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Nonmedical Opioid Use in Relation to Recency of Heroin Use in a Nationally Representative Sample of Adults in the United States

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Abstract

Nonmedical opioid use has been linked to lifetime heroin use; however, research is needed to examine associations between nonmedical opioid use and current or recent heroin use, as current users appear to be at highest risk for harm. Data were from a nationally representative sample of non-institutionalized adults (age 18–64) in households participating in the National Survey of Drug Use and Health who reported lifetime heroin use (2005–2014, $N = 7,111$). We examined associations between frequency and recency of nonmedical opioid use and recency of heroin use. Most (86.7%) lifetime heroin users reported no heroin use in the last 12 months, while 6.1% reported current use (use in the last 30 days). The majority of the sample (69.3%) reported lifetime nonmedical opioid use; 14.3% reported nonmedical use in the last 30 days. Adjusted odds for current heroin use increased as frequency of past-year nonmedical opioid use increased, with a quarter (24.7%) of current heroin users reporting nonmedical opioid use on 157–365 days in the last year. Over half (54.7%) of current heroin users reported current nonmedical opioid use. Prevention efforts should consider that high-frequency and current nonmedical opioid use is a robust correlate of continued heroin use.

Keywords

Analgesics; heroin; nonmedical drug use; opioids

Nonmedical use of prescription opioids (using analgesics, narcotics, painkillers in a non-prescribed manner) has become a major public health issue in the U.S., in part because it appears to increase risk for heroin use (Cerdá et al. 2015; Palamar et al. 2016). While links between these drugs are still being examined, additional studies examining frequency and recency of nonmedical opioid use and heroin use are needed in order to continue to inform policy, prevention, interventions, and treatment.

In 2014, an estimated 4.3 million individuals (age 12 or older) in the U.S. (1.6% of the population) reported nonmedical use of opioids in the past 30 days (Center for Behavioral Health Statistics and Quality [CBHSQ] 2015) and, in 2013, an estimated 169,000 individuals initiated use of heroin—an increase from the estimated 156,000 initiates the previous year (Lipari and Hughes 2015). Results from the National Survey on Drug Use and Health (NSDUH) suggest a recent increase in past-month heroin use, with approximately 435,000 individuals using the substance—a 100% increase from the prevalence in 2002–2013 (CBHSQ 2015). Additionally, rates of hospitalization due to opioid “overuse” have increased dramatically from 1993 to 2012, growing from 116.7 inpatient stays per 100,000 to 295.6, a cumulative increase of 153% (Owens et al. 2014). Alarming increases have also been noted for overdose deaths due to opioid use, including both pain relievers and heroin, with the Centers for Disease Control and Prevention (CDC) identifying a 14% increase, up from 7.9 overdose deaths per 100,000 in 2013 to 9.0 per 100,000 in 2014 (Rudd et al. 2016).

Research has found that heroin use is associated with nonmedical opioid use (Banerjee et al. 2016), with qualitative work suggesting that nonmedical opioid users may transition to heroin because it is cheaper and easier to access (Cicero et al. 2014). Analysis of NSDUH data from 2004–2011 by Cerdá et al. (2015) found that youth who had reported using prescription opioids nonmedically had a 13 times’ greater hazard of initiating heroin use as compared to youth who did not report nonmedical opioid use. Other previous research has found that past-30-day nonmedical opioid use was a risk factor for heroin use among high school seniors in the 2009–2013 years of the Monitoring the Future annual representative survey (Palamar et al. 2016). In this sample of high school seniors, nearly a quarter (23.2%) of those who had reported nonmedical use of opioids 40 times in their lifetime also reported using heroin in their lifetime.

While more research on order of drug initiation is needed, further determining how frequency of nonmedical opioid use is associated with heroin use may assist with developing interventions targeted precisely at those nonmedical opioid users at highest risk for transitioning to heroin use. Researchers have begun to delineate such associations through analysis of various cohorts of the NSDUH. Martins et al. (2015) found that odds of past-year heroin use were much greater for respondents who reported using opioids nonmedically on 30–99 days in the past year (adjusted odds ratio [AOR] = 2.63, 95% CI: 1.72–4.01) or 100–365 days in the past year (AOR = 7.65, 95% CI: 5.09–11.51). Jones (2013) compared NSDUH survey responses between 2002–2004 and 2008–2010, finding that estimated average annual rates of past-year heroin use per 1,000 population 12 years and older in the 2008–2010 cohorts were higher among those who reported nonmedical use of opioids on 1–29 days (14.8), 30–99 days (41.9), and 100–365 days (94.7), as compared to individuals who did not report use on any days (0.7). Rates from 2008–2010 were nearly double from 2002–2004 for each level of use. Research has demonstrated that non-medical opioid use is a strong risk factor for heroin use (Compton et al. 2016); however, it is important to understand which nonmedical opioid users are at highest risk.

Recency of nonmedical opioid use, as well as frequency of use, may also play a role in risk of heroin use. When evaluating associations between nonmedical opioid use and heroin use, as well as in substance use in general, it is particularly important to focus on current

(past-30-day) use. While past-year and lifetime use are important indicators of use, past-30-day use typically implies “current” use, and is often defined as such in surveys, including the NSDUH (CBHSQ 2016). More frequent users may be more likely to have used in the past 30 days and be classified as current users, and thus may be at particularly high risk of experiencing adverse drug-related outcomes such as dependence (Jones 2013; Martins et al. 2015), particularly as current users (in comparison to previous users) are still at immediate risk for adverse outcomes such as overdose. Frequent users of heroin have been found to be at particularly high risk for overdose (Fairbairn et al. 2008; Kinner et al. 2012). Current users of heroin are at risk for dependence and adverse effects associated with dependence, and users are also at increased risk for contracting and/or spreading bloodborne pathogens such as HIV or Hepatitis C if injection paraphernalia is shared with other users (National Institute on Drug Abuse 2014). Although more research is needed regarding recency of use as a risk factor, current users may be more likely than past-year users to be more susceptible to these adverse outcomes. Thus, examining correlates of recency of use rather than lifetime use can help inform prevention and interventions, as regular or current use appears to place users at immediate risk.

Our aims of this analysis were: (1) to determine whether current heroin users demonstrate higher severity of use (e.g., higher frequency of use, abuse, dependence) compared to those who used in the past year, but not in the past 30 days; (2) to determine how frequency and recency of nonmedical opioid use relates to recency of heroin use; and (3) to determine whether order of initiation (nonmedical opioid use vs. heroin use) and opioid abuse/dependence relate to recency of heroin use. We hypothesized that: (1) current heroin users would have higher severity use; (2) more frequent and more recent nonmedical opioid use would be associated with higher odds of reporting more recent heroin use; and (3) reporting nonmedical use of opioids before heroin and/or current opioid abuse/dependence would be related to more recent use of heroin.

Methods

Sample

Analyses focused on adults (age 18–64) from the 10 most recent cohorts (2005–2014) of NSDUH. NSDUH is a nationally representative probability sample of non-institutionalized individuals living in households in the 50 U.S. states and District of Columbia (Substance Abuse and Mental Health Services Administration [SAMHSA] 2014). This cross-sectional survey is conducted annually and data are obtained through four stages: first, census tracts (subdivisions of counties that are the primary sampling units) are selected within each state; then, segments (one or more blocks or streets) in each tract are selected; next, dwelling units are selected; and finally, respondents are selected.

Each year, surveys are administered to a new sample via computer-assisted interviewing (CAI) conducted by an interviewer and audio computer-assisted self-interviewing (ACASI). The CAI is used to collect all core variables. Respondents are provided with a computer and headphones and asked to complete the ACASI survey, and interviewers are trained to not look at the screens while the ACASI is being administered in order to maintain privacy and

confidentiality, and to increase likelihood of honest reporting (Butler et al. 2012). The ACASI collects noncore variables including drug data (LeBaron and Dean 2010).

Sampling weights were provided by NSDUH to address unit- and individual-level non-response. Weights are adjusted to ensure estimates are consistent with estimates provided by the U.S. Census Bureau. Since this analysis utilized aggregated data from 10 cohorts (to increase sample size in light of a rare outcome, as lifetime prevalence of heroin use is ~2%), we divided weights by 10 (the number of combined data-sets). Further information on sampling and survey techniques can be found elsewhere (SAMHSA 2014). We aggregated data from all cohorts and examined data for individuals who reported lifetime heroin use and were ages 12–64 ($N = 7,111$). The weighted interview response rates ranged throughout each year from 71.2–76.0%.

Drug use

Participants were asked if they had ever used heroin in their lifetime. Those who answered affirmatively were asked follow-up questions about use. Specifically, they were asked how long it has been since they last used (recency of heroin use), and answer options were: (1) use within the last 30 days; (2) use within the last 12 months, but not within the last 30 days; and (3) use within one's lifetime, but not within the last 12 months. We created a trichotomous variable categorizing these categories. Participants were also able to report using in their lifetime, but not knowing whether they used in the last 12 months. Likewise, participants were able to report using within the last 12 months, but not knowing whether they used in the last 30 days. This small subsample of participants ($n = 169$) was omitted from analyses.

Lifetime nonmedical use of opioids was also assessed. Nonmedical use was defined as use of a prescription pain reliever that was either not prescribed to the individual or used for the feeling resulting from use. It was noted that this does not include over-the-counter pain relievers such as aspirin, Advil, or Tylenol, which can be purchased without a prescription. Participants were also showed a card with images and names of specific opioid pills to help assist in identification. Similar to heroin, those reporting lifetime nonmedical opioid use were asked about recency of use. We coded this variable similar to the heroin variable although we added an extra category indicating no lifetime use. NSDUH also queried past-year use of cigarettes, alcohol, and cocaine.

Those who reported use of heroin in the past 12 months were asked how many times they have used it within the last year (range of possible times used: 0–365). The same question was asked of participants who reported past-year nonmedical opioid use. We categorized number of times heroin was used into quartiles and we categorized frequency of nonmedical opioid use into deciles (with an additional category indicating use 0 times).

Participants who indicated lifetime heroin use were also asked at what age they first used. A similar question was asked regarding age of first nonmedical opioid use. In order to determine order of age of first use (among those reporting use of both), we subtracted reported age of first nonmedical opioid use from reported age of first heroin use. We created a categorical variable indicating: (1) use of heroin first (3+ years prior); (2) use of heroin

first (1–2 years prior); (3) used both at the same age; (4) used opioids nonmedically first (1–2 years prior); and (5) used opioids nonmedically first (3+ years prior). The frequency cutoffs were determined by median split of the distribution in each direction.

Those reporting use of heroin in the past 12 months also answered questions to determine whether they met criteria for heroin abuse or dependence (American Psychiatric Association 2000). Similar questions were asked regarding nonmedical opioid use. While a diagnostic interview was not conducted, these questions were utilized as a proxy for diagnosis.

Participant demographics

With regard to demographic characteristics, we examined participant sex, race/ethnicity (i.e., White non-Hispanic, Black non-Hispanic, Hispanic, other race/ethnicity), annual family income, level of educational attainment, marriage status, and whether or not the participant reported having insurance.

Analyses

We first examined descriptive statistics with regard to recency of heroin and nonmedical opioid use. We present prevalence for the full NSDUH sample ($N = 359,735$), but the main focus of this analysis is the lifetime heroin-using subsample. We also examined demographic characteristics of the analytic sample. It should be noted that there were no missing data, as NSDUH provides imputation-revised variables.

In order to determine how severity of heroin use relates to recency of heroin use, we compared frequency of self-reported heroin use (in the last 12 months) according to whether or not use was reported within the past 30 days. We compared frequency in a continuous manner (via t -test with p -value determined via linear regression) and we also compared frequency quartiles using chi-square. We then compared whether diagnosis of heroin abuse or dependence differed according to whether heroin was used in the last 30 days.

To further investigate associations between frequency of nonmedical opioid use and recency of heroin use, we fit a multivariable multinomial logistic regression model to determine associations between each frequency decile and recency of heroin use. AORs were computed to determine how each level relates to 30-day heroin use and 12-month (but not 30-day) heroin use, with lifetime use (but not 12-month use) as the comparison group. In this model, we controlled for demographics, and past-year cigarette use, alcohol use, and cocaine use, as large-scale national studies have found that drug use disorders related to different drugs often co-occur (Grant et al. 2016) and co-use of cocaine among heroin users tends to be particularly prevalent (Leri, Bruneau, and Stewart 2003; Leri et al. 2004). We also controlled for survey year, which was entered as indicator variables with 2005 as the comparison. We then repeated the model with recency of nonmedical opioid use as the main independent variable.

Finally, we examined whether there were differences with regard to order of use and whether diagnosis of opioid abuse and dependence differ according to recency of heroin use. It should be noted that, in most descriptive tables in this article, we present both the column and row percentages to inform interpretation. All analyses were weighted to account for the

complex sample design and analyzed using Stata SE 13 (StataCorp, College Station, TX, USA), which utilized Taylor series estimation methods to provide accurate standard errors (Heeringa, West, and Berglund 2010). This analysis was deemed exempt by the New York University Langone Medical Center Institutional Review Board.

Results

The majority of this lifetime heroin-using sample identified as male (69.3%), White (72.9%, vs. 12.3% Black, 11.1% Hispanic, and 3.6% other race/ethnicity), earning <\$20,000 per year (55.0%, vs. 30.6% reporting earning \$20,000–\$49,999, 8.7% earning \$50,000–\$74,999, and 5.8% earning \$75,000), and not being married (67.7%).

Table 1 presents prevalence estimates (as weighted percentages) of recency of nonmedical opioid use and heroin use. Among the full NSDUH sample of those ages 18–64, 16.7% reported lifetime nonmedical opioid use and 2.1% reported lifetime heroin use. Over two-thirds (69.3%) of lifetime heroin users reported lifetime nonmedical opioid use; about a quarter (25.9%) reported past-year use, and 14.3% reported 30-day use. Most heroin use (86.7%) did not reportedly occur within the last year and 6.1% of lifetime heroin users reported 30-day use (current use).

Frequency of heroin use and heroin abuse/dependence among the sample of past-year heroin users is shown in Table 2. The mean number of times heroin was used by individuals who reported past-12-month use (but not 30-day use) was 51.7 (SE = 3.9), yet the mean number of times heroin was used in the past year among last 30-day users was 185.1 (SE = 8.5) ($p < .001$). Examining frequency of past-year use in a categorical manner (via quartiles) further suggests that half (49.6%) of current users reported high-frequency use (using 169–365 times) in the past year ($p < .001$). Almost two-thirds (63.4%) of current heroin users were also deemed to be dependent on the drug ($p < .001$).

Table 3 presents the associations between frequency and recency of nonmedical opioid use in relation to recency of heroin use while controlling for demographic and other substance use characteristics. The odds of recent heroin use typically increased with each decile of 12-month nonmedical opioid use, with the top three deciles of use associated with an increase of at least six times the odds for current heroin use (compared to using opioids nonmedically 0 times). Those reporting current (30-day) opioid use were also at more than five times the odds for reporting current heroin use.

Finally, as shown in the right-hand side of Table 4 (row percentages which are proportions within variable categories), those who reported using heroin before nonmedical opioid use were less likely to report current (30-day) heroin use (6%), but those who reported initiating nonmedical opioid use 1–3 years before heroin were more likely to report current heroin use (9.5%) ($p < .001$). While over a quarter (26.9%) of lifetime (but not 12-month) heroin users were deemed dependent on opioids, 46.4% of those who reported using in the last year, but not the last 30 days, were dependent. Over a third (37.4%) of current heroin users were deemed dependent on opioids.

Discussion

Considering the scope of the current public health challenge posed by nonmedical opioid and heroin use in the U.S., it is particularly important to understand the associations between use of these substances. In this analysis of lifetime heroin users derived from a nationally representative sample of non-institutionalized adults from the 2005–2014 NSDUH, we found independent associations between increased frequency and recency of nonmedical opioid use and recent (past 30-day and 12-month) heroin use. These findings add to growing evidence regarding the association between nonmedical opioid use and heroin use.

A recent study of high school seniors found strong associations between frequency and recency of nonmedical opioid use and lifetime heroin use (Palamar et al. 2016). In the current study, we add to this research, as we found robust increases in odds of current heroin use as frequency of nonmedical opioid use increased (AORs ranging from 2.52 to 9.59)—associations that held while controlling for demographic characteristics and past-year use of cigarettes, alcohol, and cocaine. As nonmedical opioid use increased, the increase in odds for current heroin use increased in somewhat of a dose-response fashion, in that substantial increases in odds were seen between reporting nonmedical opioid use 1–4 times, 5–48 times, and 49 or more times. However, since analyses were based on cross-sectional data, temporality cannot be inferred. While more research is needed—particularly longitudinal research—this stepwise increase may be representative of stages of drug use as described by Kleinig (2015), mirroring the progression from experimentation to regular use and perhaps dependence. Specifically, using opioids nonmedically a few times (e.g., 1–4 times) may indicate trial or experimentation (and thus associated increased odds for heroin use are comparatively low), while using 5–48 times may indicate occasional or more regular use, and using more than 48 times may indicate more regular use with potential dependency. Increased frequency of nonmedical opioid use increases risk for using heroin, as the costs of using nonmedical opioids increase (Cicero et al. 2014), availability decreases (Cicero et al. 2014), and physical tolerance grows stronger (Martins et al. 2015).

Findings also suggest the importance of focusing on current (past-30-day) heroin use when evaluating epidemiologic evidence (as opposed to lifetime prevalence of use), as we found that current (and recent) heroin users tended to report high frequency of past-year heroin use and they were also more likely to be dependent on the drug. Half of current users reported using heroin 169–365 days in the past year—which equates to using almost every other day or more frequently—and almost two-thirds (63.4%) of current heroin users were categorized as dependent in this national sample. Importantly, prevalence of dependence in this study was found to be similar to prevalence of dependence in another study. Specifically, Strang et al. (2006) found that 67% of individuals who reported use of heroin in the month prior to imprisonment also reported dependence, and 79% of individuals who reported using heroin one month before imprisonment continued to use heroin during their first month in prison. Thus, these findings support the supposition that current (past 30-day) heroin use is more likely to be associated with high-frequency use and/or dependence, and findings highlight the importance of focusing on this subset of heroin users, as they may be currently at high risk for experiencing more immediate drug-related adverse outcomes (as opposed to lifetime users) such as overdose. However, relapses after long periods of abstinence are also of

particular concern due to high rates of overdose and mortality (Pfab et al. 2006; Tagliaro et al. 1998); thus, those who have been abstinent for over 30 days or over 12 months may still be at unique risk for overdose. However, results suggest extra focus needs to be directed towards those reporting past-30-day use for harm reduction.

While temporal associations could not be delineated, we did examine reported order of initial drug use and found that over two-thirds (69.2%) of individuals reporting current heroin use also reported using opioids nonmedically before using heroin. Similarly, the majority of past-year and lifetime heroin users (83.3% and 61.7%, respectively) reported using opioids in a nonmedical manner first. Similar results were found in prior analyses of the NSDUH by Cerdá et al. (2015) and Jones (2013). While causality cannot be established from this study, there is emerging evidence that individuals who use opioids nonmedically may later transition to heroin when availability decreases and price increases (Mars et al. 2014).

Study limitations include reliance on drug use self-report, with potential for both recall bias and social desirability bias. As this is a repeated cross-sectional sample, temporality could not be directly assessed in most models. While a particular strength of NSDUH is that it assesses self-reported number of days a drug was used in the past year, a limitation is that there are no data regarding frequency of lifetime use. Thus, individuals may have different lifetime patterns of use that could not be examined. Similarly, order of use could not take into account frequency of use in a temporal manner. Aggregating multiple years of survey data can be limited, as there have been recent shifts in opioid/heroin use; however, survey year indicators were entered into the multivariable models to help control for changing trends. Specificity analyses were also conducted to ensure that direction of results were similar when stratifying by year (e.g., 2005–2009 vs. 2010–2014) and when examining frequency of opioid use quintiles rather than deciles. Additionally, the sample in this study was limited to lifetime heroin users, so analyses do not include the large percentage of non-medical opioid users who have never used heroin. Many individuals at high risk for heroin use (e.g., the homeless) may not have been included in the NSDUH survey due to the sampling strategy, and this limits generalizability of our findings. Finally, there is the chance for misclassification bias, as respondents may have been confused regarding use of opioids (e.g., nonmedical vs. medical use), although the NSDUH does define nonmedical use and provides photographs of different substances.

This analysis of lifetime heroin users from a nationally representative sample of non-institutionalized adults in the U.S. demonstrates that odds for current heroin use increase substantially as self-reported past-year nonmedical opioid use increases. Likewise, odds for current heroin use are increased when nonmedical opioid use was more recent or when the individual was dependent on opioids. These findings suggest the need for specific interventions targeting individuals who have been currently or recently engaging in nonmedical use of opioids, or who are using at a high frequency, as these are robust correlates of current heroin use. While only a portion of nonmedical opioid users eventually initiate heroin use, it appears most important to target individuals who report frequent or recent nonmedical opioid use, as this was most strongly associated with heroin use in our analyses and may be a predictor of transitioning to heroin use. Focusing more on frequency

and recent nonmedical opioid use may allow public health experts to maximize the potential for impact at the population level.

References

- American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 4. Washington, DC: Author; 2000.
- Banerjee G, Edelman EJ, Barry DT, Becker WC, Cerdá M, Crytal S, Gaither JR, Gordon AJ, Gordon KS, Kerns RD, Martins SS, Fiellin DA, Marshall BDL. Non-medical use of prescription opioids is associated with heroin initiation among US veterans: A prospective cohort study. *Addiction*. 2016; 111(11):2021–31. DOI: 10.1111/add.13491 [PubMed: 27552496]
- Butler, JS., Coffey, LE., Griffin, AB., Hunter, DC., Johnson, I., Liu, S., Livengood, M., Martin, PC., McKamey, AC., Morton, KB., Myers, SK., Parsons, S., Pratt, J., Riggsbee, BH., Zelko, H. Data collection final report: Prepared for the 2011 methodological resource book. Research Triangle Park, NC: RTI International; 2012. <http://archive.samhsa.gov/data/2k12/NSDUH2011MRB/NSDUHmrbdCFR2011.pdf> [accessed July 13, 2015]
- Center for Behavioral Health Statistics and Quality. Behavioral health trends in the United States: Results from the 2014 national survey on drug use and health. 2015. (HHS Publication No. SMA 15-4927, NSDUH Series H-50). <https://www.samhsa.gov/data/sites/default/files/NSDUH-FRR1-2014/NSDUH-FRR1-2014.pdf>
- Center for Behavioral Health Statistics and Quality. 2015 national survey on drug use and health: Methodological summary and definitions. Rockville, MD: Substance Abuse and Mental Health Services Administration; 2016.
- Cerdá M, Santaella J, Marshall BD, Kim JH, Martins SS. Nonmedical prescription opioid use in childhood and early adolescence predicts transitions to heroin use in young adulthood: A national study. *The Journal of Pediatrics*. 2015; 167(3):605–12. DOI: 10.1016/j.jpeds.2015.04.071 [PubMed: 26054942]
- Cicero TJ, Ellis MS, Surratt HL, Kurtz SP. The changing face of heroin use in the United States: A retrospective analysis of the past 50 years. *JAMA Psychiatry*. 2014; 71(7):821–26. DOI: 10.1001/jamapsychiatry.2014.366 [PubMed: 24871348]
- Compton WM, Jones CM, Grant T, Baldwin GT. Relationship between nonmedical prescription opioid use and heroin use. *New England Journal of Medicine*. 2016; 374(2):154–63. DOI: 10.1056/NEJMr1508490 [PubMed: 26760086]
- Fairbairn N, Wood E, Stoltz JA, Li K, Montaner J, Kerr T. Crystal methamphetamine use associated with non-fatal overdose among a cohort of injection drug users in Vancouver. *Public Health*. 2008; 122(1):70–78. DOI: 10.1016/j.puhe.2007.02.016 [PubMed: 17645904]
- Grant BF, Saha TD, Ruan WJ, Goldstein RB, Chou SP, Jung J, Zhang H, Smith SM, Pickering RP, Huang B, Hasin DS. Epidemiology of DSM-5 drug use disorder: Results from the National Epidemiologic Survey on Alcohol and Related Conditions-III. *JAMA Psychiatry*. 2016; 73(1):39–47. DOI: 10.1001/jamapsychiatry.2015.2132 [PubMed: 26580136]
- Heeringa, S., West, BT., Berglund, PA. Applied survey data analysis. Boca Raton, FL: Chapman & Hall; 2010.
- Jones CM. Heroin use and heroin use risk behaviors among nonmedical users of prescription opioid pain relievers: United States, 2002–2004 and 2008–2010. *Drug and Alcohol Dependence*. 2013; 132(1–2):95–100. DOI: 10.1016/j.drugalcdep.2013.01.007 [PubMed: 23410617]
- Kinner SA, Milloy MJ, Wood E, Qi J, Zhang R, Kerr T. Incidence and risk factors for non-fatal overdose among a cohort of recently incarcerated illicit drug users. *Addictive Behaviors*. 2012; 37(6):691–96. DOI: 10.1016/j.addbeh.2012.01.019 [PubMed: 22385733]
- Kleinig J. Ready for retirement: The gateway drug hypothesis. *Substance Use Misuse*. 2015; 50(8–9): 971–75. DOI: 10.3109/10826084.2015.1007679 [PubMed: 25774577]
- LeBaron, P., Dean, E. 2011 National Survey on Drug Use and Health: CAI specifications for programming. Research Triangle Park, NC: Research Triangle Institute; 2010. <http://archive.samhsa.gov/data/2k12/NSDUH2011MRB/2k11Q.pdf> [accessed July 13, 2015]

- Leri F, Bruneau J, Stewart J. Understanding poly-drug use: Review of heroin and cocaine co-use. *Addiction*. 2003; 98(1):7–22. DOI: 10.1046/j.1360-0443.2003.00236.x [PubMed: 12492751]
- Leri F, Stewart J, Tremblay A, Bruneau J. Heroin and cocaine co-use in a group of injection drug users in Montréal. *Journal of Psychiatry & Neuroscience*. 2004; 29(1):40–47. [PubMed: 14719049]
- Lipari, RN., Hughes, A. The NSDUH Report: Trends in heroin use in the United States: 2002–2013: The CBHSQ Report. Rockville, MD: Substance Abuse and Mental Health Services Administration, Center for Behavioral Health Statistics and Quality; 2015.
- Mars SG, Bourgois P, Karandinos G, Montero F, Ciccarone D. “Every ‘never’ I ever said came true”: Transitions from opioid pills to heroin injecting. *The International Journal on Drug Policy*. 2014; 25(2):257–66. DOI: 10.1016/j.drugpo.2013.10.004 [PubMed: 24238956]
- Martins SS, Santaella-Tenorio J, Marshall BD, Maldonado A, Cerdá M. Racial/ethnic differences in trends in heroin use and heroin-related risk behaviors among nonmedical prescription opioid users. *Drug and Alcohol Dependence*. 2015; 151:278–83. DOI: 10.1016/j.drugalcdep.2015.03.020 [PubMed: 25869542]
- National Institute on Drug Abuse. Heroin. Research Report Series, NIH Publication Number 15-0165. 2014. <https://www.drugabuse.gov/publications/research-reports/heroin/letter-director>
- Owens, PL., Barrett, ML., Weiss, AJ., Washington, RE., Kronick, R. Hospital inpatient utilization related to opioid overuse among adults, 1993–2012 (Statistical Brief #177). 2014. <http://www.hcup-us.ahrq.gov/reports/statbriefs/sb177-Hospitalizations-for-Opioid-Overuse.pdf>
- Palamar JJ, Shearston JA, Dawson EW, Mateu-Gelabert P, Ompad DC. Nonmedical opioid use and heroin use in a nationally representative sample of US high school seniors. *Drug and Alcohol Dependence*. 2016; 158:132–38. DOI: 10.1016/j.drugalcdep.2015.11.005 [PubMed: 26653341]
- Pfab R, Eyer F, Jetzinger E, Zilker T. Cause and motivation in cases of non-fatal drug overdoses in opiate addicts. *Clinical Toxicology*. 2006; 44(3):255–59. DOI: 10.1080/15563650600584394 [PubMed: 16749542]
- Rudd AR, Aleshire N, Zibbell JE, Gladden RM. Increases in drug and opioid overdose deaths: United States, 2000–2014. *MMWR Morbidity and Mortality Weekly Report*. 2016; 64(50–51):1378–82. DOI: 10.15585/mmwr.mm6450a3 [PubMed: 26720857]
- Strang J, Gossop M, Heuston J, Green J, Whiteley C, Maden A. Persistence of drug use during imprisonment: Relationship of drug type, recency of use and severity of dependence to use of heroin, cocaine and amphetamine in prison. *Addiction*. 2006; 101(8):1125–32. DOI: 10.1111/add.2006.101.issue-8 [PubMed: 16869842]
- Substance Abuse and Mental Health Services Administration. Results from the 2013 National Survey on Drug Use and Health. Rockville, MD: Summary of National Findings; 2014. <http://www.samhsa.gov/data/sites/default/files/NSDUHresultsPDFWHTML2013/Web/NSDUHresults2013.pdf> [accessed August 25, 2015]
- Tagliaro F, De Battisti Z, Smith FP, Marigo M. Death from heroin overdose: Findings from hair analysis. *Lancet*. 1998; 351(912D):1923–25. DOI: 10.1016/S0140-6736(97)10101-5 [PubMed: 9654260]

Table 1

Prevalence estimates of recency of nonmedical opioid and heroin use.

	Full NSDUH sample(N = 359,735)		Lifetime heroin users(analytic sample) (N = 7,111)	
	<i>N</i>	Weighted %	<i>N</i>	Weighted %
Heroin use				
Lifetime use	7,280	2.1	7,111	100.0
Lifetime use, but not 12-month	5,623	1.8	5,623	86.7
12-month use	1,589	0.3	1,488	13.3
12-month use, but not 30-day	868	0.1	868	7.2
30-day use	620	0.1	620	6.1
Nonmedical opioid use				
Lifetime use	71,713	16.7	5,566	69.3
Lifetime use, but not 12-month	43,921	11.3	2,920	43.4
12-month use	27,792	5.3	2,646	25.9
12-month use, but not 30-day	16,752	3.2	1,163	11.6
30-day use	11,040	2.2	1,483	14.3

Note. The analytic sample (indicating lifetime heroin use) does not contain the 169 participants who reported heroin lifetime use, but did not report whether heroin was used in the last 12 months or 30 days. Percentages are weighted so *N*s associated with some variables may not generate the same percentages presented if divided by the sample *N* in an unweighted manner. NSDUH = The National Survey on Drug Use and Health.

Table 2

Frequency of 12-month heroin use and heroin abuse/dependence diagnosis in relation to recency of heroin use.

Heroin use in last 12 months	Proportion within recency of heroin use (column percentages)		Proportion within frequency of use (row percentages)	
	30-day	12-month (not 30-day)	30-day	12-month (not 30-day)
Number of times used ***	$M = 185.1$ ($SE = 8.5$)	$M = 51.7$ ($SE = 3.9$)		
Frequency (quartiles) ***				
1–4 times	7.1	35.6	14.3	85.7
5–36 times	15.0	29.1	30.1	69.9
37–168 times	28.3	24.5	49.1	50.9
169–365 times	49.6	10.8	79.3	20.7
Diagnosis in last 12 months				
Heroin abuse	5.2	6.9	36.3	63.7
Heroin dependence ***	63.4	47.6	50.2	49.8

Note. Analyses focused on the 1,488 past-year heroin users; however, frequency of use was missing for 25 of these cases. M = mean; SE = standard error.

 $p < .001$.

Table 3

Multinomial multivariable logistic regression models examining frequency and recency of nonmedical opioid use in relation to recency of heroin use ($N = 7,111$).

Nonmedical opioid use	Recency of heroin use			
	30-day		12-month (not 30-day)	
	AOR	95% CI	AOR	95% CI
12-month frequency (deciles)				
0 times	1.00		1.00	
1 time	1.98	(0.46, 8.54)	1.77	(0.51, 6.15)
2 times	2.45	(0.60, 10.03)	7.13 **	(2.25, 22.58)
3–4 times	0.94	(0.31, 2.82)	3.71 *	(1.28, 10.72)
5–7 times	4.04 **	(1.81, 9.03)	2.86 **	(1.41, 5.77)
8–12 times	3.66 **	(1.71, 7.83)	4.35 ***	(2.06, 9.18)
13–24 times	2.95 ***	(1.70, 5.10)	4.47 ***	(2.43, 8.23)
25–48 times	2.52 **	(1.35, 4.71)	4.95 ***	(2.77, 8.84)
49–60 times	7.00 ***	(3.59, 13.66)	6.61 ***	(3.58, 12.23)
61–156 times	6.92 ***	(4.44, 10.79)	4.68 ***	(3.07, 7.12)
157–365 times	9.59 ***	(6.35, 14.48)	6.45 ***	(4.22, 9.87)
Recency of use				
No lifetime use	1.00		1.00	
Lifetime use (not 12-month)	0.69	(0.39, 1.22)	0.52 **	(0.33, 0.83)
12-month use (not 30-day)	2.35 **	(1.44, 3.83)	4.21 ***	(2.74, 6.48)
30-day use	5.64 ***	(3.42, 9.28)	2.54 ***	(1.64, 3.95)

Note. The comparison group to 30-day use and 12-month (without 30-day) use is lifetime use without use in the past year. AOR = adjusted odds ratio, controlling for all demographic covariates, past-year cigarette use, alcohol use, and cocaine use, and survey year, with each year entered as an indicator variable with 2005 as the comparison. CI = confidence interval.

* $p < .05$;

** $p < .01$;

*** $p < .001$.

Table 4

Order of initiation of use and opioid diagnosis in relation to recency of heroin use.

	Proportion within recency of heroin use categories(column percentages)			Proportion within variable categories (row percentages)		
	30-day	12-month (not 30-day)	Lifetime (not 12-month)	30-day	12-month (not 30-day)	Lifetime (not 12-month)
Order of use ***						
Used heroin first (3+ years)	10.3	4.3	14.6	6.0	2.9	91.1
Used heroin first (1–3 years)	7.7	3.8	10.6	6.1	3.6	90.3
Used both drugs same age	12.8	8.6	13.1	7.8	6.1	86.0
Used opioids first (1–3 years)	29.7	29.2	23.2	9.5	11.0	79.6
Used opioids first (3+ years)	39.5	54.1	38.5	7.6	12.3	80.1
Diagnosis in last 12 months						
Opioid abuse	5.5	7.4	4.8	16.9	27.3	55.8
Opioid dependence ***	37.4	46.4	26.9	19.3	28.4	52.4

Note. Order of use was determined by subtracting age of first reported nonmedical opioid use from age of first reported heroin use. Nonmedical opioid abuse and dependence were assessed with regard to the last 12 months, so the comparison groups are 12-month nonmedical opioid users who were not diagnosed with abuse and dependence, respectively. Diagnosis variables are limited to those who reported nonmedical opioid use within the last 12 months ($N = 2,646$).

 $p < .001$.