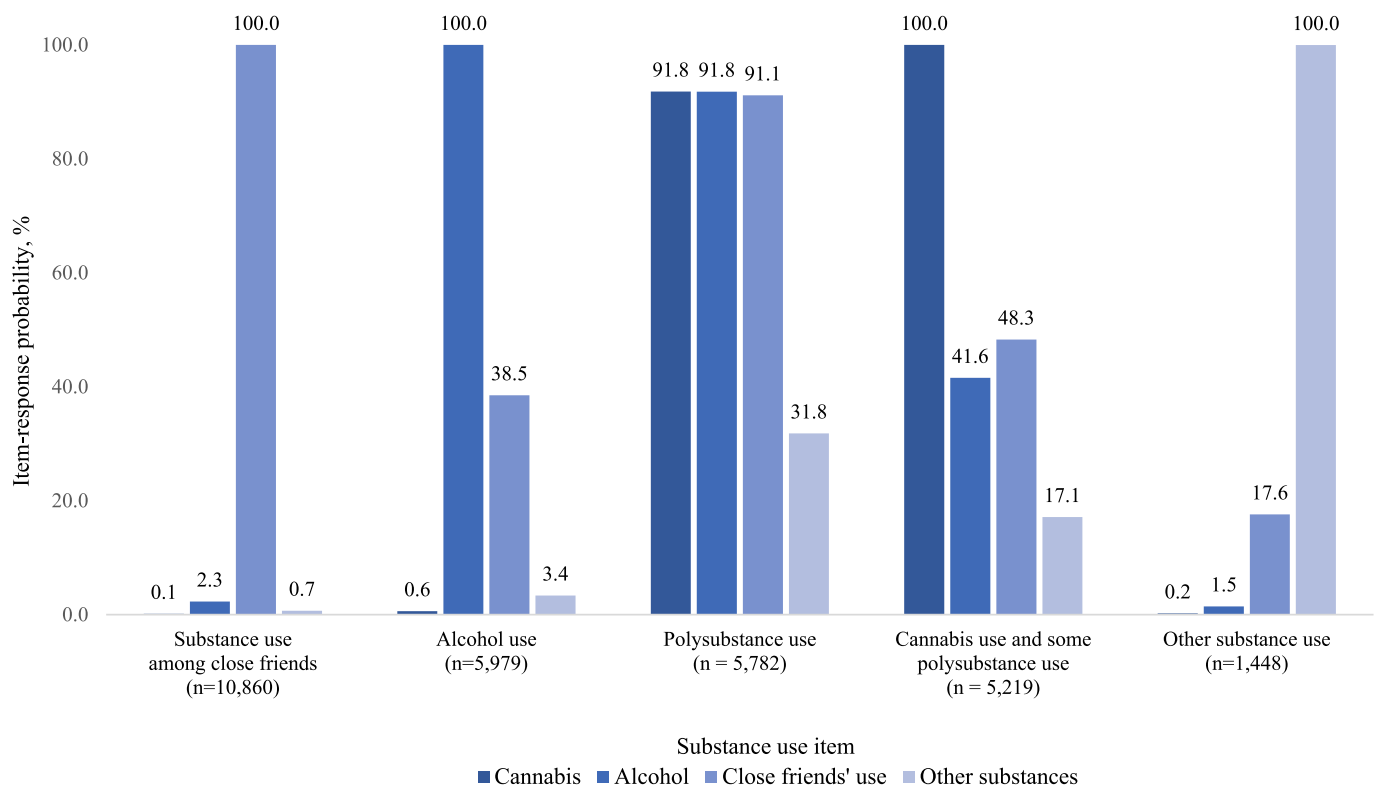

Fig. 1. Adolescent Substance Use Item-Response Probabilities Among Adolescents Reporting Substance Use Behaviors, Stratified by Substance Use Latent Class[a] [a] Item-response probabilities are among n = 29,288 individuals who endorsed any substance use characteristic. The adolescents who reported *no substance use* are not included.

multiple substances have the more severe adverse mental health and behavioral outcomes and higher risk of psychiatric comorbidities (Connor et al., 2014; Halladay et al., 2020; Hawke et al., 2018; Moss et al., 2014; Silveira et al., 2019).

Across all classes of adolescent substance use, the probability of self-reported close friends' substance use was high, particularly among the *polysubstance use* class. The association between peer substance use and an individual's own use can likely be explained by peer socialization (friends' substance use behavior contributes to adolescents' substance use) and peer selection (adolescents' substance use promotes selection of friends who engage in substance use) (Trucco, 2020), which influence social norms and acceptable risk behaviors as adolescents change their substance use over time to mirror the substance use behaviors of their peer groups (Watts et al., 2024). Although adolescents tend to

overestimate their peers' substance use behaviors (Trucco, 2020; Watts et al., 2024), these perceptions inflate norms and enhance acceptability, potentially leading to changes in their behavior (Trucco, 2020). Therefore, identifying close friends' substance use and addressing adolescent perceptions and risk behaviors prior to the substance use initiation could prevent future substance use-related problems.

Similar to prior studies (Halladay et al., 2020), findings highlight the common co-occurrence of substance use behaviors and mental health concerns. Co-occurring substance use and mental health problems can complicate both substance use and mental health treatment, since co-morbidity is related to greater severity of problems and poorer treatment outcomes (Halladay et al., 2020; Hawke et al., 2018). Polysubstance use, the latent class with the highest prevalence of depressive symptoms and suicidal ideation, can further complicate treatment due to the higher risk
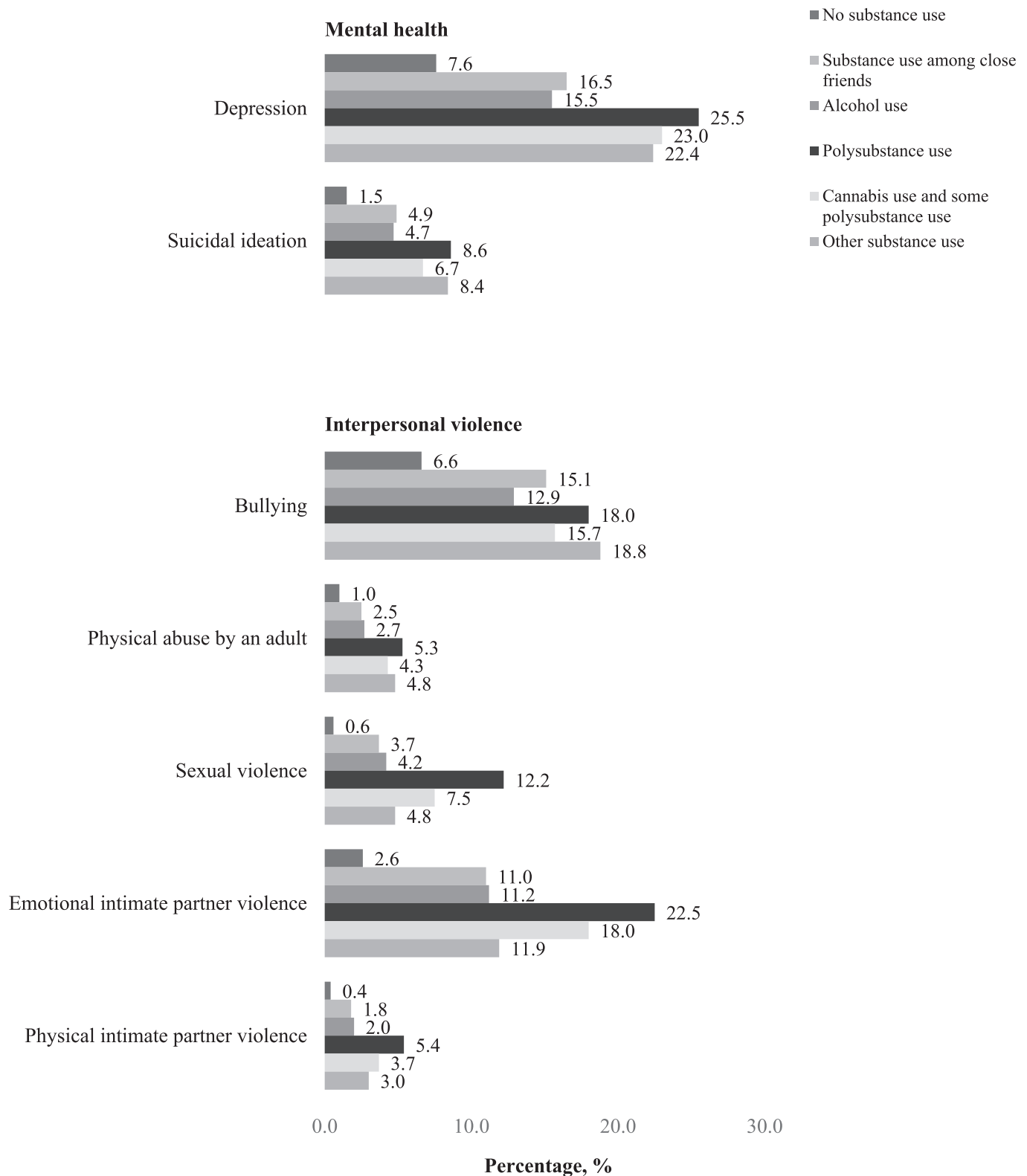
Mental health

Legend:
- No substance use
- Substance use among close friends
- Alcohol use
- Polysubstance use
- Cannabis use and some polysubstance use
- Other substance use

Depression
- 7.6
- 16.5
- 15.5
- 25.5
- 23.0
- 22.4

Suicidal ideation
- 1.5
- 4.9
- 4.7
- 8.6
- 6.7
- 8.4

Interpersonal violence

Bullying
- 6.6
- 15.1
- 12.9
- 18.0
- 15.7
- 18.8

Physical abuse by an adult
- 1.0
- 2.5
- 2.7
- 5.3
- 4.3
- 4.8

Sexual violence
- 0.6
- 3.7
- 4.2
- 12.2
- 7.5
- 4.8

Emotional intimate partner violence
- 2.6
- 11.0
- 11.2
- 22.5
- 18.0
- 11.9

Physical intimate partner violence
- 0.4
- 1.8
- 2.0
- 5.4
- 3.7
- 3.0

0.0   10.0   20.0   30.0

Percentage, %

Fig. 2. Observed Prevalence of Mental Health and Interpersonal Violence Outcomes by Substance Use Latent Class.

of comorbidities (Halladay et al., 2020; Hawke et al., 2018). The identification of patterns of substance use and mental health concerns is vital for adolescents' treatment plans. Substance use may exacerbate mental health symptoms and adolescents may use substances to alleviate mental health symptoms; concurrently addressing mental health and substance use can be essential to adolescents' recovery and overall well-being

(Brewer et al., 2017; Halladay et al., 2020; Hulvershorn et al., 2015). Interventions such as dialectical behavioral therapy and cognitive behavioral therapy are available to address suicidal ideation (Ougrin et al., 2015), and should be considered for those at high risk.

Additionally, peer substance use, mental health problems, and experiences of interpersonal violence among adolescents are risk factors

Table 2

Adjusted Prevalence Ratios Evaluating the Relationship Between Mental Health and Interpersonal Violence Outcomes and Substance Use Latent Classes.

		Substance Use Class				
		Substance use among close friends	Alcohol use	Polysubstance use	Cannabis use and some polysubstance use	Other substance use
Outcome	Sample size	aPR (95 % CI)	aPR (95 % CI)	aPR (95 % CI)	aPR (95 % CI)	aPR (95 % CI)
Mental health						
Depression	166,242	2.08 (1.98–2.18)	2.12 (1.99–2.26)	3.41 (3.24–3.58)	3.01 (2.85–3.17)	3.06 (2.79–3.37)
Suicidal ideation	164,491	3.42 (3.11–3.76)	3.85 (3.40–4.35)	7.18 (6.49–7.94)	5.15 (4.61–5.77)	6.17 (5.19–7.32)
Interpersonal violence						
Bullying	150,220	2.38 (2.26–2.50)	2.21 (2.06–2.36)	3.25 (3.07–3.45)	2.67 (2.50–2.85)	2.92 (2.63–3.25)
Physical abuse by an adult	146,836	2.54 (2.23–2.89)	2.99 (2.53–3.53)	6.05 (5.30–6.90)	4.57 (3.96–5.27)	4.76 (3.77–6.02)
Sexual violence	166,450	4.65 (4.13–5.25)	5.35 (4.64–6.16)	14.01 (12.60–15.60)	9.57 (8.48–10.80)	7.44 (5.88–9.42)
Emotional intimate partner violence	166,645	3.72 (3.49–3.97)	3.92 (3.61–4.25)	7.43 (6.98–7.91)	5.86 (5.47–6.28)	4.45 (3.86–5.13)
Physical intimate partner violence	166,609	3.76 (3.19–4.44)	4.20 (3.44–5.14)	10.58 (9.11–12.30)	7.52 (6.37–8.89)	7.41 (5.49–10.00)

Notes. Models adjusted for sex (female, other or unknown vs. male [reference]), age at well-child visit (continuous), census-based neighborhood deprivation index quartiles (2nd, 3rd, and 4th quartiles vs. 1st quartile [reference]), race and ethnicity (Asian or Pacific Islander, non-Hispanic Black, Hispanic, and multiple, other, or unknown race and ethnicity vs. non-Hispanic White [reference]). The adolescents who reported *no substance use* serve as the reference group.

for adolescents' substance use and should be assessed and appropriately addressed (Tomczyk et al., 2016; Trucco, 2020). Research has demonstrated that efforts employing comprehensive approaches across levels of socialization (e.g., peers, schools, family) can address social influences on adolescents' beliefs and behaviors (Trucco, 2020; Watts et al., 2024). Utilizing combination therapies, such as Multidimensional Family Therapy and the Adolescent-Community Reinforcement Approach, can effectively address social influences and improve substance use and mental health outcomes among adolescents (Brewer et al., 2017; Trucco, 2020). However, family-based comprehensive treatments may not be easily accessible to adolescents. Brief interventions among adolescents who screen positive for substance use or mood disorders that can be conducted during a pediatric primary care visit have shown to be effective in reducing the likelihood of SUD development and associated healthcare utilization (Sterling et al., 2022). Healthcare systems should equip clinicians with tools and resources to assess and address adolescent substance use and refer to appropriate treatment programs.

While prior studies found evidence that traumatic experiences co-occur and contribute to substance use (Afuseh et al., 2020; Cole et al., 2019; Parker & Bradshaw, 2015), this study included various forms of interpersonal violence that may be a source of trauma and analyzed their individual associations with adolescent substance use. We found a higher prevalence of all forms of interpersonal violence across all classes of substance use characteristics, with the highest being among the *polysubstance use* class. Substance use can place adolescents at higher risk for violence as they are more likely to have greater exposure to perpetrators of violence (Parker & Bradshaw, 2015). Sexual violence, followed by physical IPV, had the strongest associations across all five latent classes. This could be due to adolescents' sexual or dating partners also using substances, placing them at higher risk for violence, or they could be using substances in response to the violence (Cole et al., 2019; Parker & Bradshaw, 2015). Sexual violence and physical IPV could have more immediate devastating effects than forms of emotional abuse because of the violation of intimate trust and the physical impacts that can occur, which could contribute to substance use as a coping mechanism (Parker & Bradshaw, 2015; Piolanti et al., 2023).

With the higher prevalence of interpersonal violence among adolescents who use substances, healthcare services and substance use treatment programs should employ a trauma-informed approach (Substance Abuse and Mental Health Services Administration, 2014)

and connect adolescents to appropriate services for interpersonal violence (e.g., counseling, education on healthy relationships) (Clayton et al., 2023). Trauma-informed care (TIC) recognizes and responds to patients' trauma and its impact on health and well-being, and actively resists re-traumatization (Substance Abuse and Mental Health Services Administration, 2014). This benefits adolescent health in the short- and long-term, since traumatic experiences (e.g., interpersonal violence) are risk factors for adverse mental health, substance use, and developing a SUD (Afuseh et al., 2020; Halladay et al., 2020; Parker & Bradshaw, 2015; Tomczyk et al., 2016; Zhu et al., 2022). Additionally, TIC aligns with effective therapies focused on adolescents that incorporate social and familial networks to improve substance use and mental health outcomes (Brewer et al., 2017; Clayton et al., 2023; Hulvershorn et al., 2015; Trucco, 2020). TIC also acknowledges and addresses stereotypes and historical traumas (e.g., historical medical trauma and mistrust among Black patients) which can help minimize inequities in healthcare utilization, treatment receipt and adherence, and health outcomes related to adolescent sociodemographic characteristics.

4.1. Limitations

This analysis used adolescent self-reports at pediatric healthcare visits in California, limiting our data to those who were actively engaged in care, and some may not have disclosed certain behaviors or experiences. Notably, adolescents reported lower rates of substance use and interpersonal violence than national estimates, indicating a likelihood of substance use and violence being underreported in our sample. The well-check questionnaire was limited to past-year substance use and we included all substance use questions in the analysis. Therefore, we did not have data on use frequency or amount, or whether the use of multiple substances occurred on the same day. When adolescents endorsed "other" substance use, there was no follow-up query into the type of substance used. So, we did not have data for specific substances other than alcohol and cannabis. Further, our study is cross-sectional, limiting our ability to draw causal conclusions.

5. Conclusion

Findings indicate that a substantial proportion of adolescents attending well-check visits have substance use characteristics that cluster into distinct classes and often co-occur with mental health

concerns and interpersonal violence experiences. Adverse outcomes were also elevated among those whose friends used substances, indicating a need to assess substance use among social networks as well as by individuals. Routine screening of all substance use characteristics, mental health symptoms, and interpersonal violence is essential to ensure that at-risk adolescents are identified early and connected to appropriate services. Integrated, comprehensive, trauma-informed therapies utilizing a multifaceted approach are crucial for current and future well-being of adolescents who use substances and experience mental health symptoms and interpersonal violence.

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CRediT authorship contribution statement

Shannon N. Ogden: Writing – review & editing, Writing – original draft. **Catherine Cortez:** Writing – review & editing, Writing – original draft, Visualization, Formal analysis, Data curation. **Stacy A. Sterling:** Writing – review & editing, Methodology. **Stacey E. Alexeeff:** Writing – review & editing, Methodology, Formal analysis, Conceptualization. **Natalie E. Slama:** Writing – review & editing, Methodology. **Cynthia I. Campbell:** Writing – review & editing. **Derek D. Satre:** Writing – review & editing. **Asma H. Asyyed:** Writing – review & editing. **Monique B. Does:** Writing – review & editing, Project administration. **Andrea Altschuler:** Writing – review & editing. **Yun Lu:** Writing – review & editing, Data curation. **Kelly C. Young-Wolff:** Writing – review & editing, Supervision, Conceptualization.

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Data availability

Data will be made available on request.

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