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Characterizing and Responding to Stimulant Overdoses: Findings from a Mixed Methods Study of People who Use Cocaine and Other Stimulants in New England

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Abstract

Purpose: To explore people who use stimulants' (PWUS) stimulant overdose experiences and identify factors associated with calling 911 for personal and witnessed stimulant overdoses.

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Contributions

JMWH, TCG, and JDR conceptualized the study and acquired funding. JMWH conceptualized and conducted the analysis, interpreted the findings, and wrote and edited the manuscript. All other authors helped to interpret the findings, reviewed and edited the manuscript, and approved the final manuscript.

AUTHOR DISCLOSURES

Declaration of Competing Interest

The authors report no declarations of interest.

Ethics Approval and Consent to Participate

Written informed consent was received from participants and stakeholders. All study procedures were approved by the Institutional Review Board at Brown University (2111003140).

Methods: From 2022–2023, 222 people in Massachusetts and Rhode Island with past-30-day illicit stimulant use were surveyed. Adjusted multivariable logistic regression models examined the association between sociodemographics, substance use, and stimulant overdose history and whether 911 was called for participants' last personally experienced and witnessed stimulant overdoses.

Results: Overall, 42.2% of PWUS witnessed- and 34.5% personally overdosed on stimulants. Nearly half (48.7%) of participants who overdosed used crack cocaine prior, 35.5% reported extremely severe symptoms (e.g., heart attack, stroke, seizure, loss of consciousness), and 34.2% said 911 was called at their last overdose. Among those who last witnessed a stimulant overdose, 41.5% reported crack cocaine involvement, and 47.9% said 911 was called (20.0% personally called). Higher educational attainment and experiencing extremely severe symptoms were positively associated with 911 being called at participants' last stimulant overdose, whereas the number of overdoses witnessed and crack cocaine use by the person overdosing were negatively associated with 911 being called at participants' last witnessed stimulant overdose (all p-values<.05).

Conclusion: Stimulant overdoses were common. Most participants reported moderate-to-severe symptoms, yet 911 was called in less than half of personal or witnessed stimulant overdoses. Emergency help-seeking also varied by symptom severity, stimulant type, and the sociodemographics of the person overdosing. Research is needed to understand barriers to formal help-seeking and the practices PWUS engage in to prevent fatal stimulant overdoses.

Keywords

stimulants; cocaine; crack; methamphetamine; overdose; toxicity; overamping; 911; emergency response

1. INTRODUCTION

The United States (US) has seen a drastic increase in overdose deaths involving illicit cocaine and other psychostimulants such as methamphetamine (Spencer et al., 2022). Indeed, the age-adjusted rate of overdose deaths increased from 1.3 and 0.2 per 100,000 for cocaine and other psychostimulants, respectively, in 2001 to 7.3 and 10.0 for cocaine and other psychostimulants, respectively, in 2021 (Spencer et al., 2022) The majority of stimulant-involved overdose fatalities in recent years have been driven by the voluntary or involuntary co-use of illicitly manufactured fentanyl—deaths that demarcate the 4th wave of the opioid overdose epidemic (CDC, 2024; Ciccarone, 2021; DEA, 2020; Hoots et al., 2020).[i] Still, fatal stimulant-induced overdoses that do not involve opioids have

[i]The CDC's State Unintentional Drug Overdose Reporting System (SUDORS) collects data on drug overdose deaths from death certificates, medical examiner or coroner reports, and postmortem toxicology results. Analysis of 2020 and 2022 data for the same 28 jurisdictions with available data on the CDC website as of September 5, 2024, shows that the total percentage of drug overdose deaths involving opioids without stimulants decreased from 48.05% in 2020 to 39.0% in 2022 across all jurisdictions. There was a slight increase in the percentage of drug overdose deaths involving stimulants without opioids (12.3% in 2020 to 14.1% in 2022) but a more substantial increase in the percentage of drug overdose deaths involving both opioids and stimulants (35.2% in 2020 to 43.4% in 2022). These data show that most of the overdose deaths involving stimulants are driven by the involvement of opioids. Additionally, the majority of all opioid-involved overdose deaths with and without a stimulant involved fentanyl (85.1% in 2020; and 91.2% in 2022), indicating that fentanyl, as opposed to other opioids (e.g., heroin, prescription opioids), is the primary driver of opioid-involved overdose deaths.

also risen in the US (CDC, 2024; Hoots et al., 2020; Kariisa et al., 2019), fueled by the availability and use of cocaine, methamphetamine, and counterfeit prescription stimulants (DEA, 2019, 2020; Kariisa et al., 2019). Although the rate of change in the years leading up to 2017 was substantially greater for fatal cocaine- and psychostimulant-involved overdose with opioids (annual percentage change [APC]: 46.0=cocaine with opioids 2014–2017; 50.5=psychostimulants with opioids, 2015–2017), relative to fatal overdoses without opioids (APC: 23.6,=cocaine without opioids 2014–2017; 22.6=psychostimulants without opioids, 2008–2017) (Hoots et al., 2020), the increase in stimulant overdoses not involving opioids still warrants public health attention. Further, while the spike in non-opioid stimulant-involved overdoses has been observed nationally and across racial/ethnic groups, Black and Hispanic people and those living in the Northeast region of the US have been disproportionately affected by this crisis (CDC, 2024; Kariisa et al., 2021; MDPH, 2020, 2023; RIDOH, 2022). Research with racially diverse people who use stimulants (PWUS) who witnessed or survived a stimulant overdose that did not involve opioids is needed to characterize these events and inform efforts to reduce stimulant-related morbidity and mortality across the US, particularly in hotspot regions.

Stimulant overdoses attributable to the use of powdered or crack cocaine, methamphetamine, or other stimulants without opioids are understudied. These events are distinct from opioid overdoses in that they are less likely to be fatal in people without pre-existing conditions (Carroll JJ, 2022; Suen et al., 2022). Cardiovascular events (e.g., myocardial infarction, stroke) are the primary mechanism through which stimulants lead to fatalities; thus, people with cardiovascular disease are at higher risk for fatal overdose from consuming stimulants in any quantity, but especially in high doses (Carroll JJ, 2022; Richards and Laurin, 2023; Richards and Le, 2023; SAMSHA, 2021; Suen et al., 2022; Trescot et al., 2008). Non-fatal stimulant overdoses may also manifest as aggressively violent behaviors and psychosis, which could result in secondary harms, including assault, homicide, and suicide (Armenian et al., 2019; Carroll JJ, 2022; SAMSHA, 2021; Van Loggerenberg, 2007; Zarrabi et al., 2016). Notably, relative to the psychological effects of cocaine intoxication, methamphetamine-induced psychosis (e.g., hallucinations and paranoia) is likely to persist longer (SAMSHA, 2021). Further, while high doses of any stimulant can be lethal, the long-acting and synthetic nature of methamphetamine may lead to more extensive central nervous system impairment, more prevalent and extreme psychological symptoms, and more overdoses following methamphetamine consumption relative to cocaine use (Carroll JJ, 2022; Richards and Laurin, 2023; Richards and Le, 2023; SAMSHA, 2021).

Current medical guidance underscores that for people experiencing a stimulant overdose, medical monitoring is necessary, and the medically supervised administration of benzodiazepines may be indicated to decrease agitation, psychosis, and prevent possible cardiovascular events (Carroll JJ, 2022; Richards et al., 2016; Richards and Laurin, 2023; Richards and Le, 2023; SAMSHA, 2021). Such care is typically best provided in an emergency department (Richards et al., 2016; Richards and Laurin, 2023; Richards and Le, 2023), though the self or peer administration of a benzodiazepine may occur (Carroll JJ, 2022; Mansoor et al., 2022). Of note, compared to the psychological effects of cocaine toxicity, individuals experiencing methamphetamine-induced psychosis may not respond as quickly to benzodiazepines, and the use of antipsychotics may be needed more often

(Richards and Laurin, 2023; SAMSHA, 2021). Despite clinical guidelines calling for formal medical intervention for stimulant overdoses (Carroll JJ, 2022; SAMSHA, 2021), the extent to which people overdosing or witnessing a stimulant overdose call 911 to receive formal emergency medical treatment is understudied.

For individuals experiencing or witnessing a stimulant overdose to be motivated to call 911, they must first be able to identify the symptoms of stimulant toxicity, recognize the severity of the symptoms and the urgent need for formal medical care, and be willing to engage with the emergency response system. Yet, few studies have explored what PWUS know about stimulant overdoses. A qualitative study conducted in Vancouver, Canada, between 2019 and 2020 found that PWUS were able to identify some of the symptoms of stimulant toxicity, including elevated heart rate, unconsciousness, cardiac arrest, and seizures. Despite this awareness, the study found that there was no unified understanding of a stimulant overdose as there is with an opioid overdose, which impacted PWUS' ability to adequately respond to these events, including knowing when symptoms were severe enough to warrant calling paramedics to provide formal medical care (Mansoor et al., 2022). Another qualitative study conducted in Nevada and New Mexico between 2019 and 2020 found that people who use methamphetamine describe stimulant toxicity or "overamping" along a continuum from less to more severe (Harding et al., 2022). Moreover, none of the participants in these studies reported personally witnessing a fatal methamphetamine overdose, and few reported personal or witnessed methamphetamine overdoses in which formal medical care was sought (Harding et al., 2022; Mansoor et al., 2022).

In both of the aforementioned studies (Harding et al., 2022; Mansoor et al., 2022), many participants indicated that formal medical attention was only needed for individuals experiencing severe or concerning methamphetamine or cocaine-induced overdose symptoms that could not be managed using available resources. Although it is possible that the perceived severity of symptoms in the absence of effective self-management resources is the primary impetus for calling paramedics in response to a stimulant overdose, research conducted with people who use opioids and other drugs has identified several factors associated with emergency help-seeking that might be applicable to stimulant overdoses (Karamouzian et al., 2019; Moallef et al., 2021; Tobin et al., 2005; Wagner et al., 2021; Zadoretzky et al., 2017). For example, several US studies found that even when state Good Samaritan Laws provide bystanders and those experiencing a drug overdose with some immunity from prosecution for possessing a controlled substance or drug paraphernalia, many bystanders do not call 911 for fear of arrest (Koester et al., 2017; Latimore and Bergstein, 2017; Pamplin et al., 2023). Bystander fears about calling 911 are often driven by the fact that law enforcement officers are routinely among the first responders, and Good Samaritan Laws typically include caveats that allow police officers to arrest bystanders and those experiencing an overdose if, for example, they have outstanding warrants, probation or parole violations, are carrying weapons, or are believed to be involved in drug distribution (Koester et al., 2017; Latimore and Bergstein, 2017; Pamplin et al., 2023; Wagner et al., 2019). Relatedly, several states, including Rhode Island, have drug-induced homicide laws that may result in bystanders being reluctant to call 911 for fear of being arrested and incarcerated for homicide when they supplied the drug to the person overdosing (Beletsky, 2019; Carroll et al., 2023; Peterson et al., 2019). Police violence toward people who use

drugs may also lead bystanders to avoid calling for emergency services, particularly for Black people (Bowleg et al., 2020; Latimore and Bergstein, 2017) who have been shown to be incarcerated more frequently than other racial groups following 911 overdose-related help-seeking (Ray et al., 2022). While 911 avoidance in the event of a stimulant overdose may be a rational choice, doing so likely contributes to racial/ethnic disparities in fatal stimulant-involved overdoses (Kariisa et al., 2021; MDPH, 2023; RIDOH, 2022).

Although prior research has largely focused on barriers to calling 911 in response to opioid or drug overdoses more generally, a few studies have also identified facilitators of 911 help-seeking in response to such events. Indeed, opioid or polysubstance overdose research conducted in the US and Canada finds that having ever witnessed a fatal overdose, the number of overdoses witnessed, losing a friend or family member to an overdose, having female bystanders present, witnessing an overdose involving a male, and the type (e.g., naloxone, rescue breathing) and effectiveness of the overdose response strategies initially employed were all associated with the increased likelihood of calling 911 (Karamouzian et al., 2019; Tobin et al., 2005; Wagner et al., 2021; Zadoretzky et al., 2017). While prior research offers insights into facilitators and barriers to soliciting emergency medical care in response to drug overdoses, generally, stimulant overdoses are distinct from opioid and other drug overdoses. Given the steady rise in US fatal overdoses involving stimulants without the presence of opioids (CDC, 2024; Hoots et al., 2020; Kariisa et al., 2019), research is needed to understand how PWUS in the US understand, experience, and respond to stimulant overdoses.

To fill gaps in the literature, we administered closed and open-ended survey questions to PWUS in New England cities disproportionately affected by fatal stimulant-involved overdose deaths. We used these data to [1] explore how PWUS characterize stimulant overdoses; [2] describe PWUS' personal and witnessed stimulant overdose experiences; and [3] identify factors associated with calling 911 at PWUS' last personal and witnessed stimulant overdoses. Findings from this study can help to identify gaps in PWUS' preparedness and willingness to respond to a stimulant overdose and inform future interventions aimed at reducing stimulant-involved overdose fatalities in high-risk regions across the US and beyond.

2. MATERIAL AND METHODS

Survey data were collected from 230 PWUS between March 2021 and June 2023, starting with Greater Providence, Rhode Island, followed by Lawrence, Lynn, and Brockton, Massachusetts. These sites were selected as they had some of the highest rates of fatal stimulant-involved overdose deaths in New England between 2018 and 2020 (CDC, 2024). Extensive details on the Preventing Overdoses Involving stimulaNT Study (POINTS) recruitment and data collection methods are described elsewhere (Hughto et al., 2024). Briefly, POINTS used a modified respondent-driven sampling approach to recruit PWUS at four community sites. Individuals were eligible for the study if they: 1) were 18 years of age or older; 2) able to speak and understand English or Spanish; 3) used an illicit stimulant in the past 30 days; 4) lived in or spent the majority of their time in one of the four geographic locations; and 5) were willing and able to provide informed consent.

Consented participants completed an approximately 45-minute, interviewer-administered survey on a tablet. The survey was programmed into Qualtrics, a secure web-based survey administration tool. The survey assessed sociodemographic characteristics, drug use history, stimulant overdose knowledge, and stimulant overdose history. Participants received $20 for completing the survey. The study was approved by the Brown University Institutional Review Board.

2.1 Measures

Sociodemographics.—Age was assessed in years. Sex (assigned at birth) was assessed as male or female. Gender categories included man, woman, non-binary, and prefer not to answer. Race and Hispanic ethnicity were assessed independently and combined as Hispanic and non-Hispanic White, Black, Native American, and multi-racial/ethnic. Educational attainment was categorized as some high school or less; high school graduate or GED; and some college or more. Lifetime and past-12-month drug distribution history were also assessed (yes/no).

Stimulant and Opioid Use History: Participants were asked to report their lifetime and past-30-day use of illicit stimulants (crack cocaine, powdered cocaine, methamphetamine). Since some participants also reported using opioids in the past 30 days or in their lifetime, we stratified this sample of PWUS according to their opioid use history. Specifically, participants were asked, “At any point in your life, did you regularly use heroin, fentanyl, or prescription opioids like OxyContin, Percocet, or Vicodin?” Using an approach from the literature (Hughto et al., 2022), PWUS who said no were categorized as having *Never used opioids regularly*; those who said yes but did not report using opioids in the past 30 days were categorized as *Past history of regular opioid use*; and PWUS who used opioids in the past 30 days were categorized as having *Used opioids in the past 30 days.*[ii]

Good Samaritan Law Knowledge: Participants were asked if they had ever heard of the Good Samaritan Law in their state (yes/no). Those who answered yes were asked to describe what the law does via an open-response item. Responses were reviewed and coded as correct vs. incorrect based on the Massachusetts and Rhode Island Good Samaritan laws, which provide legal protections for people who seek medical assistance for someone experiencing a drug or alcohol overdose (Mass Gen Laws, 2012; R.I. Gen Laws, 2016).

Stimulant Overdose Perceptions and Characterization: Given the lack of a unified definition for stimulant overdose reported by PWUS in a 2022 study (Mansoor et al., 2022), participants enrolled in 2023 (n=59) were asked whether they thought it was “possible to overdose off of a stimulant, such as cocaine, crack, meth” (yes/no). Those who said no were asked to explain their response. Open-ended responses were coded to produce five non-mutually-exclusive categories: Not possible from stimulants alone - pre-existing condition is the cause; Not possible from stimulants alone - other drugs must be present; stimulants are uppers; unfamiliar with a stimulant overdose; and other. Those who indicated yes –

[ii]Among those who used opioids in the past 30 days, a reported using fentanyl or heroin; a subset also reported using fake (i.e., pressed) or real non-prescribed (i.e., prescribed to others) opioid pain medication.

stimulant overdoses are possible, were asked to describe a stimulant overdose. Open-ended responses were coded to produce 14 physical symptom categories (heart attack; trouble breathing; rapid heart rate; loss of consciousness; chest pains; seizure; stroke; shaking; sweating; restlessness; turning blue; rigid limbs; thirsty or dehydrated; other physical symptoms), two psychological symptom categories (paranoia, anxiety, panic attack; and obsessive behavior or aggression), and a don't know/unsure category – all non-mutually exclusive.

Personally Experienced Stimulant Overdose History: All participants were provided with a definition[iii] of a stimulant overdose developed by the first and senior authors using harm reduction, substance use treatment, and national public health resources (Carroll JJ, 2022; HRC, 2020; SAMSHA, 2021; Smith, 2020). After reviewing the definition, participants indicated how many times they had personally experienced a stimulant overdose (count); responses were dichotomized as any personal stimulant overdose experience (yes/no). Participants who had experienced a stimulant overdose were asked what stimulants they had consumed prior to their last event (check all that apply): crack cocaine, powdered cocaine, methamphetamine, and amphetamines (e.g., Ritalin, Adderall).

Participants were provided with a list of 16 stimulant overdose symptoms and an open-ended question that was open-coded to create additional symptom items. Drawing on the literature, input from an addiction medicine physician, and people with lived experience, we categorized the symptoms as Extremely Severe Symptoms (loss of consciousness, seizure, stroke, blindness, heart attack) and Moderate-to-Severe Symptoms (chest pains, rapidly increasing body temperature, rapidly increasing pulse, severe sweating, irregular breathing, nausea, vomiting, diarrhea, severe headache, jerking or rigid limbs, extreme anxiety or panic, extreme paranoia, confusion, hallucinations, aggression or agitation). These two items were then further combined to create a single indicator of symptom severity: Moderate-to-Severe Symptoms Only vs. Any Extremely Severe Symptoms.

Participants were also asked about the perceived cause of their last personal stimulant overdose. Open-ended responses were coded to create eight categories: consumed high quantity of stimulants; consumed high potency drug; consumed low-quality drug (e.g., bad cut); being run down (e.g., dehydrated, lack of sleep); modality (e.g., injection) induced; polysubstance use; low tolerance for stimulants; and other.

Outcome 1: Participants were asked if 911 was called at their last personal stimulant overdose (yes/no). Those who said "yes" were asked who called 911 (not mutually exclusive): friend, family, Good Samaritan/stranger, don't know. Those who had personally experienced a stimulant overdose were asked if they went to the hospital or emergency department following the overdose.

[iii]Stimulants include amphetamines (speed, prescription amphetamines like Adderall), crystal meth, powdered cocaine and crack, and MDMA (Ecstasy). Because stimulants or "uppers" speed the body up, a stimulant overdose is also called "overamping" or stimulant toxicity. It can happen when you take too much of a stimulant, mix stimulants with other drugs, have health issues that are triggered by stimulants, and for other reasons. Signs and symptoms of a stimulant overdose that could cause harm include chest pains, overheating, irritability or hypervigilance, panic or extreme anxiety, dizziness, confusion, hallucination, psychosis, nausea or vomiting, jerking or rigid limbs, hypertension or hypertensive crisis, fast heart rate or arrhythmia. Stimulant overdose symptoms may worsen and can result in life-threatening conditions and even death.

History of Witnessed Stimulant Overdose.—All participants were also asked to indicate how many times they witnessed a stimulant overdose (count); responses were reported as a continuous score and dichotomized as any witnessed stimulant overdose (yes/no). Participants who had witnessed a stimulant overdose were asked what the person had consumed prior to the overdose (check all that apply): crack cocaine, powdered cocaine, methamphetamine, and amphetamines.

Outcome 2: Participants were asked if 911 was called at the last witnessed overdose (yes/no). If yes, participants were asked who called 911 (not mutually exclusive): personally called, friend, family, Good Samaritan/stranger, other, and don't know.

2.2 Data Analysis

Initial data cleaning was performed in SPSS 24; all subsequent analyses were conducted in SAS 9.4. Distributions of individual items were assessed for outliers and missingness. Of the 230 PWUS sampled in the parent study, eight were excluded as they had missing data for one or more primary outcomes, resulting in a final analytic sample of 222. Since missingness for all other items was less than 10% (Bennett, 2001), imputation was not used for single-item measures with some degree of missingness (see Tables 1–5 for information on the analytic sample size for each variable).

Descriptive statistics (frequencies, means, standard deviations [SD], interquartile range [IQR], min/max range) were used to summarize the frequency of all variables. Since the stimulant overdose perceptions and characterization questions were only assessed among a small subset of the sample (n=59), regression analyses were not possible. Thus, the associations between participant characteristics and the perceived plausibility of a stimulant overdose were explored via t-tests (continuous variables) and chi-square and Fisher's exact tests (categorical variables) and reported as supplementary findings. Additionally, due to different sample sizes, we explored differences between the full sample (N=222), the aforementioned subsample (N=59), and the 911 help-seeking outcomes (personal overdose N=74; witnessed overdose N=94); only one significant difference was identified: 41.1% of those who personally overdosed had some college education or higher vs. 28.4% of the full sample; p=0.02.

Bivariate logistic regression analyses were used to examine the association between sociodemographics, substance use history, Good Samaritan Law knowledge, and personal and witnessed stimulant overdose history. Factors associated with each outcome at $p \leq 0.20$ in the bivariate analyses were initially entered into the respective multivariable models. The final multivariable models adjusted for sex and race/ethnicity; significance was determined at $p<0.05$.

3. RESULTS

3.1 Characteristics of the Sample

As shown in Table 1, the mean age of the sample was 43.6 (SD=10.9; IQR=16; Range: 23–73). Most of the sample was assigned male sex at birth (65.8%), identified as White, non-Hispanic (51.4%); and earned a high school degree or less (71.6%). Crack cocaine was

the most frequently used stimulant in the past 30 days (92.8%). The majority sample had used stimulants and opioids in the past 30 days (65.9%). Overall, 79.2% of the sample had heard of the Good Samaritan Law; 59.3% described it correctly.

3.2 Characterizing a Stimulant Overdose

The majority (74.6%) of the 59 participants who were asked whether they believed it was possible for someone to overdose on a stimulant indicated that it was possible (Table 2). Of the 15 who initially did not think a stimulant overdose was possible, three indicated that pre-existing conditions could lead to a heart attack or seizure following stimulant consumption; three indicated that other drugs, such as fentanyl, needed to be involved to overdose; two reported that an overdose could not occur with an “upper”; three provided other responses (e.g., “scientifically it is not possible”), and four people could not articulate their rational due to lack of familiarity with stimulant overdoses.

Participants who believed that a stimulant overdose was possible (n=44), as well as four of those who initially said such events were not possible, went on to describe the characteristics of a stimulant overdose (n=48; Table 3). Participants predominately described physical health conditions, citing common adverse outcomes, including a heart attack (50.0%); trouble breathing (22.9%); rapid heart rate (20.8%); loss of consciousness (16.7%); chest pains (14.6%); seizure (10.4%); and stroke (10.4%). Psychological symptoms were less commonly endorsed, with 10.2% of participants attributing paranoia, anxiety, or a panic attack to a stimulant overdose.

In supplementary analyses (Supplementary Table A), 80.0% of males reported that it was possible to overdose on a stimulant, compared to 63.2% of females. Additionally, 87.0% of people who used powdered cocaine and 100% of those who used methamphetamine in the past 30 days reported that it was possible to overdose on a stimulant, compared to 66.7% and 71.2% of those who had not used powdered cocaine and methamphetamine, respectively ($p<.20$).

3.3 Personal Stimulant Overdoses

After defining a stimulant overdose for all participants (N=222), they were asked about their personal or witnessed stimulant overdose experiences (Table 4). Overall, 34.2% of the sample had personally overdosed on stimulants. Among those who personally overdosed (n=76), the average number of lifetime stimulant overdoses was 15.2 (SD=31.6; IQR=4.5). The most commonly endorsed stimulant used prior to participants’ last overdose was crack cocaine (48.7%).

Most of those who overdosed (n=76) endorsed moderate-to-severe symptoms at their last stimulant overdose (82.9%), with severe sweating (52.6%), extreme anxiety or panic (52.6%), and rapidly increasing pulse (50.0%) being the most commonly endorsed symptoms in this category. However, more than a third also reported extremely severe symptoms (35.5%), with loss of consciousness being the most commonly endorsed symptom in this category (26.3%). Additionally, when asked about the cause of their last stimulant overdose, 39.5% attributed it to consuming a high quantity of stimulants, 25.0% to

consuming a highly potent drug, and 18.4% to consuming a low-quality drug (e.g., one with contaminates).

More than one-third (34.2%) reported that 911 was called in response to their last personal stimulant overdose, of which 46.2% (n=12/26) did not know who called 911, 23.1% indicated that a friend called, and 19.2% reported that a family member called. Less than one-third (28.9%) reported being taken to the hospital following their last overdose.

3.4 Witnessed Stimulant Overdoses

Overall, 42.3% of the full sample had witnessed a stimulant overdose. Among the 94 people who had witnessed a stimulant overdose, the average number of overdoses witnessed was 20.0 (SD=32.8; IQR=11.0), and the average number of years since the last overdose was 2.6 (SD=5.8; IQR=2.0). Participants reported that crack cocaine was involved in 41.5% of their last witnessed stimulant overdose.

Nearly half of the participants (47.9%) reported that 911 was called in response to their last witnessed stimulant overdose. Of those who reported that 911 was called, 42.2% did not know who called, and 20.0% said they personally called 911.

3.5 Factors Associated with 911 Being Called at Last Personal or Witnessed Stimulant Overdose

In the first adjusted, multivariable regression model (Table 5), having some college education or more (ref=high school degree or GED; aOR=6.80; 95% CI=1.29–36.01); and experiencing extremely severe symptoms (ref= moderate-to-severe symptoms only; aOR=5.25; 95% CI=1.42–19.40) were positively associated with 911 being called at participants' last personal stimulant overdose.

In the second adjusted, multivariable regression model (Table 5), number of overdoses witnessed (aOR=0.99; 95% CI=0.96–0.995) and the use of crack cocaine by the person overdosing (ref=no; aOR=0.26; 95% CI=0.10–0.70) were negatively associated with 911 being called at participants' last witnessed stimulant overdose.

4. DISCUSSION

Fatal overdose attributable to stimulants without opioids (CDC, 2024; Hoots et al., 2020; Kariisa et al., 2019) is an urgent public health problem that underscores the need to characterize these events and understand barriers to the receipt of emergency medical care so that effective interventions can be developed. Most prior quantitative research has focused on responses to opioid or other drug overdoses (Karamouzian et al., 2019; Tobin et al., 2005; Wagner et al., 2021; Zadoretzky et al., 2017), and qualitative stimulant overdose research has been primarily conducted in the western region of North America (Harding et al., 2022; Mansoor et al., 2022; Stoner et al., 2018), where methamphetamine is more available and involved in more fatal overdoses than in the Northeast (CDC, 2024; DEA, 2019, 2020). Our novel findings show that the PWUS surveyed in New England are generally adept at identifying one or more stimulant overdose symptoms. Results also suggest that educational attainment and symptom severity may facilitate 911 help-seeking for personal stimulant

overdoses, whereas more exposure to stimulant overdoses and the use of crack cocaine by the person overdosing may act as a barrier to calling 911 for witnessed stimulant overdoses. The results of this study can inform future research and interventions aimed at increasing 911 help-seeking in response to a stimulant overdose.

To reduce fatal overdoses involving stimulants without opioids, it is essential that PWUS recognize the signs and symptoms of stimulant toxicity so that they can intervene to prevent stimulant-related morbidity and mortality. Extending qualitative research conducted on the West Coast (Harding et al., 2022; Mansoor et al., 2022), PWUS in our New England-based study who experienced a stimulant overdose endorsed common psychological and physiological stimulant overdose symptoms (Carroll JJ, 2022; Richards and Laurin, 2023; Richards and Le, 2023) and recognized the role of stimulant potency, tolerance, high doses, and modality in contributing to their last stimulant overdose. However, a quarter of those who were asked did not believe that a stimulant overdose was possible as many associated overdoses with opioid use; believed that drugs other than “uppers” needed to be involved to overdose; or believed that someone would need to have other health issues for stimulant use to result in adverse health effects. Further, supplementary analyses of a subset of participants who all used crack revealed that 100% of those who used methamphetamine in the past 30 days (vs. 72.2% of those who did not) believed that a stimulant overdose was possible. The greater recognition that stimulants can lead to an overdose among people who use methamphetamine may be due to the fact that methamphetamine toxicity often yields more visibly-concerning psychological and physical symptoms, even at lower doses, and can be more treatment-resistant relative to cocaine-induced overdose symptoms (Carroll JJ, 2022; Richards and Laurin, 2023; Richards and Le, 2023; SAMSHA, 2021).

Documented differences (e.g., Palamar et al., 2015) between people who use crack vs. powdered cocaine might also contribute to variability in stimulant overdose perceptions and related outcomes among PWUS. In supplemental analyses, a higher proportion of participants who used powdered cocaine in the past 30 days endorsed the plausibility of a stimulant overdose compared to those who only used crack. Given that powdered cocaine is more expensive than crack and is more often used among employed people and those with higher educational attainment (Palamar et al., 2015), it is possible that the greater recognition of stimulant overdose plausibility among people who use powdered cocaine may be due to differential exposure to stimulant overdose risks and prevention education among higher socioeconomic status participants. These findings underscore that PWUS are a heterogeneous group and different harm reduction approaches and messaging may be needed to educate this diverse population on the potential for all forms of stimulants to produce life-threatening overdose symptoms.

We also found that the prevalence of emergency help-seeking by the participant or another bystander following a stimulant overdose was markedly lower than reported in North American studies examining 911 help-seeking in response to opioid overdoses (Jakubowski et al., 2018; Moallef et al., 2021; Wagner et al., 2021; Zadoretzky et al., 2017), though comparable to a West Coast study examining stimulant overdose help-seeking among people who use methamphetamine (Stoner et al., 2018). Unlike opioid overdoses, PWUS may not believe that stimulant overdose symptoms are severe enough to warrant formal medical

attention (Mansoor et al., 2022). To that end, the vast majority of participants in our study who last experienced a stimulant overdose reported moderate-to-severe symptoms, and only extremely severe symptoms, which were less frequently endorsed, were associated with increased odds of 911 being called. Further, the number of witnessed events was negatively associated with 911-help seeking, which could suggest a “normalization” effect (Song et al., 2023). The extent to which repeated exposure to stimulant overdoses reduces peoples’ conceptualization of these events as life-threatening emergencies that warrant 911 intervention remains to be quantitatively explored.

Additionally, we found a significant protective association between knowledge of Good Samaritan Laws and 911 help-seeking for personal or witnessed stimulant overdoses. Qualitative research finds that people who use opioids and other drugs may not trust the police to intervene due to the limitations of Good Samaritan Laws and aggressive police responses (Koester et al., 2017; Latimore and Bergstein, 2017; Pamplin et al., 2023). People with negative encounters with first responders, particularly law enforcement, may be uniquely reluctant to call 911 (Collins et al., 2019; Palamar et al., 2015; Wagner et al., 2019). Further, crack cocaine use, which is heavily criminalized and has led to the disproportionate incarceration of Black versus white PWUS (Palamar et al., 2015; Pamplin et al., 2023; Ray et al., 2022), was associated with decreased odds of calling 911 for a witnessed stimulant overdose in our study. It is possible that bystanders may be more reluctant to call 911 for crack cocaine overdoses when the person overdosing is Black due to excess policing and criminalization of crack use in Black populations, as well as the presence of drug-induced homicide laws (Beletsky, 2019; Palamar et al., 2015; Pamplin et al., 2023; Ray et al., 2022). Qualitative research is needed to explore how the race/ethnicity of the bystanders, people overdosing, and the drug used impact 911 help-seeking for stimulant overdoses, specifically.

It is also possible that people who have frequently observed or personally experienced crack or other stimulant overdoses have been able to self-manage overdose symptoms without calling 911. Self-management of stimulant overdoses had been reported among PWUS in prior research (Harding et al., 2022; Mansoor et al., 2022) and includes practices such as waiting it out, trying to rehydrate, or using another substance (e.g., benzodiazepines) to come down. As shown in our data and the literature, paranoia and hallucinations are common symptoms of a stimulant overdose, particularly following methamphetamine consumption (Carroll JJ, 2022; Richards and Laurin, 2023; Richards and Le, 2023; SAMSHA, 2021). Paranoia may amplify police fears and lead to further avoidance of 911 help-seeking. Further, due to the potential volatility of people experiencing extreme stimulant-induced paranoia (Carroll JJ, 2022; SAMSHA, 2021), bystanders may also be more reluctant to intervene by calling 911 and instead opt to provide such individuals with the time and space to come down without formal medical intervention (Harding et al., 2022; Mansoor et al., 2022). Further, given the potential consequences of engaging law enforcement (Koester et al., 2017; Latimore and Bergstein, 2017; Pamplin et al., 2023), PWUS may be more likely to avoid calling 911 for a stimulant overdose, particularly when symptoms are not severe or more psychological in nature. Qualitative research with PWUS in New England is needed to further explore the contexts and considerations shaping bystanders’ decisions to call 911 for stimulant overdoses, including how symptom severity

is assessed, the risks and benefits that bystanders consider when deciding to call 911, the efficacy of self-treatment approaches that PWUS may employ to manage stimulant overdose symptoms, and the first responder practices that may hinder or facilitate future help-seeking behavior.

Finally, our study found that more than one-third of the sample personally experienced a non-fatal stimulant overdose, and about two-fifths witnessed a stimulant overdose. The frequency of these events is higher than reported in quantitative research with people who use methamphetamine in Washington state (Stoner et al., 2018) and lower than reported in a qualitative study of PWUS in Vancouver, Canada (Mansoor et al., 2022). It is possible that these differences may represent regional variations in the demographics of PWUS or the contents of the stimulant supply, or differences in how stimulant overdose experiences are assessed (Ciccarone, 2021; DEA, 2019, 2020; Hébert and Hill, 2024; SAMSHA, 2024). To that end, the term “overdose” is commonly used in relation to opioid consumption, and due to the pervasiveness and routinely life-threatening nature of opioid overdoses, the symptoms of opioid overdoses may be better understood by PWUS, bystanders, and even first responders than those of stimulant overdoses (Carroll JJ, 2022; Mansoor et al., 2022). To ensure an accurate assessment of stimulant overdose prevalence, we presented participants with a data-informed definition of stimulant overdoses before asking them to report the frequency of their personal or witnessed stimulants. This approach is in contrast to other studies that asked PWUS to describe their experiences of a stimulant overdose or overamping but do not appear to have provided a common definition of these terms (Harding et al., 2022; Mansoor et al., 2022; Stoner et al., 2018). The lack of consistent terminology used to describe a stimulant overdose (e.g., toxicity event, overamping, overdose) not only poses a problem for accurately documenting the prevalence of these events, but terms like overdose may convey greater symptom severity than terms like overamping. Further, the differential use of these terms by people experiencing an overdose, bystanders, 911 dispatchers, and first responders during acute stimulant overdose events could lead to differences in emergency response times based on the perceived severity of symptoms and the employment of overdose response strategies with varying degrees of efficacy (e.g., naloxone does not work on stimulant overdoses) (Carroll JJ, 2022; Harding et al., 2022; Lim et al., 2019; Mansoor et al., 2022; Mayer et al., 2018; McCann et al., 2021; Neely et al., 2000; Nehme et al., 2016; Vaillancourt et al., 2011; Wilde, 2013). Given the potentially fatal implications of using diffuse terminology to refer to a stimulant overdose, there is an urgent need to identify a shared vernacular for stimulant overdoses to facilitate the seeking out of medical care when indicated and prevent stimulant overdose-related morbidity and mortality.

4.1 Limitations

The main outcomes of this analysis focused on participants’ last personal and witnessed stimulant overdose, which may not be representative of all of their stimulant overdose experiences. Additionally, we relied on self-reported data, which is subject to recall bias. Further, we were only able to assess personal overdose experiences among people who survived a stimulant overdose. It is possible that people who had more severe stimulant overdose symptoms did not survive their last overdose and were, therefore, not included in this study. Also, we did not add questions on stimulant overdose perceptions and

characterizations until 2023. Although this late addition means that we were only able to assess stimulant overdose perceptions among a subset of the sample, the full sample (n=222) and the subsample (n=59) were demographically very similar. Additionally, describing stimulant overdoses (without opioids) was a secondary aim of the study; as a result, we did not assess all potential variables that have been shown to be related to 911 help-seeking for drug overdoses. Future mixed methods research should aim to explore a broader set of individual, drug, and environmental factors that may shape emergency help-seeking following a stimulant overdose. Finally, although this research was conducted in states with some of the highest rates of stimulant overdoses nationally, findings may not be generalizable to other regions of the US. National research that examines how PWUS characterizes stimulant overdoses and identifies factors related to 911 help-seeking following a stimulant overdose is warranted.

5. CONCLUSION

This study is one of the first to characterize stimulant overdoses and identify risk and protective factors associated with 911 help-seeking among PWUS in the northeastern US. We found that although PWUS were able to characterize common symptoms of a stimulant overdose, there was notable variability in the types and severity of symptoms reported. Additionally, higher educational attainment and symptom severity were positively associated with 911 being called for personal overdoses, whereas the number of overdoses witnessed and the use of crack cocaine by the individual overdosing were negatively associated with 911 being called for witnessed stimulant overdoses. Findings point to the need to develop a unified vernacular and understanding of these events to facilitate 911 help-seeking when indicated and reduce stimulant overdose-related morbidity and mortality in New England and other high-overdose regions of the US.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Availability of Data and Materials

All data and materials will be made publicly available in accordance with our data management plan. Interested persons should contact the first author to request access to the data and materials.

GLOSSARY

Stimulant overdoses
refer to stimulant toxicity events caused by the consumption of cocaine, methamphetamine, amphetamine, or other stimulants and do not involve the consumption of opioids

Stimulant and opioid-involved overdoses
refer to overdose toxicity events following the consumption of cocaine, methamphetamine, amphetamine, or other stimulants and opioids such as heroin, fentanyl, or prescription opioid pain medication. These events can occur following the known consumption of stimulants and opioids or the unknowing consumption of fentanyl and other opioids that may be present in the illicit stimulant supply

Stimulant-involved overdoses
refer to overdose toxicity events following the consumption of cocaine, methamphetamine, amphetamine, or other stimulants. This term is an umbrella term for any overdose in which stimulants were consumed but lacks specificity regarding the cause of the overdose. For example, stimulant-involved overdoses can include overdoses caused by stimulants only or overdoses caused by the knowing or unknowing consumption of stimulants together with opioids or other drugs

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HIGHLIGHTS

- Personal and witnessed stimulant overdoses were commonly reported in this New England sample of PWUS
- Most PWUS accurately characterized stimulant overdoses but reported symptoms varied
- Although PWUS could recognize severe symptoms, 911 help-seeking was suboptimal
- Help-seeking varied by symptoms, drugs used, and the sociodemographics of the person overdosing
- Interventions are needed to increase 911 help-seeking for stimulant overdoses

Table 1.

Characteristics of people who use stimulants (PWUS) (N=222).

SOCIO-DEMOGRAPHICS		
Age (n=221)	**Mean**	**SD**
Mean | SD	43.6	10.9
IQR | Range	16	23–73
Sex & Gender	**N**	**%**
Male	146	65.8
Gender: Man	145	65.3
Gender: Nonbinary	1	0.5
Female	76	34.2
Gender: Woman	75	33.8
Gender: Nonbinary	1	0.5
Prefer not to answer		
Race/Ethnicity	114	51.4
White, non-Hispanic	60	27.0
Hispanic	34	15.3
Black, non-Hispanic	3	1.4
Native American, non-Hispanic	11	5.0
Multi Racial, non-Hispanic		
Educational Attainment	68	30.6
Some high school or less	91	41.0
High school graduate or GED	63	28.4
Some college or more	43.6	10.9
STIMULANT & OPIOID USE HISTORY		
Stimulants Use History		
Lifetime		
Crack Cocaine	212	95.5
Powdered Cocaine	215	96.8
Methamphetamine	130	58.6
Past 30 Days		
Crack Cocaine	206	92.8
Powdered Cocaine	124	55.9
Methamphetamine	51	23.0
Opioid Use History among PWUS		
Never used opioids regularly	44	19.8
Past history of regular opioid use	32	14.4
Used opioids in past 30 days	146	65.8
GOOD SAMARITAN LAW KNOWLEDGE (n=221)		
Heard of the Law		
No	46	20.8

SOCIO-DEMOGRAPHICS		
Age (n=221)	**Mean**	**SD**
Yes	175	79.2
Correctly Described the Law		
No	90	40.7
Yes	131	59.3

Note. SD=standard deviation. IQR=interquartile range (i.e., the difference between 25th and 75th percentiles. Range=minimum and maximum values. The reported n makes up the numerator of the reported percentage (%). The denominator is the analytic sample of 222 unless otherwise indicated (e.g., for the Good Samaritan Law Knowledge variables, the denominator is 221).

Table 2.

Stimulant Overdose Perceptions (N=59) [a]

	N	%
IS IT POSSIBLE TO "OVERDOSE" ON STIMULANTS?		
Yes	44	74.6
No	15	25.4
PRIMARY REASON WHY A STIMULANT OVERDOSE IS IMPOSSIBLE (n=15) [b]		
Not possible from stimulants alone - Pre-existing condition is the cause	3	20.0
You can have a heart attack but not overdose.		
From my experience, I have done a lot of stimulants and I have never overdosed. I have seen people go into seizures but I'm not sure if that is from the drugs or from the person having a problem.		
Not possible from stimulants alone - Other drugs must be present	3	20.0
I think [a stimulant] *has to be used with other drugs. It is hard to explain. I guess you can if you do too much coke and alcohol. But I don't know anyone who has experienced that. You hear about it, but I don't have personal experience with that or someone telling me about that.*		
Because there's not really anything that can make you overdose unless it was laced.		
Fentanyl needs to be involved.		
Stimulants are uppers	2	13.3
Because it's an upper.		
Unfamiliar with a stimulant overdose	4	26.7
Not familiar with that.		
I don't know, it just never happens. I never hear of it happening.		
Other		
Scientifically think it's not possible.	3	20.0

Note. Responses were entered into the electronic survey instrument by the survey administrator and do not necessarily represent participants' verbatim responses.

[a] These questions were only assessed at the last data collection site in Brockton, Massachusetts (n=59).

[b] Primary reason: open-ended responses were coded and quantified, categories are not mutually exclusive.

Table 3.

Characterizing a stimulant overdose (N=48).

Category	N	%	Example Response
PHYSICAL SYMPTOMS			
Heart Attack	24	50.0	*Your heart is going to come out of your chest. It is like a heart attack basically.*
Trouble breathing	11	22.9	*They start breathing weird and snorkeling sounds happen with heavy breathing.*
Rapid heart rate	10	20.8	*Heart goes crazy, everyone says it's scary - described as worse than overdosing on an opioid.*
Loss of consciousness	8	16.7	*They pass out. Some people fall.*
Chest pains	7	14.6	*Chest pain and gasp for air.*
Seizure	5	10.4	*Foaming at the mouth, shaking, eyes rolling back.*
Stroke	5	10.4	*It speeds up your heart rate, so you could get some sort of a stroke or heart attack.*
Shaking	4	8.3	*Sweating and shaking and then you go down.*
Sweating	4	8.3	*Red face, sweating,*
Restless	3	6.3	*Not staying still.*
Turning blue	2	4.2	*Turn blue, start wheezing, don't wake up.*
Rigid limbs	2	4.2	*It would have a certain grade, or you'd have a lot of it [to cause] shortness of breath, sweating, eyes bulging, body stiffness.*
Thirsty or dehydrated	2	4.2	*Shakes, sweats, they lose vision, they get dizzy, they lose balance, dehydrated, breathing heavy.*
Other physical symptoms	10	20.8	*Blood pressure increases.* *Going to the bathroom on themselves.* *Brain hemorrhage.*
PSYCHOLOGICAL SYMPTOMS			
Paranoia, anxiety, panic attack	5	10.4	*Severe paranoia, panic, anxiety.*
Obsessive behavior or aggression	1	2.1	*Fixating on something, aggression.*
UNABLE TO DESCRIBE SYMPTOMS			
Don't know/Unsure	3	6.3	*Honestly, I don't know.*

Note. These questions were only assessed in 2023 at the last data collection site in Brockton, Massachusetts. Participants were asked to characterize a stimulant overdose in their own words but were not asked to list every possible symptom that may occur following acute stimulant toxicity. As a result, some symptoms were more commonly cited by participants than others. Responses were entered into the electronic survey instrument by the survey administrator and do not necessarily represent participants' verbatim responses. Responses are based on open-coded free text notes and are not mutually exclusive. Four participants who indicated that they did not think it was possible to overdose on stimulants reflected further and indicated that a heart attack was possible; their responses are included in this table. Other physical symptoms = symptoms reported by only one person including: brain hemorrhage, incontinence, loss of vision, bulging eyes, dizziness, loss of coordination, nausea, increased blood pressure, red face, and substance use dependent.

Table 4.

Personal (n=76) and witnessed (n=94) stimulant overdose history among people who use stimulants (PWUS) (N=222).

	PERSONAL		WITNESSED	
Experienced a Stimulant Overdose	**N=222**	**%**	**N=222**	**%**
No	146	65.8	128	57.7
Yes	76	34.2	94	42.3
Number of Stimulant Overdoses Experienced (among those who experienced 1+)	**N=76**	**%**	**N=94**	**%**
Mean | SD	15.2	31.6	20.0	32.8
IQR | Range	4.5	1–99	11.0	1–99
Stimulants Used - Last Stimulant Overdose[a]	**N=76**	**%**	**N=94**	**%**
Crack cocaine	37	48.7	39	41.5
Powdered cocaine	29	38.2	22	23.4
Methamphetamine	13	17.1	13	13.8
Amphetamines (e.g., real or fake Adderall)	3	3.9	5	5.3
Don't know	0	0	20	21.3
Symptom Severity - Last Stimulant Overdose[a]	**N=76**	**%**	---	---
Extremely Severe Symptoms	**27**	**32.9**	---	---
Loss of consciousness	20	26.3	---	---
Seizure	10	13.2	---	---
Blindness [b]	3	3.9		
Stroke [b]	1	1.3		
Heart attack	1	1.3		
Moderate-to-Severe Symptoms	**63**	**82.9**	---	---
Severe sweating	40	52.6	---	---
Extreme anxiety or panic	40	52.6	---	---
Rapidly increasing pulse	38	50.0	---	---
Extreme paranoia	33	43.4	---	---
Rapidly increasing body temperature	31	40.8	---	---
Irregular breathing	30	39.5	---	---
Nausea, vomiting, diarrhea	24	31.6	---	---
Confusion	23	30.3	---	---
Chest pains	20	26.3	---	---
Jerking or rigid arms or legs	20	26.3	---	---
Severe headache	19	25.0	---	---
Hallucinations	18	23.7	---	---
Aggression or agitation	16	21.1	---	---
Perceived Cause of Last Stimulant Overdose[a]	**N=76**	**%**	---	---

	PERSONAL		WITNESSED	
Experienced a Stimulant Overdose	**N=222**	**%**	**N=222**	**%**
Consumed high quantity of stimulants	30	39.5	---	---
High potency drug	19	25.0	---	---
Low quality drug (e.g., bad cut)	14	18.4	---	---
Being run down (e.g., dehydrated, lack of sleep)	13	17.1	---	---
Modality (e.g., injection)	13	17.1	---	---
Polysubstance use	9	11.8	---	---
Low tolerance	3	3.9	---	---
Other	9	11.8	---	---
911 Called - Last Stimulant Overdose	**N=76**	**%**	**N=94**	**%**
No	50	65.8	49	52.1
Yes	26	34.2	45	47.9
Individual Responsible for Calling 911	**N=26**	**%**	**N=45**	**%**
Personally called	1	3.8	9	20.0
Friend called	6	23.1	7	15.6
Family called	5	19.2	3	6.7
Good Samaritan/stranger Called	2	7.7	5	11.1
Another person called [c]	0	0.0	2	4.4
Don’t know	12	46.2	19	42.2
Went to Hospital - Last Stimulant Overdose	**N=76**	**%**	---	---
Missing	4	5.3		
No	50	65.8	---	---
Yes	22	28.9	---	---

Note. SD=standard deviation. IQR=interquartile range (i.e., the difference between 25th and 75th percentiles. Range=minimum and maximum values.

--- Not assessed for witnessed stimulant overdoses.

[a] Not mutually exclusive.

[b] Open-coded write-in responses for self-reported “other” symptoms.

[c] Another person = shelter staff.

Table 5.

Bivariate and multivariable logistic regression analyses exploring factors associated with calling 911 at the last personal and witnessed stimulant overdose among a sample of people who use stimulants (PWUS).

	911 Called - Last Personal Stimulant Overdose [a]						911 Called - Last Witnessed Stimulant Overdose [a]					
	OR	**95% CI**	**P**	**AOR**	**95% CI**	**P**	**OR**	**95% CI**	**P**	**AOR**	**95% CI**	**P**
SOCIODEMOGRAPHICS												
Age												
Continuous	1.01	0.96–1.05	0.79	----	----	----	1.01	0.97–1.05	0.68	----	----	----
Sex												
Female	Ref	---	---	Ref	---	---	Ref	----	----	Ref	----	----
Male	1.56	0.49–5.00	0.45	4.63	0.90–23.86	0.07	1.55	0.62–3.91	0.35	2.62	0.91–7.56	0.08
Race/Ethnicity[b]												
Black, non-Hispanic	Ref	---	---	Ref	---	---	Ref	----	----	Ref	----	----
Hispanic	3.33	0.66–16.85	*0.15*	3.83	0.53–28.00	0.19	2.57	0.60–11.06	*0.20*	3.55	0.71–17.85	0.12
White, non-Hispanic	1.67	0.40–6.97	0.48	2.31	0.35–15.05	0.38	1.73	0.53–5.73	0.37	2.31	0.61–8.76	0.22
Multi-racial, non-Hispanic	---	---	---	---	---	---	2.00	0.29–13.74	0.48	1.83	0.23–14.54	0.57
Educational Attainment												
Some high school or less	3.64	0.89–14.86	*0.07*	4.06	0.65–25.37	0.13	1.38	0.48–3.81	0.57	----		
High school graduate or GED	Ref	---	---	Ref	---	---	Ref	----	----	----	----	----
Some college or more	4.12	1.14–14.89	**0.03**	6.80	1.29–36.01	**0.02**	0.96	0.37–2.48	0.93	----	----	----
STIMULANT & OPIOID USE HISTORY												
Crack Cocaine Use - Lifetime[c]												
No	Ref	---	---	----	----	----	---	---	---	----	----	----
Yes	0.52	0.07–3.94	0.53	----	----	----	---	---	---	----	----	----
Powdered Cocaine Use - Lifetime[d]												
No	---	---	---	----	----	----	----	----	----	----	----	----
Yes	---	---	---	----	----	----	----	----	----	----	----	----
Methamphetamine Use - Lifetime												
No	Ref	---	---	----	----	----	Ref	----	----	----	----	----
Yes	0.59	0.22–1.64	0.31	----	----	----	0.66	0.28–1.55	0.34	----	----	----
Opioid Use History among PWUS												
Never used opioids regularly	Ref	---	---	----	----	----	Ref	----	---	----	----	----
Past history of regular opioid use	2.67	0.36–19.71	0.34	----	----	----	2.40	0.52–10.99	0.26	----	----	----

	911 Called - Last Personal Stimulant Overdose [a]						911 Called - Last Witnessed Stimulant Overdose [a]					
	OR	**95% CI**	**P**	**AOR**	**95% CI**	**P**	**OR**	**95% CI**	**P**	**AOR**	**95% CI**	**P**
Used opioids in past 30 days	2.22	0.43–11.49	0.34	----	----	----	1.54	0.47–5.11	0.48	----	----	----
GOOD SAMARITAN LAW KNOWLEDGE												
Heard of the Law												
No	Ref	---	---	----	----	----	Ref	----	----	----	----	----
Yes	0.77	0.24–2.47	0.66	----	----	----	0.98	0.32–2.97	0.97	----	----	----
Correctly Described the Law												
No	Ref	---	---	---	---	---	Ref	----	----	----	----	----
Yes	0.58	0.22–1.55	0.28	---	---	---	0.94	0.41–2.16	0.88	----	----	----
PERSONAL STIMULANT OVERDOSE HISTORY												
Number of Stimulant Overdoses Experienced												
Continuous	0.87	0.72–1.05	*0.16*	0.92	0.74–1.13	0.43	0.99	0.97–1.01	0.23	----	----	----
Crack Cocaine Used - Last Personal Overdose												
No	Ref	---	---	Ref	---	---	----	----	----	----	----	----
Yes	0.32	0.12–0.87	**0.03**	0.52	0.14–1.97	0.34	----	----	----	----	----	----
Powdered Cocaine Used - Last Personal Overdose												
No	Ref	---	---	----	----	----	----	----	----	----	----	----
Yes	1.34	0.50–3.55	0.56	----	----	----	----	----	----	----	----	----
Methamphetamine Used - Last Personal Overdose												
No	Ref	---	---	----	----	----	----	----	----	----	----	----
Yes	1.76	0.52–5.92	0.36	----	----	----	----	----	----	----	----	----
Symptom Severity [e]												
Moderate-to-Severe Symptoms Only	Ref	---	---	Ref	----	----	----	----	----	----	----	----
Extremely Severe Symptoms	6.08	2.12–17.43	**<.001**	5.25	1.42–19.40	**0.01**	----	----	----	----	----	----
WITNESSED STIMULANT OVERDOSE HISTORY												
Number of Stimulant Overdoses Witnessed												
Continuous	0.96	0.91–1.01	*0.10*	0.98	0.92–1.04	0.53	0.98	0.97–0.998	**0.02**	0.98	0.96–0.995	**0.01**
Crack Cocaine Used - Last Witnessed Overdose												
No	---	---	---	---	---	---	Ref	----	----	Ref	----	----
Yes	---	---	---	---	---	---	0.32	0.13–0.77	**0.01**	0.26	0.10–0.70	**0.007**

	911 Called - Last Personal Stimulant Overdose [a]						911 Called - Last Witnessed Stimulant Overdose [a]					
	OR	95% CI	P	AOR	95% CI	P	OR	95% CI	P	AOR	95% CI	P
Powdered Cocaine Used - Last Witnessed Overdose												
No	----	----	----	----	----	----	Ref	----	----	----	----	----
Yes	----	----	----	----	----	----	0.75	0.29–1.99	0.57	----	----	----
Methamphetamine Used - Last Witnessed Overdose												
No	----	----	----	----	----	----	Ref	----	----	----	----	----
Yes	----	----	----	----	----	----	1.19	0.35–4.00	0.78	----	----	----

Note. Ref=referent; OR=odds ratio; CI = confidence interval; P = p-value.

[a]For both models, variables with a p≤0.20 were initially included in the model (as signified by italics). Both models adjusted for sex and race/ethnicity.

[b]Native American people were excluded from both models due to small cell count; multiracial people were excluded from Model 1 due to small cell count. These exclusions resulted in final model sample sizes of N=74 for model 1 and N=93 for model 2.

[c]Unable to run regression for crack cocaine as all of those who reported that 911 was not called at their last witnessed overdose had used crack cocaine in their lifetime (model 2).

[d]Unable to run regression for powdered cocaine as all of those who reported that 911 was called at their last personal overdose had used powdered cocaine in their lifetime (model 1) and all of those who reported that 911 was and was not called at their last witnessed overdose had used powdered cocaine in their lifetime (model 2).

[e]Participants who reported any extremely severe stimulant overdose symptom at only or together with moderate-to-severe symptoms were coded as “extremely severe symptoms.