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Patterns of concurrent substance use among adolescent nonmedical ADHD stimulant users

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Abstract

Objectives—There are growing concerns about nonmedical use of ADHD stimulants among adolescents; yet, little is known whether there exist heterogeneous subgroups among adolescents with nonmedical ADHD stimulant use according to their concurrent substances use.

Methods—We used latent class analysis (LCA) to examine patterns of past-year problematic substance use (meeting any criteria for abuse or dependence) in a sample of 2,203 adolescent

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participants from the National Surveys on Drug Use and Health 2006–2011 who reported past-year nonmedical use of ADHD stimulants. Multivariable latent regression was used to assess the association of socio-demographic characteristics, mental health and behavioral problems with the latent classes.

Results—The model fit indices favored a four-class model, including a large class with frequent concurrent use of alcohol and marijuana (*Alcohol/Marijuana* class; 41.2%), a second large class with infrequent use of other substances (*Low substance* class, 36.3%), a third class characterized by more frequent misuse of prescription drugs as well as other substances (*Prescription drug+* class; 14.8%), and finally a class characterized by problematic use of multiple substances (*Multiple substance* class; 7.7%). Compared with individuals in *Low substance* class, those in the other three classes were all more likely to report mental health problems, deviant behaviors and substance abuse service use.

Conclusions—Adolescent nonmedical ADHD stimulants users are a heterogeneous group with distinct classes with regard to concurrent substance use, mental health and behavioral problems. The findings have implications for planning of tailored prevention and treatment programs to curb stimulant use for this age group.

Keywords

ADHD stimulants; Substance abuse; Deviant behaviors; Latent class analysis

1. Introduction

Nonmedical use of prescription stimulants, especially stimulants prescribed for the treatment of Attention Deficit Hyperactivity Disorder (ADHD), has received increased research attention in the past decade.[1-4] These stimulants, including methylphenidate and mixed salts amphetamines, are classified as schedule II substances in the US Controlled Substances Act (CSA) due to their high abuse potential.[5]

Past research has reported an increase in nonmedical prescription stimulant use among young adults and adolescents.[6-12] According to data from the Monitoring The Future (MTF) survey, past-year nonmedical use of methylphenidate in high school seniors increased from 0.5% in 1995 to 2.5% in 2002.[10] In another high school survey, 4.5% of students reported using prescription stimulants nonmedically in their lifetime, with 23.3% reporting being approached to sell, give, or trade these drugs.[12] Emergency room visits involving ADHD stimulants tripled in the period between 2005 and 2010,[13] highlighting the health burden of nonmedical use of these medications.

Evidences supported that nonmedical ADHD stimulant users are more likely to use other substances or to engage in risky behaviors.[1, 6, 11-12, 14] Among high school students, nonmedical prescription stimulant users reported significantly higher rates of alcohol and other drug use than nonusers.[12] In a college-based survey, nonmedical prescription stimulant users were more likely to report use of alcohol, cigarettes, illegal drugs, and to engage in other risky behaviors.[2] Despite the growing evidence for nonmedical use of stimulants,

relatively little is known regarding the concurrent substance use patterns among adolescent who use prescription stimulants nonmedically.

In this study, we aimed to explore the subgroups of nonmedical adolescent ADHD stimulant users based on their concurrent problematic substance use using data from national surveys. We further examined variations in socio-demographic characteristics, mental health profiles, deviant behaviors, and service use among the empirically identified classes.

2. Methods

2.1 Study sample and measures

Combined annual data from the NSDUH public use data files for the years 2006 to 2011 (N= 338,495) were analyzed. The study sample was restricted to participants aged 12 to 17 (N=109,466) who reported using ADHD stimulants nonmedically in the past year (N=2,203). The NSDUH is an annual cross-sectional survey sponsored by the Substance Abuse and Mental Health Administration (SAMHSA) and is designed to provide estimates of the prevalence of alcohol and drug use in the household population of the United States, 12 years of age and older. The response rate for household screening ranged from 87% to 91% and for completed interviews from 74% to 76% across the 6 years. Survey items were administered by computer-assisted personal interviewing (CAPI) conducted by an interviewer and audio computer-assisted self-interviewing (ACASI) for sensitive questions. Detailed information about the sampling and survey methodology of the NSDUH can be found elsewhere.[15-20]

2.1.1 Assessment of past-year nonmedical ADHD stimulant use—For the current analyses, ADHD stimulants were defined as stimulants with specific indications for treatment of ADHD, and included Ritalin® or methylphenidate, Cylert®, Dexedrine®, Dextroamphetamine, Adderall®, and Vyvanse®. The survey used the following question to assess lifetime nonmedical use of any ADHD stimulants: "Have you ever, even once, used Ritalin or methylphenidate that was not prescribed for you or that you took only for the experience or feeling it caused?" Nonmedical ADHD stimulant use was defined as past-year use if the time since last use was within the prior 12 months.

2.1.2 Assessment of socio-demographic characteristics—Socio-demographic variables included in the analyses were sex, age (12-13,14-15,16-17), race/ethnicity (non-Hispanic white, racial/ethnic minority), school dropout, average grade (C and above, D or lower) in the last period completed, and annual household income ($19,999, $20,000-$34,999, $35,000-$69,999, $70,000). These variables were chosen based on past research on correlates of substance use in adolescents.[21]

2.1.3 Assessment of past-year problematic substances use—Past-year problematic substance use was defined by fulfilling any of the criteria for past-year substance abuse or dependence based on the Diagnostic and Statistical Manual of Mental Disorders –IV (DSM-IV).[22] The substances examined included alcohol, marijuana, cocaine, heroin, hallucinogens, inhalants, prescription opioids, and prescription tranquilizers/ sedatives (combined).

2.1.4 Assessment of past-year mental health and deviant behavior variables—
Mental health variables included were past-year clinician-identified anxiety disorder or depression Past-year mental health and substance use disorder (SUD) service use were ascertained by asking participants whether they received any mental health treatment or SUD treatment in the past year. Past-year deviant behaviors were ascertained by asking participants how many times they had attacked someone, sold drugs and stolen anything worth more than $50 over the year. Consistent with past research,[23] participants who reported any of the three behaviors were categorized as having deviant behaviors (0 for none of these behaviors and 1 for 1 time or more). Past-year arrest was defined by having been arrested and charged with lawbreaking (not counting minor traffic violations; 0 for none and 1 for at least once). Past-year sexually transmitted disease (STD) was also assessed based on participant self-reports of diagnosis by a medical professional.

2.2 Statistical analyses

Complex latent class analysis (LCA)[24,25] as implemented in the Mplus software[26] was used to identify subgroups according to concurrent problematic substance use among adolescents who reported using ADHD stimulants nonmedically in the past year. The LCA analysis was based on eight dichotomous substance use indicators (past-year problematic use of alcohol, marijuana, cocaine, heroin, hallucinogens, inhalants, prescription opioids, and tranquilizers/ sedatives).

We performed LCA for 1 to 6 classes in order to ascertain the model with the optimal fit based on fit indices. Minimum values of the Bayesian Information Criterion (BIC) was given priority over other fit indices such as Akaike Information Criterion (AIC) and Sample Size Adjusted BIC (ABIC), given BIC's more stable performance in simulation studies.[27] We also considered the class size and clinical interpretability in selecting the model.

Once the number of classes was ascertained, correlates including socio-demographic characteristics, mental health and behavioral problems were incorporated into the models using unadjusted and adjusted multinomial regressions.[28] These analyses were conducted using a modal assignment latent regression approach with Stata 13.0 software.[29] A p<0.05 was used to ascertain the statistical significance of findings.

3. Results

3.1 Subtypes of nonmedical ADHD stimulant users

Approximately 3.2% (n = 2,203) of adolescent participants from the NSDUH 2006 to 2011 reported nonmedical use of ADHD stimulants in the past year. The most commonly used substance among nonmedical ADHD stimulant users was problematic use of alcohol (53.3%), followed by problematic use of marijuana (47.9%), pain relievers (23.4%), hallucinogens (12.4%), tranquilizers and sedatives (9.9%), cocaine (7.3%), inhalants (5.8%) and heroin (1.7%). A 4-class model was chosen by taking into account the value of BIC as well as the clinical interpretability.[27] Figure 1 presents the prevalence of problematic use of different substances in the four classes of nonmedical ADHD stimulant users. Class 1 constituted 36.3% of the sample, and was comprised of individuals with low probabilities of

problematic use of alcohol and prescription opioids and near zero probabilities of other problematic substance use (*Low substance* class). Class 2 made up 14.8% of the study sample and included individuals with high probabilities of problematic use of alcohol and marijuana, moderate probabilities of problematic use of inhalants and hallucinogens, and with high probabilities of problematic use of pain relievers and sedatives/tranquilizers (*Prescription drug+* class). Class 3 included individuals with high probabilities of problematic use of marijuana and alcohol, and was the largest class (*Alcohol-marijuana* class, 41.2%). Finally, class 4 was comprised of individuals who had the highest probabilities of problematic use of most of the substances examined (*Multiple substance class*, 7.7%).

3.2 Characteristic of participants in the LCA-defined classes

Table 1 presents the socio-demographic, mental health, service use and deviant behavior profiles of the 4 classes of past-year nonmedical ADHD stimulant users. The *Prescription drug+, Alcohol-marijuana*, and *Multiple substance* classes showed particularly high prevalence of deviant behaviors (60.3%-85.5%) and arrest (23.6%- 34.2%). Furthermore, 46.4% of those in the *Prescription drug+* class reported past-year mental health service use and 27.1% reported a depression diagnosis.

Compared to the *Low substance* class, participants in all three other classes were more likely to report past-year depression (aORs=1.97 to 2.89), SUD treatment (aORs=2.97 to 7.30), deviant behaviors (aORs=4.80 to 14.52) and arrest (aOR=2.38 to 2.51). In addition, the adolescents in the *Prescription drug+* class were more likely to be female (aOR=1.69, 95% CI=1.16, 2.45) and adolescents in the *Alcohol-marijuana* class were typically older than those in the *Low substance* class (16-17 years age group compared to 12-13 years age group; aOR=3.84, 95% CI=1.53, 9.61).

4. Discussion

This study found that more than half of nonmedical adolescent ADHD stimulant users reported concurrent problematic substance use with the most frequently used substances being alcohol (53.3% of nonmedical ADHD stimulant users), marijuana (47.9%) and pain relievers (23.4%). We also found that with regard to concurrent problematic substance use, nonmedical ADHD stimulant users are a heterogeneous group encompassing four classes with distinct psychiatric and social profiles, which has implications for risk evaluation and preventive strategy development.

The classes that we labeled as *Prescription drug+*, *Alcohol-marijuana* and *Multiple substance* classes were generally more likely to report mental health problems, SUD service use, and deviant behaviors compared to the *Low substance* class, which had the lowest prevalence of concurrent problematic substance use. Similar to previous research,[30] our study points out that the association with mood disorders may be more pronounced in the subgroups that report more concurrent problematic substance use. Consistent with other studies that have shown individuals with co-occurring mental and substance disorders have higher rates of service use than those without co-occurring disorders,[23] a higher prevalence of SUD service use was also observed in the three classes identified in the present analyses.

Our finding underscores the significance of screening for mental health problems among the nonmedical ADHD stimulant users.

Despite the similarities among the three classes with a higher prevalence of concurrent substance use problems, especially with regard to psychiatric and behavior profiles, these three classes showed some differences in socio-demographic profiles. Most notably, participants in the *Prescription drug+ class* were more likely to be female compared to the *Low substance use* class, while the other two classes did not show such gender differences. As a recent review of studies of substance use in adolescents in the U.S. noted, adolescent girls are more likely to report nonmedical prescription opioids and tranquilizers use;[31] our study further shows that adolescent girls are more likely to use these medications even among nonmedical stimulant users.

Comorbid substance use and psychiatric disorders confer additional risks not only for worse social outcomes but also for poorer SUD treatment response.[32,33] Similarly, concurrent use of multiple substances is linked to more physical consequences and criminal involvement.[34] These considerations are especially relevant in the case of the *Multiple substance* class, who in addition to a greater burden of mental and substance use problems were also more likely to drop out of school. The findings call for a concerted effort to address mental health as well as substance use related problems in this vulnerable group of adolescents.

This study has multiple strengths, including a large sample size and generalizability to the US household population. However, this study has several limitations. First, all the information was based on self-report, which is prone to recall and reporting biases, although the validity of substance use reports in NSDUH has been previously established.[35] Second, the use of a cross-sectional design limits assessment of temporal relationships and causal inferences. Third, we used clinician-identified depression and anxiety in this study, which are subject to health service access and availability. Fourthly, the information regarding the frequency of nonmedical prescription stimulant use was not available, thus whether these subgroups differ by their level of severity remains unknown. Lastly, there is lack of information regarding the users' motivations, which could offer implications for prevention strategy development.

5. Conclusion

Our results suggest that adolescent nonmedical ADHD stimulant users are a heterogeneous group with distinct profiles with regard to concurrent substance use, socio-demographics and mental health profiles. Elucidating concurrent substance use patterns among adolescent stimulant users is crucial for identifying these subgroups and addressing their special needs.

Acknowledgments

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Highlights

More than half of nonmedical adolescent ADHD stimulant users reported concurrent problematic substance use.

Adolescent nonmedical ADHD stimulants users are a heterogeneous group with distinct classes with regard to concurrent substance use, mental health and behavioral problems.

Multiple substance class were significantly more likely to report mental health and behavioral problems, indicating their worse outcome and greater medical need.
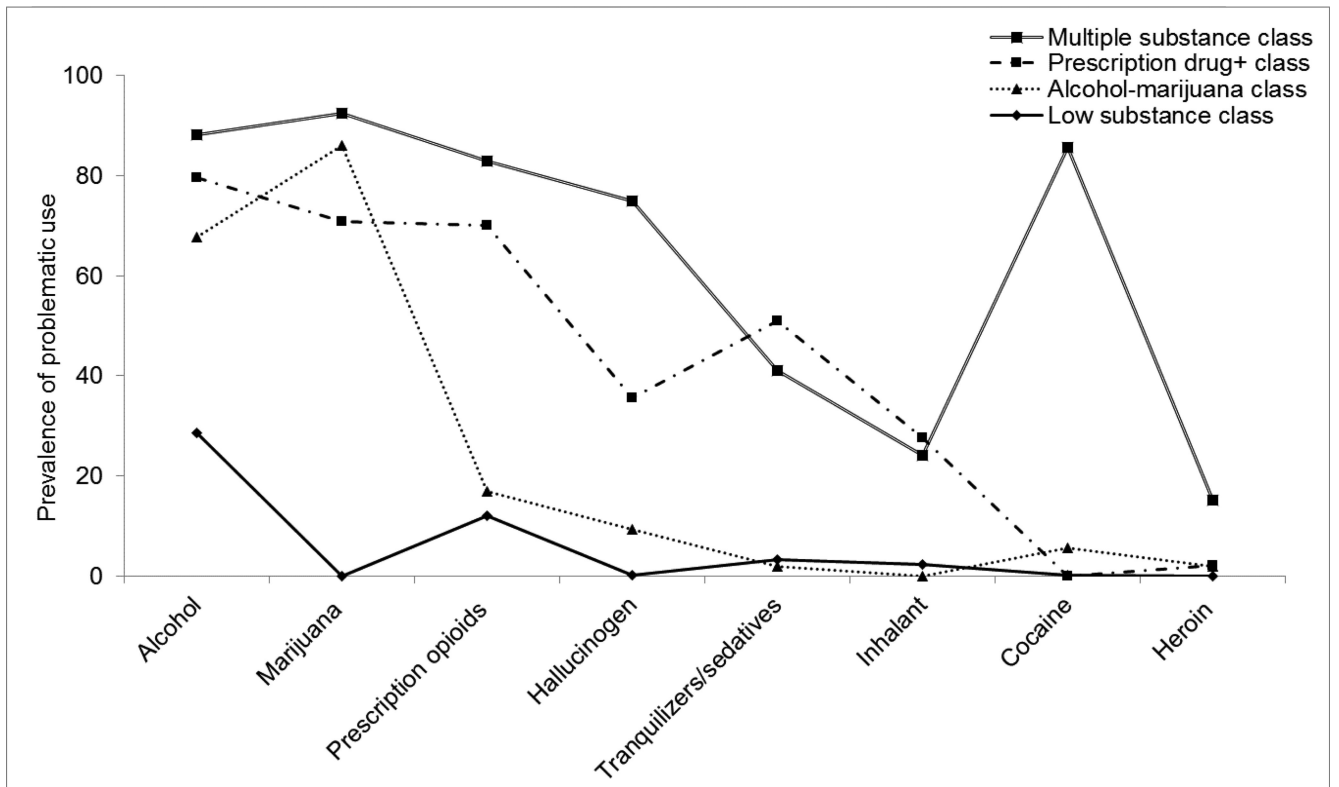
Figure 1.
Prevalence of problematic use of other substances in four classes of adolescents with past-year nonmedical ADHD stimulant use in the 2006–2011 National Survey on Drug Use and Health.

Table 1

Characteristics of past-year nonmedical ADHD stimulant users, by concurrent problematic substance use class in a sample of the US population aged 12-17 (N= 2,203): data from 2006-2011 National Survey on Drug Use and Health.

Characteristics, N (Wgt%)	Low substance class (n=784)	Prescription drug+ class (n=343)	Prescription drug+ class vs. Low substance class aOR (95% CI)	Alcohol marijuana class (n=896)	Alcohol-marijuana class vs. Low substance class aOR (95% CI)	Multiple substance class (n=180)	Multiple substance class vs. Low substance class aOR (95% CI)
Gender							
Male	376(48.0)	136(38.1)	1.00	474(52.3)	1.00	87(46.5)	1.00
Female	408(52.0)	207(61.9)	1.69(1.16,2.45)	422(47.7)	1.02(0.79,1.31)	93(53.5)	1.49(0.89,2.50)
Age							
12-13	87(11.1)	26(11.4)	1.00	17(2.3)	1.00	11(4.4)	1.00
14-15	226(19.9)	121(32.3)	0.84(0.38,1.85)	225(27.0)	2.65(0.97,7.21)	44(67.1)	1.31(0.40,4.31)
16-17	471(59.0)	196(56.4)	1.02(0.48,2.14)	654(70.7)	3.84(1.53,9.61)	125(68.5)	2.21(0.68,7.12)
Race							
Non-Hispanic White	595(77.6)	265(79.5)	1.00	725(83.3)	1.00	142(83.438)	1.00
Minorities	189(22.4)	78(20.5)	0.64(0.42,0.99)	171(16.7)	0.67(0.49,0.91)	38(16.6)	0.53(0.29,0.98)
School Dropout							
No	765(97.5)	324(95.3)	1.00	837(93.7)	1.00	162(89.5)	1.00
Yes	19(2.6)	19(4.7)	1.16(0.40,3.35)	59(6.3)	0.87(0.41,1.86)	18(10.5)	0.76(0.28,2.10)
Average Grade							
A,B, and C	713(91.2)	273(81.1)	1.00	759(86.2)	1.00	142(81.8)	1.00
D or lower	71(8.8)	70(18.9)	1.72(0.95,3.10)	137(13.8)	1.35(0.86,2.14)	38(18.2)	1.49(0.73,3.04)
Household Income							
<$20,000	103(12.4)	69(19.6)	1.00	105(10.8)	1.00	33(18.9)	1.00
$20,000-$49,999	233(28.1)	111(33.6)	0.76(0.44,1.33)	331(34.4)	1.43(0.94,2.17)	59(26.6)	0.72(0.31,1.71)
$50,000-$74,999	140(15.8)	66(16.0)	0.67(0.35,1.30)	331(34.4)	1.13(0.67,1.91)	26(11.1)	0.68(0.30,1.56)
$75,000	308(43.8)	97(30.8)	0.50(0.28,0.91)	308(39.2)	1.05(0.65,1.69)	62(43.4)	0.84(0.34,2.09)
Past-year depression							
No	667(91.9)	237(72.9)	1.00	723(85.0)	1.00	120(68.5)	1.00
Yes	72(8.1)	86(27.1)	2.89(1.86,4.48)	140(15.0)	1.97(1.25,3.10)	53(31.5)	2.76(1.41,5.40)
Past-year anxiety							
No	739(95.0)	291(86.8)	1.00	825(93.0)	1.00	144(75.6)	1.00
Yes	45(5.0)	52(13.2)	0.87(0.46,1.64)	71(7.0)	0.72(0.39,1.35)	36(24.4)	1.74(0.76,4.00)
Past-year mental health treatment							
No	601(78.6)	178(53.6)	1.00	646(72.9)	1.00	93(61.3)	1.00

Characteristics, N (Wgt%)	Low substance class (n=784)	Prescription drug+ class (n=343)	Prescription drug+ class vs. Low substance class aOR (95% CI)	Alcohol marijuana class (n=896)	Alcohol-marijuana class vs. Low substance class aOR (95% CI)	Multiple substance class (n=180)	Multiple substance class vs. Low substance class aOR (95% CI)
Yes	166(21.4)	157(46.4)	1.56(0.97,2.49)	241(27.1)	0.97(0.67,1.38)	85(38.7)	1.03(0.59,1.79)
Past-year SUD treatment							
No	754(96.8)	270(79.3)	1.00	769(85.9)	1.00	115(62.2)	1.00
Yes	30(3.3)	73(20.7)	3.45(2.13,6.93)	127(14.1)	2.97(1.60,5.46)	65(37.8)	7.30(3.73,14.27)
Past-year deviant behaviors							
No	572(73.3)	101(35.2)	1.00	355(39.7)	1.00	25(14.2)	1.00
Yes	212(26.7)	242(64.8)	4.80(3.08,7.50)	541(60.3)	3.75(2.84,4.94)	155(85.8)	14.52(8.19,25.74)
Past-year arrest							
No	718(92.7)	239(73.7)	1.00	686(76.4	1.00	113(65.8)	1.00
Yes	66(7.3)	104(26.3)	2.38(1.31,4.33)	210(23.6)	2.51(1.56,4.04)	66(34.2)	2.50(1.29,4.83)
Past-year STD							
No	776(98.9)	333(97.4)	1.00	879(98.0)	1.00	169(95.5)	1.00
Yes	8(1.1)	10(2.6)	0.58(0.11,2.94)	17(2.0)	0.56(0.11,2.91)	11(4.5)	0.43(0.08,2.47)

Note: aOR stands for adjusted odds ratio, CI for confidence interval, SUD for substance use disorder and STD for sexually transmitted diseases.