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Opioid Overdose Experience, Risk Behaviors, and Knowledge in Drug Users from a Rural versus an Urban Setting

Kelly E. Dunn¹, Frederick S. Barrett¹, Claudia Yopez-Laubach¹, Andrew C. Meyer³, Bryce J. Hruska³, Kathy Petrush², Suzan Berman², Stacey C. Sigmon^{3,4}, Michael Fingerhood², and George E. Bigelow¹

¹Johns Hopkins University School of Medicine, Behavioral Pharmacology Research Unit, Department of Psychiatry and Behavioral Sciences

²Johns Hopkins University School of Medicine, Behavioral Pharmacology Research Unit, Department of Medicine

³University of Vermont, Department of Psychiatry

⁴University of Vermont, Department of Psychology

Abstract

Background—Opioid use is highly prevalent in the United States and there has been an increased incidence in the rate of opioid-related overdose. While evidence suggests there are substantial differences in opioid use among rural versus urban settings, the rate of overdose and corresponding frequency of opioid overdose risk behaviors and overdose knowledge between rural and urban settings have not been examined.

Methods—Individuals with opioid use disorder from rural (N=98) and urban (N=247) settings completed a self-report survey regarding their lifetime history of overdose and overdose risk behaviors. Participants also completed the Brief Opioid Overdose Knowledge (BOOK) questionnaire, a 12-item self-report measure of opioid overdose knowledge.

Results—Overall, 35.6% of participants had experienced an overdose, and prevalence of overdose was significantly higher ($p<.01$) among rural (45.9%) vs. urban (31.6%) participants, though fewer rural participants reported past 30-day risk behaviors. There were few differences observed between the subset of rural and urban participants who had experienced an overdose, and fewer rural participants with a history of overdose reported past 30-day risk behaviors. Both rural and urban participants performed poorly on the BOOK, though the percent of correct responses was lowest among rural participants with a history of overdose.

Conclusion—Results demonstrate higher rates of overdose among rural opioid users, though rural participants were less likely to report recent risk behaviors. Results also suggest that

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Corresponding Author: Kelly Dunn, Ph.D. 5510 Nathan Shock Drive, Baltimore MD 21224. P: 410-550-2254, F: 410-550-0030, kdunn9@jhmi.edu.

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knowledge regarding key factors related to opioid overdose is severely lacking, particularly among rural opioid users, which could be a potential target for future intervention efforts.

Keywords

opioid; opioid use disorder; opioid overdose; naloxone; BOOK

1. Introduction

Opioids like heroin or prescription pain medications (e.g., oxycodone, hydrocodone) are a significant public health problem in the United States. In 2013, close to 12 million people reportedly misused an opioid, 2.5 million people met criteria for, and 1.4 million people sought treatment for problematic opioid use (Substance Abuse and Mental Health Services Administration (SAMHSA), 2014). Misuse of opioids is associated with myriad problems, including the risk of opioid-related overdose. The frequency of opioid-related overdose has increased throughout society, encompassing children, adolescents, elderly, patients with chronic pain, and women (Bailey, Campagna, Dart, & RADARS System Poison Center Investigators, 2009; Bohnert et al., 2011; Centers for Disease Control and Prevention (CDC), 2013; Coughlin & Krenzelok, 2006; Coben et al., 2010; K. M. Dunn et al., 2010; Palmieri, Staub, La Harpe, & Mangin, 2010; Paulozzi, Budnitz, & Xi, 2006; Rosca et al., 2012) and accidental poisonings, which are predominately opioid-related, have now surpassed motor vehicle accidents to become the leading cause of accidental death in persons aged 25–64 in the United States (CDC, 2014). Recent evidence suggests as many as 73% of drug users have witnessed an overdose and that 45% have themselves experienced a nonfatal overdose (Martins, Sampson, Cerda, & Galea, 2015). Overall, the rate of overdose from prescription opioid and heroin use has increased 3- and 6-fold, respectively, between 2001 and 2014 (CDC & Wonder Database, 2015), and the CDC has recommended increased and targeted efforts to reduce risk of opioid-related overdose (Rudd et al., 2014).

Though opioid use has traditionally been reported in urban settings (defined by the US Census Bureau as having more than 50,000 inhabitants; US Census Bureau, 2010), the onset of the prescription opioid epidemic has been associated with increases in opioid use in rural environments (Cicero, Ellis, Surratt, & Kurtz, 2014; Cicero & Kuehn, 2014). Evidence now suggests there are qualitative differences in the experience of opioid use disorder within rural versus urban settings. First, opioid users in rural settings are more likely to abuse prescription opioids (versus heroin) relative to those in urban settings (Cicero, Surratt, Inciardi, & Munoz, 2007; Rigg & Monnat, 2015; Wang, Becker, & Fiellin, 2013; Wang, Fiellin, & Becker, 2014). Second, relative to urban settings, rural settings have substantially lower availability for opioid use disorder treatments (Heil, Sigmon, Jones, & Wagner, 2008; Hirschak & Murphy, 2016; Paulozzi & Xi, 2008; Paulozzi & Xi, 2008; Rosenblum et al., 2011; Rosenblum et al., 2011; Stein et al., 2015; Stein et al., 2015), which could otherwise serve as a protective factor against opioid overdose (Schwartz et al., 2013). For instance, 90.4% of physicians who are authorized to prescribe buprenorphine reside in metropolitan areas versus 1.3% who reside in rural settings, and 82.5% of rural counties have no buprenorphine-authorized physician (Rosenblatt, Andrilla, Catlin, & Larson, 2015). Physicians who reside in rural versus urban settings are also less likely to be authorized to

prescribe buprenorphine to 100 (versus 30) patients (Stein et al., 2015). When treatment availability is low, individuals seeking opioid maintenance treatment for opioid use disorder may be placed on extended waiting lists. For instance, one study conducted within VT reported that patients waited an average of two years to begin opioid maintenance treatment (Sigmon, 2014). A further limitation in treatment access is that administration of naloxone, a fast-acting opioid antagonist that is used by first responders to reverse opioid overdose, is generally less possible in rural versus urban settings, largely due to a dearth of naloxone training and supplies for first responders (Faul et al., 2015). These differences may partially underlie the dramatic difference in overdose rates that are evident in rural versus urban settings. Specifically, opioid-related poisonings have increased by 371% in counties classified as rural, versus 52% in counties classified as urban (Paulozzi & Xi, 2008).

Given the differences in opioid treatment availability and overdose rates between rural and urban settings, there is value in examining opioid overdose knowledge and risk behaviors among opioid users residing in those settings. This information can aid in the development of public health campaigns and interventions tailored to opioid users in those areas. The majority of studies that have evaluated relative risk factors between rural and urban drug users have done so using epidemiological data from the National Survey on Drug Use and Health (Rigg & Monnat, 2015; Wang et al., 2013; Wang et al., 2014). No studies, as of yet, have reported a prospective, comprehensive evaluation of opioid overdose risk behaviors and knowledge among individuals in predominately rural versus urban geographic areas. In the present study, we compare the incidence of opioid-related overdose, overdose risk behaviors, and overdose knowledge in samples of rural and urban opioid users.

2. Methods

Participants were 345 opioid users. To be eligible for study participation, participants were required to have known opioid use disorder (e.g., assessed by staff from the program from which they were recruited), be over the age of 18, and be fluent in English. Rural participants ($N=98$) were recruited from a methadone-maintenance clinic and a syringe exchange program in Burlington, VT. In 2014, Burlington VT had a population of 42,211 (US Census Bureau, 2014), placing it below the census definition of urban (50,000 people) (US Census Bureau, 2010). Urban participants ($N=248$) were recruited from a methadone-maintenance clinic and a hospital-based drug and alcohol brief detoxification program in Baltimore MD. In 2014, Baltimore MD had a population of 622,793 (US Census Bureau, 2014), meeting the definition of an urban setting. The study was approved by University of Vermont and the Johns Hopkins University Institutional Review Boards (IRBs) and waivers of written consent were obtained for both sites. Participants were compensated \$10 in cash or giftcards for survey completion.

2.1 Study Measures

All questions were administered using self-report surveys. Participants were provided with paper questionnaires and study staff were available to assist with completion of surveys as needed.

2.1.1 Demographic, Drug Use, and Overdose History—Participants answered questions assessing demographic characteristics and past 30-day drug use, and then completed questions regarding their lifetime history of experiencing and/or witnessing an opioid overdose and their most recent overdose (e.g., what drugs had been used). Past 30-day engagement in the following behaviors that incur a heightened risk of experiencing an overdose were also assessed: using opioids while alone (which prevents someone from being available to administer aid if needed) (Davidson et al., 2003; Dietze, Jolley, Fry, Bammer, & Moore, 2006; Shah, Lathrop, Reichard, & Landen, 2008), combining opioids with alcohol (Coffin et al., 2003; Coffin et al., 2007; Davidson et al., 2003; Dietze et al., 2006; Laberke & Bartsch, 2010; Seal et al., 2001), using methadone that was not prescribed to them (Bunn, Yu, Spiller, & Singleton, 2010; Webster et al., 2011), and having a recent decrease in opioid tolerance (e.g., having recently completed an opioid detoxification or being released from jail/prison) (Kinner et al., 2012; Merrill et al., 2010; Ravndal & Amundsen, 2010; Seal et al., 2001). Finally, participants were asked (yes/no) whether they had “ever heard of naloxone (Narcan)”, “received a prescription for naloxone”, “been trained to administer naloxone”, and “been trained to administer CPR”.

2.1.2 Brief Opioid Overdose Knowledge Questionnaire (BOOK) (Dunn et al., in press)—Participants completed the BOOK as a measure of opioid overdose knowledge. The BOOK is a 12-item self-report measure that sums into three subscales: Opioid Knowledge (range 0–4), Opioid Overdose Knowledge (range 0–4), Opioid Overdose Response Knowledge (range 0–4), and a Total Score (range 0–12). The BOOK is a psychometrically sound measure that was developed and replicated within three independent samples of participants who were abusing opioids and/or using them as prescribed for the treatment of chronic pain. To discourage random guessing, response options are “True”, “False”, and “I Don’t Know” (Harris & Changas, 1994; Herrmann et al., 2013; Pennington, Pachana, & Coyle, 2001). Results were coded dichotomously as correct and incorrect for analyses, with “I Don’t Know” responses being treated as incorrect.

2.2 Data Analysis

Data were first evaluated descriptively to characterize the sample. Data were then compared as a function of rural versus urban participants, and then within the subset of rural and urban participants who reported a lifetime history of opioid-related overdose. Variables were analyzed using Chi-Squares for dichotomous variables and independent group t-tests for continuous variables. Finally, a logistic regression was conducted within the entire sample to evaluate several potential predictors of reporting a lifetime experience of opioid overdose. There was a low rate of missing data, so no corrections were made. Alpha was set at .05 and all analyses were conducted using SPSS version 21.

3. Results

3.1 Overall Sample

3.1.1 Participant Characteristics—Participant characteristics are presented in Table 1. Briefly, participants were 44.8% male, 60.0% Caucasian, 3.5% Hispanic, and 29.1% were over 30 years of age. Past-month drug use was common and consisted of heroin (54.4%),

alcohol (48.5%), cannabis (44.4%), cocaine/crack (41.1%), prescription opioids (39.5%), and other medications (defined as stimulants and benzodiazepines) (35.4%). Sixty-nine percent of participants reported lifetime injection drug use.

3.1.2. Overdose History and Risk Behaviors—Overall, 35.6% (N=123) participants reported having experienced an opioid-related overdose and, of those participants, the mean (SD) number of lifetime overdoses was 1.3 (2.2) (Table 2). Past-month and past-year overdoses were reported by 15.4% and 46.1% of those participants, respectively. A substantial percentage of participants (67.5%) reported having witnessed an overdose, with a mean (SD) of 3.2 (6.6) and 0.9 (1.8) of the witnessed overdoses surviving and dying, respectively. Participants reported using heroin (51.9%), alcohol (31.0%), cocaine/crack (26.5%), cannabis (25.4%), prescription pain medications (24.6%), and other medications (21.7%) during their last overdose. Approximately half of participants reported past 30-day overdose risk behaviors. Specifically, 55.1% of participants reported using opioids by themselves, 48.5% had undergone detoxification, and 45.6% had combined opioids with alcohol. Finally, though 49.2% of participants reported having been trained to administer CPR, only 22.6% had received training in how to administer naloxone for opioid overdose and only 16.9% reported having a valid prescription for naloxone.

3.1.3. BOOK Performance—Participants achieved relatively low accuracy on the BOOK subscales (Table 3). Total mean (SD) responses were 2.1 (1.4) out of 4 for the Opioid Knowledge scale, 1.6 (1.3) out of 4 for the Opioid Overdose Knowledge scale, and 1.8 (1.3) out of 4 for the Opioid Overdose Response Knowledge scale. Total mean score on the BOOK was 5.5 (3.1) out of 12. Analyses of individual items revealed only 5 items for which more than half of participants were able to answer correctly.

3.1.4 Predictors of Overdose in Overall Sample—Logistic regression examined the following variables to evaluate predictors of reporting a lifetime experience of opioid overdose: living in a rural setting, being male, being Caucasian, being employed, being over 30, having health insurance, having been trained to administer naloxone, and scores on the BOOK subscales. The only items to be significantly associated with history of overdose were performance on the BOOK Opioid Knowledge ($\chi^2(1)=7.6$, $p<.01$, OR=1.36 [95% CI=1.1–1.7]) and the BOOK Opioid Overdose Knowledge ($\chi^2(1)=4.5$, $p=.04$, OR=1.26 [95% CI=1.0–1.6]) subscales. These results translate into a 36% and 25% increased odds of reporting a lifetime history of overdose with every 1 point increase on those scales.

3.2 Rural vs. Urban Participants

3.2.1. Participant Characteristics—Rural participants were more likely to be Caucasian (95.9% vs. 45.7%, $\chi^2=73.6$, $p<.001$), over 30 years of age (42.7% vs. 23.8%, $\chi^2=12.0$, $p<.001$), employed (38.8% vs. 27.9%, $\chi^2=3.9$, $p=.03$), and to have health insurance (89.4% vs. 60.5%, $\chi^2=26.6$, $p<.001$) relative to urban participants, respectively. Rural participants were less likely to report past 30-day use of heroin (39.1% vs. 60.0%, $\chi^2=11.3$, $p<.01$) but more likely to report a lifetime history of injection drug use (89.4% vs. 60.1%, $\chi^2=25.4$, $p<.001$) compared to urban participants. No additional differences in demographic or drug use characteristics were observed (Table 1).

3.2.2. Overdose History and Risk Behaviors—Incidence of opioid overdose was significantly higher among rural (45.9%) versus urban (31.6%) participants ($\chi^2=6.3$, $p<.01$), and rural participants endorsed a higher mean (SD) number of lifetime overdoses (1.5 (2.5) vs. 1.0 (2.0), respectively; $t(336)=2.1$, $p=.04$). There were no differences in the frequency of overdose in the past 30 days and past year (Table 2). There was a trend towards rural participants reporting higher rates of witnessing an overdose relative to urban participants (74.4% vs. 64.9%, $\chi^2=2.6$, $p=.07$), and rural participants reported witnessing significantly fewer fatal overdoses than urban participants (0.6 (1.7) vs. 1.1 (1.8), $t(284)=2.03$, $p=.04$), respectively.

Fewer rural participants reported past 30-day overdose risk behaviors relative to urban participants. Specifically, fewer rural participants endorsed using opioids by themselves (41.9% vs. 60.3%, $\chi^2=9.7$, $p<=.001$), combining opioids with alcohol (32.6% vs. 50.1%, $\chi^2=9.1$, $p<.01$), using methadone (6.1% vs. 21.5%, $\chi^2=11.6$, $p<.001$), and undergoing detoxification from opioids (10.2% vs. 64.3%, $\chi^2=81.3$, $p<.001$) (Table 2). More rural participants reported having received a prescription for naloxone (34.4% vs. 9.6%, $\chi^2=29.7$, $p<.001$), having been trained to administer naloxone (46.9% vs. 12.6%, $\chi^2=45.6$, $p<.001$), and having been trained to administer CPR (59.4% vs. 45.0%, $\chi^2=5.6$, $p=.01$) relative to urban participants.

3.2.3. BOOK Performance—The percent of rural and urban participants who answered questions correctly on the BOOK did not differ for any of the subscales or Total score (Table 3).

3.3 Rural vs. Urban Participants with a Lifetime History of Overdose

3.3.1 Participant Characteristics—Within participants who had a prior history of opioid overdose, rural participants were significantly more likely to be Caucasian (97.8% vs. 57.7%, $\chi^2=22.9$, $p<.001$) and have health insurance (100% vs. 61.0%, $\chi^2=22.8$, $p<.001$) relative to urban participants. Fewer rural participants with a history of overdose reported past-month use of alcohol (31.6% vs. 64.1%, $\chi^2=10.9$, $p=.001$) and heroin (34.1% vs. 67.9%, $\chi^2=12.5$, $p<.001$), relative to urban participants, however more rural participants with a history of overdose reported a history of injection drug use (97.7% vs. 84.6%, $\chi^2=4.9$, $p=.02$) compared to urban participants, respectively.

3.3.2 Overdose History and Risk Behaviors—Among rural and urban participants with a history of overdose, no significant differences were observed in the number of lifetime overdoses, the percent of participants who reported their last overdose was in the past 30 days or 1 year, the percent of participants who had witnessed an overdose, or the number of witnessed overdoses who had survived or died. Significantly fewer rural participants with a history of overdose reported having gone to an emergency room for an overdose (34.1% vs. 51.3%, $\chi^2=3.4$, $p=.05$), compared to urban participants with a history of overdose, however more rural participants reported using methamphetamine (25.0% vs. 2.8%, $\chi^2=10.8$, $p<.01$) and cannabis (47.8% vs. 21.1%, $\chi^2=6.2$, $p=.02$) during their most recent overdose, relative to urban participants.

Fewer rural participants with a history of overdose reported past 30-day overdose risk behaviors. Specifically, fewer rural participants endorsed having used opioids by themselves (37.8% vs. 74.4%, $\chi^2=16.0$, $p<.001$), combining opioids with alcohol (38.9% vs. 64.1%, $\chi^2=14.2$, $p<.001$), using methadone (4.4% vs. 23.1%, $\chi^2=7.3$, $p<.01$), or undergoing detoxification from opioids (6.7% vs. 75.0%, $\chi^2=52.8$, $p<.001$) relative to urban participants, respectively. Finally, significantly fewer rural participants with a history of overdose had received a prescription for naloxone (39.5% vs. 9.5%, $\chi^2=15.1$, $p<.001$), had been trained to administer naloxone (48.8% vs. 8.0%, $\chi^2=25.8$, $p<.001$), and had been trained to administer CPR (62.7% vs. 37.3%, $\chi^2=7.1$, $p<.01$), relative to urban participants with a history of overdose, respectively.

3.3.3. BOOK Performance—Among participants who reported a history of overdose, rural participants answered incorrectly to significantly more questions on the three BOOK subscales and the Total Score, relative to urban participants with a history of overdose (Table 3).

4. Discussion

The present study evaluated self-reported overdose history, past 30-day overdose risk behaviors, and overdose-related knowledge among opioid users residing in predominately rural versus urban areas. Overdose rates were significantly higher among rural participants in this study, though fewer rural participants reported past 30-day risk behaviors relative to urban participants. Both rural and urban participants performed poorly on the BOOK, a standardized measure of opioid overdose knowledge, and knowledge was associated with significantly greater odds of experiencing a lifetime history of overdose. These results suggest that increased efforts to educate opioid users about the risks of opioid overdose are needed. Overall, these data represent the first comparison of these outcomes within rural versus urban individuals and provide insight for intervention efforts in these areas. Though comparison of rural versus urban settings is necessarily confounded with regional differences (such as in differences in treatment access and efforts to dispense naloxone), some general conclusions can be made.

First, there was a relatively high rate of overdose in this sample (35.5%) and a substantial number of participants (67.5%) reported having witnessed an overdose. The incidence of overdose was higher among rural (45.9%) versus urban (31.6%) participants (Table 2), and rural participants also reported experiencing significantly more lifetime overdoses relative to urban participants. However fewer rural participants reported risk behaviors over the past 30-days and these reduced risks may reflect the fact that rural participants were also more likely to have reported receiving a prescription and been trained to administer the opioid antagonist naloxone. There were few significant differences observed between rural and urban participants who reported a history of overdose, and the lack of systematic differences between this subset of participants suggests that opioid overdose intervention efforts can be developed for potential use across both rural and urban settings.

Second, overall knowledge of opioid overdose risk was low in both rural and urban participants. Overdose knowledge was assessed using the BOOK, a standardized measure of

opioids, opioid overdose, and opioid overdose response knowledge (Dunn et al., in press) (Table 3). Fewer than 55% of all rural and urban participants answered items correctly. Comparison of the BOOK outcomes within rural and urban participants who had experienced an overdose indicated that, relative to urban participants, fewer rural participants with a history of overdose were able to answer questions correctly. Ultimately, these results suggest that knowledge deficits, as measured by the BOOK, could signify increased overdose risk potential, which supports increasing opioid overdose education efforts, particularly in rural settings.

Finally, few of the variables examined predicted likelihood of overdose. Only performance on the BOOK Opioid Knowledge and Opioid Overdose Knowledge subscales successfully distinguished between participants with and without a history of overdose, and these data revealed that odds of having a lifetime history of overdose increased by 35% and 26% for each 1 unit change on those BOOK subscales, respectively. This suggests that individuals who achieved higher scores on the BOOK were more likely to have a history of overdose, which seems counter-intuitive since more knowledge is generally associated with better outcomes (in this case, lower odds of having experienced an overdose). Yet this result is supported by a previous study that reported a similar association between overdose history and better performance on a knowledge measure (Dietze et al., 2006). This speaks to a general issue regarding overdose research, which is that in order for participants to endorse a lifetime history of overdose, they must be able to correctly identify an event as a nonfatal overdose. It is possible that participants in this study who endorsed a lifetime history of overdose were those who were able to identify their event as being a nonfatal overdose, which translated into more accurate performance on the BOOK subscales. Research regarding opioid overdose and prediction of overdose is generally complex. No studies have prospectively evaluated risk behaviors in the longitudinal method that would be necessary for thoroughly evaluating predictors of overdose, and no studies have assessed whether educating patients about features of opioid overdose changes the likelihood that patients may then identify an event as being an opioid overdose. Ultimately, these data suggest that knowledge may in some way be associated with a history of experiencing a nonfatal overdose, and this association provides a concrete target for intervention efforts. Additional studies in larger samples and collected prospectively over time are needed to more systematically identify risks for overdose.

This study has limitations. First, the sample was predominately women and was not adequately powered to evaluate the contribution of sex to study outcomes. Second, the two locations selected for the study (Burlington VT and Baltimore MD) were meant to broadly characterize rural and urban settings, yet regional differences that exist beyond just rural and urban settings may have influenced outcomes. For instance, in this study 89.4% of rural participants reported having health insurance. This value is very high and likely driven by the fact that VT enacted state-supported healthcare in 2011; this and other state-level variables may limit generalizability of the study locations to other rural and urban settings in different regions. Nevertheless, these data address an important topic (regional differences in overdose knowledge) and support further evaluation of overdose as a function of region and setting.

5. Conclusion

These data provide a point-prevalence assessment of opioid overdose risk and knowledge in samples of rural and urban individuals with opioid use disorder. Results suggest substantial rates of overdose in these settings, and that rural participants were more likely to report having experienced an overdose. Both rural and urban participants performed poorly on the BOOK, a standardized knowledge test for opioid overdose, and performance on the BOOK was significantly associated with lifetime history of overdose. Results demonstrate a clear need to increase opioid overdose educational efforts for persons with opioid use disorder, and the low number of differences between rural and urban participants suggests it is not necessary to develop different opioid overdose interventions for these two settings.

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References

- Bailey JE, Campagna E, Dart RC. RADARS System Poison Center Investigators. The underrecognized toll of prescription opioid abuse on young children. *Annals of Emergency Medicine*. 2009; 53(4): 419–424. [PubMed: 18774623]
- Bohnert AS, Valenstein M, Bair MJ, Ganoczy D, McCarthy JF, Ilgen MA, et al. Association between opioid prescribing patterns and opioid overdose-related deaths. *JAMA*. 2011; 305(13):1315–1321. [PubMed: 21467284]
- Bunn TL, Yu L, Spiller HA, Singleton M. Surveillance of methadone-related poisonings in kentucky using multiple data sources. *Pharmacoepidemiology and Drug Safety*. 2010; 19(2):124–131. [PubMed: 20077525]
- Centers for Disease and Prevention (CDC). [Last accessed on July 29, 2016] Wide-ranging OnLine data for epidemiologic research (WONDER) [online]. 2014. <http://wonder.cdc.gov/mortsql.html>
- Centers for Disease Control and Prevention (CDC). Vital signs: Overdoses of prescription opioid pain relievers and other drugs among women--United States, 1999–2010. *MMWR Morbidity and Mortality Weekly Report*. 2013; 62(26):537–542. [PubMed: 23820967]
- Centers for Disease Control and Prevention (CDC) & Wonder Database. [Last accessed on July 29, 2016] National center for health statistics. Underlying Cause of Death, 1999–2014. 2015. Available at <http://wonder.cdc.gov/ucd-icd10.html>
- 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):821–826. [PubMed: 24871348]
- Cicero TJ, Kuehn BM. Driven by prescription drug abuse, heroin use increases among suburban and rural whites. *JAMA*. 2014; 312(2):118–119. [PubMed: 25005636]
- Cicero TJ, Surratt H, Inciardi JA, Munoz A. Relationship between therapeutic use and abuse of opioid analgesics in rural, suburban, and urban locations in the United States. *Pharmacoepidemiology and Drug Safety*. 2007; 16(8):827–840. [PubMed: 17636553]
- Cobaugh DJ, Krenzelo EP. Adverse drug reactions and therapeutic errors in older adults: A hazard factor analysis of poison center data. *American Journal of Health-System Pharmacy*. 2006; 63(22): 2228–2234. [PubMed: 17090743]

- Coben JH, Davis SM, Furbie PM, Sikora RD, Tillotson RD, Bossarte RM. Hospitalizations for poisoning by prescription opioids, sedatives, and tranquilizers. *American Journal of Preventive Medicine*. 2010; 38(5):517–524. [PubMed: 20409500]
- Coffin PO, Galea S, Ahern J, Leon AC, Vlahov D, Tardiff K. Opiates, cocaine and alcohol combinations in accidental drug overdose deaths in New York City, 1990–98. *Addiction*. 2003; 98(6):739–747. [PubMed: 12780362]
- Coffin PO, Tracy M, Bucciarelli A, Ompad D, Vlahov D, Galea S. Identifying injection drug users at risk of nonfatal overdose. *Academic Emergency Medicine*. 2007; 14(7):616–623. [PubMed: 17554010]
- Davidson PJ, McLean RL, Kral AH, Gleghorn AA, Edlin BR, Moss AR. Fatal heroin-related overdose in San Francisco, 1997–2000: A case for targeted intervention. *Journal of Urban Health*. 2003; 80(2):261–273. [PubMed: 12791802]
- Dietze P, Jolley D, Fry CL, Bammer G, Moore D. When is a little knowledge dangerous? circumstances of recent heroin overdose and links to knowledge of overdose risk factors. *Drug and Alcohol Dependence*. 2006; 84(3):223–230. [PubMed: 16542798]
- Dunn KE, Barrett FS, Yopez-Laubach C, Meyer AC, Hruska BJ, Sigmon SC, et al. Brief opioid overdose knowledge (BOOK): A measure to assess overdose knowledge in individuals who use illicit or prescribed opioids. *Journal of Addiction Medicine*. (in press).
- Dunn KM, Saunders KW, Rutter CM, Banta-Green CJ, Merrill JO, Sullivan MD, et al. Opioid prescriptions for chronic pain and overdose: A cohort study. *Annals of Internal Medicine*. 2010; 152(2):85–92. [PubMed: 20083827]
- Faul M, Dailey MW, Sugerman DE, Sasser SM, Levy B, Paulozzi LJ. Disparity in naloxone administration by emergency medical service providers and the burden of drug overdose in US rural communities. *American Journal of Public Health*. 2015; 105(Suppl 3):e26–32. [PubMed: 25905856]
- Harris DK, Changas PS. Revision of palmore's second facts on aging quiz from a true–false to a multiple-choice format. *Educational Gerontology*. 1994; 20:741–754.
- Heil SH, Sigmon SC, Jones HE, Wagner M. Comparison of characteristics of opioid-using pregnant women in rural and urban settings. *The American Journal of Drug and Alcohol Abuse*. 2008; 34(4):463–471. [PubMed: 18584576]
- Herrmann ES, Heil SH, Sigmon SC, Dunn KE, Washio Y, Higgins ST. Characterizing and improving HIV/AIDS knowledge among cocaine-dependent outpatients using modified materials. *Drug and Alcohol Dependence*. 2013; 127(1–3):220–225. [PubMed: 22889696]
- Hirschak KA, Murphy SM. Assessing differences in the availability of opioid addiction therapy options: Rural versus urban and American Indian reservation versus nonreservation. *The Journal of Rural Health*. 2016 [epub ahead of print].
- 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):691–696. [PubMed: 22385733]
- Laberke PJ, Bartsch C. Trends in methadone-related deaths in Zurich. *International Journal of Legal Medicine*. 2010; 124(5):381–385. [PubMed: 20349188]
- Martins SS, Sampson L, Cerda M, Galea S. Worldwide prevalence and trends in unintentional drug overdose: A systematic review of the literature. *American Journal of Public Health*. 2015; 105(11):e29–49. [PubMed: 26451760]
- Merrall EL, Kariminia A, Binswanger IA, Hobbs MS, Farrell M, Marsden J, et al. Meta-analysis of drug-related deaths soon after release from prison. *Addiction*. 2010; 105(9):1545–1554. [PubMed: 20579009]
- Palmiere C, Staub C, La Harpe R, Mangin P. Parental substance abuse and accidental death in children. *Journal of Forensic Sciences*. 2010; 55(3):819–821. [PubMed: 20345788]
- Paulozzi LJ, Budnitz DS, Xi Y. Increasing deaths from opioid analgesics in the United States. *Pharmacoepidemiology and Drug Safety*. 2006; 15(9):618–627. [PubMed: 16862602]
- Paulozzi LJ, Xi Y. Recent changes in drug poisoning mortality in the United States by urban-rural status and by drug type. *Pharmacoepidemiology and Drug Safety*. 2008; 17(10):997–1005. [PubMed: 18512264]

- Pennington HR, Pachana NA, Coyle SL. Use of the facts on aging quiz in New Zealand: Validation of questions, performance of a student sample, and effects of a don't know option. *Educational Gerontology*. 2001; 27:409–416.
- Ravndal E, Amundsen EJ. Mortality among drug users after discharge from inpatient treatment: An 8-year prospective study. *Drug and Alcohol Dependence*. 2010; 108(1–2):65–69. [PubMed: 20022184]
- Rigg KK, Monnat SM. Urban vs. rural differences in prescription opioid misuse among adults in the United States: Informing region specific drug policies and interventions. *The International Journal on Drug Policy*. 2015; 26(5):484–491. [PubMed: 25458403]
- Rosca P, Haklai Z, Goldberger N, Zohar P, Margolis A, Ponizovsky AM. Mortality and causes of death among users of methadone maintenance treatment in Israel, 1999–2008. *Drug and Alcohol Dependence*. 2012
- Rosenblatt RA, Andrilla CH, Catlin M, Larson EH. Geographic and specialty distribution of US physicians trained to treat opioid use disorder. *Annals of Family Medicine*. 2015; 13(1):23–26. [PubMed: 25583888]
- Rosenblum A, Cleland CM, Fong C, Kayman DJ, Tempalski B, Parrino M. Distance traveled and cross-state commuting to opioid treatment programs in the united states. *Journal of Environmental and Public Health*. 2011; 2011:948789. [PubMed: 21776440]
- Rudd RA, Paulozzi LJ, Bauer MJ, Burleson RW, Carlson RE, Dao D, et al. Increases in heroin overdose deaths - 28 states, 2010 to 2012. *MMWR Morbidity and Mortality Weekly Report*. 2014; 63(39):849–854. [PubMed: 25275328]
- Schwartz RP, Gryczynski J, O'Grady KE, Sharfstein JM, Warren G, Olsen Y, et al. Opioid agonist treatments and heroin overdose deaths in Baltimore, Maryland, 1995–2009. *American Journal of Public Health*. 2013; 103(5):917–922. [PubMed: 23488511]
- Seal KH, Kral AH, Gee L, Moore LD, Bluthenthal RN, Lorvick J, et al. Predictors and prevention of nonfatal overdose among street-recruited injection heroin users in the San Francisco bay area, 1998–1999. *American Journal of Public Health*. 2001; 91(11):1842–1846. [PubMed: 11684613]
- Shah NG, Lathrop SL, Reichard RR, Landen MG. Unintentional drug overdose death trends in New Mexico, USA, 1990–2005: Combinations of heroin, cocaine, prescription opioids and alcohol. *Addiction*. 2008; 103(1):126–136. [PubMed: 18028518]
- Sigmon SC. Access to treatment for opioid dependence in rural America: Challenges and future directions. *JAMA Psychiatry*. 2014; 71(4):359–360. [PubMed: 24500040]
- Stein BD, Pacula RL, Gordon AJ, Burns RM, Leslie DL, Sorbero MJ, et al. Where is buprenorphine dispensed to treat opioid use disorders? the role of private offices, opioid treatment programs, and substance abuse treatment facilities in urban and rural counties. *The Milbank Quarterly*. 2015; 93(3):561–583. [PubMed: 26350930]
- Substance Abuse and Mental Health Services Administration (SAMHSA). HHS Publication No. (SMA) 14–4863. 2014. Results from the 2013 national survey on drug use and health. NSDUG series H-48.
- US Census Bureau. [Last accessed on July 29, 2016] Urban and rural classification. Available at <https://www.census.gov/geo/reference/urban-rural.html>
- US Census Bureau. [Last accessed on July 29, 2016] Quick facts: United States. 2014. Available at: <https://www.census.gov/quickfacts/table/PST045215/00>
- Wang KH, Becker WC, Fiellin DA. Prevalence and correlates for nonmedical use of prescription opioids among urban and rural residents. *Drug and Alcohol Dependence*. 2013; 127(1–3):156–162. [PubMed: 22819293]
- Wang KH, Fiellin DA, Becker WC. Source of prescription drugs used nonmedically in rural and urban populations. *The American Journal of Drug and Alcohol Abuse*. 2014; 40(4):292–303. [PubMed: 24853143]
- Webster LR, Cochella S, Dasgupta N, Fakata KL, Fine PG, Fishman SM, et al. An analysis of the root causes for opioid-related overdose deaths in the United States. *Pain Medicine*. 2011; 12(Suppl 2):S26–35. [PubMed: 21668754]

Highlights

- Both rural and urban drug users report high rates of opioid overdose
- Rural participants had more overdose experience but also more naloxone training
- Both groups performed poorly on a standardized knowledge measure of opioid overdose

Table 1

Demographic and Drug Use Characteristics

	Entire Sample			p-value	Participants with History of Overdose			p-value
	Total (N=345)	Rural (N=98)	Urban (N=247)		Total OD (N=123)	Rural OD (N=45)	Urban OD (N=78)	
Demographics (%)								
Male	44.8	44.9	44.8	0.53	39.8	48.8	34.6	0.09
Caucasian	60.0	95.9	45.7	<.001	72.4	97.8	57.7	<.001
Hispanic	3.5	2.1	4.1	0.29	2.6	4.5	1.4	0.32
Over 30	29.1	42.7	23.8	<.001	27.5	34.1	23.1	0.14
Never Married	68.1	66.3	68.8	0.37	64.2	55.6	69.2	0.09
Employed	31.0	38.8	27.9	0.03	24.4	26.7	23.1	0.41
Health Insurance	68.6	89.4	60.5	<.001	75.2	100	61.0	<.001
Drug Use Past 30 Days (%)								
Heroin	54.5	39.1	60.0	<.01	56.3	34.1	67.9	<.001
Alcohol	48.5	41.5	50.8	0.09	53.4	31.6	64.1	0.001
Cannabis	44.4	55.7	40.5	0.01	55.8	59.5	53.9	0.34
Cocaine/Crack	41.1	36.9	42.5	0.22	46.7	38.1	51.3	0.12
Prescription Opioids	39.5	45.1	37.7	0.14	41.9	33.3	46.6	0.13
Other medications ^a	35.4	32.9	36.2	0.35	39.3	35.9	41.0	0.37
Hallucinogens	9.0	6.5	9.8	0.28	10.4	8.1	11.5	0.42
Methamphetamine	5.3	8.1	4.4	0.17	7.0	13.5	3.9	0.07
Ever Injected Drug (%)	69.0	89.4	60.1	<.001	89.3	97.7	84.6	0.02

All data represent percent of participants. P-values based on Chi-squares for dichotomous variables. OD=overdose

^aDefined as stimulants and/or benzodiazepines

Overdose History and Risk Factors

Table 2

	Entire Sample			p-value	Participants with History of Overdose			p-value
	Total (N=345)	Rural (N=98)	Urban (N=247)		Total OD (N=123)	Rural OD (N=45)	Urban OD (N=78)	
Overdose (OD) History								
Lifetime Overdose (%)	35.6	45.9	31.6	<.01	100	100	100	N/A
Number ODs (mean times, SD) ^a	1.3 (2.2)	1.5 (2.5)	1.0 (2.0)	0.04	3.2 (2.6)	3.3 (2.8)	3.1 (2.4)	0.66
OD past 30 days (%)	15.4	10.1	18.2	0.28	15.6	10.1	18.5	0.23
OD past year (%)	46.1	47.4	45.5	0.51	46.1	45.9	46.2	0.57
Gone to Emergency Department for OD (%)	26.1	31.9	23.9	0.08	45.1	34.1	51.3	0.05
Emergency Department (mean visits, SD) ^a	1.0 (4.3)	0.9 (2.0)	1.0 (6.7)	0.87	1.6 (6.3)	0.6 (.98)	2.6 (11.6)	0.28
Witnessed OD (%)	67.5	74.4	64.9	0.07	73.0	69.2	75.0	0.33
Person survived (mean times, SD) ^a	3.2 (6.6)	3.0 (4.5)	3.5 (8.8)	0.60	3.7 (9.0)	2.4 (4.0)	4.9 (14.0)	0.26
Person died (mean times, SD) ^a	0.9 (1.8)	0.6 (1.7)	1.1 (1.8)	0.04	1.1 (2.3)	0.9 (2.3)	1.4 (2.1)	0.21
Drugs Used During Most Recent OD (%)								
Heroin	51.9	58.7	48.9	0.13	64.4	68.9	62.5	0.35
Alcohol	31.0	35.7	29.1	0.23	40.0	31.6	42.2	0.28
Cannabis	25.4	43.9	18.1	<.001	21.7	47.8	21.1	0.02
Cocaine/Crack	26.5	43.1	19.7	0.001	30.5	48.0	24.3	0.03
Prescription Opioids	24.6	42.9	17.5	<.001	28.3	42.9	23.9	0.08
Methadone	9.3	6.0	10.5	0.26	4.5	0.0	5.6	0.40
Other medications ^b	21.7	35.7	16.2	<.01	25.3	38.1	21.4	0.11
Hallucinogens	6.7	11.5	4.9	0.10	7.6	14.3	5.6	0.19
Methamphetamine	6.0	15.4	3.4	<.01	7.7	25.0	2.8	<.01
Naloxone History								
Received naloxone prescription (%)	16.9	34.4	9.6	<.001	20.5	39.5	9.5	<.001
Trained to administer naloxone (%)	22.6	46.9	12.6	<.001	22.9	48.8	8.0	<.001
Trained to administer CPR (%)	49.2	59.4	45.0	0.01	46.6	62.7	37.3	<.01
Past 30 Day Risk Factors (%)								
Used opioids by themselves	55.1	41.9	60.3	0.001	60.1	37.8	74.4	<.001

	Entire Sample			Participants with History of Overdose				
	Total (N=345)	Rural (N=98)	Urban (N=247)	p-value	Total OD (N=123)	Rural OD (N=45)	Urban OD (N=78)	p-value
Number days past 30 (mean days, SD) ^a	2.0 (2.3)	1.2 (1.9)	2.7 (2.6)	<.001	2.1 (2.0)	1.0 (1.6)	3.2 (2.5)	<.001
Combining opioids with alcohol	45.6	32.6	50.1	<.01	61.2	38.9	64.1	<.001
Number days past 30 (mean days, SD) ^a	1.5 (2.0)	0.7 (1.5)	2.2 (2.6)	<.001	1.5 (1.9)	0.5 (1.2)	2.5 (2.5)	<.001
Using methadone	17.1	6.1	21.5	<.001	16.3	4.4	23.1	<.01
Number days past 30 (mean days, SD) ^a	0.3 (.93)	0.1 (.53)	0.5 (1.4)	<.01	0.3 (.85)	0.1 (.47)	0.5 (1.2)	0.06
Undergoing detoxification from opioids	48.5	10.2	64.3	<.001	49.6	6.7	75.0	<.001
Number days past 30 (mean days, SD) ^a	0.5 (.99)	0.2 (.71)	0.9 (1.27)	<.001	0.5 (.76)	0.1 (.25)	0.9 (1.3)	<.001
Been in jail or prison	7.2	7.1	7.3	0.58	6.5	8.9	5.1	0.32
Number days past 30 (mean days, SD) ^a	0.2 (.07)	0.1 (.45)	0.2 (.91)	0.29	0.1 (.39)	0.2 (.56)	0.1 (.22)	0.15

P-values based on Chi-squares for dichotomous variables and independent groups t-tests for continuous variables.

OD=overdose; SD=standard deviation

^aRepresents mean reported by participants who endorsed the event

^bDefined as stimulants and/or benzodiazepines

Table 3

Brief Opioid Overdose Knowledge (BOOK) Questionnaire

	Entire Sample			Participants with History of Overdose				
	Total (N=345)	Rural (N=98)	Urban (N=247)	p-value	Total OD (N=123)	Rural OD (N=45)	Urban OD (N=78)	p-value
Individual Items (% Correct)								
1. Long-acting opioids are used to treat chronic, “round-the-clock” pain (T)	55.1	47.9	58.1	0.06	66.7	55.6	73.3	0.04
2. Methadone is a long-acting opioid (T)	50.4	49.9	51.5	0.32	60.0	48.9	66.7	0.04
3. Restlessness, muscle and bone pain, and insomnia are symptoms of opioid withdrawal (T)	56.2	47.9	59.6	0.03	65.3	48.9	75.0	0.03
4. Heroin, OxyContin, and fentanyl are all examples of opioids (T)	58.0	50.0	61.6	0.03	66.7	55.6	73.3	0.04
5. Trouble breathing is not related to opioid overdose (F)	37.9	20.4	45.1	<.001	43.8	20.0	57.9	<.001
6. Clammy and cool skin is not a sign of an opioid overdose (F)	39.8	42.9	37.8	0.23	53.7	53.3	53.9	0.55
7. All opioid overdoses are fatal (deadly) (F)	49.1	43.9	51.3	0.13	55.9	53.3	57.5	0.40
8. Using a short-acting and a long-acting opioid at the same time does not increase your chance for an opioid overdose (F)	38.7	34.9	40.4	0.20	47.1	33.3	55.4	0.02
9. If you see a person overdosing on opioids, you can begin rescue breathing until health workers arrive (T)	51.3	41.9	55.2	0.02	59.5	48.9	65.8	0.051
10. A sternal rub helps you evaluate whether someone is unconscious (T)	33.8	33.7	33.9	0.54	38.0	33.3	40.8	0.27
11. Once you confirm the individual is breathing, you can place into the recovery position (T)	48.6	45.9	49.8	0.30	56.3	37.8	67.6	0.001
12. Narcan (naloxone) will reverse the effect of an opioid overdose (T)	47.8	49.0	47.5	0.43	57.1	51.1	60.8	0.20
Subscales (Mean, SD Correct)								
Opioid Knowledge (range 0–4)	2.1 (1.3)	1.9 (1.2)	2.2 (1.4)	0.08	2.5 (1.2)	2.1 (1.3)	2.9 (1.2)	0.001
Opioid Overdose Knowledge (range 0–4)	1.5 (1.2)	1.4 (.99)	1.7 (1.4)	0.10	1.9 (1.2)	1.6 (.99)	2.2 (1.4)	0.01
Opioid Overdose Response Knowledge (range 0–4)	1.7 (1.3)	1.7 (1.1)	1.8 (1.4)	0.61	2.0 (1.4)	1.7 (1.3)	2.3 (1.5)	0.02
BOOK Total Score (range 0–12)	5.4 (2.7)	5.1 (2.0)	5.7 (3.5)	0.10	6.4 (2.8)	5.4 (2.2)	7.4 (3.3)	0.01

P-values based on Chi-squares for dichotomous variables and independent groups t-tests for continuous variables. OD=overdose, T=True, F=False, SD=Standard Deviation