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Abstract

(1) Background: Housing instability, a key social determinant of health, disproportionately affects people who use drugs (PWUD), increasing their risk for adverse outcomes. This study explores the relationship between housing status and drug-related health outcomes among PWUD in an urban setting in the Southeastern United States (US) and determines the cut-off point for the Housing Instability Scale (HIS). (2) Methods: We conducted a cross-sectional survey from July to November 2024 among adult PWUD. Recruitment was through syringe services programs (SSPs), nightlife venues, and community outreach. HIS was used to assess housing status, cluster analysis to determine cutoff, and Gaussian Mixture Modeling (GMM) to validate. Logistic regression models were employed to examine associations between housing instability and health outcomes. (3) Results: Among 164 participants (mean age = 41.2; 79.9% Black/African American), the average HIS score was 3.23. Scores of 0-3 represented stable housing; 4-7 represented unstable housing on the HIS. Multivariate logistic regression revealed that housing instability was significantly associated with infections (AOR = 1.55, p = 0.064), blackouts (AOR = 1.47, p = 0.0457), and seizures (AOR = 1.28, p = 0.0667). Overdose and wounds showed no significant association. SSP use, opioid, and Xanax use were strong predictors.

Keywords: Housing Instability; People Who Use Drugs (PWUD); drug-related health outcomes; cut-off

1. Introduction

1.1. Background

Housing stability is a fundamental determinant of health that impacts virtually every aspect of an individual's life [1]. Being unstably housed has a greater impact on one's health, including physical, mental, and overall well-being, compared to the general population [2–4]. Housing instability can be broadly defined as the lack of fixed or adequate housing, unstable neighborhoods [5], and homelessness due to a lack of a nighttime residence [6]. A person who is unstably housed moves frequently, spends almost all their income on rent, or lives in a shared space that is grossly inadequate [7]. Homelessness is defined as the lack of a fixed and adequate nighttime residence or a primary nighttime residence designed to provide temporary accommodation to individuals or

families, whether privately or publicly operated [7]. There is an additional layer of homelessness known as unsheltered homelessness, where people who experience this sleep in unconventional places: places that do not qualify for human habitation, like sidewalks, train stations, tents, sheds, and garages [8]. The United States has a lifetime prevalence of homelessness of approximately 4.2% [9]. As of January 2023, over 650,000 people in the United States experienced homelessness on a single night, and over 50% of those people were unsheltered [8]. Out of these numbers, over 12,000 were from the State of Georgia [8]. Studies have shown that about 1 out of every 3 to 4 people experiencing homelessness use drugs [9,10]. People who use drugs (PWUD) and are experiencing homelessness suffer more harmful effects of drug use compared with people who are housed, including drug overdose-related deaths [11,12]. Not only is housing a fundamental determinant of an individual's health, but it also imposes a financial as well as logistical burden on the healthcare system [13]. A study by Kertesz et al. (2020) found that people experiencing homelessness in the program had average annual healthcare costs of $18,764, compared to $7,561 for housed Medicaid patients. This is largely due to increased use of emergency departments and outpatient services. Without stable housing, these conditions often go unmanaged, leading to frequent and costly hospital visits. The difference in annual costs between the two groups, about $4,400 more per year, highlights how increased spending is tied to the financial strain of delayed and inaccessible care. In summary, this study highlights that unstable housing leads to poorer health outcomes, which directly contributes to rising healthcare costs [14].

1.2. Measure Housing Instability

For this study, we chose the Housing Instability Scale by Farero et al (2022) [29].

Before the development and validation of the 7–item Housing Instability Score (HIS) by Farero et al. (2022) [29], researchers employed various scales and measures to evaluate housing conditions across diverse contexts [29]. Annett et al. (2024) assessed housing insecurity among incarcerated women with opioid use disorder using a brief two-item index based on homelessness and precarious housing in a period of 90 days [15]. Glynn et al (2024 & 2025) utilized subscales of Economic Hardship to evaluate the financial strain among patients at risk of HIV and emergency department patients, respectively [16,17]. Donoghue et al (2025) used an abbreviated four-item version of the HIS among undergraduate students in a Hispanic-serving institution, finding it practical for identifying psychosocial risk [18]. It, however, failed to explore validated cutoffs. In recent studies, the full seven-item scale has been used in longitudinal studies such as those by Sullivan et al (2023) and Goodman-William et al (2023), who evaluate housing instability over a two-year period among survivors of the Domestic Violence Program [19,20].

Despite the diverse application of this scale, there remains a lack of standardized cutoffs and its validation across studies. One of our study aims is to establish a validated HIS cutoff to aid in more coherent findings on housing stability in future research.

The intersection of housing instability and drug use has become increasingly concerning amid the ongoing opioid crisis. Opioid overdose deaths have been on the rise over the past two decades, with over 80,000 deaths recorded in 2022 alone - a surge largely attributed to the proliferation of synthetic opioids like fentanyl [11,12,21]. Infectious diseases like HIV/AIDS and Hepatitis C infections are a major cause of morbidity and mortality among people who inject drugs [22], and studies have found this association amplified among those experiencing homelessness and the unstably housed [6]. Up to one-fifth of incident cases of HIV and hepatitis C infections are unstably housed people who inject drugs in countries like the United States, Czech Republic, England, and India [23].

1.3. Substance Use and Health Outcomes

Individuals with substance use disorders and people who use drugs generally face multiple barriers to securing stable housing, primarily due to drug-related stigma and healthcare inequities [6,24]. These disparities have been found to be barriers to health-seeking behaviors like seeking

primary care and preventive services among this population [25]. The population of people experiencing homelessness is also difficult to access and therefore underscores interventions such as HIV treatments, following up on patients with mental illness, and substance use disorder [26]. Adequate housing has also been found to reduce the number of hospital admissions and emergency room visits [26]. These challenges extend beyond housing to healthcare access, contributing to elevated rates of infectious diseases (such as Hepatitis C and HIV/AIDS), mental health disorders, and drug overdose deaths within this population [6,24,27]. Despite the apparent connection between housing stability and adverse health outcomes, including overdose deaths, this relationship remains understudied [2].

While various socioeconomic factors influence housing stability, understanding its direct impact on the health outcomes of PWUD is crucial and needs to be explored [28].   This research aims to examine this relationship comprehensively, potentially informing evidence-based policies to address healthcare access disparities among this vulnerable population. Understanding this relationship would inform interventions such as building structural institutions, such as housing, in efforts to reduce drug-related morbidity and mortality, which would complement the efforts being made by the government to treat health outcomes such as drug addiction [12]. This study aims to characterize the housing status of people who use drugs in an urban setting in the Southeastern United States (US), determine a cut-off score of the housing insecurity scale to categorize housing stability [29], and lastly, examine the relationship between the housing status of people who use drugs and health outcomes, including opioid-related overdose between June and October 2024.

2. Materials and Methods

This study aimed to investigate the relationship between housing stability and drug-related health outcomes among people who use drugs in an urban setting in the Southeastern US.

2.1. Parent Study

We employed a community-based participatory and concurrent iterative mixed methods design to assess barriers and facilitators to community drug checking in a convenience sample of harm reductionists, workers from a County Board of Health, and people who use drugs in an urban setting in the Southeastern United States. People who use drugs were recruited from syringe exchange sites, community settings (primarily festivals and bars), and by using a snowball sample. Survey data recruitment and collection with people who use drugs spanned a period over five months in 2024. The inclusion criteria for survey participation were 18 years and older and had used at least one unregulated drug (outside of a prescription) in the past 12 months, excluding marijuana. There were no other exclusion criteria. We chose to exclude those who exclusively used marijuana for two reasons; firstly, marijuana is a prevalent drug used outside of a prescription in the urban area, and there is insufficient evidence that marijuana can be tested with drug checking supplies and has been adulterated with drugs that cause harm, e.g., fentanyl and xylazine.

2.2. Project Design

This cross-sectional study used a survey to collect data from people who use drugs to assess current drug use, housing insecurity, and health outcomes. Data was collected from July 2024 to November 2024. This project focused on characterizing housing status, determining cut-off scores of the Housing Instability Scale, and drug-related health outcomes of people who use drugs in an urban setting in the Southeastern US.

2.3. Survey Development

The survey was developed in collaboration with community members with lived and living experiences of drug use and drug-related harm, harm reductionists, and researchers. Co-creation of such surveys is an important step to ensuring community priorities are included in studies [56] and

is frequently seen in programs that involve PWUD [57,58]. The survey collected data on demographics, housing status, substance use history in the past 12 months, and drug-related health outcomes. The housing status data were collected using the Housing Instability Scale [29].

2.4. Measure: The Housing Instability Scale

The Housing Instability Scale (HIS) is a seven-item validated scale that aims to measure housing instability to inform policies and public health interventions [29]. These seven items serve as indicators, dichotomized into a score of either 0 or 1. The higher the score (0 – 7), the more instability in housing. The specific items of the scale are:

1.　Lived in an undesired or unstable housing situation in the past 6 months
2.　Uncertainty about maintaining current housing for the next 6 months
3.　Stayed with family or friends to avoid homelessness
4.　Experienced difficulty paying for housing (eg. Rent or mortgage)
5.　Faced challenges obtaining stable housing
6.　Low confidence in ability to pay for housing this month
7.　Experienced frequent moving (3 or more times) in the past 6 months

Concurrent and predictive validity were assessed using the time-invariant factor, examining HIS factor scores and relevant concurrent and future variables [29]. These models were conducted using MPlus version 8 [30].

2.5. Sample

A convenience sampling approach was used to recruit participants to the study during harm reduction syringe exchange programming, local nightlife events at bars and clubs, at festivals, and via snowball sampling. Inclusion criteria were those aged 18 years and older who had used any unregulated drugs outside prescription in the past 12 months other than marijuana; there were no exclusion criteria. We recruited 180, and of those, N=164 participated in the study with a response rate of 91%.

2.6. Data Management

All data were collected through RedCap [31] with restricted access to ensure participant confidentiality. Data was de-identified by assigning each participant an ID number to maintain anonymity. Regular audits were conducted periodically to ensure data confidentiality and correctness.

2.7. Data Analysis

All analyses were conducted using R version 4.3.3 [32]. The following packages were used: dplyr [33], ggplot2 [34], corrplot [35], GGally [36], car [37], MASS [38], tidyr [39], psych [40], readr [41], sjPlot [42], tableone [43], flextable [44], and officer [45].
Descriptive statistics were calculated for demographic variables, housing scores, and patterns of drug use. Means and standard deviations were reported for continuous variables and counts and percentages for categorical variables.

Drugs with similar mechanisms of action were grouped: The group 'Opioids' contained drugs like fentanyl, codeine, oxycontin, heroin, and nitazenes. Methamphetamine and Adderall made up the group Amphetamine, while cocaine was used broadly for cocaine and crack use. The Housing Instability Scale (HIS) was used to assess potential housing instability in the sample [29]. Descriptive statistics were calculated for the housing instability score using the 'dplyr' package [33]. Data visualization was conducted using the 'ggplot2' package, in which a bar plot and a kernel density plot were used to assess the shape of the distribution. The density plot was reviewed to assess where natural divisions in the housing instability score occurred [59]. To prepare the data for cluster

analysis, scaling was performed to standardize the score. K-means cluster analysis was performed using base R with k=2 (due to the appearance of two natural clusters in the data) and with 25 random starts to ensure model stability. Cluster assignments were visualized using density plots. As a secondary validation strategy, we applied Gaussian Mixture Modeling (GMM) using the 'mclust' package. A two-component model (G=2) was fit to the housing stability scale to estimate probabilistic classifications based on underlying normal distributions. Model fit statistics, including Bayesian Information Criterion (BIC), were reviewed to assess model adequacy. Model summaries and classification plots were generated to visualize the results. All analyses were conducted on a complete-case dataset, excluding participants with missing values on any of the housing stability scale items.

Logistic regression models were used to examine the association between housing stability and health outcomes. Both crude and adjusted models were estimated as follows:

- Crude models included housing stability as the sole predictor.
- Adjustment models controlled for relevant confounders such as SSP use, employment status, and use of specific drug classes (example: opioids, amphetamines).
- Model results were presented as Odds Ratios (OR) with 95% confidence intervals (CIs), along with corresponding p-values. Statistical significance was set at $p < 0.05$.

3. Results

3.1. Demographic Characteristics

A total of 164 participants who use drugs in an urban setting in the Southeastern US, participated in this study. The average age of participants was 41.17 (SD = 13.8), with a bimodal distribution in age groups. The minimum age was 18 and the maximum was 72. Of the 164 participants, 63.4% (n=104) identified as male, 34.8% (n=57) identified as female, and 1.8% (n=3) chose neither. The majority of participants (79.9%, n=131) were Black or African American, followed by White participants (15.9%, n=26), while other racial groups constituted 4.2% (n=7). Among participants, 35.3% (n=49) were unemployed, 21.9% (n=36) were fully employed, and 18.2% (n=30) were self-employed. Additionally, 13.4% (n=22) reported part-time employment, and 11.2% (n=18) constituted other sources of income. The majority of participants (34.8%, n=57) had completed high school or obtained a GED, followed by 23.8% (n=39) who had some college education. Additionally, 17.7% (n=29) had some high school education, and other levels of education constituted 11.6% (n=19). 37 of the 164 participants (22.6%) reported using a syringe services program (SSP), while 76.4% (n = 124) of the study population did not. 3 (1.8%) individuals did not answer this question. Details are illustrated in Table 1.

Table 1. Baseline Characteristics of Participants (N = 164).

Characteristic	Level	Overall
Age, mean (SD)	—	41.72 (13.81)
Sex, n (%)	Male	104 (64.6)
	Female	57 (35.4)
Race, n (%)	Black or African American	131 (79.9)
	White	26 (15.9)
	Asian	2 (1.2)
	Other Race	3 (1.8)
	Unknown	2 (1.2)
Education, n (%)	High School Graduate or GED	57 (35.0)
	Some College	39 (23.9)
	Some High School	29 (17.8)
	Bachelor's Degree	20 (12.3)

	Associate's Degree	9 (5.5)
	Other	5 (3.1)
	Graduate Degree (Masters, MD, PhD)	4 (2.5)
Employment, n (%)	Unemployed	57 (35.0)
	Employed full-time	36 (22.1)
	Self-employed	30 (18.4)
	Employed part-time	22 (13.5)
	Receiving disability	8 (4.9)
	Retired	6 (3.7)
	Unable to work due to disability/injury	2 (1.2)
	Other means of employment	2 (1.2)
Housing Stability, mean (SD)	—	3.23 (2.43)
SSP Use, n (%)	No	124 (77.0)
	Yes	37 (23.0)
Opioid Use, n (%)	No	81 (51.6)
	Yes	76 (48.4)
Cocaine Use, n (%)	No	61 (38.4)
	Yes	98 (61.6)
Xanax Use, n (%)	No	118 (74.2)
	Yes	41 (25.8)
MDMA Use, n (%)	No	107 (67.7)
	Yes	51 (32.3)
Amphetamine Use, n (%)	No	97 (61.4)
	Yes	61 (38.6)

3.2. Reported Drug Use

The most commonly used drug was cocaine (59.8%, n = 98), followed by opioids (46.3%, n = 76). 37.2% (n = 61) of people used amphetamines, while about 31% (n = 51) used MDMA. 25% (n = 41) used Xanax, and about 13% (n = 21) of participants used drugs other than the ones mentioned above. The 'other drugs' category consists of drugs like buprenorphine, nitazene, methadone, ketamine, etc. Details are illustrated in Figure 1.
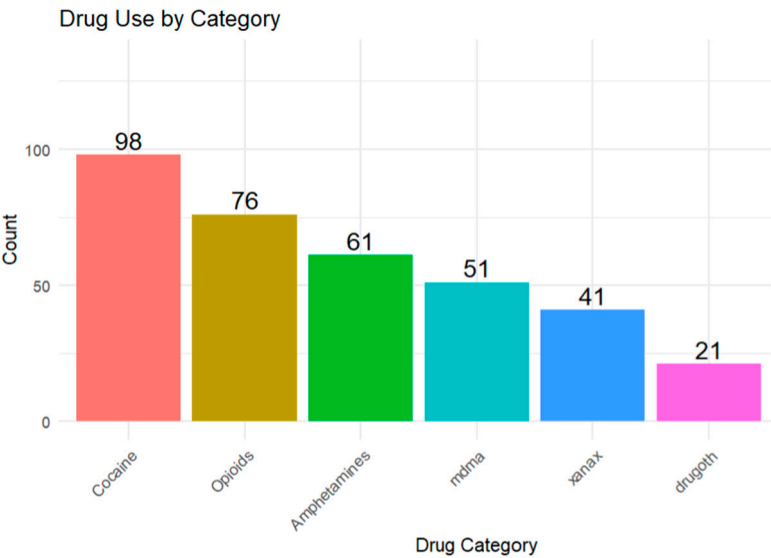

Figure 1. Bar Graph Displaying the Distribution of Drugs Used in the past 12 months.

3.3. Housing Instability Scale Cut-Off

HIS scores range between 0 and 7, with higher scores indicating greater housing instability. The mean housing score overall for this study was 3.23 (SD = 2.43); SSP users had higher score with a mean of 4.57 (SD = 2.34).

The k-means cluster analysis revealed two distinct clusters, cluster 1, representing those with scores of 0-3 (stably housed/stability) on the housing instability scale, and cluster 2, representing those with scores of 4-7 (unstably housed/instability) on the housing instability scale (Figure 2) which was corroborated by the density plot (Figure A1). Similar results were found using GMM methodology, with two distinct classifications. Cluster 1, representing those with scores of 0-3 on the housing instability scale, and cluster 2, representing those with scores of 4-7 on the housing instability scale (Figure A2).

Figure 2. Distribution of Housing Stability Scores by Cluster Membership Identified via K-means Clustering. Cluster 1 represents those with low housing instability (scores 0-3), and cluster 2 represents those with high housing instability (scores 4-7).

3.4. Housing Stability and Health Outcomes

Multivariate logistic regression analyses were conducted to examine associations between housing stability and various health outcomes among participants. Details are illustrated in Table 2.

Table 2. Logistic Regression Results (Crude and Adjusted Odds Ratios).

Outcome	Predictor	Crude OR (95% CI)	Adjusted OR (95% CI)	p-value
Overdose	Housing Stability	1.34 (1.10–1.66)	1.17 (0.94 – 1.48)	0.178
	SSP Use	–	4.04 (1.42 – 11.76)	0.009*
Infections	Housing Stability	1.55 (1.16–2.21)	1.55 (1.16–2.21)	0.0064*
	SSP Use	–	3.92 (1.18–13.88)	0.0273*
	Opioid Use	–	15.03 (2.67–284.90)	0.0121*
Wounds	Housing Stability	1.28 (0.99–1.69)	1.28 (0.99–1.69)	0.0667
	SSP Use	–	4.50 (1.38–15.80)	0.0142*

	Opioid Use	–	1.77 (0.50–7.24)	0.392
Blackouts	Housing Stability	1.47 (1.05–2.29)	1.47 (1.05–2.29)	0.0457*
	SSP Use	–	4.89 (0.74–98.00)	0.161
	Unemployment Benefits	–	4.38 (0.67–86.60)	0.188
Seizures	Housing Stability	1.54 (1.09–2.37)	1.54 (1.09–2.37)	0.0257*
	Xanax Use	–	8.03 (1.84–43.35)	0.0078*
	Opioid Use	–	6.77 (1.19–65.16)	0.0530

* Statistical significance $p < 0.05$.

3.4.1. Overdose

Housing stability was not significantly associated with overdose after adjustment (adjusted OR = 1.17, 95% CI: 0.94-1.48, p = 0.178). However, SSP use was significantly associated with higher odds of overdose (adjusted OR = 4.04, 95% CI: 1.42-11.76, p = 0.009).

3.4.2. Infections

Housing instability was significantly associated with higher odds of reporting infections (adjusted OR = 1.55, 95% CI: 1.16-2.21, p = 0.0064). SSP use (adjusted OR = 3.92, 95% CI: 1.18-13.88, p = 0.0273) and opioid use (adjusted OR = 15.03, 95% CI: 2.67-284.90, p = 0.0121) were also found to be significantly associated with increased odds of infections.

3.4.3. Wounds

Though an association was found between housing instability and wounds, it was non-significant (adjusted OR = 1.28, 95% CI: 0.99 - 1.69, p = 0.0667). SSP was significantly associated with wounds (adjusted OR = 4.50, 95% CI: 1.38-15.80, p = 0.0142), whereas opioid use was not significantly associated (adjusted OR = 1.77, 95% CI: 0.50-7.24, p = 0.392).

3.4.4. Blackouts

Housing instability was significantly associated with increased odds of blackouts (adjusted OR = 1.47, 95% CI: 1.05 - 2.29, p = 0.0457). SSP use (adjusted OR = 4.89, 95% CI: 0.74-98.00, p = 0.161) and receiving unemployment benefits (AOR = 4.89, CI = 0.74–98.00, p = 0.161) were not statistically significant.

3.4.5. Seizures

Both housing instability (adjusted OR = 1.54, 95% CI: 1.09-2.37, p = 0.0257) and Xanax use (adjusted OR = 8.03, 95% CI: 1.84-43.35, p = 0.0078) were significantly associated with increased odds of seizures. Opioid use was also found to be marginally associated with the odds of reporting seizures (adjusted OR = 6.77, 95% CI: 1.19 - 65.16, p = 0.0530)

4. Discussion

This study aimed to characterize the housing status of people who use drugs in an urban setting in the Southeastern US, to examine the cut-off score for the HIS, and to examine the relationship between housing status and health outcomes, like infections, opioid-related overdoses, wounds, seizures, and blackouts. Our findings revealed significant associations between housing instability and the abovementioned adverse health outcomes. When confounders were adjusted for, housing status was not a strong predictor of overdose risk. However, it had a positively significant association with the others: infections, wounds, seizures, and blackout risks.

Housing is an independent determinant of health across all populations, regardless of drug use status [60–62]. Unstable housing has been associated with several adverse health outcomes, including obesity, cardiovascular diseases [61], mental disorders [63], infectious diseases like HIV, viral

hepatitis [6,64], and limited healthcare access [65]. Identifying individuals who are unstably housed or at imminent risk of homelessness is critical in implementing timely and effective interventions.

Identifying a cutoff score for the HIS allows for meaningful interpretation of the scale to quantify housing as an independent determinant of health in research, like other screening tools, such as how the PHQ-9 is used as a screening tool for depression [66]. In the context of this study, clinicians would benefit from having meaningful cutoff scores for the Housing Instability Scale (HIS) [29] to identify unstably housed patients, which would, in turn, help them understand disease patterns and curate preventive and targeted interventions for their patients based on housing insecurity. This is one of many reasons why establishing a validated cutoff score for the HIS is essential in the field of research, healthcare, and public health. Our study identified the cutoff scores for the HIS as 0-3 (stably housed/stability) and 4-7 (unstably housed/instability). Cutoff validation of HIS should be replicated in other studies.

4.1. Housing Instability and Health Outcomes

The relationship between housing stability and adverse health outcomes is well-documented. Housing instability is significantly associated with several health outcomes. A study conducted in Chicago found a significant positive association between housing instability and increased lifetime overdose count among people who inject drugs (PWID) [46]. This highlights the critical role that stable housing plays in protecting the health of vulnerable populations such as PWUD [47]. To be specific, higher housing instability scores were associated with increased odds of infections (Adjusted OR: 1.55, 95% CI: 1.16 – 2.21, p = 0.0064), blackouts (AOR: 1.47, 95% CI: 1.05 – 2.29, p = 0.0457), and seizures (AOR: 1.54, 95% CI: 1.09 – 2.37, p = 0.0257) in our sample. Chiang et al. (2022) found that PWID who are unstably housed have an increased risk of infections, particularly HIV and HCV [48]. A systematic review conducted by Arum et al. (2021) also shows that PWUD who are unstably housed or experienced homelessness are 39% more likely to be diagnosed with HIV and have a 65% chance of HCV infection due to high-risk behaviors [6]. A global modeling study estimates that 17.2% and 19.4% of new cases of HIV and HCV, respectively, among PWID in high-income countries such as the U.S. are unstably housed [23]. It also suggests that individuals experiencing housing instability may be at elevated risk of engaging in health-compromising behaviors or experiencing conditions that predispose them to these adverse outcomes [6,49]. Beyond physical health, housing instability exposes individuals to increased risk of victimization, compounding mental health issues, which can further aggravate substance use outcomes [6].

Although housing instability had a crude association with overdose (Crude OR: 1.34), the adjusted model revealed no statistically significant relationship (AOR: 1.17, p = 0.178). This suggests that other variables, such as SSP use or unemployment, may also be at play. Cano et al. (2023) found that states with higher homelessness rates had higher overdose mortality rates across the United States [50]. Another study in Boston revealed that the leading cause of death among adults experiencing homelessness was overdose, with synthetic opioids accounting for 91% of those deaths [2].

Similarly, while the association with wounds was not statistically significant (AOR: 1.28, p = 0.0667), it approached significance and may warrant further investigation with a larger sample.

4.1.1. Role of SSP Use

Syringe Service Program (SSP) use emerged as a strong and consistent predictor in our sample across multiple health outcomes. Individuals who patronized SSP had significantly increased odds of experiencing overdoses (AOR: 4.04, 95% CI: 1.42 – 11.76), infections (AOR: 3.92, 95% CI: 1.18 – 13.88), and wounds (AOR: 4.50, 95% CI: 1.38 – 15.80). This supports the notion that SSP users represent a high-risk subgroup of PWUD, some of whom may have started patronizing this service after experiencing complications such as infections from unsafe drug injection practices [51]. A study on a syringe service organization in Washington DC showed that 67% of its users were either homeless or unstably housed, with about a third reporting that their housing conditions impact their

access to primary health care [52]. A systematic review conducted by Mackey KM et al. (2023) highlights the fact that syringe exchange programs do not increase drug injection frequency but play a vital role in reducing the incidence of infections such as HIV and HCV, increasing naloxone education and possession, and linkage to care when necessary [53]. While SSP effectively reduces the risk of HIV and hepatitis C, expanding the services to include wound care and the management of other skin infections would help address this gap [49].

4.1.2. Substance Use as a Confounder

Certain drug use behaviors also contributed to adverse health outcomes. Opioid use was significantly associated with infections (AOR: 15.03, p = 0.0121), and marginally associated with seizures (AOR: 6.77, p = 0.0530) in our study, highlighting opioid use's role in driving adverse health outcomes. This aligns with existing literature, which suggests that PWUD who are unstably housed are more likely to suffer from infections due to their limited access to healthcare, lack of water for personal hygiene, and care of injection-related wounds [47,54]. Additionally, Xanax use was strongly associated with seizures (AOR: 8.03, p = 0.078) in our sample. This is biologically plausible as the abrupt withdrawal of benzodiazepines like alprazolam (Xanax) has been found to induce seizures, especially when combined with opioids [55].

4.1.3. Public Health Impact

These study findings highlight the urgent need for housing support among PWUD. The housing-first approach, which offers people housing regardless of their drug-use history, has been found to be effective in reducing substance use and its health-related outcomes among PWUD [6,47]. Researchers, clinicians, and policy makers should support housing-first approaches when designing programs with PWUD due to the approach's success in reducing negative health effects due to substance use. Secondly, syringe service programs can expand to include primary healthcare, including wound care, to reduce the transmission and complications of infections, overdose education, and mental health services [49]. Lastly, this study indicated that unemployment was a strong predictor of an overdose. Economic empowerment through job training and integration could help address the root cause of drug-related harm and unstable housing. Implementing these comprehensive interventions that combine housing support and health services is crucial in improving health outcomes among this population.

4.1.4. Limitations

There were several limitations in this study. Firstly, it was a cross-sectional study in a single urban area; therefore, causality cannot be determined. Repeating this study in other urban areas with PWUD and people who do not use drugs will help to further validate the HIS cutoff proposed here and the associations between housing and negative health outcomes due to substance use. Secondly, self-reported data on substance use may be subject to recall and social desirability bias. In future studies, the use of biomarkers to validate substance use and infections would enhance data accuracy. Thirdly, another limitation in this study is the sample size. The small sample size likely contributed to the wide confidence intervals observed in the analysis. Increasing the sample size in future research would enhance the precision of estimates, narrow confidence intervals, and improve the generalizability of findings.

5. Conclusions

This study highlights the complex interaction between housing stability and health outcomes among PWUD in an urban setting. While housing instability was strongly associated with health outcomes such as infections, wounds, blackouts, and seizures, other predictors such as SSP use and unemployment were found to be strong predictors. This underscores the multifaceted nature of the problem that requires a multifaceted approach to intervention. Some of these approaches include

housing support, employment workshops for this population, and the expansion of syringe service programs to include primary healthcare. Addressing these structural determinants of health is essential for reducing disparities and improving health outcomes among PWUD in urban settings.

Abbreviations

The following abbreviations are used in this manuscript:

|	
United States	US
PWID	People who inject drugs
PWUD	People Who Use Drugs
SSP	Syringe Services Program
HIS	Housing Instability Scale
AOR	Adjusted Odds Ratio
OR	Odds Ratio
CI	Confidence Interval
MD	Doctor of Medicine
PhD	Doctor of Philosophy
GED	General Educational Development
R	R Programming Language (Statistical Computing)
GMM	Gaussian Mixture Modeling
BIC	Bayesian Information Criterion
MPlus	MPlus Statistical Software
mclust	Model-based Clustering R Package
HCV	Hepatitis C Virus
HIV	Human Immunodeficiency Virus
IRB	Institutional Review Board

Appendix A
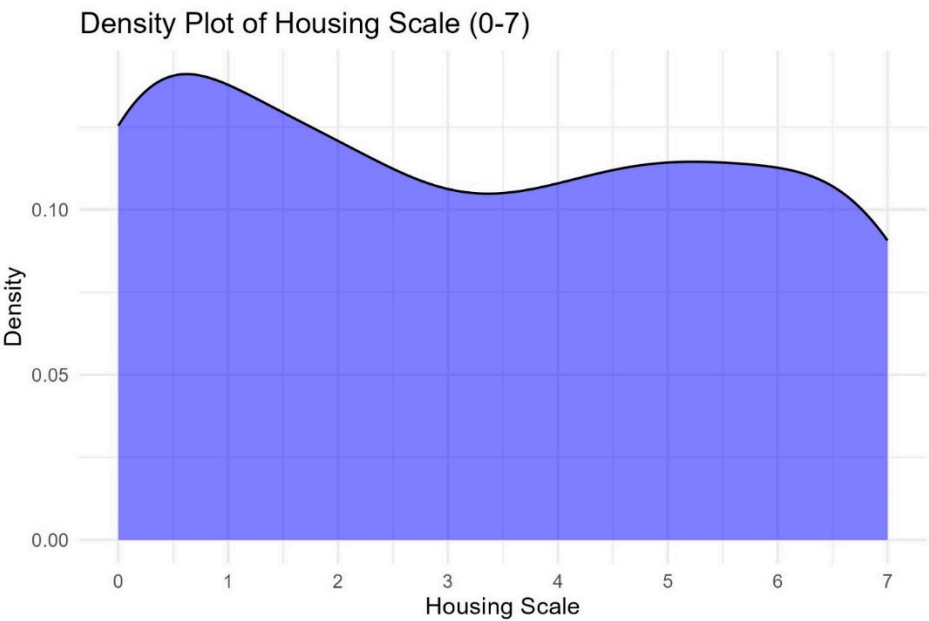
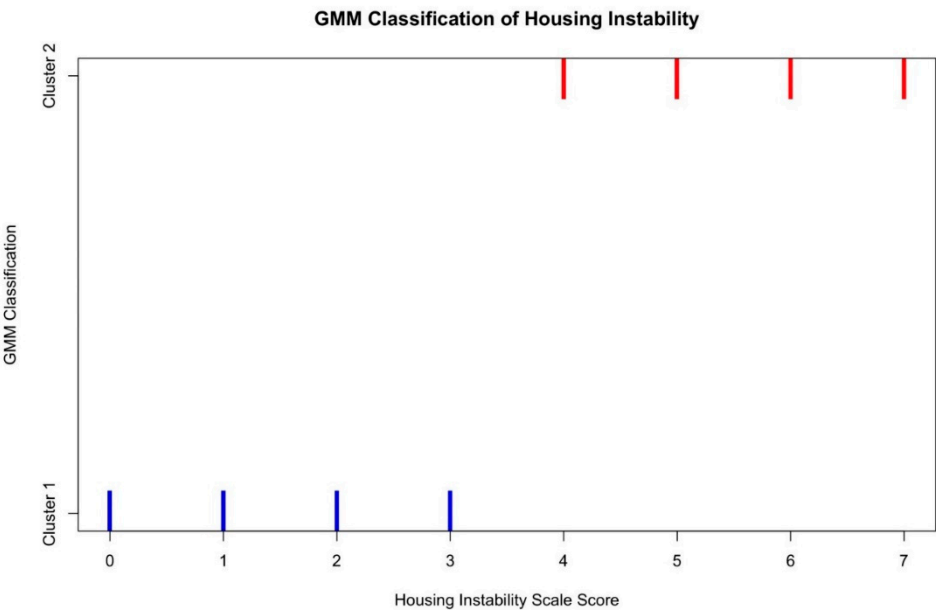**Figure A1.** Density Plot of Housing Scale (0-7).

Figure A2. Classification of Housing Instability Scores Based on Gaussian Mixture Modeling. Cluster 1 represents those with low housing instability (scores 0-3) and cluster 2 represents those with high housing instability (scores 4-7).

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