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Not just heroin: Extensive polysubstance use among US high school seniors who currently use heroin

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Abstract

Background: Heroin-related deaths are on the rise in the US and a large portion of heroin overdoses involve couse of other drugs such as benzodiazepines. A better understanding of heroin polysubstance use patterns could help discern better prevention measures.

Methods: Data were examined from past-month ("current") heroin users from a nationally representative sample of high school seniors in the Monitoring the Future study (2010–2016, n = 327). We examined how past-month use and frequency of use of various drugs relate to frequency of current heroin use using chi-square and multivariable ordinal logistic regression.

Results: Prevalence of any past-month use of various other drugs (and past-month use 10+ times) tends to increase as the frequency of heroin use increases; however, other drug use tends to decline among those reporting the use of heroin 40+ times in the past month. In multivariable models controlling for demographic characteristics, most levels of alcohol use were associated with decreased odds of higher-frequency heroin use (ps < .05). Nonmedical opioid (aOR = 5.84, p = .037) and tranquilizer (aOR = 14.63, p = .045) use 40+ times in the past month were associated with increased odds of higher-frequency heroin use.

Conclusions: High school seniors who use heroin also use multiple other drugs. Increases in the frequency of heroin use are associated with shifts in the nature and frequency of polysubstance use, with a higher frequency of heroin use associated with the highest percentage and frequency of use of depressants (nonmedical opioid and benzodiazepine use), compounding the risk of

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Contributors

All authors are responsible for this reported research. JP conceptualized and designed the study and conducted the statistical analyses. JP, PMG, and AL drafted the initial manuscript, interpreted results, and critically reviewed and revised the manuscript. All authors approved the final manuscript as submitted.

Conflict of interest

No conflict declared.

overdose. Prevention measures should consider polysubstance use patterns among heroin-using adolescents.

Keywords

Heroin; Polysubstance use; Benzodiazepines; Adolescents

1. Introduction

Heroin use has risen in the United States (US), with the prevalence of past-year use having more than doubled between 2002 and 2016 (Center for Behavioral Health Statistics and Quality, 2017). This increase has been rather marked in recent years despite a decrease in the nonmedical use of prescription opioids (Dart et al., 2015). In 2016, an estimated half-million Americans aged 12 or older were current heroin users (defined as having used in the past month) (Center for Behavioral Health Statistics and Quality, 2017), and over 15,000 heroin-related deaths were reported—a five-fold increase since 2010 (Centers for Disease Control and Prevention, 2017a). Heroin use is also associated with high rates of dependence, increased likelihood of transmission of HIV or HCV, and social marginalization (Brown, 2015; Hser et al., 2015; Zhou et al., 2015), making heroin among the most dangerous of illegal drugs.

A significant body of literature demonstrates a strong link between nonmedical use of opioids and heroin use, and research suggests that nonmedical prescription opioid users in particular—especially frequent users—are at high risk for heroin use (Cerdá et al., 2015; Jones et al., 2015; Mateu-Gelabert et al., 2015; Palamar and Shearston, 2017; Surratt et al., 2017). The incidence of heroin initiation, for example, was found to be 19 times greater among those who reported prior nonmedical opioid use than those who did not (Muhuri et al., 2013), and prescription opioid abuse and dependence is strongly related to heroin abuse or dependence as well (Jones et al., 2015).

While the relationship between nonmedical prescription opioid use and heroin use has been investigated extensively, fewer recent epidemiologic studies have examined potential links between heroin use and the use of other drugs. Benzodiazepines, for example, are now commonly co-used with heroin (Mateu-Gelabert et al., 2017), and are involved in approximately a quarter (23%) of heroin-related overdose deaths in the US (Centers for Disease Control and Prevention, 2017b). Concurrent use of various types of other sedatives, such as barbiturates, is also prevalent among current heroin users (Moses et al., 2018), while current marijuana use appears to be lower among heroin users than primary users of cocaine or methamphetamine (Brecht et al., 2008). Furthermore, past studies have found a positive association between cocaine use and heroin use (Brecht et al., 2008; Leri et al., 2003; Leri et al., 2005; Wang et al., 2017), attributable, in part, to the co-use of heroin and cocaine in the form of “speedball”, or sequential use of cocaine after heroin use to enhance euphoria and/or reduce withdrawal symptoms (Leri et al., 2003). In contrast, an inverse relationship between concurrent alcohol and heroin use has been observed (Anglin et al., 1989; Brecht et al., 2008; Wang et al., 2017). Nevertheless, polysubstance use remains an important problem among users of heroin.

Insofar as patterns or trajectories of heroin use are related to use of other drugs, then, it may be inadequate to tackle heroin-related problems in isolation. Rather, it may prove beneficial to consider users' overall drug use profiles, in part because concurrent use with other drugs can exacerbate the dangers and adverse health effects associated with heroin use (Coffin et al., 2003; Jones et al., 2012; Meacham et al., 2015; Verdejo-Garcia et al., 2007), and because polysubstance use, in general, is an established risk factor for overdose death (Jones et al., 2013; Warner et al., 2009). Indeed, over half (59%) of heroin-related overdose deaths in the US involve at least one other drug (Jones et al., 2015). Notably, researchers have documented high rates of poly-substance use among adolescents that use heroin (Gandhi et al., 2006; Hopfer et al., 2002; Motamed et al., 2008). Furthermore, adolescents using heroin may be quicker to transition from initial use to dependence when compared with heroin users who initiated during adulthood (Mills et al., 2004). Therefore, this young demographic may represent an important and potentially understudied subpopulation as it relates to current heroin and polysubstance use.

In short, heroin use is becoming more of a public health threat in the US. Heroin users are increasingly reporting abuse of or dependence on other substances, and many heroin-related deaths now involve co-use of other drugs. It is thus important to investigate the extent and patterns of current use of other drugs among current heroin users in order to inform appropriate prevention, intervention, and harm reduction strategies. To this end, we analyze data from a nationally representative sample of high school seniors to better understand how use and frequency of use of other drugs relate to the frequency of current heroin use, which can serve as an indicator for severity of use.

2. Methods

2.1. Procedure

Monitoring the Future (MTF) is a nationally representative cross-sectional study of high school seniors. Approximately 15,000 are surveyed each year from approximately 130 public and private schools throughout 48 states. A multi-stage random sampling procedure is used; geographic areas are selected, then schools within, and then classes within schools are selected. Since the main outcome (past-month heroin use) was rare, these analyses focused on aggregated data collected from the seven most recent cohorts (2010–2016). MTF protocols were approved by the University of Michigan Institutional Review Board (IRB), and the authors' IRB deemed this secondary analysis exempt from review.

2.2. Demographic variables

Students reported their age (predefined as < 18, ≥18 years), sex, and race/ethnicity (i.e., black, white, Hispanic). Students were also asked about the level of educational attainment of each parent and answer options were 1) grade school, 2) some high school, 3) high school graduate, 4) some college, 5) college graduate, and 6) graduate school. We recoded responses to indicate the highest level of education completed by either parent (as applicable) as an indicator of socioeconomic status. Students were also asked whether their mother (or female guardian) and/or father (or male guardian) resides with them in their household and we recoded responses into residing with 1) no parents, 2) one parent, and 3)

two parents. Students were asked how much money they earn during the average week from 1) a job or other work, and 2) from other sources. We recoded responses into 1) $0, 2) $1–125, and 3) > $125 for each variable. MTF also categorized population density of students as non-metropolitan statistical area (non-MSA), small MSA, or large MSA.

2.3. Drug use

Students were asked about past-month use of various drugs including heroin, alcohol, marijuana, LSD, other psychedelics, powder cocaine, crack, ecstasy (MDMA, Molly), nonmedical use of amphetamine (or other prescription stimulants; e.g., Adderall, Ritalin), sedatives (e.g., phenobarbital, Nembutal), tranquilizers (e.g., Valium, Xanax), and opioids (e.g., Vicodin, OxyContin). Nonmedical use was defined as using a prescription drug on one's own without a doctor telling one to use it. Answer options for each drug were use on 1) 0 occasions, 2) 1–2 occasions, 3) 3–5 occasions, 4) 6–9 occasions, 5) 10–19 occasions, 6) 20–39 occasions, and 7) 40+ occasions. After extensive sensitivity analyses we collapsed responses into 1) 0 occasions (for drugs other than heroin), 2) 1–2 occasions, 3) 3–9 occasions, 4) 10–39 occasions, and 5) 40+ occasions.

2.4. Analyses

Analyses focused on the 327 students who reported past-month ("current") heroin use out of the full sample (N = 92,242), although we first compared demographic and other drug use characteristics between the analytic sample of current heroin users and the full MTF sample. For survey year, we also examined whether a linear trend was present regarding the prevalence of past-month heroin use. This was done by estimating the odds of past-month use as a linear function of time (year) as a continuous predictor. We then examined how demographic characteristics and survey year differ according to the frequency of heroin use using chi-square. Similar analyses were conducted to examine potential differences in frequency of heroin use according to 1) any past-month use of any other drug, and 2) use of any other drug 10+ times in the past month. Sensitivity tests suggested 10+ times as the optimal cutoff as the use of some drugs was too infrequent to cut-off at 20+ or 40+ times.

We then examined associations between frequency of heroin use and frequency of use of other drugs. Specifically, we first determined whether the frequency of use of any of the 11 other drugs was significantly related to the frequency of heroin use in separate bivariable ordinal regression models. Drug frequency variables that were significant were then fit into a multivariable model simultaneously, controlling for survey year and demographic covariates determined to be significantly related to the frequency of heroin use via chi-square. Aside from controlling for a potential cohort or secular trends in use in these models, missing data indicators were entered into the multivariable model for demographic variables with missing data in order to prevent casewise deletion of these cases. For example, MTF does not provide race/ethnicity data on students other than those identifying as white, black, or Hispanic, so the 24.5% with missing data were accounted for in the models by including an indicator for a fourth level of the variable (Palamar et al., 2016; Terry-McElrath et al., 2015; Terry-McElrath et al., 2017). Analyses were design-based for survey data (Heeringa et al., 2010) and sample weights were utilized. Stata 13 SE (StataCorp, 2013) software was used for all analyses.

3. Results

Less than 1 out of 100 (0.4%) students in the full sample reported past-month heroin use (N = 327). Prevalence of current heroin use decreased from 0.4% in 2010 to 0.2% in 2016. While differences in prevalence by year was not significant in a chi-square test (p = 0.197), it should be noted that a test for linear trend was, in fact, significant (p = .029), suggesting a downward linear trend. Of current users, a third (33.8%) reported using 1–2 times in the past month, 27.3% reported using 3–9 times, 18.7% reported using 10–39 times, and a fifth (20.3%) reported using 40+ times.

Table 1 presents characteristics of the heroin-using sample in comparison to the full MTF sample. Older students, males, black students, students earning more money per week (either from a job and other sources), and students residing with fewer parents and/or parents with lower education were more likely to report current heroin use (ps < 0.001). However, it should be noted that within heroin users, the majority were still white (51.5%) and relative majorities resided with two parents (42.1%) and have a parent with a college degree or higher (43.7%). The use of each of the 11 drugs examined was each more prevalent among heroin users (ps < 0.001). As shown in Table 2, the percentage of female users tended to decrease as the frequency of heroin use increased (ps = 0.0367). There were also significant differences regarding age (p = 0.0232), race/ethnicity (p = 0.0017), weekly income from job (p = 0.0447), and number of parents at home (p = 0.0366), but no clear pattern associated with frequency of heroin use emerged. Frequent heroin use (40+ times in the past month) was most common among older students (68.2%), males (83.8%), students of parents with a high school education or some college (46.0%), and those with no weekly income from a job (47.3%). Black students (45.5%) were more likely than White or Hispanic students to report using 40+ times, and white students (65.4%) were more likely to report using 1–2 times.

Table 3 presents other drug use according to the frequency of heroin use. On average, students used 5.24 drugs other than heroin in the past month. Prevalence of any past-month use of most drugs examined (including total number used) tended to increase as the frequency of heroin use increased, and then prevalence dipped substantially among those reporting heroin use 40+ times in the past month. In fact, the frequency of use of six drugs dropped by half or more between those reporting using heroin 10–39 times and 40+ times. Similarly, the frequency of use of eight drugs used 10+ times dropped by half or more between those reporting using heroin 10–39 times and 40+ times.

We then examined how the frequency of use of other drugs related to the frequency of heroin use as an outcome variable using ordinal logistic regression. As is shown in Table 4, the frequency of use of alcohol, opioids, tranquilizers, marijuana, LSD, and other psychedelics were all significantly related to the frequency of heroin use. Low-frequency LSD use and both low- and high-frequency alcohol and marijuana use were associated with decreases in odds of a higher frequency heroin use in bivariable models. Low-frequency tranquilizer use was associated with decreased odds of a higher frequency of heroin use, but higher-frequency tranquilizer use was associated with higher odds of higher frequency heroin use. Higher frequency use of opioids and other psychedelics were also associated with higher odds of higher frequency of heroin use. When controlling for significant demographics in

bivariable models (i.e., sex, age, race/ethnicity, income from job, number of parents) and survey year, only three of these six frequency covariates remained significant. Specifically, most frequencies of alcohol use (compared to no use) were associated with decreases in odds of higher frequency of heroin use (with alcohol use 40+ times approaching significance [$p = 0.051$]). Using prescription opioid pills (aOR = 5.84, $p = 0.037$) and tranquilizers (aOR = 14.63, $p = 0.045$) (nonmedically) 40+ times was associated with increased odds of higher frequency heroin use. It should be noted that we conducted a sensitivity test also controlling for parent education and results were nearly identical.

4. Discussion

Heroin use is becoming more of a public health threat, and nearly three out five of heroin-related deaths involve co-use of other drugs as well (Jones et al., 2015). Consequently, it is important to investigate the extent and patterns of use of other drugs among current heroin users in order to inform appropriate prevention, intervention, and harm reduction strategies. We examined self-reported polysubstance use among current heroin users in a nationally representative sample of high school seniors to better understand how the use of other drugs relates to frequency of current heroin use.

In terms of sociodemographic factors, the results present two coexisting patterns: the largest proportions of current heroin users (within the analytic sample) appear to be from higher socioeconomic status (e.g., white, two-parent households, parents with college degrees), yet heroin use, historically, affects disproportionally those from lower socioeconomic status (e.g., African Americans, individuals emancipated or living in a one parent household, parents with less than a high school education) (Brown, 2004; Cicero et al., 2014). When compared to the overall sample of high school seniors, however, disparities emerge. Specifically, heroin users are more likely to identify as black (31.2% vs. 14.8% black non-users), reside without their parents (33.9% vs. 6.2% of non-users), and have parents with less than a high school diploma (21.3% vs. 9.0% of non-users) than their respective demographic counterparts from the full sample.

The large proportion of white students reporting heroin use within the analytic sample may indicate that heroin use among youth is expanding across races and ethnicities in a manner paralleling that of the general population. For example, whereas previous generations of heroin users in the US comprised a nearly equal ratio of white to nonwhite, the current generation is comprised predominantly of white users (Cicero et al., 2014). To a fair extent, this may be reasonably attributed to the ongoing opioid epidemic in that the rates of transition from prescription opioids to heroin have significantly risen in recent years (Cicero et al., 2015), and that nonmedical users of prescription opioids are more likely to have been white and employed (Fischer et al., 2009; Rigg and Monnat, 2015). Our findings also include non-significant but notable differences in heroin use across localities of different densities that may be similarly indicative of an expansion of heroin use from urban areas to rural and suburban populations, which has been reported in previous studies as well (Cicero et al., 2014; Rigg and Monnat, 2015). When taken together, these results holistically suggest that heroin use affects adolescents of all socioeconomic statuses while disproportionally affecting those groups that are more vulnerable.

An important aspect of our study was the focus on past-month ("current") use of drugs, and we found that high school seniors who use heroin also commonly engage in the concurrent use of multiple other drugs. In fact, we found that current heroin users are concurrently using five other drugs on average. Such results suggest that it may be apt to reframe our understanding of the opioid epidemic towards one that regards problems of opioid use in tandem with polysubstance use. For example, although there has been much discourse surrounding the transition from prescription opioid use to heroin use (e.g., in the media), it may be equally, if not more, important to consider that those heroin users also tend to use an expansive repertoire of other drugs. While this analytic sample was small and limited to high school seniors, more research is needed to determine the extent to which use of various other drugs affects the likelihood of nonmedical opioid users potentially progressing to heroin use.

Moreover, results suggest the nature of polysubstance use seems to differ depending on the frequency of current heroin use. For instance, it was observed that concurrent use of multiple drugs increases as the frequency of current heroin use increases. That is to say, high school seniors who use heroin more often also report using several other drugs more frequently. Notably, the frequency of concurrent use of most drugs becomes markedly high among those students who reported using heroin 10–39 times in the past month. This parallel spike in the frequency of use of other drugs with a higher frequency of heroin use further supports the notion that young heroin users may be facing a polysubstance use challenge.

However, an equally important finding was that a stark reversal in this trend is observed among students who reported the highest frequency of current heroin use. Specifically, those who reported using heroin 40 or more times in the past-month reported significantly less concurrent use of other drugs, both in terms of number of drugs and frequency of use. We hypothesize that this across-the-board drop in use of all other drugs may be attributable to the increased costs and needs associated with such high levels of heroin use. For example, high-frequency heroin use may be indicative of a stronger current opioid dependency that would require more frequent or habitual heroin intake to evade withdrawal. The costs associated with such high levels of use, monetary or otherwise, may prove to be substantial and preclude heroin users from using other drugs in deference to the increasingly demanding needs of opioid dependence.

Notwithstanding the general reduction of polysubstance use among the most frequent of heroin users, multivariable analyses provide further, more granular insights showing that the concurrent use of some drugs remains at significant levels. Specifically, results suggest that the highest frequency heroin users were still more likely to frequently use depressants, including other opioids and tranquilizers. Among heroin users, use of other opioids was expected, given the strong and well-researched link between prescription opioids and heroin (Cicero et al., 2015; Cicero et al., 2014). The use of tranquilizers, such as benzodiazepines, has also been corroborated as common in several Australian studies among heroin users with opioid dependence (Darke, 1994; Darke et al., 2010; Ross and Darke, 2000; Ross et al., 1996, 1997). Although further studies generalizable to the American population would be ideal, one recent New York City study found benzodiazepine use to be common and often used concurrently in conjunction with nonmedical prescription opioid and/or heroin use (Mateu-Gelabert et al., 2017). A potential explanation is that benzodiazepines can augment

the rewarding and reinforcing effects of opioids (Walker and Ettenberg, 2001), and heroin users have, indeed, reported that the intensity and duration of the heroin high were extended with the addition of flurazepam (Jones et al., 2012).

Finally, alcohol was one of the most common drugs consumed in this current heroin-using sample, but the prevalence of use tended to decrease (relative to some other drugs) as the frequency of heroin use increased. In our multivariable model, we found that most levels of alcohol use were associated with lower odds of frequent heroin use, which is in accordance with previous studies that have demonstrated a robust, inverse relationship between current use of these two substances (Anglin et al., 1989; Brecht et al., 2008; Valdez et al., 2008). So while prevalence of alcohol use was still high across levels of heroin use, this decrease might be explained by an the avoidance of alcohol by some more frequent heroin users as use significantly increases risk for fatal outcomes when both substances are used (Caupp et al., 2018; Darke et al., 1997; Polettini et al., 1999). Indeed, it has been reported that the majority of heroin-related overdose deaths have involved the presence of alcohol (Darke, 2016; Meissner et al., 2002), and alcohol has been shown to be a risk factor for heroin-related overdose (Darke, 2016).

Overall, the “drug selection process” demonstrated by the most frequent of heroin-using high school seniors supports the aforementioned hypothesis that heroin dependency is what drives polysubstance use patterns towards one that satisfies dependency by either supplementing opioid intake with prescription opioids, or resorting to benzodiazepines as a means of enhancing the opioid high and/or preventing withdrawal. We reported similar results in a separate study (Mateu-Gelabert et al. 2017).

4.1. Limitations

The MTF survey does not assess students who dropped out of high school, nor does it include those who were absent during survey administration, which may affect the generalizability of findings. While taken from a nationally representative sample, current heroin use was so rare that the analytic sample was still relatively small and likely not representative of all adolescent heroin users in the US. Prevalence of current use decreased over time; however, we controlled for the year in the multivariable model. Missing data were also problematic. While we used case-complete data for bivariable tests, missing data indicators were included in the multivariable model to limit casewise deletion. MTF did not query abuse or dependence of drug use. Finally, since this study was cross-sectional, we were unable to deduce temporal associations between frequency of use of heroin and use of other drugs.

4.2. Conclusions

Ultimately, our study found that current heroin use among high school seniors in the US captures part of a problem that appears to affect all socioeconomic levels and that concurrent use with multiple other drugs is common. Increases in the frequency of heroin use are associated with changes in the nature and frequency of polysubstance use, with higher frequency heroin use being associated with a greater percentage and frequency of nonmedical use of other opioids and benzodiazepines in a manner that may be dictated by an

opioid dependency. However, further research is needed to determine how frequency of use of other drugs relates to diagnosed dependency or severity of dependency. Because the combination of these drugs greatly compounds the risk of overdose and other adverse health outcomes, preventative measures and harm reduction policies geared towards heroin-using adolescents should appropriately consider the overall polysubstance use profile commonly exhibited by this population.

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Table 1

Sample characteristics.

	Full Sample (*N* = 92,242), %	Current Heroin Users (*N* = 327), %
Age		
< 18	42.5	30.8
> 18	57.5	69.2
Sex		
Male	49.0	74.4
Female	51.0	25.6
Race		
White	66.9	51.5
Black	14.8	31.2
Hispanic	18.3	17.3
Number of Parents at Home		
0 parents	6.2	33.9
1 parent	27.9	24.0
2 parents	65.9	42.1
Parent Education		
Less than High School	9.0	21.3
High School Diploma or Some College	39.1	35.1
College Degree or Higher	51.9	43.7
Weekly Income from Job		
$0	44.8	33.1
$1–125	34.6	35.7
> $125	20.6	31.1
Weekly Income from Other Sources		
$0	45.1	28.7
$1–125	50.8	48.2
> $125	4.1	23.1
Population Density		
Non-MSA	20.2	16.4

	Full Sample (*N* = 92,242), %	Current Heroin Users (*N* = 327), %
Small MSA	49.4	48.8
Large MSA	30.4	34.8
Lifetime Drug Use		
Alcohol	67.3	90.0
Marijuana	44.6	88.9
LSD	4.0	57.8
Other Psychedelics	6.2	64.9
Amphetamine (nonmedical)	11.5	73.1
Sedatives (nonmedical)	6.7	64.6
Tranquilizers (nonmedical)	7.9	69.4
Opioids (nonmedical)	10.8	76.7
Powder Cocaine	4.2	76.7
Crack	1.9	63.0
Ecstasy	6.5	80.9

Note. All comparisons were made using chi-square and all comparisons were statistically significant ($p < .001$) other than metropolitan statistical area (MSA) ($p = .188$). Percentages represent valid percentages, which exclude missing data.

Table 2

Sample characteristics according to frequency of current heroin use (N = 327).

	1–2 times (n = 102), %	3–9 times (n = 101), %	10–39 times (n = 61), %	40+ times (n = 63), %	P
Age					0.0232
< 18	41.6	19.5	26.1	31.8	
> 18	58.4	80.5	73.9	68.2	
Sex					0.0367
Male	66.5	69.6	84.9	83.8	
Female	33.5	30.4	15.1	16.2	
Race					0.0017
White	65.4	51.7	37.6	41.9	
Black	28.0	29.9	23.0	45.5	
Hispanic	6.6	18.4	39.4	12.6	
Number of Parents at Home					0.0366
0 parents	24.9	47.1	32.9	32.0	
1 parent	21.2	23.7	17.8	35.1	
2 parents	54.1	29.2	49.2	32.9	
Parent Education					0.3351
Less than High School	19.5	26.3	21.3	17.1	
High School Diploma or Some College	26.8	33.9	41.1	46.0	
College Degree or Higher	53.7	39.8	37.7	37.0	
Weekly Income from Job					0.0447
$0	34.9	29.9	19.8	47.3	
$1–125	30.3	49.2	40.0	21.6	
> $125	34.8	21.0	40.1	31.2	
Weekly Income from Other Sources					0.3508
$0	38.7	26.6	21.8	20.5	
$1–125	44.6	51.9	46.5	50.6	
> $125	16.7	21.5	31.7	28.9	
Population Density					0.2472
Non-MSA	19.0	13.6	21.4	11.1	

	1–2 times (n = 102), %	3–9 times (n = 101), %	10–39 times (n = 61), %	40+ times (n = 63), %	P
Small MSA	51.8	47.4	34.5	58.8	
Large MSA	29.2	39.0	44.1	30.1	

Note. All comparisons were made using chi-square. Parent education was coded as the highest level of education reported by either parent, as applicable. Valid percentages are presented which exclude missing data. A quarter (24.5%) of race/ethnicity responses were not provided by MTF as they only provide data on those identifying as white, black, or Hispanic. Parent education (11.0%), sex (11.3%), income from job (14.5%), income from other sources (15.5%), and number of parents (5.9%) were also missing data. MSA = metropolitan statistical area.

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Table 3

Frequency of other drug use according to frequency of current heroin use (N = 327).

Any Past-Month Use	Full Sample, %	1–2 times (n = 102), %	3–9 times (n = 101), %	10–39 times (n = 61), %	40+ times (n = 63), %	P
Number Used - Mean (SE)	5.24 (0.19)	5.27 (0.32)	5.82 (0.32)	6.20 (0.34)	3.46 (0 .51)	0.0001
Alcohol	81.4	88.0	89.2	87.2	51.6	< 0.0001
Marijuana	77.1	84.9	78.0	80.6	57.8	0.0077
LSD	46.5	50.5	53.4	60.6	18.8	0.0022
Other Psychedelics	49.1	40.3	55.6	76.6	31.4	0.0012
Amphetamine (nonmedical)	55.4	55.0	57.4	72.7	37.2	0.0240
Sedatives (nonmedical)	55.0	50.0	62.3	74.5	35.5	0.0019
Tranquilizers (nonmedical)	58.6	60.2	66.7	73.1	30.4	0.0002
Opioids (nonmedical)	63.6	52.4	70.8	86.9	52.3	0.0006
Powder Cocaine	62.7	58.0	74.2	75.7	50.2	0.1695
Crack	50.0	42.8	60.0	68.5	33.4	0.0077
Ecstasy	61.1	62.0	63.6	50.6	62.1	0.9271
Used 10+ in Past Month	Full Sample, %	1–2 times (n = 102), %	3–9 times (n = 101), %	10–39 times (n = 61), %	40+ times (n = 63), %	P
Alcohol	38.7	39.8	45.0	48.6	18.6	0.0657
Marijuana	45.4	49.3	49.3	55.6	23.9	0.0291
LSD	12.7	13.1	11.3	22.4	6.5	0.3704
Other Psychedelics	13.9	6.2	11.3	31.5	14.4	0.0293
Amphetamine (nonmedical)	17.0	18.0	8.4	31.4	13.5	0.1121
Sedatives (nonmedical)	10.8	5.5	7.1	29.7	6.6	0.0007
Tranquilizers (nonmedical)	12.2	6.0	5.0	28.8	17.5	0.0004
Opioids (nonmedical)	18.0	10.4	9.5	38.6	23.8	0.0007
Powder Cocaine	16.0	14.6	24.6	21.7	4.9	0.1874
Crack	17.4	12.0	10.7	36.5	18.3	0.0104
Ecstasy	10.6	2.0	17.1	14.2	17.0	0.1752

Note. Comparisons were made using chi-square with exception of number of drugs used, which in which we generated means and tested differences using linear regression. Powder cocaine and ecstasy were only queried on four out of six survey forms and these variables were missing 46.1% and 33.9% of data, respectively. In addition, alcohol (25.0%), LSD (21.3%), marijuana (19.8%), other psychedelics (18.3%), crack (17.3%), opioids (10.4%), amphetamine (7.9%), sedatives (6.2%), and tranquilizers (4.8%) were also missing data. SE = standard error.

Table 4

Ordinal regression models examining associations between frequency of other drug use and frequency of heroin use (N = 327).

	Bivariable Models		Multivariable Model	
	aOR	**(95% CI)**	**aOR**	**(95% CI)**
Alcohol				
0 times	1.00		1.00	
1–2 times	0.23**	(0.08, 0.68)	0.21*	(0.06, 0.79)
3–9 times	0.24**	(0.09, 0.68)	0.19*	(0.04, 0.89)
10–39 times	0.24**	(0.09, 0.64)	0.16**	(0.04, 0.63)
40+ times	0.26*	(0.08, 0.87)	0.15	(0.02, 1.00)
Opioids (nonmedical)				
0 times	1.00		1.00	
1–2 times	1.01	(0.36, 2.84)	0.58	(0.16, 2.14)
3–9 times	1.26	(0.68, 2.32)	1.73	(0.58, 5.10)
10–39 times	2.00	(0.86, 4.61)	0.78	(0.14, 4.48)
40+ times	8.58**	(2.42, 30.50)	5.84*	(1.11, 30.81)
Tranquilizers (nonmedical)				
0 times	1.00		1.00	
1–2 times	0.29**	(0.14, 0.59)	0.64	(0.22, 1.89)
3–9 times	0.55	(0.30, 1.04)	0.43	(0.13, 1.41)
10–39 times	1.44	(0.68, 3.08)	0.57	(0.09, 3.54)
40+ times	11.24**	(2.18, 57.90)	14.63*	(1.07, 200.59)
Marijuana				
0 times	1.00		1.00	
1–2 times	0.26*	(0.09, 0.78)	0.35	(0.08, 1.58)
3–9 times	0.55	(0.24, 1.31)	0.46	(0.13, 1.64)
10–39 times	0.41*	(0.20, 0.84)	0.68	(0.21, 2.14)
40+ times	0.37*	(0.17, 0.83)	0.73	(0.24, 2.22)
LSD				
0 times	1.00		1.00	
1–2 times	0.35*	(0.13, 0.94)	0.31	(0.07, 1.34)
3–9 times	0.94	(0.44, 1.99)	1.64	(0.28, 9.65)
10–39 times	0.77	(0.36, 1.65)	0.70	(0.13, 3.65)
40+ times	1.80	(0.87, 3.70)	0.89	(0.17, 4.60)
Other Psychedelics				
0 times	1.00		1.00	
1–2 times	0.85	(0.41, 1.76)	0.75	(0.12, 4.69)
3–9 times	0.89	(0.46, 1.74)	1.53	(0.35, 6.69)
10–39 times	2.46**	(1.26, 4.80)	2.49	(0.35, 17.69)

	Bivariable Models		Multivariable Model	
	aOR	**(95% CI)**	**aOR**	**(95% CI)**
40+ times	1.44	(0.31, 6.78)	0.58	(0.04, 8.24)
Sedatives				
0 times	1.00			
1–2 times	0.63	(0.28, 1.41)		
3–9 times	0.90	(0.49, 1.66)		
10–39 times	1.38	(0.63, 3.02)		
40+ times	2.93	(0.75, 11.37)		
Amphetamine (nonmedical)				
0 times	1.00			
1–2 times	0.61	(0.31, 1.20)		
3–9 times	0.96	(0.50, 1.82)		
10–39 times	0.74	(0.30, 1.84)		
40+ times	3.39	(0.31, 37.32)		
Powder Cocaine				
0 times	1.00			
1–2 times	0.53	(0.18, 1.58)		
3–9 times	1.78	(0.81, 3.93)		
10–39 times	0.83	(0.28, 2.49)		
40+ times	0.87	(0.22, 3.48)		
Crack				
0 times	1.00			
1–2 times	0.59	(0.23, 1.51)		
3–9 times	0.96	(0.53, 1.73)		
10–39 times	1.79	(0.96, 3.32)		
40+ times	1.56	(0.45, 5.35)		
Ecstasy				
0 times	1.00			
1–2 times	0.57	(0.09, 3.76)		
3–9 times	0.80	(0.26, 2.47)		
10–39 times	1.58	(0.45, 5.51)		
40+ times	3.50 †	(1.14, 10.72)		

Note. Bivariable ordinal regression models for each drug were calculated separately with no adjustments. The six significant frequency variables were then fit simultaneously into the multivariable model controlling for survey year, sex, age, race/ethnicity, income from job, and number of parents. Missing data indicators were included in this model for sex, age, race/ethnicity, income from job, and number of parents, to prevent casewise deletion. Specifically, an extra level of each covariate was included. While results of these demographics are consistent (regarding direction and significance) to bivariable tests presented, we chose only to present our estimates on drug use which contained missing data indicators. aOR = adjusted odds ratio; CI = confidence interval.

† The model utilizing ecstasy frequency as the independent variable was not significant (P = .165).

* $p < 0.05$,

** $p < 0.01$.