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# Psychostimulant use among college students during periods of high and low stress: An interdisciplinary approach utilizing both self-report and unobtrusive chemical sample data

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## HIGHLIGHTS

- Patterns of psychostimulant use over periods of high and low stress
- Self-report measures and chemical wastewater analysis compared
- Psychostimulant use increased during periods of higher academic stress.
- Predictors of lifetime non-prescriptive psychostimulant use investigated

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## ABSTRACT

This study quantified psychostimulant use patterns over periods of high and low stress from both self-report measures and chemical wastewater analyses and identified possible predictors of psychostimulant abuse on a college campus. Self-report data were collected at three times of varying stress levels throughout one college semester: during the first week of school ($N = 676$), midterms ($N = 468$), and shortly before final exams ($N = 400$). Campus wastewater samples were collected over 72-hour periods during the same time frames as the surveys. The metabolites of Adderall and Ritalin were quantified through solid phase extraction and liquid chromatography–tandem mass spectrometry (LC–MS/MS). Samples were normalized with creatinine. Evidence was found to suggest an increase in psychostimulant use during periods of stress, with significant differences found from self-report data between the first week and midterms and from chemical data between these same two assessment periods as well as between the first week of classes and finals. Key predictors of lifetime non-prescriptive psychostimulant use included self-reported procrastination and poor time-management, use of other substances (especially nicotine/tobacco, alcohol, and cocaine), and students' perception of non-prescriptive psychostimulant use as normative on campus. The findings shed further light on psychostimulant use patterns among college students, particularly as a function of stress; the study also highlights the benefit of utilizing an interdisciplinary approach that uses both subjective and objective empirical data. The results have implications for prevention/intervention programs on college campuses designed to reduce stress and facilitate healthier coping.



## 1. Introduction

The internal and external demands experienced by college students can create significant pressure to consistently perform at one's best. With these demands increasing over time, overall stress levels of college students have shown an increase from previous decades (Hudd et al., 2000; Pryor, Hurtado, DeAngelo, Palucki Blake, & Tran, 2011; Sax, 1997, 2003). More so than in previous decades, psychostimulant drugs that can help individuals focus and increase performance for hours at a time are easily obtained (DeSantis, Webb, & Noar, 2008; Substance Abuse and Mental Health Services Administration [SAMHSA], 2012). Popularly known as "Study Buddies" or "Smart Drugs," prescription drugs designed to treat attention-deficit hyperactivity disorder (ADHD) are now being used by some students as study aids to increase academic performance (Arria et al., 2008, 2012; Carroll, McLaughlin, & Blake, 2006; Farah et al., 2004; Robach, 2011).

There are two main classes of psychostimulant drugs: amphetamine-containing salts (e.g. Adderall and Vyvanse) and methylphenidate (e.g. Ritalin, Focalin, and Concerta). Dexamphetamine-based drugs are yet another class of psychostimulants, comprised of only the dextrorotary, or right-handed, stereoisomer (Dextroamphetamine

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& amphetamine, 2010). Amphetamine salts, methylphenidate compounds, and dexamphetamine-based drugs increase the neurotransmitters dopamine and noradrenaline by either stimulating their release or inhibiting their reuptake (Sulzer, Sonders, Poulsen, & Galli, 2005; Volkow et al., 2001). The increase of neurotransmitters boosts attention, focus, learning, and impulse control.

Whether prescribed by a doctor or bought from a friend, psychostimulant drugs are easy to obtain free of charge or for a price (DeSantis et al., 2008; Robach, 2011; SAMHSA, 2012). Easier access to pharmaceutical stimulants is due in part to the increased diagnosis of ADHD in the past decade, with a recent study reporting a 66% increase in diagnosis during physician outpatient visits from 2000 to 2010 (Garfield et al., 2012). Production of methylphenidate has also risen, showing an almost three-fold increase worldwide between 2000 and 2009 (International Narcotics Control Board, 2010). Even with increased diagnosis and production, individuals who misuse psychostimulants often obtain the pills illegally. On a college campus, students can buy the pills from friends or acquaintances who are prescribed the drug, with prices often increasing at high-stress periods such as midterms and finals (McCabe, Teter, & Boyd, 2006; Trudeau, 2009). Studies indicate that anywhere from 23 to 84% of students with psychostimulant prescriptions have been asked about selling, trading, or giving away their medication (Advokat, Guidry, & Martino, 2008; Boyd, McCabe, Cranford, & Young, 2007).

Although psychostimulants can be beneficial for individuals with ADHD when taken as prescribed, non-prescriptive use can have dangerous side effects and have high potential for abuse (Dextroamphetamine & amphetamine, 2010). Psychostimulants affect the sympathetic nervous system, increasing heart rate, blood pressure, and respiration. Over time, the increased activity of the sympathetic nervous system can lead to detrimental changes in cardiac function (Vetter et al., 2008). Bypassing a doctor's prescription also decreases awareness of potential risks and increases the likelihood of other problems associated with misuse. For example, studies indicate that psychostimulant misuse is associated with increased use of alcohol and other illicit substances, and individuals who misuse psychostimulants are more likely to misuse and combine use with other drugs, which may increase toxicity (Barrett, Darredeau, Bordy, & Pihl, 2005; McCabe & Teter, 2007; SAMHSA, 2009).

Surveys conducted at undergraduate universities indicate variable rates of psychostimulant use and misuse on college campuses. Low and Gendaszek (2002) reported a lifetime amphetamine use of over 35% for students from a small college, Babcock and Byrne (2000) found a lifetime methylphenidate use of more than 16% for students at a liberal arts college, and Teter, McCabe, Cranford, Boyd, and Guthrie (2005) reported a lifetime prescription stimulant use of over 8% from a random sample of undergraduate students. In a national survey of 119 four-year undergraduate institutions, McCabe, Knight, Teter, and Wechsler (2005) found a 6.9% lifetime illicit use of prescription stimulants and a 2.1% use in the past 30 days. Of the previous studies, none investigated the independent use of both methylphenidate and amphetamine in the same study; rather, the two were grouped together or only one of these compounds was studied. Despite differing percentages of lifetime use of amphetamine and methylphenidate, research indicates that college students are more than twice as likely to report non-prescriptive psychostimulant use than their counterparts in the general population (Kaye & Darke, 2012). Further, young adults aged 18–25 show a higher percentage of nonmedical use of psychotherapeutic drugs than youths aged 12–17 and adults aged 26 and older (SAMHSA, 2012). Such findings suggest a need for further research to clarify the rates of non-prescriptive use for both Adderall and Ritalin. Additional research is also needed to examine predictors of psychostimulant use and misuse, especially among college students.

Surveying and interviewing students can be a useful way to gather psychostimulant use data, but these methods can lead to underreporting (Del Boca & Noll, 2000; Harrell, Kapsak, Cisin, & Wirtz, 1997; Sloan, Bodapati, & Tucker, 2004). When paired with objective measures, however, self-report data can be a valuable complement, facilitating increased confidence in the obtained data, particularly when findings from both objective and subjective measures converge. When it comes to investigating substance use, one objective method that has been applied successfully involves the use of chemical wastewater sampling. Over the past few decades, sampling aquatic environments for illicit drug metabolites has been used increasingly, and this procedure has demonstrated utility in answering questions about human population substance abuse (Banta-Green et al., 2009; Castiglioni & Zuccato, 2011; Castiglioni et al., 2006; Van Nuijs et al., 2011). As with other substances for which this procedure has been applied, psychostimulants can be identified in wastewater from their known metabolites. The metabolite of Adderall is a combination of l-amphetamine and d-amphetamine, whereas Vyvanse is excreted specifically as d-amphetamine. Ritalin/Focalin/Concerta are excreted as α-phenyl-2-piperidine acetic acid, commonly known as ritalinic acid.

To investigate the use patterns of psychostimulants on a college campus, this study utilized both self-report measures of psychostimulant use as well as objective, chemical data derived from unobtrusive campus wastewater samples. For both types of methods, data were collected at three points throughout the semester that accounted for varying levels of stress: during the first week of classes (Time 1), midterms (Time 2), and shortly before final exams (Time 3). Results were compared between the self-report and wastewater sample data, and predictors of psychostimulant use were investigated.

## 2. Methods

### 2.1. Self-report data

The self-report measures consisted of three anonymous web-based surveys administered to undergraduate students at a private, liberal arts college in the Pacific Northwest with an undergraduate population of approximately 2600 students. Surveys were designed by the researchers but administered through the university's Office of Institutional Research. Students who completed the first survey at the start of the semester ($N = 627$ respondents) were eligible to take the second survey at midterms ($N = 468$) and the third survey shortly before final exams ($N = 400$). Participation was compensated by entries into a raffle to win an Apple iPad2. Given the inclusion of human participants, approval by the university's Institutional Review Board was obtained prior to conducting the surveys. The survey questions that were the focus of the present study were presented to participants in the context of a broader study of *Stress, Wellness, and Coping*, which included a variety of questions on respondents' subjective stress and the factors that they believe contribute to their stress, questions regarding the students' physical and mental health, and survey items on a wide variety of coping strategies (both healthy and unhealthy) that respondents have used in the past and/or that they use currently. Copies of the complete survey questions are available from the first author, upon request. Anonymity of the participants to the researchers was maintained by the Office of Institutional Research, which stripped the database of any identifying information (e.g., student identification numbers, which were used to link participant data across the three survey administrations and to identify the iPad2 raffle winner at the end of the study). This safeguard meant that it was impossible for researchers to identify participants who had completed the study.

#### 2.1.1. Sample demographics

The mean age of respondents was 20.14 ($SD = 2.04$), and all four class ranks were fairly equally represented (27.0% freshmen, 21.6% sophomores, 25.1% juniors, and 25.6% seniors). Consistent with the overall undergraduate population at this university, the majority of the sample was female (65.2%) and White (non-Hispanic; 80.3%); other races/ethnicities represented included Hispanic (5.9%), Asian (5.3%), and Mixed Race (6.7%). Less than 1% of the sample was