Published in final edited form as:

Am J Drug Alcohol Abuse. 2014 January ; 40(1): 44–50. doi:10.3109/00952990.2013.844821.

Latent Class Analysis of Substance Use among Adolescents Presenting to Urban Primary Care Clinics

Kipling M. Bohnert, Ph.D.^{1,2}, Maureen A. Walton, M.P.H., Ph.D.², Stella Resko, M.S.W., Ph.D.^{3,4}, Kristen T. Barry, Ph.D.^{1,2}, Stephen T. Chermack, Ph.D.^{1,2}, Robert A. Zucker, Ph.D.², Marc A. Zimmerman, Ph.D.⁵, Brenda M. Booth, Ph.D.^{6,7}, and Frederic C. Blow, Ph.D.^{1,2}

¹National Serious Mental Illness Treatment Resource and Evaluation Center, Department of Veterans Affairs, Ann Arbor, Michigan, USA

²Department of Psychiatry, University of Michigan, Ann Arbor, Michigan, USA

³School of Social Work, Wayne State University, Detroit, Michigan, USA

⁴Merrill Palmer Skillman Institute, Wayne State University, Detroit, Michigan, USA

⁵School of Public Health, University of Michigan, Ann Arbor, Michigan, USA

⁶Center for Mental Health Outcomes and Research, Department of Veterans Affairs, Little Rock, AR, USA

⁷Department of Psychiatry, University of Arkansas for Medical Sciences, Little Rock, AR, USA

Abstract

Background—Polysubstance use during adolescence is a significant public health concern; however, few studies have investigated patterns of use during this developmental window within the primary care setting.

Objectives—This study uses an empirical method to classify adolescents into polysubstance use groups, and examines correlates of the empirically-defined groups.

Methods—Data come from patients, ages 12–18 years, presenting to urban, primary care community health clinics (Federally Qualified Health Centers) in two cities in the Midwestern United States (n=1664). Latent class analysis (LCA) was used to identify classes of substance users. Multinomial logistic regression was used to examine variables associated with class membership.

Results—LCA identified three classes: Class 1 (64.5%) exhibited low probabilities of all types of substance use; Class 2 (24.6%) was characterized by high probabilities of cannabis use and consequences; Class 3 (10.9%) had the highest probabilities of polysubstance use, including **heavy episodic** drinking and misuse of prescription drugs. Those in Class 2 and Class 3 were more likely to be older, and have poorer grades, poorer health, higher levels of psychological

distress, and more sexual partners than those in Class 1. Individuals in Class 3 were also less likely to be African-American than those in Class 1.

Conclusion—Findings provide novel insight into the patterns of polysubstance use among adolescents presenting to low-income urban primary care clinics. Future research should examine the efficacy of interventions that address the complex patterns of substance use and concomitant health concerns among adolescents.

Keywords

Polysubstance Use; Adolescent Health; Primary Care; Latent Class Analysis

Introduction

Alcohol, tobacco, and other drug use in adolescence is a salient public health concern. In the United States, experimentation and use before adulthood is relatively common. According to recent data from Monitoring the Future, an estimated 71.0%, 42.2%, and 48.2% of twelfth graders have used alcohol, tobacco cigarettes, and other illegal drugs at least once in their lives, respectively (1). Cannabis was the most commonly used illegal drug, with an estimated lifetime prevalence of 43.8% among twelfth graders (1). Of recent concern are the misuse of prescription drugs, such as opioids (2). Although it is common, prior evidence links substance use before adulthood with a number of adverse psychiatric and social consequences, including continued use, substance use disorders, other psychiatric disturbances, and poorer educational outcomes (3-9).

Use of multiple substances during adolescence may be especially harmful (10, 11). One important methodological tool for understanding poly-substance use patterns among young people is latent class analysis (LCA) (12). LCA is an empirical method that identifies distinct classes of individuals based on response patterns of a finite number of indicator variables (12). Whereas traditional variable-centered approaches examine variables individually, assuming sample homogeneity, person-centered approaches such as LCA assume sample heterogeneity and identify subgroups with shared characteristics. Most of the prior studies using the LCA approach to examine substance use among adolescents have relied on school-based samples or samples from the public service systems (e.g., the child welfare system) (e.g., (13, 14)). In addition, prior studies have generally focused on older adolescents, and have examined a limited number of substances, chiefly alcohol, tobacco, and cannabis (e.g., (15)), with no studies to date examining misuse of prescription drugs. For example, Whitesell and colleagues conducted an LCA among a representative sample of individuals aged 15 to 21 years in the United States using data from the 1999 National Household Survey on Drug Abuse. The authors identified a four class model of lifetime use (i.e., abstainers, primarily alcohol users, primarily alcohol and cannabis users, and polysubstance users), and a three class model of past year use (i.e., abstainers, primarily alcohol users, and alcohol and drug users) (16).

The primary care setting offers an important venue for screening and intervention approaches that seek to address substance use among young people (17, 18). Preliminary work in this area has shown promise, especially for alcohol and/or cannabis use (18-22).

Additional data on subgroups of adolescents presenting to primary care who use various substances, including misuse of prescription medications (e.g., opioids and sedatives), could provide critical data to inform future intervention efforts in this setting, with tailored interventions that address specific substance use patterns. To date, however, no prior study has used an LCA approach to examine poly-substance use patterns among adolescents in primary care.

Therefore, the present study uses an LCA approach to understand current patterns of substance use, including alcohol, tobacco, cannabis, other illegal drugs, and misuse of prescription drugs, among adolescents presenting to low-income, urban federally qualified community health clinics. These clinics serve as a primary health care source for families who earn a low-income, are uninsured, or are covered by Medicaid or other public programs (23). Using substance use classes identified via LCA, we further examine background and health characteristics that have been positively associated with individual substance use variables in the extant literature including: older age, male gender, poor grades, working, poorer physical and mental health, and sexual activity (e.g., see (24, 25) for reviews). Prior research, however, has not examined these correlates in relation to subgroups of substance use among adolescents in primary care.

Method

Sample

Data come from a cross-sectional sample of adolescent patients, ages 12 to 18 years, presenting to Federally Qualified Community Health Centers (FQHCs) from April, 2007 through December, 2009. The clinics are located in two socio-economically disadvantaged cities in the Midwestern United States. The study was approved and conducted in compliance with the University of Michigan's Institutional Review Board guidelines. A Certificate of Confidentiality was obtained from the National Institute on Drug Abuse for this study.

The research team obtained appointment logs and staffed clinics during days with higher volumes of adolescent patients. During recruitment, project staff approached patients in the waiting room or treatment rooms to obtain assent/consent. Written informed assent/consent was obtained from adolescents and their parents (i.e., participants 12-17 years of age); consent was obtained from adult patients (i.e., participants 18 years of age). Participants self-administered a 10-minute computerized survey, which included accompanying audio via headphones, and received a token \$1.00 gift (e.g., pen, lip balm).

Measures

Substance use—Past three month alcohol, tobacco, and other drug use was assessed via standardized self-reported questions from the National Longitudinal Study of Adolescent Health (Add Health) (26). Other drug use included separate questions assessing past three month: cannabis use, inhalant use, cocaine use, heroin use, hallucinogen use (e.g., LSD, PCP, mushrooms, and ecstasy), and prescription drug misuse, which included the use of painkillers/opioids (e.g., Codeine, OxyContin, Vicodin, Darvocet, and Percodan), stimulants

(e.g., Ritalin), and sedative/hypnotics (e.g., Xanax and Valium). Heavy episodic drinking (5 or more drinks) (27) in the past three months was assessed using the Alcohol Use Disorder Test (AUDIT-C) (28). In addition, the five-item Severity of Dependence Scale was used to assess lifetime cannabis consequences (29). Items include: (1) perception that cannabis use is “out of control”; (2) being anxious or worried about the prospect of missing a smoke; (3) worrying about the use of cannabis; (4) wishing to stop using it; (5) difficulty in going without or stopping cannabis use. For the present investigation, a single dichotomous variable was constructed to indicate the presence of one or more of the five consequences versus no consequences.

Other Variables—Demographic information was elicited from the participants via selected items from Add Health (26). These standardized items were used to assess age, sex, and race/ethnicity. Information on grades in school was ascertained via a single self-reported question with response options: Mostly A's (1), A's and B's (2), Mostly B's (3), B's and C's(4), Mostly C's (5), C's and D's (6), Mostly D's(7), D's and F's (8), and Mostly F's (9) (30, 31). Participants were also asked how many hours per week that they worked for pay, with response values in five hour increments: None (0), 1-5 hours (1), 6-10 hours (2), 11-15 hours (3), 16-20 hours (4), 21-25 hours (5), 26-30 hours (6), 31-35 hours (7), 36 or more hours (8).

Self-reported general health was measured via a single item, i.e., “how would you rate your general health?” Response options included: Poor (1), Fair (2), Good (3), Very good (4), Excellent (5) (26). Eleven anxiety and depression items from the Brief Symptom Inventory (BSI) were used to assess psychological distress (32). A summary variable was created corresponding to the number of distress symptoms reported. Finally, the number of sexual partners was obtained by asking the participants whether they had ever had sexual intercourse and the number of past year partners, with response categories ranging from 0 to 6 (26).

Statistical Analysis

LCA was used to empirically identify past three month substance use subgroups among the study participants. The following seven dichotomous items were used as indicators in the LCA: tobacco cigarette use, alcohol use, heavy episodic drinking, cannabis use, cannabis use consequences, prescription drug misuse, and other illegal drug use. Because past three month use of inhalants, cocaine, heroin, and hallucinogens was rare, use of these drugs was combined to form the other illegal drug use indicator. LCA was performed using Mplus software version 5.2. Models were fit in an exploratory fashion using both statistical and theoretical endpoints. A two-class model was examined first. Next, classes were added to the model until no further statistical and theoretical improvements were observed. Model fit was evaluated empirically using the Bayesian Information Criterion (BIC), with lower values reflecting an improved fit (33). Entropy was also considered; a value closer to 1.0 indicates better prediction (33). In addition, a visual representation of the subgroups was produced to evaluate the conceptual fit of each model. The most parsimonious LCA model was retained. Next, bivariate analyses (e.g., chi-square, ANOVA) were conducted to compare the classes on background (i.e., age, sex, race, grades, working hours) and health

characteristics (i.e., perceived health, psychological distress, and sexual activity). In a final step, multinomial logistic regression was used to examine all of the covariates in a single model, with adjusted odds ratios indicating the relative associations between background and health characteristics and the substance use classes.

Results

Characteristics of the Sample and Substance Use

Among the 1813 potentially eligible patients who presented to the primary care clinics during recruitment, 91.8% (n=1664) were approached and 8.2% (n=149) were missed. Common reasons for missing participants were: the research assistant was occupied with another participant (71.1%); the patient left the clinic before the research assistant could approach them (12.1%); some other reason (16.8%). Among the 1664 eligible patients who were approached, 1416 (85.1%) completed the screen. Two hundred forty-eight (14.9%) refused to participate. Reasons for refusal included: family refused (8.1%); the patient was not interested (36.3%); the patient did not have time (17.3%); the patient left the clinic before completing the screen (7.7%); the patient was willing to return within 2 weeks (12.9%); another reason (17.7%). Comparisons of those screened with those who refused were conducted; males (18.0%) were more likely to refuse than females (12.9%) ($\chi^2(1)=8.18$ $p<.01$) and Caucasians (21.9%) were more likely to refuse than African-Americans (12.8%) and other races (15.6%) ($\chi^2(2)=14.72$, $p<0.001$). No additional data could be obtained from those who refused without written informed consent.

Table 1 depicts background and health characteristics of the sample. The average age of the sample was 15.2 years; 54.2% were ages 12-15 and 45.8% were ages 16-18 years. More participants were female (62.8%); 37.2% were male. A majority were African-American (63.6%). With respect to academic achievement, the mean grade was 3.7 (SD=1.6) (indicating “Mostly B’s” to “B’s and C’s”); 19.5% reported grades of D or lower. Few patients were currently working (18.2%), with a mean of 0.6 (SD=1.5), indicating “1-5 hours” per week. With respect to health, the mean was 3.6 (SD=1.0), indicating “good” to “very good” health; only 14.0% rated their health as fair/poor. In addition, participants had, on average, 5.1 symptoms of psychological distress; 20.2% reported no symptoms. One-half of the sample was sexually active (50.5%); the mean number of partners was 0.9 (SD=1.3) among the entire sample.

Prevalence of substance use in the past 3 months was greatest for cannabis (26.1%), followed by alcohol (22.8%) and tobacco cigarettes (16.9%). There were lower percentages of past 3 month prescription drug misuse (8.4%) and other illegal drug use (4.2%). In addition, 9.5% of the sample had one or more occasions of heavy episodic drinking and 26.3% experienced one or more cannabis use consequences.

Empirically-Identified Patterns of Substance Use

The latent class model with the three-class solution was identified as the best-fitting model, that is, had the lowest BIC value and the highest entropy estimate, and retained for subsequent analyses. Specifically, the estimates for BIC and entropy for the three-class

model were 6657.24 and 0.87, respectively; compared with those obtained from the two-class model (BIC=6868.57; entropy=0.86) and the four-class model (BIC=6666.45; entropy=0.86). The three-class model was also the most interpretable and consistent with theory in this line of research.

Table 2 (also see Figure 1) depicts the results for the three-class model. Class 1 (64.5% of the sample) exhibited low probabilities of all types of substance use, which might suggest a “nonuser” class. Class 2 (24.6% of the sample) was characterized by high probabilities of cannabis use and consequences, moderate probabilities of tobacco and alcohol use, and low probabilities of other forms of substance use. This might suggest a “cannabis user” class. The smallest class was class 3 (10.9% of the sample), which had the highest probabilities of heavy episodic drinking and other substance use compared with the other two classes, with the exception of cannabis consequences, which was equal to class 2. This class might reflect a “polysubstance user” class.

Correlates of the Three Substance Use Classes

Bivariate chi-square analyses were conducted to examine individual variables as potential correlates of class membership (Table 3). The bivariate analyses revealed differences in class composition by all of the variables examined, with the exception that there were no gender differences noted by class.

Multinomial logistic regression was conducted to examine the relative influence of the potential correlates of class membership with Class 1 as the referent (displayed in the sixth and seventh columns in table 3). Specifically, compared with Class 1 (nonuser), individuals in Class 2 (cannabis user) were more likely to be older and have poorer grades. In addition, adolescents in Class 2 (cannabis user) were significantly more likely to have poorer health and higher levels of psychological distress than those in Class 1 (nonuser). Adolescents in Class 2 (cannabis user) were also more likely to have a greater number of sexual partners than individuals in Class 1 (nonuser).

A similar pattern was observed for the multinomial logistic regression results that compare Class 3 (polysubstance user) versus Class 1 (non-user). Namely, compared with Class 1 (non-user), individuals in Class 3 (polysubstance user) were more likely to be older and have poorer grades, poorer health, higher levels of psychological distress, and a greater number of sexual partners. In addition, adolescents in Class 3 (polysubstance user) were significantly less likely to be African-American than those in Class 1 (non-user).

In a further analytic step we compared Class 3 (polysubstance user) with Class 2 (cannabis user) by changing the reference group from Class 1 (nonuser) to Class 2 (cannabis user) in the multinomial regression. We found that individuals in Class 3 (polysubstance user) were less likely to be African-American than those in Class 2 (cannabis user). In addition, those in Class 3 had significantly higher levels of psychological distress and a greater number of sexual partners than those in Class 2.

Discussion

The present study used a person-centered, LCA approach to examine patterns of substance use among young people presenting to FQHCs. The results suggested three unique subgroups of adolescents: nonusers, cannabis users, and polysubstance users. To our knowledge, this type of analysis has not been conducted previously among young people in primary care. The present study also provides a unique perspective on this topic via data from two socio-economically disadvantaged communities. Prior studies using person-centered approaches to examine subgroups of adolescent substance users have been conducted almost exclusively among samples from school or public service settings (e.g., (13-16, 34, 35). Our findings also extend prior work in this area by including measurement of prescription drug misuse, which was more common among polysubstance users, highlighting this emerging public health concern (36).

Unlike prior studies, the present investigation was the first of its kind to be conducted among adolescents in an urban, primary care context, and has key implications for this population and setting. The findings highlight the importance for clinicians in this setting to assess the use of multiple substances among their young patients, including substances which may be legal at certain ages, such as cigarettes, alcohol, and prescription drugs (e.g., opioids, sedatives), as well as illegal drugs such as cannabis. Findings from this study suggest that a majority of adolescents in primary care are nonusers and may support the delivery of universal youth prevention programs in this setting. Nonetheless, prior prevention research has largely been conducted in school settings (37-42); therefore, adolescent substance use prevention research in primary care is a potential area for future research.

The findings from the present study also suggest that about one-third of adolescents in primary care may benefit from screening, brief intervention, and referral to treatment (SBIRT) approaches (20, 22, 43, 44). These approaches could be tailored to address polysubstance use, including potential prescription drug misuse, as opposed to use of a single substance. Traditionally, brief interventions have been focused on alcohol only or cannabis only; only recently have SBIRT studies started to examine the use of multiple substances (22, 44-46). Further research is needed to evaluate how individuals in different substance use classes respond to these types of interventions, and, in particular, whether the efficacy and effectiveness differs for individuals in the cannabis user group as compared to the polysubstance user group.

Furthermore, results from this study indicate that those in the cannabis user and polysubstance user classes may have additional associated health needs. Consistent with prior work on the clustering of problem behavior (47), the present investigation found that having more sexual partners was associated with being in the cannabis user or polysubstance user class. Given health disparities in rates of sexually transmitted infections and subsequent increased risk for HIV infection among youth residing in socioeconomically disadvantaged communities (48, 49), future SBIRT efforts in primary care should address sexual risk behaviors in concert with substance use. Finally, a higher level of psychological distress was noted among adolescents in the polysubstance user class, with increased distress also

documented in the cannabis user class, in comparison to nonusers. The notion of providing concurrent SBIRT efforts for mental health issues along with substance use is supported by this study.

Background characteristics were also associated with substance use class membership. Specifically, older age was positively associated with membership in both of the substance user classes. This finding is congruent with prior research depicting the escalation of different types of drug use with increasing age (7, 50, 51). Poorer grades in school were also positively associated with both substance use classes, a finding consistent with the large body of evidence describing the association between lower academic achievement and drug use (52, 53). In addition, African-Americans were less likely to be in the polysubstance user class; this finding is consistent with prior studies examining substance use, in general, and prescription drug misuse, in specific (54, 55).

Limitations

The findings from the present study should be considered in light of several potential limitations. First, as in all cross-sectional and observational research, causal interpretations are not warranted. Another limitation that the present study shares with prior studies of substance use among young people is that substance use was measured via self-report; however, constraining the assessment of substance use to the past three months may have minimized the potential for recall bias, and assurances of confidentiality as well as self-administration on a computer may enhance reliability and validity (56, 57). In addition, findings may not generalize to adolescents in other contexts, such as those residing in more socio-economically advantaged communities or those receiving medical care at non-urban primary care clinics, or to other adolescents in the study communities who do not receive care at the FQHCs. Finally, in order to maintain assessment brevity, we could not ask about consequences in relation to all forms of substance use. Future LCA studies may wish to incorporate additional measures on other substance use consequences. Despite these limitations, the findings from this research offer important and unique information about patterns of substance use among young people presenting to urban primary care clinics.

Conclusions

The findings from the present research provide novel insight into the patterns of substance use among young people presenting to primary care clinics in socio-economically disadvantaged urban communities. Future tailored SBIRT efforts for adolescents presenting to urban primary care clinics should not only focus on the use of cannabis, but also on polysubstance use in order to prevent future health consequences such as overdose. In addition, SBIRT efforts may wish to address factors associated with polysubstance use, particularly sexual risk behaviors and psychological distress. Further research is needed to examine how different classes of substance users respond to such tailored SBIRT approaches.

Acknowledgments

This project was supported by a grant (DA020075) from the National Institute on Drug Abuse (NIDA). We would like to thank project staff: Cassandra Brooks, Amber Hart, Angela Turkelson, Carolyn Gibson, NaTosha Murry,

Janelle Kapa, Karen Ross, Kay Doerr, Bianca Burch, and Jessica Lantz. We would also like to thank Linping Duan for statistical support. Finally, special thanks are owed to the patients and medical staff at Hamilton Community Health Centers, Health Delivery Inc., and Mott Children's Health Center for their support of this project.

References

1. Johnston, LD.; O'Malley, PM.; Bachman, JG.; Schulenberg, JE. Monitoring the Future national survey results on drug use, 1975-2010 Volume I: Secondary school students. Ann Arbor: The University of Michigan; 2011.
2. United Nations Office on Drugs and Crime (UNODC). The non-medical use of prescription drugs: Policy direction issues. New York: United Nations; 2011.
3. Anthony JC, Petronis KR. Early-onset drug use and risk of later drug problems. *Drug Alcohol Depend.* 1995; 40(1):9–15. [PubMed: 8746919]
4. Chen CY, Storr CL, Anthony JC. Early-onset drug use and risk for drug dependence problems. *Addict Behav.* 2009; 34(3):319–322. [PubMed: 19022584]
5. Dawson DA, Goldstein RB, Chou SP, Ruan WJ, Grant BF. Age at first drink and the first incidence of adult-onset DSM-IV alcohol use disorders. *Alcohol Clin Exp Res.* 2008; 32(12):2149–2160. [PubMed: 18828796]
6. Fergusson DM, Boden JM. Cannabis use and later life outcomes. *Addiction.* 2008; 103(6):969–976. discussion 977-968. [PubMed: 18482420]
7. Kandel DB, Yamaguchi K, Chen K. Stages of progression in drug involvement from adolescence to adulthood: further evidence for the gateway theory. *J Stud Alcohol.* 1992; 53(5):447–457. [PubMed: 1405637]
8. Lynskey M, Hall W. The effects of adolescent cannabis use on educational attainment: a review. *Addiction.* 2000; 95(11):1621–1630. [PubMed: 11219366]
9. Tien AY, Anthony JC. Epidemiological analysis of alcohol and drug use as risk factors for psychotic experiences. *J Nerv Ment Dis.* 1990; 178(8):473–480. [PubMed: 2380692]
10. Earleywine M, Newcomb MD. Concurrent versus simultaneous polydrug use: prevalence, correlates, discriminant validity, and prospective effects on health outcomes. *Exp Clin Psychopharmacol.* 1997; 5(4):353–364. [PubMed: 9386962]
11. Hakansson A, Schlyter F, Berglund M. Associations between polysubstance use and psychiatric problems in a criminal justice population in Sweden. *Drug Alcohol Depend.* 2011; 118(1):5–11. [PubMed: 21419580]
12. McCutcheon, AL. Latent class analysis. Thousand Oaks, California: Sage Publications; 1987.
13. Marti CN, Stice E, Springer DW. Substance use and abuse trajectories across adolescence: a latent trajectory analysis of a community-recruited sample of girls. *J Adolesc.* 2010; 33(3):449–461. [PubMed: 19640578]
14. Shin SH, Hong HG, Hazen AL. Childhood sexual abuse and adolescent substance use: a latent class analysis. *Drug Alcohol Depend.* 2010; 109(1-3):226–235. [PubMed: 20197217]
15. Cleveland MJ, Collins LM, Lanza ST, Greenberg MT, Feinberg ME. Does individual risk moderate the effect of contextual-level protective factors? A latent class analysis of substance use. *J Prev Interv Community.* 2010; 38(3):213–228. [PubMed: 20603758]
16. Whitesell NR, Beals J, Mitchell CM, Novins DK, Spicer P, Manson SM. Latent class analysis of substance use: comparison of two American Indian reservation populations and a national sample. *J Stud Alcohol.* 2006; 67(1):32–43. [PubMed: 16536127]
17. Polen, MR.; Whitlock, EP.; Wisdom, JP.; Nygren, P.; Bougatsos, C. Screening in Primary Care Settings for Illicit Drug Use: Staged Systematic Review for the U S Preventive Services Task Force. Rockville, MD: 2008.
18. Stern SA, Meredith LS, Gholson J, Gore P, D'Amico EJ. Project CHAT: a brief motivational substance abuse intervention for teens in primary care. *J Subst Abuse Treat.* 2007; 32(2):153–165. [PubMed: 17306724]
19. Haller DM, Meynard A, Lefebvre D, Tylee A, Narring F, Broers B. Brief intervention addressing excessive cannabis use in young people consulting their GP: a pilot study. *Br J Gen Pract.* 2009; 59(560):166–172. [PubMed: 19275832]

20. Knight JR, Sherritt L, Van Hook S, Gates EC, Levy S, Chang G. Motivational interviewing for adolescent substance use: a pilot study. *J Adolesc Health*. 2005; 37(2):167–169. [PubMed: 16026730]
21. Mason M, Pate P, Drapkin M, Sozinho K. Motivational interviewing integrated with social network counseling for female adolescents: a randomized pilot study in urban primary care. *J Subst Abuse Treat*. 2011; 41(2):148–155. [PubMed: 21489741]
22. D'Amico EJ, Miles JN, Stern SA, Meredith LS. Brief motivational interviewing for teens at risk of substance use consequences: a randomized pilot study in a primary care clinic. *J Subst Abuse Treat*. 2008; 35(1):53–61. [PubMed: 18037603]
23. Falik M, Needleman J, Wells BL, Korb J. Ambulatory care sensitive hospitalizations and emergency visits: experiences of Medicaid patients using federally qualified health centers. *Med Care*. 2001; 39(6):551–561. [PubMed: 11404640]
24. Hawkins JD, Catalano RF, Miller JY. Risk and protective factors for alcohol and other drug problems in adolescence and early adulthood: implications for substance abuse prevention. *Psychol Bull*. 1992; 112(1):64–105. [PubMed: 1529040]
25. Stone AL, Becker LG, Huber AM, Catalano RF. Review of risk and protective factors of substance use and problem use in emerging adulthood. *Addict Behav*. 2012; 37(7):747–775. [PubMed: 22445418]
26. Sieving RE, Beuhring T, Resnick MD, Bearinger LH, Shew M, Ireland M, Blum RW. Development of adolescent self-report measures from the National Longitudinal Study of Adolescent Health. *J Adolesc Health*. 2001; 28(1):73–81. [PubMed: 11137909]
27. Chung T, Colby SM, Barnett NP, Monti PM. Alcohol use disorders identification test: factor structure in an adolescent emergency department sample. *Alcohol Clin Exp Res*. 2002; 26(2):223–231. [PubMed: 11964562]
28. Bush K, Kivlahan DR, McDonell MB, Fihn SD, Bradley KA. The AUDIT alcohol consumption questions (AUDIT-C): an effective brief screening test for problem drinking. Ambulatory Care Quality Improvement Project (ACQUIP). Alcohol Use Disorders Identification Test. *Arch Intern Med*. 1998; 158(16):1789–1795. [PubMed: 9738608]
29. Martin G, Copeland J, Gates P, Gilmour S. The Severity of Dependence Scale (SDS) in an adolescent population of cannabis users: reliability, validity and diagnostic cut-off. *Drug Alcohol Depend*. 2006; 83(1):90–93. [PubMed: 16310973]
30. Shope JT, Copeland LA, Maharg R, Dielman TE. Effectiveness of a high school alcohol misuse prevention program. *Alcohol Clin Exp Res*. 1996; 20(5):791–798. [PubMed: 8865950]
31. Shope JT, Copeland LA, Marcoux BC, Kamp ME. Effectiveness of a school-based substance abuse prevention program. *J Drug Educ*. 1996; 26(4):323–337. [PubMed: 9071055]
32. Derogatis LR, Melisaratos N. The Brief Symptom Inventory: an introductory report. *Psychol Med*. 1983; 13(3):595–605. [PubMed: 6622612]
33. Magidson, J.; Vermunt, JK. Latent Class Models. In: Kaplan, D., editor. *The Sage Handbook of Quantitative Methodology for the Social Sciences*. Thousand Oaks: Sage Publications; 2004. p. 175-198.
34. Dierker LC, Vesel F, Sledjeski EM, Costello D, Perrine N. Testing the dual pathway hypothesis to substance use in adolescence and young adulthood. *Drug Alcohol Depend*. 2007; 87(1):83–93. [PubMed: 16959436]
35. Mitchell CM, Plunkett M. The latent structure of substance use among American Indian adolescents: an example using categorical variables. *Am J Community Psychol*. 2000; 28(1):105–125. [PubMed: 10824276]
36. Center for Lawful Access and Abuse Deterrence (CLAAD). *The National Prescription Drug Abuse Prevention Strategy: 2011-2012 Update*. Arlington: 2011.
37. Catalano RF, Berglund ML, Ryan JAM, Lonczak S, Hawkins JD. Positive Youth Development in the United States: Research Findings on Evaluations of Positive Youth Development Programs. *The ANNALS of the American Academy of Political and Social Science*. 2004; 591:99–124.
38. Conway KP, Vullo GC, Nichter B, Wang J, Compton WM, Iannotti RJ, Simons-Morton B. Prevalence and patterns of polysubstance use in a nationally representative sample of 10th graders in the United States. *J Adolesc Health*. 2013; 52(6):716–723. [PubMed: 23465320]

39. D'Amico EJ, Tucker JS, Miles JN, Zhou AJ, Shih RA, Green HD Jr. Preventing alcohol use with a voluntary after-school program for middle school students: results from a cluster randomized controlled trial of CHOICE. *Prev Sci.* 2012; 13(4):415–425. [PubMed: 22311178]
40. Hanley SM, Ringwalt C, Ennett ST, Vincus AA, Bowling JM, Haws SW, Rohrbach LA. The prevalence of evidence-based substance use prevention curricula in the nation's elementary schools. *J Drug Educ.* 2010; 40(1):51–60. [PubMed: 21038763]
41. Hecht ML, Marsiglia FF, Elek E, Wagstaff DA, Kulis S, Dustman P, Miller-Day M. Culturally grounded substance use prevention: an evaluation of the keepin' it R.E.A.L. curriculum. *Prev Sci.* 2003; 4(4):233–248. [PubMed: 14598996]
42. Tobler NS, Stratton HH. Effectiveness of school-based drug prevention programs: A meta-analysis of the research. *The Journal of Primary Prevention.* 1997; 18(1):71–128.
43. Screening, Brief Intervention and Referral to Treatment: SBIRT Core Components. Substance Abuse and Mental Health Services Administration. 2008
44. Walton MA, Bohnert K, Resko S, Barry KL, Chermack ST, Zucker RA, Zimmerman MA, Booth BM, Blow FC. Computer and therapist based brief interventions among cannabis-using adolescents presenting to primary care: One year outcomes. *Drug Alcohol Depend.*
45. D'Onofrio G, Degutis LC. Integrating Project ASSERT: a screening, intervention, and referral to treatment program for unhealthy alcohol and drug use into an urban emergency department. *Acad Emerg Med.* 2010; 17(8):903–911. [PubMed: 20670330]
46. Mitchell SG, Gryczynski J, O'Grady KE, Schwartz RP. SBIRT for adolescent drug and alcohol use: current status and future directions. *J Subst Abuse Treat.* 2013; 44(5):463–472. [PubMed: 23352110]
47. Jessor, R.; Jessor, SL. A longitudinal study of youth. New York: Academic Press; 1977. Problem behavior and psychosocial development.
48. Characteristics associated with HIV infection among heterosexuals in urban areas with high AIDS prevalence --- 24 cities, United States, 2006–2007. *MMWR Morb Mortal Wkly Rep.* 2011; 60(31):1045–1049. [PubMed: 21832975]
49. Dembo R, Belenko S, Childs K, Wareham J, Schmeidler J. Individual and community risk factors and sexually transmitted diseases among arrested youths: a two level analysis. *J Behav Med.* 2009; 32(4):303–316. [PubMed: 19224357]
50. Yamaguchi K, Kandel DB. Patterns of drug use from adolescence to young adulthood: III. Predictors of progression. *Am J Public Health.* 1984; 74(7):673–681. [PubMed: 6742253]
51. Yamaguchi K, Kandel DB. Patterns of drug use from adolescence to young adulthood: II. Sequences of progression. *Am J Public Health.* 1984; 74(7):668–672. [PubMed: 6742252]
52. Bachman JG, Staff J, O'Malley PM, Schulenberg JE, Freedman-Doan P. Twelfth-grade student work intensity linked to later educational attainment and substance use: new longitudinal evidence. *Dev Psychol.* 2011; 47(2):344–363. [PubMed: 21171751]
53. Wheeler SB. Effects of self-esteem and academic performance on adolescent decision-making: an examination of early sexual intercourse and illegal substance use. *J Adolesc Health.* 2010; 47(6):582–590. [PubMed: 21094435]
54. Turner RJ, Gil AG. Psychiatric and substance use disorders in South Florida: racial/ethnic and gender contrasts in a young adult cohort. *Arch Gen Psychiatry.* 2002; 59(1):43–50. [PubMed: 11779281]
55. Boyd CJ, Young A, Grey M, McCabe SE. Adolescents' nonmedical use of prescription medications and other problem behaviors. *J Adolesc Health.* 2009; 45(6):543–550. [PubMed: 19931825]
56. Brener ND, Kann L, McManus T, Kinchen SA, Sundberg EC, Ross JG. Reliability of the 1999 youth risk behavior survey questionnaire. *J Adolesc Health.* 2002; 31(4):336–342. [PubMed: 12359379]
57. Buchan BJ, Dennis ML, Tims FM, Diamond GS. Cannabis use: consistency and validity of self-report, on-site urine testing and laboratory testing. *Addiction.* 2002; 97(Suppl 1):98–108. [PubMed: 12460132]

Figure 1. Conditional Probabilities of Endorsing the Substance-Related Variables for the Three Classes

Table 1
Characteristics of the sample of adolescents screened (n=1416)

Variable	% or mean (SD) ¹
<u>Demographics</u>	
Age ²	15.2 (2.0)
Male	37.2%
African-American	63.6%
Grades ³	3.7 (1.6)
Working Hours ⁴	0.6 (1.5)
<u>Health</u>	
Health ⁵	3.6 (1.0)
Psychological Distress ⁶	5.1 (5.9)
Sexual Partners ⁷	0.9 (1.3)

Notes:

¹ SD = standard deviation.

² Age: Age in years ranging from 12 to 18

³ Grades: Mostly A's (1), A's and B's (2), Mostly B's (3), B's and C's(4), Mostly C's (5), C's and D's (6), Mostly D's(7), D's and F's (8), and Mostly F's (9)

⁴ Working Hours: None (0), 1-5 hours (1), 6-10 hours (2), 11-15 hours (3), 16-20 hours (4), 21-25 hours (5), 26-30 hours (6), 31-35 hours (7), 36 or more hours (8)

⁵ Health: Poor (1), Fair (2), Good (3), Very good (4), Excellent (5)

⁶ Psychological Distress: Number distress symptoms ranging from 0 to 11

⁷ Sexual Partners: Number of past year partners ranging from 0 to 6

Table 2
Conditional probabilities of substance-related variables for the three-class model (n=1416)

Items	Class 1 (64.5%; n=914)	Class 2 (24.6%; n=348)	Class 3 (10.9%; n=154)
Cigarette Use	0.02	0.35	0.59
Alcohol Use	0.07	0.26	1.00
Heavy Episodic Drinking	0.00	0.00	0.77
Cannabis Use	0.00	0.68	0.77
Cannabis Consequences	0.01	0.70	0.69
Prescription Drug Misuse	0.04	0.06	0.34
Other Illegal Drug Use	0.03	0.03	0.14

Table 3
Background and health characteristics associated with the three substance use classes (n=1416)

Variable	Class 1 (n=914, 64.5%)	Class 2 (n=348, 24.6%)	Class 3 (n=154, 10.9%)	Bivariate Test F-value Or chi-square	Class 2 (vs. Class 1) (CI)	AOR	Class 3 (vs. Class 1) AOR(CI)	Class 3 (vs. Class 2) AOR(CI)
Age ^{a,b}	14.6 (1.6)	16.2 (1.6)	16.2 (1.9)	125.21 ***	1.37 (1.26-1.51) ***		1.31 (1.15-1.49) ***	0.95 (0.83-1.09)
Male (vs. Female)	38.6%	33.3%	37.7%	3.0	0.92 (0.67-1.27)		1.00 (0.64-1.57)	1.09 (0.69-1.72)
African-American (vs. Other)	65.2%	70.7%	37.0%	51.1 ***	1.14 (0.82-1.57)		0.33 (0.21-0.51) ***	0.29 (0.19-0.45) ***
Grades ^{a,b}	3.5 (1.6)	4.0 (1.7)	4.2 (1.8)	17.46 ***	1.17 (1.08-1.26) ***		1.22 (1.10-1.36) ***	1.05 (0.95-1.16)
Working Hours ^{a,b}	0.4 (1.2)	0.8 (1.8)	1.0 (1.8)	13.98 ***	1.03 (0.94-1.14)		1.12 (0.99-1.27)	1.09 (0.97-1.22)
Health ^{a,b, c}	3.7 (1.0)	3.5 (0.9)	3.3 (1.0)	14.98 ***	0.87 (0.74-1.00) *		0.78 (0.62-0.98) *	0.90 (0.72-1.14)
Psychological Distress ^{a,b, c}	4.1 (4.8)	5.7 (6.1)	9.5 (8.5)	62.64 ***	1.04 (1.01-1.07) **		1.10 (1.07-1.14) ***	1.06 (1.03-1.09) **
Sexual Partners ^{a,b, c}	0.4 (0.9)	1.5 (1.4)	2.0 (1.8)	200.26 ***	2.04 (1.76-2.37) ***		2.50 (2.11-2.96) ***	1.23 (1.08-1.40) **

Notes: For bivariate analyses, post-hoc test between groups are denoted as follows:

^a significant difference between Class 1 and Class 2;

^b Significant difference between Class 1 and Class 3;

^c Significant difference between Class 2 and Class 3.

AOR=Adjusted Odds ratio, CI=95% Confidence Interval. Model statistics: Wald Chi-square (16) = 329.51; p<0.0001.

*** p<0.001;

** p<0.01;

* p<0.05.