RESEARCH

Harm Reduction Journal

Open Access

Drug use and harm reduction practices of applicants to a public health vending machine service in Clark County, NV, 2021– 2023

Rachel Q. Bryant^{1*}, Kathleen Reich², Jessica A. Johnson¹, Brandon Delise¹, Ying Zhang¹, Cassius Lockett¹ and Sean T. Allen³

Abstract

Background In 2017, Clark County, NV, implemented Public Health Vending Machines (PHVMs), an innovative approach to the dispensation of harm reduction supplies to persons who inject drugs (PWID), including sterile equipment and naloxone. Administrative data associated with PHVM operations can be valuable for understanding drug use behaviors among PWID. The current study examines the demographics and drug use profiles of PHVM registrants who completed the harm reduction survey between January 2021 to June 2023 with comparison to nation-wide trends.

Methods All registration forms for PHVM services in Clark County, NV, between 1/1/2021-6/30/2022 with a completed harm reduction survey were included for analysis. Descriptive statistics were used to characterize differences in applicant demographics as well as self-reported injection and non-injection drug use, risk behaviors, and interest in harm reduction services. Logistic regression models tested the association between types of injection drug use and overdose and risk behaviors.

Results A total of 637 PHVM applications with completed survey data were included for analysis. Respondents were an average of 36.1 ± 10.2 years old, 56.3% male sex, and 63.6% non-Hispanic White with 85.1% reporting injection drug use (IDU). Notably, greater proportions of respondents with histories of IDU also indicated non-injection drug administration, such as smoking and snorting. In the 3 months prior to registration, the majority of IDU respondents reported high risk drug use behaviors, including daily use, multiple injections per day, and opioid and stimulant co-use. Fentanyl was suspected in 62.1% of overdoses in the last 3 months. Compared to PWID using stimulants only, respondents with opioid and stimulant co-use had a higher likelihood of overdose (aOR 4.51; 95% CI 2.05, 11.1; p < 0.001) and re-using injection supplies (aOR 2.14; 95% CI 1.33, 3.48; p = 0.002). More opioid and stimulant co-use respondents were interested in treatment/detox and obtaining naloxone than those without co-use.

*Correspondence: Rachel Q. Bryant rqbryant@gmail.com

Full list of author information is available at the end of the article



© The Author(s) 2025. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by-nc-nd/4.0/.

Conclusions The demographics and drug use behaviors of the PHVM PWID are consistent with contemporaneous county and nation-wide. As the overdose crisis evolves, PHVM could be pivotal tools in the early detection of new risks to facilitate timely adaptation of harm reduction strategies to improve morbidity and mortality.

Keywords Harm reduction, Public health vending machines, Injection drug use, Opioid, Stimulant, Overdose, Naloxone

Background

Drug overdoses-the majority involving an opioidcaused over a million deaths in the United States (US) between 1999 and 2020, quadrupling in rate during that time [1]. Three distinct mortality waves have driven the overdose crisis to date: (1) prescription opioid-related deaths from 1999 to 2017; (2) heroin-related deaths from 2010 to 2017; and (3) synthetic opioid-related deaths, principally illegally manufactured fentanyl and its analogs, from 2014 to the present [2]. In 2022, more than 70% of opioid-related deaths involved fentanyl [3]. Fentanyl-related overdoses may result from intention use or unintentional ingestion due to contamination of other drugs with fentanyl. Now, a fourth wave is rising, characterized by co-use of opioids with stimulants, primarily methamphetamine and cocaine, with mortality further exacerbated by new toxic adulterants, such as xylazine [4, 5]. Co-use of opioids and stimulants may also increase the risks for contracting blood-borne viral diseases [6, 7].

Overdose deaths related to the concurrent use of fentanyl and stimulants increased 60-fold between 2010 and 2021 [8]. In a sample of approximately one million urine toxicology results from 2013 to 2018, fentanyl positivity among cocaine- or methamphetamine-positive urine toxicology results increased by 1850% [9]. Qualitative interviews among people who inject drugs (PWID) suggest that the reasons for co-use include improving daily functioning and lessening withdrawal symptoms [10]. Among PWID reporting "goofball" (heroin + methamphetamine) as their main drug, prior experiences witnessing an opioid overdose were frequently reported [11]. Collectively, these data underscore the importance of scaling and tailoring harm reduction services to reduce morbidity and mortality.

Clark County, Nevada, has a population of approximately 2.3 million persons, accounting for 69.7% of the state's urban population, the majority in Las Vegas [12]. The Nevada legislature passed several measures (SB 459, AB 474, and AB 239) between 2015 and 2019 targeted to reducing opioid-related morbidity and mortality. Opioid prescriptions in Clark and Washoe counties subsequently fell 27.4% with a corresponding decline in prescription opioid deaths [13]. Overall opioid-related fatalities continued to rise, attributed to fentanyl and its analogs, paralleling the nation-wide pattern. Between January 2018 and July 2022, an estimated 1412 opioid-related overdose deaths occurred in Clark County with 46% involving fentanyl [14]. Of the fentanyl deaths, 65% were male and 51% non-Hispanic White. Younger adults, ages 20–34, were at highest risk for fentanyl overdose death during this time [14].

In 2013, the Nevada legislature passed SB 410, which decriminalized the possess of non-prescription syringes, permitting Syringe Services Programs (SSPs) to provide sterile syringes and collect used syringes to curb the spread of blood-borne viruses among PWID. The first SSP in Las Vegas consisted of a storefront operated by Trac-B, the non-profit arm of the Harm Reduction Center-Las Vegas, a community-based organization that provides addiction recovery services. In 2017, Trac-B expanded its efforts to include public health vending machines (PHVM), the first in the US [15]. Compared to pharmacy -and community-based SSPs, PHVM offer unique advantages over storefronts, including increased access, privacy, and anonymity [16]. Over time, naloxone, first aid, personal hygiene, and reproductive health kits were added to address additional harm reduction goals.

An underexplored aspect of PHVM implementation pertains to ancillary data collection and whether resulting data can be used to elucidate trends in risky drug use behaviors and better understand the population accessing services. In 2021, Clark County's PHVM program added an optional harm reduction survey to its registration application to collect information on drug use and harm reduction practices. The current study examines the demographics and drug use profiles of PHVM registrants who completed the harm reduction survey between January 2021 to June 2023 with comparison to nation-wide trends.

Methods

PHVM service. Harm Reduction Center-Las Vegas is a community-based partner of the Southern Nevada Health District, funded by the Nevada State Opioid Response Grant, which provides harm reduction services, including peer support, naloxone distribution, medical consultation and HIV/HCV screening, as well as syringe services. Trac-B Impact Exchange is the nonprofit arm of the Harm Reduction Center that operates the storefront- and PHVH-based SSPs. Trac-B currently has 6 PHVMs in Las Vegas, NV, located within community organizations and clinics that offer medical or behavioral health services to PWID [15]. The machines offer sterile syringe kits (sterile syringes, sterile water, band-aids, cottons, cookers, sharps container); naloxone kits (nasal with 2 doses, injectable with 3 doses); personal hygiene kits (toothbrush, toothpaste, body wash, soap, comb); first aid kits (band-aids, gauze, antiseptic towelettes and ointment, iodine prep pads); safe sex kits (condoms, lube); pregnancy test kits; and hormone injection kits. The availability of items varies by location.

Any individual over the age of 18 years may register to access the PHVM regardless of reported drug use. Individuals must register online or in-person at a PHVM site (Monday-Friday, hours vary by site) and complete a consent form before first use. The consent form indicates that limited data may be shared with state public health collaborators for research purposes. The registration form for PHVM service access collects information on date of birth, sex assigned at birth, gender identity, race, ethnicity, zip code, and homelessness status. Upon review and approval by Trac-B, individuals receive a magnetic swipe card and a unique identifier to permit inventory tracking.

Harm reduction survey. Starting in 2021, during online or in-person registration for PHVM services, individuals were offered an optional survey on injection drug use and harm reduction practices (Supplemental Table S1). The instrument, developed by Trac-B, included questions on the individual's injection drug use in the last 3 months, spanning (1) frequency of drug injection; (2) specific drugs or drug combinations injected; (3) frequency of using sterile or re-used needles; (4) needle sharing behaviors; (5) other routes of drug use (e.g., snorting, smoking); (6) interest in detox or treatment; (7) overdose experiences and familiarity with Narcan; and (8) interest in HIV or Hepatitis C testing, including prior positive results or treatment. Individuals were permitted to refuse response to any question and/or decline the entire survey. Refusal did not impact receipt of PHVM services. No incentives were offered for survey completion. All PHVM data, including harm reduction survey data, are collected and secured by Trac-B.

Data source & study design. The current study is a cross-sectional, secondary analysis of de-identified data provided by Trac-B. All PHVM registrations completed between 1/1/2021 and 6/30/2023 with a completed harm reduction survey were included in the current analysis.

Statistical analysis. All analyses were completed in R (version 4.3.2). Descriptive statistics were used to assess differences in characteristics of respondents by comparator of interest (e.g., injection vs. non-injection drug use). Group differences for categorical responses were tested by chi-square or Fisher's exact test (cell counts \leq 5). Applicants were required to be at least 18 years of age, as such, age was non-normal in distribution with differences tested by Wilcoxon rank-sum test. For all comparison tests, significance was set at p < 0.05. To examine the association between types of injection drug use and

overdose or risk behaviors (reusing needles or reusing supplies), adjusted odds ratios (aORs) and corresponding 95% confidence intervals (CIs) were estimated using logistic regression models. Injection co-use is defined as reporting injection of opioids and stimulants or explicit combinations of opioids and stimulants in the last 3 months. Models were adjusted for relevant covariates from the literature, namely sociodemographic factors (age, sex, race/ethnicity, homelessness status) and injection frequency (daily vs. non-daily injection) [17–22]. Due to the multiple comparisons conducted, the false discovery rate (FDR) was controlled at <5% using the Benjamini-Hochberg procedure to calculate q-values. A q-value below 0.05 was considered statistically significant.

Results

A total of 1113 individuals submitted applications for the PHVM service between 1/1/2021 and 6/30/2023 with 638 completing the harm reduction survey (response rate = 57.3%). One survey lacked necessary sociodemographic data and was removed, leaving 637 surveys for analysis. As shown in Table 1, the survey respondents were an average of 36.1 ± 10.2 years old, 56.3% male sex, 1.7% transgender/gender non-conforming, 63.6% non-Hispanic White, and 32.5% homeless. Most participants (N = 550; 85.1%) reported injection drug use (IDU), while smoking (74.4%) was the most reported non-injection route of use (Table 1). Of note, the percentage of registrants reporting IDU decreased from 92.1% in 2021 to 77.8% in 2023 (p<0.001) (Supplemental Table S2). Of the 87 individuals who did not report IDU in the last 3 months, only 2 reported drug use by other methods.

Compared to those persons without a history of IDU (Table 1), PWID were older (36.4 ± 10.0 vs. 34.4 ± 11.4 years; p = 0.029), with a higher percentage of male sex (58.4% vs. 42.9%; p = 0.008), non-Hispanic White (66.7% vs. 43.7%; p < 0.001), and homelessness (36.4% vs. 8.0%; p < 0.001). Higher rates of snorting (17.2% vs. 32.5%; p = 0.004) and smoking (80.9% vs. 33.3%; p < 0.001) routes of use were also reported among those with a history of IDU compared to those without this history. Rectal administration (e.g., "boof", "booty bump") was the most reported route among all respondents (N=16) from the free text responses.

Among PWID (Table 2), in the last 3 months, the majority reported injecting daily (68.5%) at a frequency of 2 to 4 times per day (63.7%). Methamphetamine (74.0%), heroin (56.0%), goofball (22.2%), fentanyl (14.0%), and speedball (10.9%) were the most injected substances. Opioid and stimulant injection co-use was reported by 41.2% of respondents. Most (60.7%) respondents reported discarding their used needles in a puncture-proof container "always" or "most of the time"; using a new, sterile needle

Table 1 Sociodemographic and drug use characteristics of registrants for public health vending machine services with a completed harm reduction survey (n = 637)

		Injection Drug Us	se	
Characteristic	Overall, N=637	No, <i>N</i> =87	Yes, N = 550	p-value
Age (years), Mean (SD)	36.1 (10.2)	34.4 (11.4)	36.4 (10.0)	0.029 ¹
Sex assigned at birth, n (%)				0.008 ²
Female	276 (43.7%)	48 (57.1%)	228 (41.6%)	
Male	356 (56.3%)	36 (42.9%)	320 (58.4%)	
Missing	5	3	2	
Gender identity, n (%)				< 0.001 ³
Female	275 (43.2%)	47 (54.0%)	228 (41.5%)	
Male	351 (55.1%)	34 (39.1%)	317 (57.6%)	
Transgender	11 (1.7%)	6 (6.9%)	5 (0.9%)	
Race/Ethnicity, n (%)				< 0.001 ²
Al/AN/Other	37 (5.8%)	2 (2.3%)	35 (6.4%)	
Asian, Native Hi, Or Pl	40 (6.3%)	14 (16.1%)	26 (4.7%)	
Black	45 (7.1%)	13 (14.9%)	32 (5.8%)	
Hispanic	110 (17.3%)	20 (23.0%)	90 (16.4%)	
White, Not Hispanic	405 (63.6%)	38 (43.7%)	367 (66.7%)	
Homeless, n (%)	207 (32.5%)	7 (8.0%)	200 (36.4%)	< 0.001 ²
Non-injection routes of drug use				
Snort, n (%)	194 (30.5%)	15 (17.2%)	179 (32.5%)	0.004 ²
Smoke, n (%)	474 (74.4%)	29 (33.3%)	445 (80.9%)	< 0.001 ²
Oral, n (%)	155 (24.3%)	24 (27.6%)	131 (23.8%)	0.4 ²

¹Wilcoxon rank sum test

²Pearson's Chi-squared test

³Fisher's exact test

"always" or "most of the time" (62.3%); and employing a bleached or sterilized used needle "rarely" or "never" (76.6%). However, 21.5% of respondents indicated sharing syringes to divide drugs (e.g., backloading). Of the 18.7% of respondents that shared needles (e.g., points, rigs), 63.7% shared needles received from others. Of the 29.5% of individuals that shared equipment (e.g., cookers, cotton, water), 49.4% shared the equipment of others. Finally, 77.6% of respondents indicated reusing their own needles and 66.4% reusing their own supplies. Approximately 10.4% of respondents had an overdose in the last 3 months. Reported rates of past HCV and HIV infection among respondents were 14.9% and 6.4%, respectively.

The majority of overdoses (98.3%) in the last 3 months were among PWID participants (Supplemental Table S3). Persons reporting an overdose were mean age of 35.6 ± 12.5 years, 51.7% male sex, 74.1% non-Hispanic White, and 37.9% homeless. Fentanyl (62.1%), heroin (58.6%), and methamphetamine (37.9%) were most frequently associated with overdose; with 63.2% of those individuals experiencing an overdose reporting opioid and stimulant injection co-use. Approximately 64.4% used naloxone during their overdose and 32.7% reported more than one overdose in the last 3 months.

Compared to PWID respondents using stimulants only (Table 3), after adjusting for sociodemographic factors and daily injection use, respondents with opioid and stimulant co-use had a higher likelihood of overdose (aOR 4.51; 95% CI 2.05, 11.1; p < 0.001) and reusing supplies (aOR 2.14; 95% CI 1.33, 3.48; p = 0.002) in the last 3 months, but not reusing needles. These associations remained after correction for multiple testing. Full regression results are available in Table S4. Of note, female sex, homelessness, and daily injection use significantly associated with reuse of needles and supplies, but not overdose (Supplemental Table S4).

Harm reduction behaviors are shown in Table 4. Among PWID respondents, 14.8% were interested in treatment/detox, 28.8% in naloxone education, 55.4% in obtaining naloxone, 13.7% in rapid HCV testing, 4.1% in referral for HCV medical treatment, 15.7% in rapid HIV testing, 0.9% in referral for HIV medical treatment, and 13.7% in referral for STD testing. A total of 40.1% of PWID reported ever using naloxone. Significantly (p < 0.05) more opioid and stimulant co-use respondents reported ever using naloxone and were interested in treatment/detox, obtaining naloxone, and referral for HCV medical treatment compared to their opioid or stimulant only counterparts.

Discussion

The US is currently grappling with a "fourth wave" in the ever-evolving overdose crisis, one marked by high mortality rates due to the simultaneous use of opioids **Table 2** Injection frequency and drug type, needle practices, and outcomes among PWID, last 3 Mo. (N = 550)

A 1	N 550 ²
<u>N</u> .	/v=550*
549	40 (7.20()
	40 (7.3%)
	35 (6.4%)
	98 (17.9%)
275	376 (68.5%)
375	12 (11 52()
	43 (11.5%)
	239 (63.7%)
	69 (18.4%)
	24 (6.4%)
550	407 (74.0%)
550	308 (56.0%)
550	122 (22.2%)
550	77 (14.0%)
550	60 (10.9%)
550	36 (6.5%)
550	35 (6.4%)
550	22 (4.0%)
550	13 (2.4%)
550	9 (1.6%)
550	8 (1.5%)
534	
	220 (41.2%)
	104 (19.5%)
	210 (39.3%)
527	
	320 (60.7%)
	62 (11.8%)
	145 (27.5%)
536	
	334 (62.3%)
	146 (27.2%)
	56 (10.4%)
531	
	57 (10.7%)
	67 (12.6%)
	407 (76.6%)
543	117 (21.5%)
550	103 (18.7%)
102	65 (63.7%)
549	162 (29.5%)
158	78 (49.4%)
540	419 (77.6%)
541	359 (66.4%)
550	57 (10.4%)
	N1 549 375 550 536 537 536 537 536 537 536 537 536 531 543 550 527 536 531 543 550 102 549 158 540 541 55

Table 2 (continued)

Characteristic	N ¹	N=550 ²
HCV, past, n (%)	550	82 (14.9%)
HIV, past, n (%)	550	35 (6.4%)
I Count of a complexity of because times		

¹Count of non-missing observations

²Respondents (N = 16) with hormone or steroid only injection use removed

³Question skipped if injections per month not equal to daily

⁴Question skipped if respondent not sharing needles

⁵Question skipped if respondent not sharing supplies

⁶Respondents were instructed to check all options that applied, as such, sum

exceeds 100%

Table 3 Association of injection co-use to overdose and needle/supply reuse among PWID

Outcome	Event N	aOR ¹	95% Cl	<i>p</i> -value	q-value ²
Overdose, last 3 mo.	57				
Stimulants only		1.00	—		
Opioids & stimulants		4.51	2.05, 11.1	< 0.001	0.002
Opioids only		3.44	1.36, 9.18	0.010	0.020
Reused needles, last 3 mo.	414				
Stimulants only		1.00	—		
Opioids & stimulants		1.18	0.67, 2.08	0.6	0.6
Opioids only		0.72	0.39, 1.33	0.3	0.3
Reused supplies, last 3 mo.	357				
Stimulants only		1.00	—		
Opioids & stimulants		2.14	1.33, 3.48	0.002	0.006
Opioids only		1.71	0.98, 3.00	0.060	0.090

¹aOR: Adjusted Odds Ratio. Adjusted for age, sex, race/ethnicity, homelessness status, daily injection use

² Benjamini-Hochberg correction for multiple testing

Table 4 Harm re	eduction practices	among PWID with	comparison b	y drug co-use
		- /		/ ./

Characteristic	Overall,	Opioids & stimulants, N=220	Opioids only,	Stimulants only,	<i>p</i> -value
	N=534		N=104	N=210	
Interested in treatment/detox, n (%)	79 (14.8%)	47 (21.4%)	18 (17.3%)	14 (6.7%)	< 0.001 ¹
Ever used naloxone, n (%)	214 (40.1%)	132 (60.0%)	45 (43.3%)	37 (17.6%)	< 0.001 ¹
Interested in naloxone education, n (%)	154 (28.8%)	71 (32.3%)	33 (31.7%)	50 (23.8%)	0.12 ¹
Want to obtain naloxone, n (%)	296 (55.4%)	153 (69.5%)	61 (58.7%)	82 (39.0%)	< 0.001 ¹
Rapid HCV test wanted, n (%)	73 (13.7%)	33 (15.0%)	14 (13.5%)	26 (12.4%)	0.7 ¹
HCV medical referral wanted, n (%)	22 (4.1%)	15 (6.8%)	5 (4.8%)	2 (1.0%)	0.004 ²
Rapid HIV test wanted, n (%)	84 (15.7%)	44 (20.0%)	10 (9.6%)	30 (14.3%)	0.043 ¹
HIV medical referral wanted, n (%)	5 (0.9%)	1 (0.5%)	0 (0.0%)	4 (1.9%)	0.2 ²
Referral for STD testing wanted, n (%)	73 (13.7%)	38 (17.3%)	8 (7.7%)	27 (12.9%)	0.058 ¹

¹Pearson's Chi-squared test

²Fisher's exact test

and stimulants [4, 8]. It is critical to closely monitor trends and identify the risk factors contributing to overdoses and associated health complications to tailor harm reduction interventions and allocate resources effectively. PHVMs have emerged as an innovative harm reduction strategy that additionally offer advantages for surveillance. Prior to this study, however, it was unclear if the drug use and harm reduction practices of PHVM clients were representative of the broader population of PWID.

Our analysis of PHVM registrants who completed an optional harm reduction survey revealed that the majority were PWID. As of 2018, the estimated prevalence of IDU in the US is highest among males (2.1%), non-Hispanic Whites (1.8%), and individuals aged 18–39 years (1.8%) [23]. The demographic composition of the PHVM respondents mirrored this pattern with a mean age of 36.4 years, 58.4% male, and 66.7% non-Hispanic White among those reporting IDU. Methamphetamine was the most reported injected substance among PHVM PWID, followed by heroin, "goofball" (methamphetamine combined with heroin), and fentanyl. This is consistent with data from the Treatment Episode Data Set which found that among those admitted for treatment of primarily methamphetamine use, the percentage reporting injection as the usual route of administration increased from 18% in 2010 to 28.2% in 2019 [24]. Furthermore, the PHVM PWID reported high risk use (e.g., daily use, multiple injections per day, or polydrug combinations), which aligns with recent findings from the National Survey on Drug Use and Health findings that reported an increase in frequency of use among those who inject methamphetamine versus those with methamphetamine use but without injection [25].

Nationally, between 2016 and 2021, overdose deaths involving fentanyl increased by 279% (p < 0.05), methamphetamine by 357% (p < 0.05), and cocaine by 216% (p < 0.05) [26]. Oxycodone and heroin deaths, declined by 21% (p < 0.05) and 41% (not significant), respectively [26]. Nevada experienced a similar trend with a 97% increase in overdose deaths involving fentanyl and stimulant co-use from 2020 to 2023 [27]. Within the PHVM data, most PWID respondents with an overdose in the past 3 months reported co-injecting opioids and stimulants with fentanyl as the most implicated drug. Our findings suggest that co-use of opioids and stimulants is strongly linked with overdose risk. Furthermore, recent data from seizures of illicit drugs have found the presence of fentanyl in opioid and stimulant supplies has steadily increased over time [28, 29]. Even if respondents did not indicate report explicit use of fentanyl, the likelihood of fentanyl exposure is high.

Emerging CDC data indicate a shift from injection to inhalation as the primary route in overdose fatalities [30]. Comparing January to June 2020 to July to December 2022 across 28 jurisdictions, overdose deaths with evidence of injection decreased 29.1%, whereas those with smoking increased 73.7% [30]. Smoking/inhalation was the most reported non-injection route of drug use in our PHVM sample with approximately 81% reporting both IDU and smoking. Sharing smoking or snorting equipment (e.g., pipes, straws) is an underrecognized risk factor for contracting viral disease. Injuries from heated metal or glass equipment (or the inherently caustic nature of the drugs) can injure skin and mucous membrane barriers [31]. Drug use is also associated with high rates of dental caries and periodontal disease. Additionally, as observed in the current study, rectal administration ("booty bump") is another commonly reported route with the potential for injury [32]. Individuals with skin or mucous membrane lesions risk infection from exposure to contaminated equipment or unprotected sex [17, 20, 33–36]. These trends underscore the importance of Clark County's efforts to expand PHVM offerings to include clean equipment (e.g., sterile water, cottons, cookers), hygiene/wound care items, and safe sex kits.

In North America, the prevalence of HCV and HIV infections among PWID, by antibody testing, is estimated to be 55.2% and 9%, respectively [37]. The prevalence of past diagnosis of HCV infection in the PHVM sample (15%) was substantially lower than nationwide estimates, while that of past HIV infection, approximately 6%, was more comparable. The lower rates may reflect bias due to self-report. However, approximately a quarter of respondents reported sharing needles, syringes, or equipment, consistent with prior studies [17, 38]. Interest in HCV and HIV testing did not significantly differ across between persons with and without drug co-use.

Respondents with a history of opioid and stimulant couse were more likely to have used naloxone previously and were more interested in obtaining it compared to those with opioid or stimulant use alone. This supports prior studies that those at increased risk of overdose are proactive in learning and using take-home naloxone [10, 39]. After the introduction of naloxone dispensation in the PHVMs in 2019, a prompt decrease in opioidinvolved overdose deaths was observed [15]. The high rate of fentanyl among reported overdoses indicates a need to add testing strips to the current PHVM offerings, an effort already underway.

PHVM are primarily utilized by PWID. However, persons who do not inject can also benefit from the harm reduction supplies at PHVMs. While the risks of viral transmission from sharing injection equipment are wellknown among people who use drugs, the risks of viral transmission via injured mucous membranes and skin lesions may be less well understood among persons without histories of injection drug use. Further, given the additional risks for severe skin wounds due to xylazine contamination [40], initiatives are needed to increase awareness as to the importance of sterile equipment, hygiene/wound care, and safer sex practices, regardless of preferred route of use. Additionally, the rise of smoking as the primary route of fentanyl-related overdose deaths suggests a need to increase naloxone distribution broadly.

A recent system review found that users of PHVM differ significantly from those who access fixed site SSPs with higher PHVM use among those who are financially unstable [16]. We also found high interest among those experiencing homelessness for PHVM services. Homelessness associates with high rates of needle and equipment sharing and reuse in other studies [41–43]. We likewise found that homelessness associated with reuse of needles and supplies. Several factors may impede PHVM utilization by persons experiencing homelessness, including fear of law enforcement interactions, stigma, loss of registration card or number, and competing survival needs. When resources are constrained, individuals may have to prioritize nourishment and avoiding withdrawal over transport to a PHVM to secure sterile equipment. One solution is to increase service delivery (e.g., syringe services programs and PVHMs) in areas frequented by people who use drugs. The need to register for the PHVM is itself a barrier to access, although removing this requirement would preclude meaningful data collection.

The strengths of the current study include the sample size and novelty of the program evaluated. Limitations include the relatively brief period of collection since survey implementation and reliance on self-report for estimating the prevalence of overdose, viral infections, and risk behaviors, which are likely underreported. Only partial data were available for 2023. The survey is also voluntary with selection bias potentially impacting the generalizability of the findings.

Conclusions

PHVMs represent a groundbreaking strategy with dual benefits toward harm reduction and data collection on high-risk behaviors among PWID. Enrollees in the PHVM services in Clark County, NV reflect the demographic composition and trends observed nation-wide among PWID. PHVM could therefore be an essential tool in monitoring and combating the overdose epidemic. The scope of PHVM's harm reduction capabilities extends to persons without injection drug use. There is a critical need to raise community awareness about the overdose dangers and health risks of non-IDU, which may be less obvious than those associated with IDU.

Abbreviations

IDUInjection Drug UsePHVMPublic Health Vending Machine(s)PWIDPersons Who Inject Drugs

Supplementary Information

The online version contains supplementary material available at https://doi.or g/10.1186/s12954-025-01207-x.

Supplementary Material 1

Acknowledgements

We wish to extend our sincere appreciation to those whose contributions have been integral to the PHVM efforts in Nevada, including Bob Clarke, Marlo Tonge, Chelsi Cheatom, Rick Reich, Elmer Belmonte, Kathryn Baker, Dr. Jessica Penney, and Liz Vasquez. We give our gratitude and thanks to our clients for their feedback and expertise.

Author contributions

RB, KR, JAJ, and STA were involved in the conception of the study. RB completed the statistical analysis and drafted the manuscript. KR, JAJ, BD, YZ, and CL supplied contextual information about the overdose landscape in Clark County. KR provided information about PHVM implementation and operations. All authors were involved in the interpretation of the findings and manuscript editing. All authors reviewed and approved the final manuscript and agree to be held accountable for all aspects of the work.

Funding

RB is partly funded by an applied epidemiology fellowship sponsored by the Council of State and Territorial Epidemiologists. STA is supported by the

Bloomberg American Health Initiative at the Johns Hopkins Bloomberg School of Public Health.

Data availability

Data that supported the findings of this study are available from the Southern Nevada Health District upon reasonable request.

Declarations

Ethics approval and consent to participate

Given that this analysis did not constitute human subjects research, it was not reviewed by an Institutional Review Board.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details

¹Southern Nevada Health District, 280 S. Decatur Blvd, Las Vegas, NV 89107, USA ²Impact Exchange, Las Vegas, NV, USA ³Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA

Received: 30 May 2024 / Accepted: 1 April 2025 Published online: 12 April 2025

References

- Ghaddar T, Ferris A, Mejia MC, Ravi SN, Levine RS, Hennekens CH, Caceres JW. Evolving trends in US mortality from opioid overdose: heroin and beyond. Am J Med. 2023;136:1211–5.
- Ciccarone D. The triple wave epidemic: supply and demand drivers of the US opioid overdose crisis. Int J Drug Policy. 2019;71:183–8.
- Mattson CL, Tanz LJ, Quinn K, Kariisa M, Patel P, Davis NL. Trends and geographic patterns in drug and synthetic opioid overdose Deaths - United States, 2013–2019. MMWR Morb Mortal Wkly Rep. 2021;70:202–7.
- Palamar JJ, Cottler LB, Goldberger BA, Severtson SG, Grundy DJ, Iwanicki JL, Ciccarone D. Trends in characteristics of fentanyl-related poisonings in the united States, 2015–2021. Am J Drug Alcohol Abuse. 2022;48:471–80.
- Kariisa M, O'Donnell J, Kumar S, Mattson CL, Goldberger BA. Illicitly manufactured Fentanyl-Involved overdose deaths with detected Xylazine - United States, January 2019-June 2022. MMWR Morb Mortal Wkly Rep. 2023;72:721–7.
- Jawa R, Stein MD, Anderson B, Liebschutz JM, Stewart C, Phillips KT, Barocas JA. Behavioral risk factors for HIV infection in hospitalized persons who Couse stimulants and opioids. AIDS Behav. 2022;26:1047–55.
- Serota DP, Bartholomew TS, Tookes HE. Evaluating differences in opioid and stimulant Use-associated infectious disease hospitalizations in Florida, 2016–2017. Clin Infect Dis. 2021;73:e1649–57.
- Friedman J, Shover CL. Charting the fourth Wave: geographic, Temporal, race/ethnicity and demographic trends in polysubstance Fentanyl overdose deaths in the united States, 2010–2021. Addiction. 2023;118:2477–85.
- LaRue L, Twillman RK, Dawson E, Whitley P, Frasco MA, Huskey A, Guevara MG. Rate of Fentanyl positivity among urine drug test results positive for cocaine or methamphetamine. JAMA Netw Open. 2019;2:e192851.
- Lopez AM, Dhatt Z, Howe M, Al-Nassir M, Billing A, Artigiani E, Wish ED. Co-use of methamphetamine and opioids among people in treatment in Oregon: A qualitative examination of interrelated structural, community, and individual-level factors. Int J Drug Policy. 2021;91:103098.
- Glick SN, Klein KS, Tinsley J, Golden MR. Increasing heroin-methamphetamine (goofball) use and related morbidity among Seattle area people who inject drugs. Am J Addictions. 2021;30:183–91.
- 12. Clark, County. [https://nevadaruralhousingstudies.org/county/clark/]
- Cornwell-Hinrichs T, Wyant C, Vanier C, Havins W, Paul Hardy J. Trends in opioid death rates following implementation of Nevada's opioid prescribing laws. Am J Intern Med. 2021;9:204–9.
- 14. Health District issues an advisory. to the public as fentanyl deaths increase in Clark County [https://www.southernnevadahealthdistrict.org/news-release/

health-district-issues-an-advisory-to-the-public-as-fentanyl-deaths-increase-in-clark-county]

- Allen ST, O'Rourke A, Johnson JA, Cheatom C, Zhang Y, Delise B, Watkins K, Reich K, Reich R, Lockett C. Evaluating the impact of Naloxone dispensation at public health vending machines in Clark County, Nevada. Ann Med. 2022;54:2692–700.
- Russell E, Johnson J, Kosinski Z, Kaplan C, Barnes N, Allen S, Haroz E. A scoping review of implementation considerations for harm reduction vending machines. Harm Reduct J. 2023;20:33.
- 17. Allen ST, Schneider KE, Morris M, Rouhani S, Harris SJ, Saloner B, Sherman SG. Factors associated with receptive injection equipment sharing among people who inject drugs: findings from a multistate study at the start of the COVID-19 pandemic. Harm Reduct J. 2023;20:18.
- Biondi BE, Anderson BJ, Phillips KT, Stein M. Sex differences in injection drug risk behaviors among hospitalized persons. J Addict Med 2022, 16.
- Handanagic S, Finlayson T, Burnett JC, Broz D, Wejnert C. HIV infection and HIV-Associated behaviors among persons who inject drugs–23 metropolitan statistical areas, united States, 2018. MMWR Morb Mortal Wkly Rep. 2021;70:1459–65.
- Zhou B, Cai GFF, Lv HKK, Xu SFF, Wang ZTT, Jiang ZGG, Hu CGG, Chen YDD. Factors correlating to the development of hepatitis C virus infection among drug Users—Findings from a systematic review and Meta-Analysis. Int J Environ Res Public Health. 2019;16:2345.
- Jones AA, Schneider KE, Mahlobo CT, Maggs JL, Dayton L, Tobin KE, Latkin CA. Fentanyl overdose concerns among people who inject drugs: the role of sex, Racial minority status, and overdose prevention efforts. Psychol Addict Behav. 2023;37:191–8.
- Mateu-Gelabert P, Sabounchi NS, Guarino H, Ciervo C, Joseph K, Eckhardt BJ, Fong C, Kapadia SN, Huang TT. Hepatitis C virus risk among young people who inject drugs. Front Public Health. 2022;10:835836.
- 23. Bradley H, Hall EW, Asher A, Furukawa NW, Jones CM, Shealey J, Buchacz K, Handanagic S, Crepaz N, Rosenberg ES. Estimated number of people who inject drugs in the united States. Clin Infect Dis. 2023;76:96–102.
- 24. Jones CM, Han B, Seth P, Baldwin G, Compton WM. Increases in methamphetamine injection among treatment admissions in the U.S. Addict Behav. 2023;136:107492.
- Han B, Compton WM, Jones CM, Einstein EB, Volkow ND. Methamphetamine use, methamphetamine use disorder, and associated overdose deaths among US adults. JAMA Psychiatry. 2021;78:1329–42.
- Spencer MR, Warner M, Cisewski JA, Miniño A, Dodds D, Perera J, Ahmad FB. Estimates of drug overdose deaths involving Fentanyl, methamphetamine, cocaine, heroin, and oxycodone: united States, 2021. Vital statistics rapid release. Volume 27. Hyattsville, MD: National Center for Health Statistics; May; 2023.
- 27. Health District calls attention. to health risks of combining stimulants and fentanyl [https://www.southernnevadahealthdistrict.org/news-release/healt h-district-calls-attention-to-health-risks-of-combining-stimulants-and-fentan vl]
- Park JN, Rashidi E, Foti K, Zoorob M, Sherman S, Alexander GC. Fentanyl and Fentanyl analogs in the illicit stimulant supply: results from U.S. Drug seizure data, 2011–2016. Drug Alcohol Depend. 2021;218:108416.
- Cano M, Timmons P, Hooten M, Sweeney K. Drug supply measures and drug overdose mortality in the era of Fentanyl and stimulants. Drug Alcohol Depend Rep. 2023;9:100197.

- Tanz LJ, Gladden RM, Dinwiddie AT, Miller KD, Broz D, Spector E, O'Donnell J. Routes of drug use among drug overdose Deaths - United States, 2020–2022. MMWR Morb Mortal Wkly Rep. 2024;73:124–30.
- 31. Martinez A, Talal AH. Noninjection drug use: an under-appreciated risk factor for hepatitis C virus transmission. Liver Int. 2008;28:757–60.
- Grov C, Westmoreland D, Morrison C, Carrico AW, Nash D. The crisis we are not talking about: One-in-Three annual HIV seroconversions among sexual and gender minorities were persistent methamphetamine users. J Acquir Immune Defic Syndr. 2020;85:272–9.
- Neaigus A, Reilly KH, Jenness SM, Hagan H, Wendel T, Gelpi-Acosta C. Dual HIV risk: receptive syringe sharing and unprotected sex among HIV-negative injection drug users in new York City. AIDS Behav. 2013;17:2501–9.
- Crooks D, Tsui J, Anderson B, Dossabhoy S, Herman D, Liebschutz JM, Stein MD. Differential risk factors for HIV drug and sex risk-taking among non-treatment-seeking hospitalized injection drug users. AIDS Behav. 2015;19:405–11.
- Handanagic S, Finlayson T, Burnett JC, Broz D, Wejnert C, National HIVBSSG. HIV infection and HIV-Associated behaviors among persons who inject drugs–23 metropolitan statistical areas, united States, 2018. MMWR Morb Mortal Wkly Rep. 2021;70:1459–65.
- Pouget ER, Hagan H, Des Jarlais DC. Meta-analysis of hepatitis C seroconversion in relation to shared syringes and drug Preparation equipment. Addiction. 2012;107:1057–65.
- Degenhardt L, Peacock A, Colledge S, Leung J, Grebely J, Vickerman P, Stone J, Cunningham EB, Trickey A, Dumchev K, et al. Global prevalence of injecting drug use and sociodemographic characteristics and prevalence of HIV, HBV, and HCV in people who inject drugs: a multistage systematic review. Lancet Glob Health. 2017;5:e1192–207.
- Strike C, Buchman DZ, Callaghan RC, Wender C, Anstice S, Lester B, Scrivo N, Luce J, Millson M. Giving away used injection equipment: missed prevention message? Harm Reduct J. 2010;7:2.
- Enteen L, Bauer J, McLean R, Wheeler E, Huriaux E, Kral AH, Bamberger JD. Overdose prevention and Naloxone prescription for opioid users in San Francisco. J Urban Health. 2010;87:931–41.
- German D, Genberg B, Sugarman O, Saloner B, Sawyer A, Glick JL, Gribbin M, Flynn C. Reported xylazine exposure highly associated with overdose outcomes in a rapid community assessment among people who inject drugs in Baltimore. Harm Reduct J. 2024;21:18.
- Hotton A, Mackesy-Amiti ME, Boodram B. Trends in homelessness and injection practices among young urban and suburban people who inject drugs: 1997–2017. Drug Alcohol Depend. 2021;225:108797.
- Bozinoff N, Wood E, Dong H, Richardson L, Kerr T, DeBeck K. Syringe sharing among a prospective cohort of Street-Involved youth: implications for needle distribution programs. AIDS Behav. 2017;21:2717–25.
- Wagner KD, Simon-Freeman R, Bluthenthal RN. The association between law enforcement encounters and syringe sharing among IDUs on skid row: a mixed methods analysis. AIDS Behav. 2013;17:2637–43.

Publisher's note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.