Title

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Publication Date

2024-09-14

Data Availability

The data associated with this publication are available upon request.

Peer reviewed

Title: A mixed methods study to inform fatal overdose prevention in San Diego, California: perspectives from people who use drugs

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Highlights

• We measured personal naloxone accessibility as frequency of having a nearby dose

• Women were significantly more likely to report having accessible naloxone

• Witnessing an overdose was associated with greater personal naloxone accessibility

• Structural factors and individual attitudes contributed to varied naloxone accessibility

• Harm reduction outreach and peer mutual aid were key for naloxone access

Abstract

Background: In the United States, community overdose education and naloxone distribution (OEND) programs have demonstrated efficacy in reducing opioid-related mortality. OEND programs have expanded across San Diego County, California, but differential naloxone accessibility among people who use drugs (PWUD) has not been assessed. We examined factors that shape individual naloxone accessibility in San Diego.

Methods: We employed a convergent parallel mixed methods design using surveys (n=194) and qualitative interviews (n=20). Ordinal logistic regression examined factors associated with personal naloxone accessibility (i.e., the frequency with which participants could access naloxone within five minutes, categorized as *never*, *sometimes*, or *always*). Qualitative interviews explored participant perceptions of naloxone accessibility and whether and how they maintained naloxone. We organized multilevel findings into a modified social-ecological model.

Results: In quantitative and qualitative samples, participants were majority male (72% and 70% respectively), non-White race/ethnicity (55% and 75%),

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with an average age around 42 years. In the quantitative sample, 24% never had personally accessible naloxone, 52% sometimes did, and 24% always did. Factors independently associated with greater personal naloxone accessibility were female gender (Adjusted Odds Ratio [AdjOR]: 2.51, 95% Confidence Interval [CI]: 1.31–4.85), monthly income <$500 (AdjOR: 0.42, 95%CI:0.19, 0.90), witnessing an overdose (AdjOR: 3.51, 95%CI:1.67–7.55), and knowing where to get free naloxone (AdjOR: 3.44, 95%CI: 1.79–6.75). Qualitative data suggested that naloxone was generally easy to acquire in San Diego due to community harm reduction outreach and mutual aid among peers, albeit community barriers including distance to harm reduction providers and frequent relocation/displacement for those experiencing homelessness. Individual attitudes toward overdose risk, naloxone, and community responsibility contributed to varied individual naloxone accessibility.

Conclusions: This study highlights multilevel factors influencing personal naloxone accessibility among people who use drugs in San Diego, emphasizing the importance of harm reduction outreach and peer-to-peer support. We identified opportunities for interventions that address both individual attitudes and community-level barriers to improve naloxone accessibility.

Keywords

Naloxone, overdose prevention, people who use drugs, harm reduction

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Introduction

The overdose epidemic in the United States (US) has resulted in over one million deaths since 1999 (Ahmad et al., 2024), fueled by an increasingly toxic, unregulated drug supply (Ciccarone, 2019). Most drug overdoses are attributable to opioids, particularly illicitly manufactured fentanyl and its analogues (National Institute on Drug Abuse (NIDA), 2023).

In the US community overdose education and naloxone distribution (OEND) programs have demonstrated efficacy in reducing opioid-related mortality (Naumann et al., 2019; Razaghizad et al., 2021). It is particularly important for OEND programs to reach people who use drugs as they are often the nearest bystanders to overdose events and are effective responders (Razaghizad et al., 2021; Walley et al., 2013). While OEND programs have expanded rapidly since the early 2010s (Wheeler et al.,

2015), research has identified differential naloxone accessibility across

communities. Previous studies across the US assessing varied measures of

naloxone accessibility have found racial/ethnic disparities (Dayton et al.,

2020; Khan et al., 2023; Kim et al., 2021; Kinnard et al., 2021; Nolen et al.,

2022; Roth et al., 2024) and geographic inequalities (Nolen et al., 2023; Ong

et al., 2020). Additional factors found to be positively associated with

naloxone accessibility were drug use behaviors (e.g., injecting opioids)

(Nikolaides et al., 2018; Roth et al., 2024; Rowe et al., 2015), female gender

(Roth et al., 2024; Tobin et al., 2018), prior overdose and naloxone

experiences (Moustaqim-Barrette et al., 2019; Roth et al., 2024; Tobin et al.,

2018), higher income (Ong et al., 2020), access to drug treatment (Ong et

al., 2020), syringe service program (SSP) engagement, and police encounters

(Reed et al., 2019). Researchers have found divergent findings regarding

housing status and naloxone accessibility, where unhoused people who used

drugs had lower accessibility in Los Angeles and San Francisco, California

(Kinnard et al., 2021), but higher accessibility in Southeast Michigan (Ong et

al., 2020) and Philadelphia, Pennsylvania (Reed et al., 2019). Qualitative

research has also described individual-level barriers to naloxone uptake

among people who use drugs, including stigma toward substance use,

indifference toward overdose, fear of law enforcement repercussions, and

fear of misusing naloxone or precipitating side effects such as severe

withdrawal symptoms (Bennett et al., 2020; Kline et al., 2020). It is important

to assess the factors that shape naloxone accessibility among people who

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use drugs to inform community efforts to ensure consistent access among those with elevated risk of experiencing and witnessing overdose.

Community organizations in California received authorization to distribute naloxone in 2017 (California Department of Public Health, 2022) and could utilize state and federal funding for OEND programs by 2018 (California Department of Health Care Services, 2022). Although naloxone became more available in San Diego County following this approval, there was a 33% increase in drug overdose fatalities in San Diego County during the present study (2020 – 2022) (California Department of Public Health, n.d.). Recent descriptive assessments among harm reduction service providers and people who use drugs in San Diego identified naloxone as a high priority, but cited several structural (e.g., transportation and safety concerns) and individual level (e.g., anticipated stigma) barriers to accessing services that provide the medication (Lewis & Asmus, 2020; San Diego State University Institute for Public Health, 2022). In 2022, the County initiated efforts to "saturate the community with naloxone," (San Diego County Health & Human Services Agency, n.d.), yet specific plans to understand factors that may drive differences in naloxone accessibility among people who use drugs were not specified. To inform ongoing efforts to improve overdose prevention across San Diego, we undertook a mixed methods study of naloxone accessibility among people who use drugs. We opted to utilize data prior to the County's 2022-2023 naloxone expansion efforts to establish a baseline understanding of naloxone accessibility that can serve as a

benchmark for future comparison and to build upon the prior-mentioned descriptive assessments that were conducted around the same time. In both qualitative and quantitative inquiry, we drew from guidance set forth by McDonald et al. (2021), who encouraged using measures of naloxone accessibility that go beyond assessing current carriage or possession of the medication to also account for its location relative to its owner and the owner's capacity to consistently access it when needed.

Methods

Mixed methods design and organizing framework

This study utilized a convergent parallel mixed methods design (Creswell, 2009). Quantitative and qualitative data were collected concurrently and findings from both datasets were integrated in the discussion and considered with equal weight in interpretations (QUAN+QUAL). Our goal was complementarity, allowing both methods to provide insights into understanding factors influencing differential naloxone accessibility in San Diego. Survey data enabled the examination of associations between individual naloxone accessibility and key multilevel factors. Qualitative interviews provided context around participant experiences accessing naloxone and partially informed the selection of pre-existing survey measures to test associations with our quantitative naloxone accessibility measure.

We organized quantitative and qualitative findings into a modified Social Ecological Model (SEM) (Brofenbrenner, 1977) with attention to policy,

community, interpersonal, and individual domains. The SEM is well-suited for examining naloxone accessibility among people who use drugs because it considers the interplay of factors at multiple levels to shape behavior and outcomes and supports the development of interventions by highlighting potential targets at each level. The policy domain considers laws that have facilitated OEND programs in San Diego, the community domain reflects the role of the community environment and available resources in accessing naloxone, the interpersonal domain addresses how relationships shape naloxone accessibility, and the individual domain focuses on personal attributes, perceptions, and preferences that may influence differences in personal naloxone accessibility.

Study design and participants

We drew from *La Frontera*, a longitudinal, observational cohort study of cross-border mobility, drug supply trends, blood-borne disease transmission and overdose among people who use drugs in the San Diego, California and Tijuana, Baja California, Mexico border region (National Institute on Drug Abuse [NIDA] R01DA049644) (Strathdee et al., 2021). Bilingual field staff recruited 612 participants ("Cohort 1") between October 2020–October 2021 via mobile street outreach. Inclusion criteria were being ≥18 years old, speaking English or Spanish, residing in San Diego or Tijuana, and past-month injection drug use. San Diego resident participants (n=410) were purposively recruited such that around half (n=206) had engaged in cross-border drug use in the preceding two years, indicating they had gone to

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Mexico to use drugs. Eligible persons were invited to participate and provided written informed consent. The institutional review boards (IRBs) of the University of California, San Diego (UCSD) and Xochicalco University approved study protocols.

Additional *La Frontera* participants ("Cohort 2", n=108) were recruited between February–June 2022 using similar methods for a supplemental study of COVID-19 testing and vaccination (*LinkUP*) (Bazzi et al., 2022) that required additional San Diego-based participants. The UCSD IRB approved the re-opening of recruitment and study procedures specific to Cohort 2. The focus of the present study was naloxone accessibility in San Diego and, as such, we included only participants who reported past six-month residence in San Diego.

A subset (n=20) of San Diego-based participants from Cohorts 1 and 2 were recruited for qualitative interviews. In August 2022, author 1 (KB) accompanied the outreach team to recruit participants, employing purposive sampling based on age, gender, race/ethnicity, and location to obtain a diversity of experiences.

Data collection

Quantitative data were collected by field staff via computer-assisted surveys conducted in English or Spanish. Participants completed a baseline survey and follow-up surveys every six months, receiving USD$20 for each. This study utilized data from the second follow-up survey from Cohort 1

(December 2021–December 2022) and the baseline survey from Cohort 2 (February–June 2022).

Qualitative interviews were semi-structured and lasted between 20 minutes and one hour. Participants were asked their preferred language and all preferred to complete interviews in English. Participants received USD$20 compensation.

Quantitative measures. Our dependent measure of "individual naloxone accessibility" asked participants, "*In the past six months, how often have you had naloxone on you where you could get it within five minutes?*" to which they could respond *always*, *mostly*, *sometimes*, or *never*. After examining the distribution of the data, we observed that the responses for the "mostly" and "sometimes" categories were more similar to each other compared to the "never" and "always" categories, making it difficult to distinguish meaningful differences between them. Therefore, we collapsed the "mostly" and "sometimes" categories into a single "sometimes" category to reflect the practical similarities in responses.

Based on prior research and theoretical relevance, we selected *a priori* independent variables to explore potential multilevel associations with individual naloxone accessibility. Further, we drew from qualitative findings to include additional pre-existing independent variables to assess potential associations described by participants.

Individual-level demographic factors included age, assigned sex, gender, race, and ethnicity. We reported descriptive statistics of all racial

categories, but additionally created a binary variable indicating whether participants were White or non-White race/ethnicity (i.e., those who were non-White race or Hispanic/Latinx/Mexican ethnicity). A socioeconomic measure indicated whether a participant had an average monthly income (from any source) of less or more than USD$500.

Drug use variables indicated the substances participants knowingly used by any method in the prior six months. We also created a binary variable indicating whether an individual had smoked opioids as participant interviews suggested this may be associated with perceptions of decreased overdose risk and, therefore, a lower likelihood of consistent individual naloxone accessibility. Participants also reported whether they had injected a combination of opioids with stimulants (polysubstance co-injection), the average number of times they injected drugs daily, or when they stopped injecting drugs. Participants reported personal past six-month and lifetime overdose experiences and indicated whether they were carrying naloxone at the time of the survey.

Interpersonal overdose response factors included whether participants had witnessed an overdose in the prior six months and, if so, whether they administered naloxone or responded with alternative methods including rescue breathing, rubbing the person's chest, pouring cold water or ice on the person, or hitting or slapping the person.

Most community factors referred to participant experiences within the six months prior to survey completion. These included primary residence

within San Diego County, cross-border drug use, having been stopped or arrested by police, having been in jail or prison, homelessness, income, syringe services program (SSP) engagement, and drug/alcohol treatment. We created a binary measure indicating whether participants resided in Downtown San Diego zip codes or elsewhere in the County. Homelessness was determined based on participant reports of sleeping "always or most often" in a "shelter, workplace, hotel/motel, vehicle, abandoned building, or on the street." Drug/alcohol treatment included receiving rehabilitation, medication, or other program to help reduce or stop alcohol or drug use. Finally, participants were asked if they knew where they could get free naloxone "today" (i.e., on the day of survey completion).

Qualitative interviews. Key domains of open-ended interview questions were perceptions of general naloxone access in San Diego, perceived importance of naloxone carriage and ensuring personal naloxone accessibility, and experiences acquiring naloxone and responding to overdose. Additional probes were included to ascertain multilevel influences on acquiring and maintaining naloxone access.

Data analysis

Quantitative analysis. For participants with complete data on key survey questions, we compared groups based on their reported individual naloxone accessibility (i.e., *never*, *sometimes*, *always*) using analysis of variance (ANOVA) for continuous variables and Chi-square or Fisher's exact tests for categorical variables. When these analyses indicated a significant

difference between groups, we conducted post-hoc pairwise comparisons to determine which groups were significantly different from one another.

Next, we assessed univariable associations with naloxone accessibility using ordinal logistic regression where "*never*" was the reference category. Factors associated with the dependent variable in univariable models at an alpha level of 0.1 were considered in a multivariable ordinal logistic regression modeling process. We used a manual forward selection process including variables one at a time, prioritizing theoretical relevance and the largest effect sizes from univariable models. The final model included only variables that had significant associations with the dependent variable at an alpha level of 0.05. We checked the final model for multicollinearity using variance inflation factors, tested for interactions between independent variables, and assessed the proportionality of odds assumption with the Brant test (Brant, 1990). All analyses were conducted using base R (R Core Team, 2021) and RStudio (RStudio Team, 2022), and regression analyses were conducted using the POLR R package (Heinze et al., 2019).

Qualitative analysis. Interviews were digitally recorded, professionally transcribed, and assessed for accuracy. We used a general inductive analysis approach with the broad goal of uncovering multilevel naloxone accessibility themes from the data (Thomas, 2006). This inductive analysis approach is influenced by study objectives (i.e., to determine multilevel factors that shape naloxone accessibility) but allows for findings to arise directly through analysis of raw data, rather than fitting the data to

predetermined models. First, two researchers (KB and AS) used inductive open coding to develop memos from their initial read of all 20 interview transcripts to establish potential codebook codes and definitions. Next, KB, AS, and WHE used the preliminary codebook to independently code an initial set of five interviews and convened to discuss the process, find consensus, and agree upon a coding scheme. Coders then independently coded an additional five transcripts each according to the agreed upon strategy, taking notes of additional emerging themes. Final themes were refined through consensus discussions between team members and presented to four *La Frontera* study participants for member checking and co-authors for feedback. Finally, themes were organized within the SEM. Consistent with the general inductive analysis approach, classifying themes into a framework occurred at the end of the analytic process (Thomas, 2006).

Results

Quantitative sample characteristics

Seventeen participants from Cohort 1 and 50 participants from Cohort 2 were excluded from analysis due to nonresponse on the outcome variable. The final sample size was 194, with 136 (70%) from Cohort 1 and 58 (30%) from Cohort 2. Those excluded from analysis were slightly older and less likely to use fentanyl and methamphetamine in the preceding six months (see Supplementary Table).

About a quarter of participants (24%) always had naloxone accessible, 52% sometimes did, and 24% never did (Table 1). Participants had an

average age of 42 years (standard deviation [SD]=11.3) and were mostly

male (n=139, 72%) (Table 1). Except for one participant who did not identify

with any gender category, all reported a gender identity aligned with their

sex assigned at birth. About half identified as non-White (n=106, 55%),

among whom 72% were Hispanic/Latinx/Mexican ethnicity. Eighteen percent

had an average monthly income less than USD$500.

Table 1. Participant descriptive characteristics by personal naloxone accessibility category[a] among people who use drugs in San Diego, California, December 2021 – December 2022 (N=194)

	Never	Someti mes	Always	p-value	Overall
n (%)	47 (24)	101 (52)	46 (24)		194
Cohort 1 (n(%))	39 (83)	67 (66)	30 (65)		136 (70)
Cohort 2 (n(%))	8 (17)	34 (34)	16 (35)	0.085	58 (30)
Individual demographic and socioeconomic factors					
Age (mean(SD)	39.6 (9.3)	43.3 (12.4)	41.9 (10.4)	0.181	42.1 (11.3)
Sex (assigned female at birth) (n(%))	10 (21)	25 (25)	20 (44)		55 (28)
Sex (assigned male at birth) (n(%))	37 (79)	76 (75)	26 (57)	0.030	139 (72)
Race					
Indigenous[b] (n(%))	0 (0)	4 (4)	4 (9)	0.108	8 (4)
Black[b] (n(%))	5 (11)	11 (11)	6 (13)	0.916	22 (11)
Asian[b] (n(%))	1 (2)	0 (0)	1 (2)	0.334	2 (1)
Pacific Islander[b] (n(%))	0 (0)	0 (0)	1 (2)	0.198	1 (1)
White[b] (n(%))	25 (53)	63 (62)	29 (63)	0.517	117 (60)
Other race[b] (n(%))	16 (34)	28 (28)	15 (33)	0.690	59 (30)
Hispanic/Latinx/Mexican ethnicity[b] (n(%))	21 (45)	34 (34)	21 (46)	0.260	76 (39)
Non-White race/ethnicity[c] (n(%))	27 (57)	50 (50)	29 (63)	0.282	106 (55)
Income <$500/month (vs. ≥$500)[d] (n(%))	11 (23)	20 (20)	4 (9)	0.146	35 (18)

Individual drug use[d] and overdose factors					
Heroin (n(%))	19 (40)	45 (45)	23 (50)	0.648	87 (45)
Methamphetamine (n(%))	35 (75)	84 (83)	43 (94)	0.047	162 (84)
Fentanyl (n(%))	27 (57)	61 (60)	30 (65)	0.739	118 (61)
Rx opioids (n(%))	1 (2)	6 (6)	4 (9)	0.386	11 (6)
Benzodiazepines/Tranquilizer (n(%))	3 (6)	11 (11)	1 (2)	0.172	15 (8)
China White (n(%))	3 (6)	10 (10)	1 (2)	0.237	14 (7)
Smoked any opioid (n(%))	23 (49)	52 (52)	30 (65)	0.215	105 (54)
Polysubstance Co-injection (n(%))	9 (19)	30 (30)	12 (26)	0.398	51 (26)
Average number injections/day (mean (SD))	0.7 (1.2)	1.3 (1.4)	1.2 (1.6)	0.101	1.1 (1.4)
Stopped injecting ≥6 months ago (n(%))	3 (6)	6 (6)	6 (13)	0.302	15 (8)
Past 6-month overdose (n(%))	2 (4)	21 (21)	8 (17)	0.036	31 (16)
Lifetime overdose (n(%))	22 (47)	70 (69)	29 (63)	0.031	121 (62)
Currently carrying naloxone (n(%))	2 (4)	33 (33)	34 (74)	<0.001	69 (36)
Interpersonal overdose response factors[d]					
Witnessed overdose (n(%))	12 (26)	71 (70)	37 (80)	<0.001	120 (62)
Administered naloxone (n(%))	5 (11)	38 (38)	29 (63)	<0.001	72 (37)
Responded to an overdose with alternative methods (n(%))	1 (2)	17 (17)	3 (7)	0.015	21 (11)
Community factors					
Resides near downtown San Diego[d] (n(%))	19 (40)	27 (27)	11 (24)	0.152	57 (30)
Cross-border drug use[d] (n(%))	3 (6)	7 (7)	7 (15)	0.207	17 (9)
Stopped/Arrested by police[d] (n(%))	12 (26)	41 (41)	23 (50)	0.049	76 (39)
Jail/prison[d] (n(%))	4 (9)	11 (11)	8 (17)	0.379	23 (12)
Homelessness[d] (n(%))	36 (77)	75 (74)	32 (70)	0.731	143 (74)
Sheltered (n(%))	9 (19)	16 (16)	5 (11)	0.537	30 (16)
Unsheltered (n(%))	27 (57)	59 (58)	27 (59)	0.991	113 (58)

SSP client (n(%))	26 (55)	62 (61)	30 (65)	0.611	118 (61)
Received drug or alcohol treatment[d] (n(%))	9 (19)	15 (15)	11 (24)	0.405	35 (18)
Knows where to get free naloxone today (n(%))	18 (38)	78 (77)	38 (83)	<0.001	134 (69)

Notes: [a]Participant responses to the question "*In the last six months, how often have you had naloxone on you where you could get it within five minutes?*"
[b]Indicated race variables are not mutually exclusive.
[c]Calculated variable indicating all those who reported a race other than White and/or reported Hispanic/Latinx/Mexican ethnicity.
[d]Indicated variables refer to the preceding six months.

Most participants used methamphetamine in the preceding six months (n=162, 84%), followed by fentanyl (n=118, 61%) and heroin (n=87, 45%). Nearly 30% reported polysubstance co-injection and over half (n=105, 54%) smoked opioids in the preceding six months. Participants injected drugs an average of 1.1 times per day (SD=1.4), although 15 (8%) had stopped injecting. Sixteen percent experienced a non-fatal overdose in the preceding six months (n=31) and 62% had ever overdosed (n=121). About a third (n=69, 36%) was carrying naloxone at the time of the interview.

A majority witnessed someone else overdose in the preceding six months (n=120, 62%). Nearly half (n=90, 46%) administered naloxone to someone else and 21 (11%) responded to an overdose using alternative methods in the preceding six months.

Thirty percent (n=57) resided Downtown San Diego and few reported cross-border drug use (n=17, 9%). Nearly 40% were stopped or arrested by police and 12% spent time in jail or prison in the preceding six months. Most were unhoused (n=143, 74%), over half (n=118, 61%) reported SSP

engagement, and less than one in five (n=35, 18%) had enrolled in drug/alcohol treatment in the preceding six months. Nearly 70% (n=134) knew where they could get free naloxone on the day of the interview.

Quantitative findings: differences between participants always, sometimes, or never having accessible naloxone

Women were more likely to report always having accessible naloxone relative to sometimes or never having it (44% vs. 25% and 21%, p=0.030) (Table 1). A larger proportion of those who always had accessible naloxone reported having been stopped or arrested by police and using methamphetamine relative to those who never had naloxone (50% vs. 26% and 94% vs. 75%, ps<0.049). Relative to those who never had accessible naloxone, those who always or sometimes had accessible naloxone were more likely to have overdosed themselves (17% and 21% vs. 4%), witnessed an overdose (80% and 70% vs. 26%), and administered naloxone (63% and 38% vs. 11%) in the previous six months, and to report knowing where to get free naloxone "today" (83% and 77% vs. 38%, ps<0.036). Finally, compared to those who sometimes or never had accessible naloxone, those who always did were more likely to have been carrying naloxone at the time of the survey (74% versus 33% and 4%, p<0.001).

Ordinal logistic regression

In a final multivariable model, women had 2.51 times higher odds of greater naloxone accessibility relative to men (95% confidence interval [CI]: 1.31–4.85) (Table 2). Participants with monthly income <USD$500 had 58%

lower odds of greater naloxone accessibility relative to those with a higher

monthly income (Adjusted odds ratio [AdjOR]: 0.42, 95% CI: 0.19–0.90).

Having witnessed an overdose in the prior six months was associated with

3.51 times higher odds of greater naloxone accessibility (95% CI: 1.67–7.55).

Finally, knowledge of where to get free naloxone was associated with 3.44

times higher odds of greater naloxone accessibility (95% CI: 1.79–6.75).

Table 2. Ordinal logistic regression univariable and multivariable associations with personal naloxone accessibility (never, sometimes, always)[a] among people who use drugs in San Diego, California, December 2021–2022 (N=194)						
	OR	95% CI	p-value	AdjOR	95% CI	p-value
Individual demographic and socioeconomic factors						
Sex (Female)	2.10	1.15, 3.90	0.016	2.51	1.31, 4.85	0.006
Age	1.01	0.99, 1.03	0.343			
Non-White Race/Ethnicity	1.15	0.68, 1.98	0.599			
Income <$500/month (vs. ≥$500)	0.53	0.26, 1.05	0.070	0.42	0.19, 0.90	0.027
Individual drug use[d] and overdose factors						
Heroin	1.29	0.75, 2.22	0.353			
Methamphetamine	2.46	1.20, 5.12	0.014			
Fentanyl	1.24	0.72, 2.15	0.444			
Rx opioids	2.19	0.70, 6.99	0.176			
Benzodiazepines/ Tranquilizer	0.71	0.28, 1.84	0.485			
China White	0.70	0.26, 1.85	0.467			
Polysubstance co-injection	1.26	0.69, 2.31	0.447			
Smoked any opioid	1.54	0.90,	0.117			

		2.65				
Average number injections/day	1.17	0.96, 1.42	0.111			
Stopped injecting ≥6 months ago	1.92	0.68, 5.47	0.217			
Past 6-month overdose	1.83	0.91, 3.72	0.093			
Lifetime overdose	1.61	0.92, 2.84	0.096			
Interpersonal overdose response factors[d]						
Witnessed overdose	5.67	3.07, 10.8	<0.001	3.51	1.67, 7.55	0.001
Administered naloxone[b]	4.95	2.71, 9.29	<0.001			
Responded to an overdose with alternative methods[b]	1.31	0.59, 2.92	0.510			
Community factors[b]						
Resides near downtown San Diego	0.58	0.32, 1.06	0.076			
Cross-border drug use	2.15	0.81, 5.76	0.123			
Stopped/Arrested by police	1.98	1.14, 3.48	0.015			
Jail/prison	1.77	0.77, 4.11	0.182			
Unhoused	0.79	0.43, 1.45	0.441			
SSP client	1.32	0.76, 2.29	0.327			
Received drug or alcohol treatment	1.24	0.61, 2.54	0.549			
Knows where to get free naloxone today	4.58	2.45, 8.76	<0.001	3.44	1.79, 6.75	<0.001

Notes: [a]Participant responses to the question "*In the last six months, how often have you had naloxone on you where you could get it within five minutes?*"
[b]Indicated variables refer to the preceding six months.

Qualitative sample characteristics

Like the overall quantitative sample, most qualitative interview participants were male (70%) and had an average age of 41 (SD=7.7) (Table

2). Around half reported White race (55%), 65% reported Hispanic/Latinx/Mexican ethnicity, and about half (55%) resided near Downtown San Diego. Most participants used fentanyl (80%), followed by methamphetamine (70%), heroin (25%), and benzodiazepines or other tranquilizers (10%). Five (25%) experienced one or more overdoses in the preceding six months and over half (n=11, 55%) had ever overdosed.

Table 3. Sample characteristics of qualitative interview participants, August 2022 (N=20)	
Sex (female) (n(%))	6 (30)
Age (mean(SD))	41 (7.7)
Race (n(%))	
Black[a]	1 (5)
Indigenous[a]	1 (5)
White[a]	11 (55)
Other[a]	6 (30)
Hispanic/Latinx/Mexican ethnicity[a]	13 (65)
Non-White race/ethnicity[b]	15 (75)
Resides near downtown San Diego (n(%))	11 (55)
Cohort 2 (n(%))	3 (15)
Drug preferences (n(%))	
Fentanyl	16 (80)
Methamphetamine	14 (70)
Heroin	5 (25)
Benzodiazepines/Tranquilizer	2 (10)
Past 6-month overdose (n(%))	5 (25)
Lifetime overdose (n(%))	11 (55)
Notes: [a]Indicated race variables are not mutually exclusive. [b]Calculated variable indicating all those who reported a race other than White and/or reported Hispanic/Latinx/Mexican ethnicity.	

Qualitative findings: multilevel factors shaping naloxone accessibility

We integrated quantitative and qualitative findings in a modified version of the SEM (Figure 1). Below we report qualitative findings that provide context for differential individual naloxone accessibility according to (1) policy, (2) community, (3) interpersonal, and (4) individual SEM domains.

Figure 1. Mixed-methods findings on factors shaping naloxone accessibility among people who use drugs in San Diego, California in a modified social ecological model
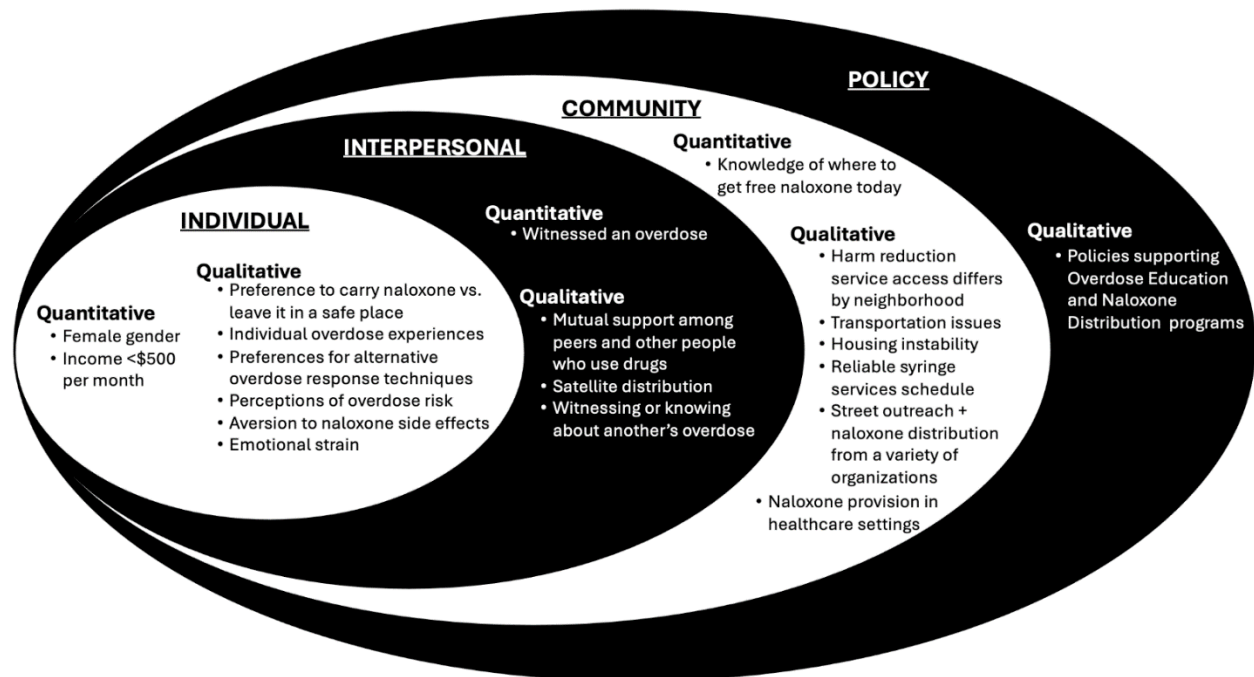
1.Policy factors

Interview participants overwhelmingly viewed naloxone as very easy to acquire in San Diego, likely due to policies that have promoted OEND programs in California. Indeed, some participants noted that naloxone has become more easily accessible in recent years:

At first [naloxone] wasn't [easy to access in San Diego], but now it's like everywhere. If you ask for it, most likely they'll give it to you, because they're trying to reduce the rate of people falling out [overdosing] so quickly, especially with the fentanyl outbreak. (Male, 32)

Several participants expressed that nearly anyone who wanted naloxone in San Diego would not have trouble acquiring it, implying that naloxone accessibility may be more related to individual desires to obtain and keep it readily available rather than structural barriers to access:

Somebody who uses drugs and wants Narcan, it's easy to get... That stuff is thrown at us sometimes. I mean, I just don't see it as something that's hard to get. (Male, 31)

2. Community factors

Community sources of naloxone. Most participants indicated they acquired naloxone from a community SSP or other street-outreach providers. Several participants described habitually seeking naloxone from a local SSP. As one woman said, "*I go [to the SSP] and get [naloxone] once a week, I have a routine.*" (Female, 55)

Other participants said they typically acquired naloxone passively through regular street-outreach distribution, which is provided by multiple community organizations in San Diego County: "*People from organizations come walking around with Narcan... They keep us full supplied right here.*" (Male, 40)

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Finally, some participants also shared that they received naloxone in healthcare settings, including hospitals or clinics providing medications for opioid use disorder (MOUD):

> *I was just in the hospital recently getting Subutex [buprenorphine]... And they'll give you Narcan just in case... like they'll ask if you want it just because they know most likely we're gonna go back out and use. (Female, 31)*

Differential access to harm reduction services. Despite an overwhelming perception that naloxone was easy to obtain in San Diego, some participants reported that naloxone was relatively much easier to acquire Downtown relative to other parts of San Diego County:

> *People in the downtown have more [naloxone]...out here [in a city South of San Diego] it's a little harder because there's not that many programs. (Male, 42)*

Further, several participants who were unhoused and were not living downtown indicated that traveling to access naloxone was an obstacle:

> *Transportation's probably why [people who use drugs here] don't want to go through the whole process [of acquiring naloxone]. Because, like, oh I got to take the bus. I got to wait in line and, you know, stuff like that. (Male, 56)*

Housing instability. Some participants described difficulties related to housing instability as barriers to keeping accessible naloxone. Participants who reported frequent relocation explained they struggled to keep track of their belongings, particularly while staying in the street:

It's just been hard to really carry anything on me lately. Like, when I was staying in my vehicle, I had Narcan in there and everything else like that because it was my place to stay and just mine, and I knew it wasn't going to get messed with... But being out here [unsheltered] and getting all my stuff stolen all the time, it's hard to have [naloxone] on me. (Male, 28)

Others who were experiencing homelessness described the difficulties of keeping naloxone and other personal belongings safe due to recurrent displacement. One participant staying downtown was upset that his belongings had been taken by police in preparation for a street sweep prior to the interview and described the frustrating process of being placed on a waitlist for a shelter bed, yet being regularly displaced or arrested while staying in the street:

You get on a list [for a shelter bed] and while we are waiting for the bed, we're still homeless. And we get pushed around all over the place while waiting for the bed...Now we're getting even arrested for being homeless and waiting for a bed. (Male, 41)

3. Interpersonal factors

Mutual aid and satellite distribution. Participants' perceptions of easily accessible naloxone in San Diego were also related to mutual aid and satellite distribution among people who use drugs. Some described a motivation to help prevent fatal overdose after experiencing the death of a friend or peer. One participant explained she always kept naloxone with her, *"because you never know... my friend, they left him [overdosed] in the park.*

And so, if I can try to help prevent that from happening, I'm gonna do it... I can't have that on my conscience" (Female, 31).

Several participants reported keeping naloxone around in case others needed it or actively seeking naloxone to distribute to others:

> *I like to have [naloxone doses] close on hand just in case anybody needs them, I could always run [to get it]. Or anytime I know someone who's doing black [tar heroin] or fentanyl, I give it to them like, 'Here, just to be sure.' And I give them that same 30-second lesson that I was given. (Male, 32)*

> *Usually I'm the one [who] keeps Narcan with me all the time. I get it like once every two months, but I get a bunch every time I get it. And I always keep some, just make sure that it stays with me, but I usually end up giving it to other people. (Male, 41)*

Other participants reported keeping naloxone in an easily accessible location for themselves and others. As one participant described, although she never carries naloxone, she and her peers created a system to ensure it is always visible and easily accessible:

> *We have it up on the walls and shit, you know. In a bag, so it'll be easy to find if somebody's screaming, 'Narcan!" (Female, 51)*

Several participants reported they could rely on their partners, close friends, or other people in the street to have accessible naloxone, easing the burden of having to consistently carry it:

It's always available to where, you know, if you walk up and
down the street and if you know a couple of people…of course
they'll get you a Narcan. (Male, 36)

Additionally, some participants noted that particular people were known in the street for their role as reliable satellite naloxone distributers who regularly acquire supplies from harm reduction organizations to disseminate to other people who use drugs. One participant described a peer who was standing nearby:

The girl with the black shorts on, I always go to her. If I haven't
gotten any [naloxone] and I need it, or I have it in my bag and I
need more… I'll go to that girl and she's got the huge supply of
anything that we need. She's kind of like a mother hen out here.
(Female, 55)

4.Individual-level factors

Carrying naloxone versus having it easily accessible. Interview participants reported a range of personal naloxone access behaviors, from always carrying it to actively avoiding it. Most, however, reported either always carrying naloxone (i.e., keeping it in their pocket or in a bag that they carry with them) or keeping it in an easily accessible location (i.e., leaving it in a known location that they can return to if needed). For some, consistently carrying naloxone was routine behavior:

I carry it with me everywhere I go, you know, usually I'll have my
backpack so for me [naloxone access is] not really an issue…
(Female, 31)

Some participants shared that they preferred to keep naloxone in the place where they are most likely to use drugs, rather than consistently carrying it, to ensure it is accessible if needed for personal use:

> I don't usually have it on me because usually I do my drugs there [near my tent], so I make sure everything stays there. It's not like I'm gonna be out on the street [using drugs]. Most of the time I'll just leave it there at my spot. (Male, 32)

Individual overdose experiences. Some participants described their desire to keep naloxone on hand was related to personal experiences of overdose. One participant shared that he overdosed two days before the interview after spending two months in jail where he underwent unmedicated detoxification. He shared that he kept naloxone on him, "*especially now... my tolerance has gone down a lot recently, so I always have it on me now*" (White male, 36).

Preference for alternative overdose responses. Some participants reported personal preferences, perceptions, and attitudes that prevented them from ensuring naloxone accessibility for themselves. For example, some participants who did not typically keep naloxone on them expressed a preference for using lay remedies for preventing or responding to an overdose:

> I've learned to, you know, put water on people. Put ice down people. Give them mouth-to-mouth... make sure, you know, keep

the guy up... I've learned a lot of things without the Narcan... You can snap people [inject them] with salt water, too... Or crystal [methamphetamine], crystal wakes you up, too. Coke [cocaine] wakes you up. They're uppers, you know, so you do that and you throw people in the shower or... throw cold water on them. And, you know, slap them around a little bit... just keep them up so they can stay alive, you know. (Male, 56)

Despite this participant's extensive experiences with lay remedies to address opioid overdose, he was receptive to using naloxone in such situations, had it been available:

Interviewer: If you had naloxone in those situations, do you think you would use it?
Interviewee: Yes... now that I know more about it, yeah. (Male, 56)

Aversion to potential naloxone side effects. Some participants shared experiences related to the side effects of naloxone administration for themselves or others, which may result in aversions to its use. While some reported using up to four doses of naloxone to revive a person, others were particularly concerned with the side effects related to excessive dosing of the medication that one participant described as "*almost life threatening*" *(Male, 31)*. As another participant explained, "*Actually, I think they put too much [naloxone in me] because I got sick real quick*" *(Male, 56)*.

Perceived opioid tolerance. One participant did not feel a need to consistently keep naloxone on him because he perceived a low risk of

overdose for himself and his peers, which he attributed to a behavioral change from injecting to smoking opioids:

> *I felt like the need for me to have [naloxone] on me has become less important... I think it has something to do with the fact that heroin used to affect us as a whole more because we would shoot it rather than smoke it. So, because everybody was shooting, there were more overdoses. And now, everyone's just smoking fentanyl. And there seems to be less overdoses. (Male, 31)*

Emotional strain. Finally, one participant shared that his decision not to keep naloxone on hand was related to a desire to avoid the emotional toll of responding to overdose:

> *Hopefully you won't judge me too harshly, but I haven't really been carrying [naloxone]... I just don't wanna be involved... if they're doing too much and they overdose then it's like, I don't really care... I just feel like I've lost too many friends and it's a lot to deal with. It really is a lot to deal with. It's like, very emotionally fucking draining. (White male, 36)*

Discussion

This study found variations in individual naloxone accessibility among a group of people who use drugs in San Diego with elevated risk of experiencing and witnessing overdose. Integrated quantitative and qualitative findings elucidated several multilevel factors influencing individual naloxone accessibility. Importantly, however, interview participants generally felt that naloxone was very easy to acquire in San Diego,

underscoring the importance of policies that have promoted OEND programs in California.

At a community level, our quantitative analysis indicated that familiarity with naloxone access sites was associated with greater levels of individual naloxone accessibility. Qualitative interviews further highlighted the importance of SSPs and other harm reduction providers in naloxone acquisition for people who use drugs. Future research should examine potential disparities in connections with harm reduction providers to determine whether tailored outreach strategies could reach those who report not knowing where to get free naloxone. Additionally, since our study, 16 naloxone-dispensing harm reduction vending machines have been placed throughout the County, which could contribute to reducing this gap in knowledge of where to get naloxone for some (Russell et al., 2023).

Several participants indicated that harm reduction services were concentrated in the Downtown area and naloxone was more difficult to access in other parts of the county. Distance from services may explain why some participants do not report always having accessible naloxone which echoes findings from earlier county-level assessments of harm reduction needs (Lewis & Asmus, 2020; San Diego State University Institute for Public Health, 2022). Our binary quantitative measure of geographic location (residing near downtown San Diego vs. elsewhere in the county) was not independently associated with naloxone accessibility in the final multivariable model. Due to low representation of participants from other

specific areas of the county, we were not able to determine if participants in certain geographic areas had relatively lower naloxone accessibility as described in interviews. Nonetheless, to prevent major geographic disparities, OEND programs should consider increased mobile distribution efforts to reach more geographically isolated individuals. Spatial mapping techniques overlaying naloxone access points and area-specific overdose rates or other indications of overdose prevention needs could further illuminate gaps in accessibility (Yi et al., 2022). Importantly, San Diego County's 2022 naloxone expansion efforts included distribution partnerships with 85 community organizations and the placement of harm reduction vending machines in various locations, including community organizations, methadone clinics, tribal reservations, and jails (Wooten & Leroy, 2023). It will be important to ensure people who use drugs are aware of these additional efforts and determine if perceptions of naloxone accessibility change in areas of the county where it was not previously widely available.

Although we did not find a significant relationship between housing status and naloxone accessibility in quantitative analyses, descriptions of unstable sleeping conditions and recurrent displacement among unhoused interview participants may explain why some lack consistently accessible naloxone. Goldshear and colleagues (2023) recently detailed the negative consequences of street sweeps for people who use drugs experiencing homelessness, including the frequent loss of important personal items and medications, such as naloxone. Additional research has estimated negative

health outcomes related to frequent relocation and involuntary displacement of people who use drugs experiencing homelessness, including higher odds of overdose (Barocas et al., 2023; Chiang et al., 2022). The California governor recently called for the dismantling of homeless encampments across the state following a 2024 Supreme Court ruling that granted state and local governments greater authority to forcibly remove people sleeping in public places (Hubler, 2024). Governments should prioritize the development of housing first options for people who use drugs and coordinate with harm reduction and social service providers when relocating individuals to ensure they have access to harm reduction supplies and maintain connections to services.

Interpersonal factors had a salient role in naloxone accessibility. In quantitative analyses, having witnessed an overdose was related to greater naloxone accessibility, and, as described in interviews, witnessing an overdose may influence people who use drugs to keep naloxone accessible (Allen et al., 2019; Valasek et al., 2023). Qualitative findings illuminated the important role of peer satellite distribution and mutual aid in promoting naloxone accessibility among people who use drugs. Reliance on peers to have naloxone may explain why some participants did not report consistent individual naloxone accessibility and highlights the relational aspects of overdose prevention. People who distribute and administer naloxone to others may be motivated by a sense of community responsibility (Kano et al., 2020) and empowerment in their capacity to prevent fatal overdose,

particularly in light of the powerlessness they may feel in other aspects of life (Rochester & Graboyes, 2022). As this study demonstrated interest in community overdose prevention among people who use drugs, programs to promote peer-to-peer overdose prevention training and naloxone distribution could further foster psychological wellbeing for peer trainers and increase the effectiveness of OEND programs (Perreault et al., 2023; Wagner et al., 2010).

Finally, individual-level factors provided explanation for some of the variation in naloxone accessibility. We found that women were more likely to report greater levels of personal naloxone accessibility, echoing prior studies in other US cities (Roth et al., 2024; Tobin et al., 2018). Women may be more concerned with personal naloxone accessibility due to elevated perceptions of overdose risk for themselves and others relative to men (Jones et al., 2023). Additionally, gender extends beyond an individual-level construct, carrying significant social implications related to societal roles and expectations. Prior research has identified community responsibility as a motivator for women's intentions to acquire, provide education, and distribute naloxone (Kano et al., 2020). This result may be related to our qualitative findings describing a sense of mutual aid that contributes to naloxone accessibility in San Diego combined with gendered socialization of women that results in more prosocial behavior relative to men (Espinosa & Kovářík, 2015). Previous literature assessing the effect of safer injection practice interventions on PWID injection networks found that a greater

presence of women in a network was related to a more robust intervention effect (Smith et al., 2017; Wiginton et al., 2023). This may indicate network effects whereby more connections to women results in greater agency to adopt harm reduction strategies due to lower exposure to gendered and unequal power dynamics. Future research should further explore the role of gendered socialization, power dynamics, and peer network composition in the uptake of harm reduction strategies like ensuring naloxone accessibility.

Despite the increase in free naloxone distribution in San Diego in recent years, having an average monthly income of less than USD$500 was negatively associated with naloxone accessibility. While income was not a focus of qualitative interviews, participant accounts of poverty and housing instability, including difficulty maintaining naloxone and other belongings, may partially explain this association. Further, in areas where free naloxone distribution was less common, people who use drugs with little or no income may have perceived naloxone to be less accessible due to the barriers associated with purchasing it in a pharmacy, including unavailability, lack of prescription, lack of insurance, and cost (Darracq et al., 2019; Puzantian et al., 2021). The Federal Drug Administration only recently approved over-the-counter Narcan® nasal spray naloxone in 2023 (Office of the Commissioner, 2023), which costs around USD$50 for two doses (Lovelace Jr., 2023), a price that is unaffordable for many people who use drugs in our study.

Qualitative inquiry also identified potential explanations for lower levels of naloxone accessibility related to individual perceptions of overdose

risk and response. These included a perception of reduced overdose risk related to smoking rather than injecting opioids, a preference for lay remedies to respond to overdose, an aversion to the potential side effects of naloxone, and emotional strain of witnessing multiple overdoses. Communities should assess the prevalence of such perceptions and attitudes among people who use drugs to determine the extent to which targeted interventions are needed. For example, community education that emphasizes evidence-based options to prevent overdose, such as oxygen administration (Suen et al., 2023), rescue breathing (Lankenau et al., 2013), and not using alone, as well as appropriate naloxone dosing strategies to reduce the risk of side effects from excessive naloxone administration (Lemen et al., 2023; Payne, 2024), may be appealing for people who have aversions to naloxone.

Limitations

We identified an important consideration for measuring naloxone accessibility related to terminology. Several interview participants expressed unfamiliarity with the term "naloxone" and most commonly referred to it as "Narcan®." Use of the term "naloxone" in surveys and interviews may have confused some participants. Although the qualitative interview guide was adjusted once this pattern was detected, skip-logic for Cohort 2 resulted in premature exclusion of 50 participants who were not familiar with the generic term but may have recognized the medication by its brand name.

Exclusion of these study participants indicates the possibility of nonresponse bias.

Participants were purposively sampled to meet parent study objectives and likely represent an especially marginalized group of people who use drugs in San Diego. Additionally, our quantitative analysis was limited to the variables available in the parent study and may not include all key factors that influence individual naloxone accessibility. Survey and interview data are subject to recall and social desirability bias (Tourangeau et al., 2000). Our study used cross-sectional data, limiting causal and temporal inferences in the relationships between independent variables and naloxone accessibility. Finally, while some of our findings mirrored those of other cities, our conclusions may not be generalizable to other geographic regions.

Conclusions

Although there were variations in reported accessibility, people who use drugs generally perceived that naloxone was easy to acquire in San Diego, likely attributable to successful OEND efforts that include regular street outreach from harm reduction organizations and mutual aid and satellite distribution among peers. Although we did not identify geographic differences in naloxone accessibility in quantitative analyses, qualitative insights indicated there may be location-related disparities in naloxone distribution. Finally, our analyses revealed individual-level factors that influence personal naloxone accessibility, including differences by gender

and income as well as perceptions of overdose risk and response that may indicate a need for additional overdose prevention education.

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Ethics approval

The authors obtained ethics approval from the Institutional Review Boards of Xochicalco University and the University of California, San Diego, (project number 191390).

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary Table 1. La Frontera participants included vs. excluded from analysis due to non-response				
	Included	Excluded	p-value	Overall
n	194	67		261
Non-White Race/Ethnicity (n(%))	106 (54.6)	34 (50.7)	0.683	140 (53.6)
Sex assigned at birth (female) (n(%))	55 (28.4)	25 (37.3)	0.223	80 (30.7)
Age (mean(SD))	42.1 (11.3)	46.3 (11.7)	**0.009**	43.2 (11.5)
Unhoused[a]	143 (73.7)	57 (85.1)	0.084	200 (76.6)
SSP engagement[a] (n(%))	118 (60.8)	46 (68.7)	0.319	164 (62.8)
Fentanyl[a] (n(%))	118 (60.8)	30 (44.8)	**0.032**	148 (56.7)
Heroin[a] (n(%))	87 (44.8)	35 (52.2)	0.366	122 (46.7)
Methamphetamine[a] (n(%))	162 (83.5)	47 (70.1)	**0.029**	209 (80.1)
Benzodiazepines/Tranquilizers[a] (n(%))	15 (7.7)	6 (9.0)	0.955	21 (8.0)
No longer injecting (n(%))	15 (7.7)	9 (13.4)	0.251	24 (9.2)
Average daily injections[a] (median (IQR))	1.12 (1.40)	1.33 (1.28)	0.281	1.17 (1.37)
Lifetime overdose (n(%))	121 (62.4)	34 (50.7)	0.127	155 (59.4)
Notes: [a]Indicated variables refer to the prior six months				