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Prescription stimulant misuse and risk correlates among racially-diverse urban adolescents

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Abstract

Background: Most research on prescription stimulant misuse has focused on college students, and research on high school-aged adolescents is limited.

Objectives: This study aimed to characterize risk correlates of prescription stimulant misuse among a racially-diverse and socioeconomically-disadvantaged sample of urban adolescents.

Method: Cross-sectional data were drawn from an ongoing study of adolescent health behaviors, *Project Teen*. Participants were 414 9th to 11th graders (M_{age}=16.00 [*SD*=1.08]; 57% female; 41% Black or African American, 22% White, 18% Asian, 17% Multiracial, 2% Pacific Islander, and 1% Native American; 12% Hispanic/Latinx). Participants completed a web-based survey assessing prescription stimulant misuse, demographics, mental health and personality, social environment, and substance use.

Results: Eight percent of participants endorsed past-year prescription stimulant misuse. Compared to non-misusing peers, participants endorsing past-year prescription stimulant misuse reported greater depression/anxiety symptoms, sensation seeking, perceived peer risk behavior, and alcohol and cigarette use, as well as a lower level of parental monitoring; null group differences were observed for academic goal orientation, perceived peer approval of risk behavior, and cannabis use. Binary logistic regression demonstrated that binge drinking and cigarette use were significantly associated with prescription stimulant misuse over and above all other identified risk variables.

Conclusions: Adolescent prescription stimulant misuse appears to overlap with general adolescent substance use, sharing several known risk correlates. Results highlight potential targets for identification of emerging prescription stimulant misuse risk profiles at earlier stages of development. Longitudinal replication is needed to examine directional associations and risk mechanisms underlying adolescent prescription stimulant misuse.

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Keywords

stimulant misuse; adolescent; high school; ADHD; depression; anxiety; sensation seeking; substance use; peer norms; diversity

Stimulant medications such as mixed amphetamine salts and methylphenidate are FDA-approved medications for treating attention deficit/hyperactivity disorder (ADHD) in children, adolescents, and adults. While efficacious for managing symptoms of ADHD (Cortese et al., 2018), many individuals use stimulant medications illicitly without a prescription (Weyandt et al., 2016); this illicit use is referred to as *prescription stimulant misuse*. Prescription stimulant misuse contributes substantially to public health burden due to associated adverse medical events and emergency room visits (for a review, see Faraone et al., 2019).

In 2018, approximately 369,000 Americans aged 12–17 endorsed past-year prescription stimulant misuse (Substance Abuse and Mental Health Services Administration [SAMHSA], 2019). Despite growing empirical interest in understanding prescription stimulant misuse across the lifespan (versus strictly emerging adulthood), the demographic, mental health and personality, social environment, and substance use correlates of prescription stimulant misuse during adolescence are largely unknown. Improved understanding of risk factors of prescription stimulant misuse during adolescence may assist identification and targeted prevention and intervention efforts for a subset of adolescents at emerging risk for prescription stimulant misuse.

Demographic correlates

Consideration of demographic correlates may help identify adolescents at greater risk for prescription stimulant misuse. A national study of 8th, 10th, and 12th graders indicated that stimulant misuse was associated with White race and higher grade levels (i.e., 10th and 12th grades versus 8th grade; McCabe et al., 2004). Further, two studies of adolescents aged 12–17 from the National Survey on Drug Use and Health (NSDUH) indicated that stimulant misuse was associated with White race, male sex, and older age, but not with family socioeconomic status (Conn & Marks, 2014; Oluwoye, Merianos, & Nabors, 2017). Consistent with extensive literature demonstrating that college stimulant misuse is associated with White race and male sex (for a review, see Faraone et al., 2019), high school stimulant misuse may be associated with white race, male sex, and older age (or more advanced grade).

Mental health and personality correlates

Positive associations of stimulant misuse with mental health symptoms such as depression (Benson & Flory, 2017; Chinneck et al., 2018) and anxiety (Dussault & Weyandt, 2013) are also well-documented in the college literature. Although there remains a paucity of comparable work in the adolescent literature, adolescents endorsing stimulant misuse with frequent concurrent use of other substances such as alcohol or cannabis (versus those with infrequent or no concurrent substance use) were more likely to receive mental health

treatment (Chen et al., 2015). These mental health correlates require replication and ongoing explication among high school students.

Regarding personality, sensation seeking refers to the characteristic tendency to pursue arousing experiences (Zuckerman et al., 1964). Prescription stimulant misuse has been associated with trait sensation seeking among college students (Antshel et al., 2019; Chinneck et al., 2018). Although this association has not yet been investigated in adolescents, its potential generalizability to this earlier developmental period is implicated by normative increases in sensation seeking and associated risk-taking behavior during adolescence (for a review, see Harden & Mann, 2015).

Recent research (Antshel et al., 2019) also suggests that prescription stimulant misuse is associated with a greater level of Performance Goal Orientation (i.e., cognitive representations of subjective competence focused on outcomes and between-person comparisons; Dweck & Leggett, 1988), but not with Learning Goal Orientation (i.e., cognitive representations of subjective competence focused on learning goals and the proportionality of learning/performance). Evidence suggests that college students misuse prescription stimulants with the intention of improving their academic performance (Chinneck et al., 2018; DeSantis, Webb, & Noar, 2008), and also perceive this behavior to be effective (Looby, De Young, & Earleywine, 2013; Partridge et al., 2011). However, college prescription stimulant misuse is actually associated with impaired academic functioning both concurrently (e.g., procrastination; Antshel et al., 2019; Ponnet et al., 2015) and prospectively (e.g., increased class-skipping and lower grade point average; Arria et al., 2017; Arria et al., 2013). This association of stimulant misuse with academic goal orientation remains to be explored among high-school aged adolescents.

Social environment correlates

To better understand adolescent prescription stimulant misuse, there is a need for ongoing consideration of the social environment correlates. Adolescent prescription drug misuse broadly (i.e., stimulants, sedatives, tranquilizers, and pain relievers) has been negatively associated with parental and close friends' disapproval of substance use (Conn & Marks, 2014). This result is in line with findings that college prescription stimulant misuse is concurrently associated with perceived peer approval of prescription stimulant misuse (Antshel et al., 2019; Judson & Langdon, 2009; Ponnet et al., 2015). Further, although parental monitoring has demonstrated a protective role against adolescent risk behaviors (e.g., alcohol and cannabis use; Rusby et al., 2018), potentially-risky social environment variables such as low parental monitoring remain largely unexamined as correlates of adolescent prescription stimulant misuse.

Substance use correlates

Extensive research demonstrates positive associations of stimulant misuse with other substance use across all age groups (for a review, see Faraone et al., 2019). A national study of 8^{th}, 10^{th}, and 12^{th} graders demonstrated that stimulant misuse was associated with other substance use, such as alcohol, cannabis, and cigarettes (McCabe et al., 2004). Further, a

study of 2,203 adolescents who reported past-year stimulant misuse found that stimulant misuse prevalently co-occurred with other problematic substance use (i.e., abuse or dependence), including alcohol (53% of sample) and cannabis (48% of sample) during the past year (Chen et al., 2015). Continued identification of substance use correlates during adolescence may help characterize emerging risk profiles at earlier stages of development.

Study aims and hypotheses

This study characterized the prevalence and correlates of prescription stimulant misuse among a racially-diverse and socioeconomically-disadvantaged sample of urban, high school-attending adolescents. Differences between subgroups of adolescents who did versus did not endorse past-year prescription stimulant misuse were examined broadly in terms of demographics, mental health and personality, social environments, and other substance use. It was hypothesized that individuals reporting past-year prescription stimulant misuse (versus non-misusing peers) would: (a) be more likely to be male, White, and higher grade level; (b) report greater depression/anxiety, sensation seeking, and performance (but not learning) goal orientation, (c) report greater risk behavior peer norms and lower parental monitoring, and (d) report heavier concurrent alcohol, cannabis, and cigarette use.

Method

Participants and procedure

Data was collected as part of a larger, longitudinal, genetically-informed alcohol study, *Project Teen.* All study procedures were approved by the Institutional Review Board and the school district, and a Certificate of Confidentiality was obtained from National Institutes of Health to protect confidentiality of sensitive information (e.g., illicit substance use). High school students were recruited through class visits for three semesters (Spring 2017, Fall 2017, and Spring 2018) and each enrolled participant provided informed assent and guardian consent. Participants received an email link to two web-based surveys assessing diverse health behaviors (including prescription stimulant misuse) and their correlates at Year 1 and Year 2 (average interval of 389.05 days [*SD*=27.36]). All Year 1 participants were invited for the Year 2 survey for the larger longitudinal study, although current analyses use cross-sectional data from Year 1. Most participants completed the survey during a regular class period on an individual computer fitted with a privacy screen in the school computer lab (no teachers were present), but a few participants completed the survey via a personal phone/computer after school hours. Participants were compensated with up to $15 (Year 1) or $20 (Year 2) via a gift card for completing each survey; additionally, any student who returned a complete guardian consent (regardless of their actual participation or their guardian's consent to participate) could receive extra credit based on individual teacher discretion. Participants were also invited to provide cheek swabs for genotyping for an additional $5 at Year 1 as part of the larger study, although cheek swab donation was not required to participate in the survey portion of the study.

Overall, cross-sectional data were drawn from 414 adolescents (M_{age}=16.00 years [*SD*=1.08], 57% female) at an urban public high school in the northeastern U.S. Students were eligible if they were English-speaking and enrolled in the 9th, 10th, or 11th grade at the time

of study enrollment (32% 9th grade, 33% 10th grade, and 35% 11th grade students). Students were ineligible if enrolled in the 12th grade, because they would no longer be high school students during the one-year follow-up. The sample consisted of: 41% Black or African American, 22% White, 18% Asian, 17% Multiracial, 2% Pacific Islander, and 1% Native American students, with 12% of students reporting Hispanic/Latinx ethnicity. Demonstrating considerable socioeconomic disadvantage, 87% of students were eligible for free or reduced-price lunch, 20% reported having a primary caregiver without a high school diploma, and 75% reported living in a neighborhood where at least 20% of residents fall below the federal poverty line (United States Census Bureau, 2017). The current sample is representative of high school students in this district in terms of race, ethnicity, and socioeconomic status, although proportion of girls in this sample is higher than that of the school district (consistent with other health survey studies; e.g., Geers et al., 2017). In 2018, this high school reported a 64% graduation rate, which is lower than the national average of 85% (United States Department of Education, 2019).

Measures

Prescription stimulant misuse.—Participants were oriented to prescription stimulants (i.e., “Doctors sometimes prescribe stimulant-type drugs [such as, amphetamine, methylphenidate, and pemoline] for people who have problems concentrating [attention deficit disorder], or with being too active or too disruptive [hyperactive], or both [ADHD]. These drugs include Ritalin, Adderall, Concerta, Metadate, Dexedrine, Focalin, Cylert, and others.”), consistent with a large national study of youth health behaviors (Johnston, Bachman, & O’Malley, 2016). Past-year frequency of prescription stimulant misuse was then assessed via a single item (i.e., “During the last 12 months, on how many occasions have you taken someone else’s stimulant-type prescription drug that was not prescribed to you?”; adapted from Johnston, Bachman, & O’Malley, 2016). Response options were based on a 7-point Likert scale (0=*Never*, 1=*1–2 occasions*, 2=*3–5 occasions*, 3=*6–9 occasions*, 4=*10–19 occasions*, 5=*20–39 occasions*, 6=*40 or more occasions*). Dichotomized scores (0=*No*, 1=*Yes*) were used for analyses due to low frequencies of endorsements for multiple occasions of misuse (M=0.15 [SD=0.56], median=0.00, mode=0, skewness=4.43; n=371 did not misuse prescription stimulants, n=21 misused 1–2 occasions, n=7 misused 3–5 occasions, n=6 misused 6–9 occasions, n=2 misused 10–19 occasions, and no students misused 20 or more occasions in the past year). The past-year assessment timeframe (as opposed to shorter timeframes such as past-month) was chosen due to the low prevalence and infrequent nature of adolescent prescription stimulant misuse (for a review, see Kaye & Darke, 2012; Wilens et al., 2008). A shorter timeframe may compromise reliability and in turn validity because highly infrequent behaviors captured within a short term period are likely to be determined by random chance (such as accidental availability) instead of stable risk behavior patterns. Also, a very small percentage of non-zero endorsements would preclude planned analyses and interpretation of results.

Demographics.—Sex assigned at birth (0=*Female*, 1=*Male*), age, grade, race, ethnicity, and free/reduced-price lunch eligibility (as a proxy for family socioeconomic status) were assessed based on previous findings demonstrating their associations with adolescent stimulant misuse (e.g., Cottler, Striley, & Lasopa, 2013; Kaye & Darke, 2012).

Mental health and personality.

ADHD diagnosis and treatment.: Lifetime ADHD diagnosis was assessed via a single, investigator-developed item (i.e., "Have you ever been diagnosed with attention deficit hyperactivity disorder [ADHD] or attention deficit disorder [ADD] by a professional?"; 0=*No*, 1= *Yes*), consistent with recommendations for stimulant misuse research (Benson et al., 2015). If indicating a history of an ADHD diagnosis, students were subsequently presented with a single item (Johnston, Bachman, & O'Malley, 2016) to assess current and historical stimulant prescription (i.e., "Have you ever taken any of these stimulant-type prescription drugs under a doctor's supervision for [ADHD symptoms as described above]?"); dichotomized scores (0=*No*, 1= *Yes*) were used for analyses. ADHD diagnosis and treatment were assessed in order to determine prevalence rates of prescription stimulant misuse (as opposed to prescribed, medical use), which is the key variable of interest in this study. Thus, single items were considered sufficient to assess history of diagnosis and prescription while minimizing participant burden, as symptom criteria and clinical cutoffs are outside the scope of these analyses.

Mood/anxiety.: The 4-item Patient Health Questionnaire (Kroenke et al., 2009) assessed frequency of depression and anxiety symptoms over the past 2 weeks. Response options were based on a 4-point Likert scale ranging from 0 (*Not at all*) to 3 (*Nearly every day*). Continuous subscale scores of depression (Cronbach's α=.75) and anxiety (Cronbach's α=.81) were used for analyses, consistent with the validated two-factor structure representing distinct domains of depression and anxiety underlying the total sum score (Kroenke et al., 2009).

Sensation seeking.: A 4-item subscale from the Short UPPS-P Impulsive Behavior Scale (Cyders et al., 2014) assessed sensation seeking. Participants indicated their agreement with a series of statements (e.g., "I quite enjoy taking risks"), with response options based on a 4-point Likert scale ranging from 1 (*Strongly disagree*) to 4 (*Strongly agree*). A continuous sum score (Cronbach's α=.68) was used for analyses, consistent with the validated factor structure highlighting sensation-seeking as one of five distinct domains underlying the overall construct of impulsivity (Cyders et al., 2014), with higher scores indicating greater sensation seeking.

Academic goal orientation.: Four of the highest-loading items from the achievement motivational goal framework (Elliot & McGregor, 2001) were administered ("It is important for me to get better grades than other students"; "Sometimes I'm afraid that I may not understand the content of my school work as thoroughly as I'd like"; "I want to learn as much as possible from my school classes"; "I want to avoid doing poorly in my school classes"). Item wording was adapted slightly for generalizability to academic work broadly (consistent with Antshel et al., 2019) and response options were based on a 4-point Likert scale (adapted from the original 7-point Likert scale) ranging from 0 (*Not at all true*) to 3 (*Very true*). Continuous sum scores were used in analyses for subscales of performance (Cronbach's α=.40) and learning (Cronbach's α=.54) goal orientation, consistent with the validated two-factor structure representing distinct domains of performance and learning goal orientation underlying the overall construct of academic goal orientation (Jagacinski &

Duda, 2001); low internal reliability is expected given 2 items per subscale (Cronbach, 1951; Nunnally, 1978). Use of the abbreviated scale is supported by robust correlations of selected items with the corresponding full performance and learning subscale scores (*r*s=.27-.29, *p*s < .001; Cronbach's α=.81-.85) administered at Year 2, despite the one-year interval between the two assessments.

Social environment.

Peer norms.: Five items (adapted from Johnston, Bachman, & O'Malley, 2016) assessed descriptive norms (i.e., perceptions of peers' typical risky health behaviors; "How many of your close friends [used tobacco/used marijuana or hashish/drink alcohol at least once a month/get drunk at least once a week/are having sex]?") with response options based on a 5-point Likert scale ranging from 1 (*None*) to 5 (*All*). Five items (adapted from Johnston, Bachman, & O'Malley, 2016) assessed injunctive peer norms (i.e., peers' prevailing attitudes toward risky health behaviors; "How would your close friends feel about you doing [using tobacco/using marijuana or hashish/drinking alcohol at least once a month/getting drunk at least once a week/having sex]?") with response options based on a 5-point Likert scale ranging from 1 (*Strongly disapprove*) to 5 (*Strongly approve*). Separate sum scores for descriptive and injunctive norms were used for analyses (Cronbach's α=.84–87); higher scores indicated more friends engaging in risky health behaviors and greater perceived peer approval of risky health behaviors.

Parenting.: Three items (adapted from Olivares et al., 2016; Stattin & Kerr, 2000) assessed parental monitoring (e.g., "How much do your parents or primary caregivers really know about who your friends are?"). Response options were based on a 5-point Likert scale ranging from 0 (*Never*) to 4 (*Always*). A continuous sum score was used in analyses (Cronbach's α=.80), with higher scores indicating greater parental monitoring.

Substance use.

Alcohol.: Three items (Johnston, Bachman, & O'Malley, 2016) assessed: (a) frequencies of alcohol use in the lifetime and in the past year (i.e., "On how many occasions have you had alcoholic beverages to drink [more than just a few sips] [in your lifetime/during the last 12 months]"; response options were based on a 7-point Likert scale ranging from 0 [*Never*] to 6 [*40 or more occasions*]); (b) past-2-week frequency of binge drinking (i.e., 5 or more drinks in a row for boys, 4 for girls; response options were based on a 6-point Likert scale ranging from 0 [*None*] to 5 [*10 or more times*]), dichotomous "binge drinker status" was used for analyses (0=*No*, 1=*Yes*). One additional item (National Institute on Alcohol Abuse and Alcoholism, 2003) assessed lifetime maximum number of drinks (i.e., "During your lifetime, what is the largest number of drinks containing alcohol that you drank within a 24-hour period?"); response options were based on a 10-point Likert scale ranging from 1 (*1 drink*) to 10 (*36 or more drinks*). Lifetime alcohol abstainers (*n*=239; 58% of sample) were coded as missing on other alcohol consumption items.

Cannabis.: Two items (Johnston, Bachman, & O'Malley, 2016) assessed lifetime and past-year frequency of cannabis use (i.e., "On how many occasions have you used cannabis [in your lifetime/during the last 12 months])"); response options were based on a 7-point Likert

scale ranging from 0 (*Never* or *0 occasions*) to 6 (*40 or more occasions*). Lifetime cannabis abstainers (n=303; 73% of sample) were coded as missing on other cannabis consumption items.

Cigarettes.: One item (Johnston, Bachman, & O'Malley, 2016) assessed lifetime prevalence of cigarette use ("Have you ever smoked cigarettes?"); response options were based on a 5-point Likert scale ranging from 1 (*Never*) to 5 (*Regularly now*). Dichotomous "cigarette user status" was used for analyses (0=*No*, 1= *Yes*).

Data analytic strategies

Data analyses were conducted using *SPSS* Version 23 (IBM Corp., 2016). Bivariate correlations (i.e., Pearson's correlation coefficients for associations of two continuous variables; Spearman's coefficients for associations of a continuous and dichotomous variable; Phi coefficients for associations of two dichotomous variables) among select study variables were examined (Table 1). Descriptive statistics were computed for all study variables among the full sample, as well as subsamples of students who did versus did not endorse past-year prescription stimulant misuse (Table 2). To compare these subgroups, independent-sample t-tests were used for continuous outcomes (skewness≤|2.08|; kurtosis≤|3.62|) and chi-square difference tests were used for categorical outcomes (Table 2). Lastly, a binary logistic regression was conducted to assess associations of past-year prescription stimulant misuse with all variables found to significantly differentiate between subgroups of students who did versus did not endorse past-year prescription stimulant misuse.

Results

Descriptive statistics and correlations

Bivariate correlations for select study variables are presented in Table 1 and descriptive statistics for the full sample (N=414) are presented in Table 2 (first column). Overall, 7% of the full sample reported a diagnosis of ADHD at some point during their life and 5% reported a current or historical stimulant prescription; thus, 2% of the full sample endorsed an ADHD diagnosis without history of prescribed stimulant medication. After excluding students with a current or historical stimulant prescription, 8% of students endorsed lifetime prescription stimulant misuse.

On average, students reported low levels of depression/anxiety symptoms and other substance use. Specifically, students reported drinking 1–2 occasions and using cannabis 1–2 occasions in their lifetime. Students that endorsed lifetime drinking (41%) reported an average lifetime maximum of 2 drinks and drinking 1–2 occasions in the past year, and 6% endorsed binge drinking in the past 2 weeks. Students that endorsed lifetime cannabis use (26%) reported using 3–9 occasions in the past year. Lastly, 10% of students reported lifetime cigarette use.

Group comparisons between prescription stimulant misuse and non-misuse groups

Students who did (n=33; 8% of sample) versus did not (n=354; 90% of sample) endorse past-year prescription stimulant misuse differed significantly in a number of domains (see

Table 2, last column). Consistent with hypotheses, students that misused prescription stimulants (versus non-misusing peers) reported: (a) greater depression, anxiety, and sensation-seeking; (b) greater perceptions of peers' typical risky health behaviors and less parental monitoring; (c) more frequent personal alcohol use (lifetime, past year), greater likelihood of binge drinking in past 2 weeks, and more frequent lifetime cigarette use. Inconsistent with hypotheses, students that misused stimulants did *not* differ from non-misusing peers in terms of (a) demographics (i.e., sex, age, grade, race, ethnicity, or free/reduced-price lunch eligibility), (b) lifetime ADHD diagnosis or academic goal orientation, (c) perceptions of peers' prevailing attitudes toward risky health behaviors, or (d) lifetime drink maximum or personal cannabis use frequency.

Binary logistic regression assessing past-year prescription stimulant misuse

After controlling for the nine previously-identified factors which significantly differentiated students who endorsed prescription stimulant misuse versus those who did not (depression symptoms, anxiety symptoms, sensation seeking, descriptive peer norms, parental monitoring, lifetime alcohol use frequency, past-year alcohol use frequency, past-2-week binge drinker status, and cigarette user status), the overall binary logistic regression model assessing past-year prescription stimulant misuse among cases with complete data (n=161) was significant, $\chi^2(9)=19.13$, p=.02, Nagelkerke R^2=.23. Past-2-week binge drinker status (Wald $\chi^2(1)=3.89$, p=.049; OR=3.60, 95% CI [1.01, 12.86]) and cigarette user status (Wald $\chi^2(1)=4.32$, p=.04; OR=3.91, 95% CI [1.08, 14.18]) were significantly associated with past-year prescription stimulant misuse after accounting for other variables in the model.

Discussion

This cross-sectional study characterized the prevalence and correlates of prescription stimulant misuse among a racially-representative and socioeconomically-disadvantaged sample of urban high school students. Eight percent of our sample reported prescription stimulant misuse in the past year, which is consistent with prior prevalence estimates from samples of predominantly White high school-aged adolescents (i.e., 5 – 9%; for a review, see Wilens et al., 2008), with the majority of stimulant misusing students reporting 1 – 2 occasions in the past year and no students endorsing greater than 20 occasions in the past year. This prevalence indicates that stimulant misuse among high school-aged adolescents may not differ across familial socioeconomic status, and/or racial/ethnic backgrounds, which is also in line with null findings in sub-group differences within our sample. Because this is the first study to establish stimulant misuse prevalence among a racially-diverse, socioeconomically disadvantaged, and urban adolescent sample, however, replication among heterogeneous samples is exigent to explore generalizability of our finding and potential prevalence differences across sociodemographic characteristics. Overall, adolescent prescription stimulant misuse appears to overlap with general substance use behavior, sharing several common demographic, mental health and personality, social environment, and substance use risk correlates. Because even single, acute occasions of prescription stimulant misuse can result in consequences (e.g., sleep impairment, dizziness, headache, stomachache, appetite dysregulation, sadness, and irritability; for a review, see Faraone et al., 2019), characterization of past-year prevalence and risk correlates, regardless of

frequency, has real-world utility to identify at-risk students and/or inform targeted prevention or intervention programming among diverse racial and socioeconomic groups.

Regarding group differences in demographics, adolescents misusing prescription stimulants did not differ from non-misusing peers in terms of sex, grade, race, or ethnicity. Inconsistent with some previous findings (Conn & Marks, 2014; although see null findings reported by McCabe et al., 2004), nonsignificant group differences in sex may be attributable to recent trends toward a narrowing sex disparity in risky substance use (Keyes, Grant, & Hasin, 2008; Seedat et al., 2009). Also inconsistent with previous findings (Conn & Marks, 2014; McCabe et al., 2004; Oluwoye, Merianos, & Nabors, 2017), nonsignificant group differences in race may be explained by the greater racial diversity at the study high school, implicating reduced peer segregation and more homogenous prescription stimulant misuse patterns relative to previous studies. Notably, relatively low rates of depression/anxiety symptoms and substance use observed in this sample are consistent with previous studies highlighting higher same-race/ethnicity density within-school as protective factor for mental well-being (for a review, see DuPont-Reyes & Villatoro, 2019) and narrowing racial/ethnic disparities in adolescent substance use over time (Johnston, 2020), suggesting that prevalence of adolescent stimulant misuse may be comparable across heterogeneous samples regardless of these presumed risk factors.

Regarding group differences in mental health and personality, adolescent prescription stimulant misuse appears to occur within the context of depression, anxiety, and sensation seeking, but not ADHD diagnosis or academic goal orientation. Indeed, individuals with depression or anxiety symptoms may misuse stimulants to regulate mood (consistent with self-medication models of substance use; e.g., Khantzian 1997) or to cope with stressors, such as academic difficulties; conversely, prescription stimulant misuse may increase depression symptoms, particularly if desired effects of stimulants (e.g., improved academic functioning) are not observed. Sensation seeking has likewise been demonstrated to lead to increased substance use behavior (e.g., heavy drinking among college students; Park et al., 2014). In contrast, nonsignificant group differences in lifetime ADHD diagnosis may be attributable to under-diagnosis of ADHD and known barriers to treatment access in racial/ethnic minority and socioeconomically-disadvantaged youth (Bax et al., 2019; Coker et al., 2016). Further, nonsignificant group differences regarding academic goal orientation may be explained because stimulant misuse is associated with lower commitment to education in the high school population (McCabe et al., 2004; Wojciechowski, 2019), although findings require replication and are interpreted cautiously. In sum, stimulant misuse among high school students may not be motivated by academic performance, but is instead similar to general substance use in terms of mental health and personality risk correlates.

Regarding group differences in social environment, findings indicate that adolescent prescription stimulant misuse may be associated with perceptions of greater peer risk behaviors (i.e., descriptive norms) and lower levels of parental monitoring, but not peer approval of personal risk behaviors (i.e., injunctive norms). Findings are in line with theory that perceived social norms influence individual behavior (Festinger, 1954), as well as previous research demonstrating associations with adolescent substance use (e.g., alcohol; Brooks-Russell et al., 2014). However, given the cross-sectional nature of current findings,

the directionality of these peer-personal use relationships remains unknown. Results are also in line with previous research demonstrating the protective role of parental monitoring against adolescent risk behaviors (e.g., alcohol and cannabis use; Rusby et al., 2018). In contrast, null group differences in injunctive peer norms may be explained because stimulant misuse is not socially-motivated, but rather reasoned (Pomery et al., 2009) and motivated by perceived functional benefits (consistent with college studies; e.g., Chinneck et al., 2018). Overall, results regarding perceptions of peer risk behaviors and relative lack of parental monitoring further support the notion that prescription stimulant misuse is similar to general substance use behaviors among adolescents.

Regarding other substance use, students who reported past-year prescription stimulant misuse reported greater alcohol and cigarette use, but not cannabis use, compared to non-using peers. Indeed, binge drinking and cigarette use were associated with prescription stimulant misuse over and above all other significant risk correlates. These findings add to limited research indicating that stimulant misusing students are more likely to report other substance use (i.e., binge drinking, cigarette use, cannabis use) compared to non-misusing peers (McCabe et al., 2004). Null group differences in cannabis use may be explained by different motives for alcohol and stimulant use compared to cannabis use, or possibly a greater predisposition or reward sensitivity to stimulant effect drugs as compared to depressants such as cannabis among prescription stimulant misusing youth. Future research is needed to explicate motives, expectancies, and risk profiles potentially underlying novel, mixed findings regarding associations of prescription stimulant misuse with other substance use during adolescence.

Clinical implications

Findings may inform interventions targeting prescription stimulant misuse during adolescence. School-wide primary prevention and harm reduction programming may emphasize the low prevalence of stimulant misuse (to combat inappropriate subjective norms that “everyone is doing it”) and provide education and skills to minimize harm (see Marlatt et al., 2012) on infrequent occasions of adolescent stimulant misuse. Further, individual-level correlates of stimulant misuse identified herein (i.e., sensation seeking, depression/anxiety, and other substance use) may be used to identify at-risk students and tailor secondary intervention programming (e.g., concurrent treatment of ADHD symptoms and risky substance use; Zaso, Park, & Antshel, 2015). This is especially important given that college stimulant misuse is associated with impaired academic functioning both concurrently (e.g., procrastination; Antshel et al., 2019; Ponnet et al., 2015) and prospectively (e.g., increased class-skipping; Arria et al., 2017). Intervention programs may also provide psychoeducation and evidence-based techniques for increasing time management, planning, and organization skills, potentially reducing the perceived need for stimulant medication for academic achievement. Although the current results did not find a relationship between goal orientation and stimulant misuse, emphasis on learning (versus performance) goals throughout high school may reduce the risk of prescription stimulant misuse in those who go on to attend college.

Limitations and future directions

Several limitations must be considered. First, it is not possible to infer causal relationships among study variables given the current cross-sectional design. Also, this study enrolled school-attending adolescents in a northeastern city with a high prevalence of socioeconomic disadvantage, and eligibility criteria excluded non-English speaking students; thus, results might not generalize to non-school-attending adolescents, students from other geographical locations with different socioeconomic demographic compositions, or non-English speaking students (e.g., recent immigrants). Next, assessment of prescription stimulant misuse herein is limited given the item's past-year timeframe and ordinal Likert response scale, precluding more nuanced assessment of frequency or chronicity. Further, self-report measures may have been vulnerable to memory errors and/or social desirability bias, and single-item self-report assessments of ADHD diagnosis, prescription, and prescription stimulant misuse may have limited construct validity. Also, the current definition and assessment of prescription stimulant misuse (i.e., use of another person's prescribed stimulant medication) precludes examination of high school students with ADHD misusing their personal prescriptions (e.g., taking too much at once or using it to get high). Further, comparison of gradations of misuse chronicity is not feasible in the current sample due to the low prevalence and lack of variability in non-zero prescription stimulant misuse frequency in the past year. Lastly, this study did not examine drugs other than alcohol, cannabis, and cigarettes, and future research is needed to assess relationships with other illicit substance use (e.g., prescription opioids and benzodiazepines).

Results may inform future research. Longitudinal research is needed to (a) replicate the current cross-sectional relationships over time to clarify directionality and (b) assess risk mechanisms underlying adolescent prescription stimulant misuse. As this is the first study to characterize the prevalence and correlates of high school prescription stimulant misuse among a sample of racially-diverse, socioeconomically disadvantaged, urban high school students, replication is necessary among both general adolescent samples and specific high-risk subsamples (e.g., heavy substance using students). In order to optimize reporting accuracy, future investigations should use measures robust to retrospective reporting error for prescription stimulant misuse (e.g., adapted Timeline Follow-Back; Sobell & Sobell, 1992), consider using validated scale assessments and/or clinical interviews to maximize construct validity of ADHD assessment, and additionally assess for motives precipitating prescription stimulant misuse. Future research is also needed to investigate subgroups of adolescents potentially misusing prescription stimulants at varying levels of frequency or chronicity, as well as implications for differential risk.

Conclusions

Results of this cross-sectional study highlight a past-year prescription stimulant misuse prevalence of 8% among a racially-diverse and socioeconomically-disadvantaged sample of urban high school students, as well as positive associations with individual differences, social environments and other substance use behaviors. Adolescent prescription stimulant misuse appears to share risk factors common to general substance use, highlighting potential targets for identification of emerging risk profiles at earlier stages of development.

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Table 1

Bivariate Correlation Coefficients of Study Variables among All Participants

		r													
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**14**	**15**
1.	Past-year Prescription Stimulant Misuse (1 vs. 0)	—													
2.	Male Sex (1 vs. 0)	−.02	—												
3.	Age	.03	**.11**	—											
4.	White Race (1 vs. 0)	−.04	.07	**−.13**	—										
5.	Lifetime ADHD Diagnosis (1 vs. 0)	.09	.03	−.04	**.16**	—									
6.	Depression	**.18**	**−.11**	.06	.04	**.14**	—								
7.	Anxiety	**.12**	**−.18**	−.02	**.19**	**.17**	**.70**	—							
8.	Sensation Seeking	**.12**	**.10**	.02	.05	**.19**	**.18**	**.15**	—						
9.	Performance Goal Orientation	−.05	−.08	**−.13**	.07	.03	−.05	.05	−.04	—					
10.	Descriptive Peer Norms	**.12**	.06	**.22**	.09	.07	**.27**	**.19**	**.18**	.03	—				
11.	Injunctive Peer Norms	.05	**.13**	**.20**	**.12**	−.02	**.21**	.09	.10	−.06	**.45**	—			
12.	Parental Monitoring	**−.17**	−.06	**−.12**	**.14**	−.00	**−.18**	−.08	−.09	**.21**	−.05	**−.13**	—		
13.	Past-year Alcohol Frequency	**.20**	.05	**.19**	**.22**	.10	.08	**.17**	**.17**	−.05	**.29**	**.37**	.04	—	
14.	Past-year Cannabis Frequency	.09	−.09	.06	.19	**.24**	.01	.12	.04	**.25**	**.34**	.17	**.20**	**.55**	—
15.	Cigarette User Status (1 vs. 0)	**.20**	.09	.06	.01	.05	**.16**	**.13**	**.19**	−.02	.07	.06	**−.12**	−.02	.04

Note. N = 106–414 due to lifetime alcohol abstainers (58% of sample) and cannabis abstainers (73% of sample). Pearson's correlation coefficients are reported for correlations between two continuous variables; Spearman's coefficients (r_S) are reported for correlations between a continuous and dichotomous variable; Phi coefficients (r_φ) are reported for correlations between two dichotomous variables. Significant correlation coefficients at $p < .05$ are highlighted in bold font.

Table 2

Means (and Standard Deviations) or Percentages of Study Variables as a Function of Past-Year Prescription Stimulant Misuse

	***N* (%)**	**All Participants (*N* = 414)**	**Stimulant Misuse (*n* = 33)**	**Non-Stimulant Misuse (*n* = 354)**	**Comparison between Misuse & Non-Misuse Groups**
Study Variables (possible range)					
Demographics					
Male Sex	414 (100%)	43%	39%	43%	$\chi^2(1) = 0.13$
Age	412 (99%)	16.00 (1.08)	16.15 (1.10)	16.00 (1.08)	$t(385) = 0.71$
% 9th Grade	412 (99%)	32%	21%	32%	$\chi^2(1) = 1.70$
% 10th Grade	412 (99%)	33%	36%	33%	$\chi^2(1) = 0.18$
% 11th Grade	412 (99%)	35%	42%	35%	$\chi^2(1) = 0.72$
Black Race	414 (100%)	41%	58%	41%	$\chi^2(1) = 3.41^{\dagger}$
White Race	414 (100%)	22%	15%	21%	$\chi^2(1) = 0.56$
Asian Race	414 (100%)	18%	9%	20%	$\chi^2(1) = 2.25$
Multi-Race	414 (100%)	17%	15%	16%	$\chi^2(1) = 0.03$
Other Race	414 (100%)	2%	3%	2%	$\chi^2(1) = 0.08$
Hispanic/Latinx Ethnicity	414 (100%)	12%	9%	12%	$\chi^2(1) = 0.32$
Free/Reduced-Price Lunch Eligibility (1 vs. 0)	412 (99%)	87%	91%	86%	$\chi^2(1) = 0.53$
Mental Health and Personality					
% Lifetime ADHD Diagnosis	346 (84%)	7%	7%	2%	$\chi^2(1) = 2.81^{\dagger}$
Depression Symptoms (0–6)	**402** (97%)	**1.53 (1.69)**	**2.63 (1.74)**	**1.41 (1.66)**	$\mathbf{t(380) = 3.95}^{***}$
Anxiety Symptoms (0–6)	**402** (97%)	**1.53 (1.73)**	**2.28 (2.04)**	**1.43 (1.69)**	$\mathbf{t(380) = 2.67}^{**}$
Sensation Seeking (4–16)	**402** (97%)	**9.30 (2.89)**	**10.28 (3.39)**	**9.11 (2.82)**	$\mathbf{t(380) = 2.21}^{*}$
Goal Orientation: Performance (0–6)	402 (97%)	3.97 (1.58)	3.59 (1.64)	3.99 (1.58)	$t(380) = -1.34$
Goal Orientation: Learning (0–6)	402 (97%)	3.78 (1.50)	3.69 (1.49)	3.76 (1.50)	$t(380) = -0.26$
Social Environment					
Peer Norms: Descriptive (5–25)	**406** (98%)	**8.31 (3.79)**	**9.94 (4.26)**	**8.16 (3.73)**	$\mathbf{t(384) = 2.59}^{**}$
Peer Norms: Injunctive (5–25)	406 (98%)	9.84 (4.97)	11.03 (4.52)	9.82 (5.03)	$t(384) = 1.33$
Parental Monitoring (0–24)	**407** (98%)	**7.40 (3.23)**	**5.39 (3.25)**	**7.60 (3.19)**	$\mathbf{t(385) = -3.78}^{***}$
Other Substance use					
Alcohol					
Lifetime Alcohol Use Frequency (0–6)	**410** (99%)	**0.82 (1.28)**	**1.36 (1.67)**	**0.74 (1.19)**	$\mathbf{t(385) = 2.10}^{*}$
Lifetime Drink Maximum (0–10)	173 (42%)	2.34 (1.81)	3.41 (2.58)	2.12 (1.59)	$t(160) = 2.02^{\dagger}$
Past-Year Alcohol Use Frequency (0–6)	**174** (42%)	**1.33 (1.26)**	**2.12 (1.65)**	**1.21 (1.17)**	$\mathbf{t(161) = 2.21}^{*}$
% Past-2wk Binge Drinker status	**173** (42%)	**6%**	**41%**	**10%**	$\mathbf{\chi^2(1) = 12.33}^{***}$

	***N* (%)**	**All Participants (*N* = 414)**	**Stimulant Misuse (*n* = 33)**	**Non-Stimulant Misuse (*n* = 354)**	**Comparison between Misuse & Non-Misuse Groups**
Cannabis					
Lifetime Cannabis Use Frequency (0–6)	409 (99%)	0.84 (1.76)	1.36 (2.23)	0.78 (1.68)	$t(385) = 1.46$
Past-Year Cannabis Use Frequency (0–6)	106 (26%)	2.52 (2.14)	3.08 (2.15)	2.39 (2.11)	$t(99) = 1.06$
Cigarettes					
% Cigarette User Status	**407** (98%)	**10%**	**27%**	**9%**	$\mathbf{\chi^2(1) = 11.77}^{***}$

Note. Individuals with current or lifetime history of stimulant medication prescription ($n = 20$; 5% of full sample) were excluded from group comparison analyses. Significant group differences at $p < .05$ are highlighted in bold font.

$^{\dagger}p < .10$.

$^{*}p < .05$.

$^{**}p < .01$.

$^{***}p < .001$.