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REVIEW



Determinants of emergency department use and hospitalization among people who inject drugs: A systematic review and meta-analysis

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ABSTRACT

Background: The present study aimed to identify sociodemographic characteristics, risky behaviors, type of drug use, and service use variables associated with emergency department (ED) use and hospitalization among people who inject drugs (PWID).

Methods: Studies in English published from January 1, 1995, to December 15, 2021, were searched for on *PubMed*, *Scopus*, *Cochrane*, and *Web of Science* to identify primary studies on ED use and hospitalization among PWID.

Results: After a detailed assessment of 17,348 outputs, a total of 19 studies met the eligibility criteria for inclusion in the analysis. Greater risks of ED use and hospitalization among PWID were associated with (i) a history of homelessness, (ii) HIV-positive status, and (iii) injecting drugs more than four times per day. Individuals were more likely to use the ED if they (i) had a history of physical abuse, (ii) were using cocaine and methamphetamine, and (iii) had used primary care services. Women and individuals with chronic physical illnesses were more likely to be hospitalized.

Conclusions: The present study is the first to integrate determinants related to ED use and hospitalization based on sociodemographic characteristics, risky behaviors, type of drug, and service use determinants among PWID. To reduce ED use and hospitalization among PWID, the paper also recommends various strategies could be implemented.

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KEYWORDS

Emergency department use; hospitalization; people who inject drugs; psychoactive substances; primary care services

Introduction

People who inject drugs (PWID) are more likely to frequently use hospital emergency departments (EDs) and be hospitalized (i.e., receive acute care) than those who do not inject drugs (Nambiar, Stoové, & Dietze, 2017; Palepu et al., 2001). A Canadian study reported 64% of PWID had ED use in the previous 12 months, and 35% of them had at least two ED visits during that period (Fairbairn et al., 2012). Moreover, hospitalization rates have been reported to range from 35% to 40% among PWID (Palepu et al., 2001; Takahashi et al., 2007). PWID are affected by depressive and psychotic disorders (Michel et al., 2022; Reddon et al., 2018) and/or physical diseases such as HIV infection or hepatitis C, which may result in greater ED use and/or hospitalization (Kendall et al., 2017; Lloyd-Smith et al., 2010).

ED use and hospitalization are the most costly health services (Galarraga & Pines, 2016; Mejia de Grubb et al., 2020). They are also key indicators of adverse outcomes (Armoon, Grenier, et al., 2021; Fleury et al., 2019) and may be a sign of poor access or insufficient quality of outpatient care (Sørup et al., 2013). PWID need harm reduction interventions, including access to

needle and syringe programs (Noroozi et al., 2018, 2019) and safe injecting facilities (Kerr et al., 2007). However, PWID often do not take benefit of such services, and many of them do not receive helpful support such as long-term primary care services (Chitwood et al., 2001).

To the best of the present authors' knowledge, no systematic review and meta-analysis has previously investigated determinants of ED use and hospitalization among PWID. Identifying determinants of ED use and hospitalization among PWID can help inform health-care decision-makers regarding unmet health needs for this vulnerable population, and help in the development of strategies to reduce acute care use. Additionally, since drug use appears to be increasing in many countries (Brunt et al., 2021; Seitz et al., 2019), comprehensive knowledge of acute care use of PWID is essential to meet their needs and help in the consolidation of effective drug policy. The present study aimed to identify sociodemographic characteristics, risky behaviors (such as HIV-positive status, injecting drugs more than four times per day), type of drug use, and service use variables associated with ED use and hospitalization among PWID.

Methods

Search strategy and study selection

Two independent researchers individually reviewed the literature from January 1, 1995, to December 15, 2021, using *PubMed*, *Scopus*, *Web of Science*, and *Cochrane* databases. A librarian confirmed the search strategy, and it was modified for use in different databases including Boolean operators (AND/OR) and initial keywords “(emergency medical services), (emergency service, hospital), (hospitalization), (injection drug), (people who inject drugs), (substance abuse, intravenous)”. References of the included studies were also searched by hand for further relevant studies (see Supplementary File 1).

Inclusion and exclusion criteria

All studies had to meet inclusion criteria based on “Population, exposures, comparison, outcome, and study design” (PECOs) criteria. In “population” only PWID was included; for “exposures,” associations with sociodemographic characteristics, risky behaviors, type of drug use, and service use variables regarding PWID on ED use and hospitalization were assessed; the “comparison” group was PWID not reporting ED use and hospitalization; the “outcomes” were ED use and hospitalization among PWID; finally, the “study design” integrated cross-sectional, cohort, or case-control studies. As an outcome, the previous 6 or 12 months of ED use or hospitalization (yes or no) among PWID was considered. To be included in the present study, at least two studies with the same acute care measure needed to be found, which is a minimal standard of meta-analyses study inclusion (Ryan, 2016). Studies were excluded if they were (i) qualitative, (ii) not written in English, (iii) did not include primary data, (iv) abstracts, books, theses, or conference proceedings, systematic reviews, and meta-analyses. Studies with high heterogeneity or outcome variations from the considered groups were also excluded.

Data extraction procedure

Two of the authors (BA and AB) independently reviewed and evaluated the selected papers, based on a standardized data collection checklist. The two researchers independently selected the studies in a four-phase monitoring procedure. Initially, the duplicated titles/abstracts (89% agreement) meeting the Newcastle-Ottawa Scale criteria (explained below) were removed. Next, the papers’ titles/abstracts were screened for a full-text review based on the inclusion criteria of the study (96% agreement). Any disagreements between the authors were resolved by the third author (EA). Following this, the full texts of selected papers were reviewed. Finally, the required data were extracted from the selected papers. Data extraction and management were performed in *Microsoft Excel* software.

Quality assessment of the studies

The Newcastle-Ottawa Scale (NOS); (Stang, 2010) was used to examine the quality of the reviewed studies. There are three

domains of selection, comparability, and exposure/outcome in the NOS comprising 3, 1, and 1 items for cross-sectional studies and 4, 1, and 3 items for cohort studies. The studies were also categorized as unsatisfactory, satisfactory, good, or very good. The agreement levels of poor, slight, fair, moderate, substantial, and almost perfect were considered by the values 0, 01–0.02, 0.021–0.04, 0.041–0.06, 0.061–0.08, and 0.081–1.00, respectively (Landis & Koch, 1977). In total, seven studies were rated as high quality, eight studies were rated as good quality, and four were rated as satisfactory quality (Supplementary File 2).

Data synthesis and statistical analysis

Systematic review and meta-analysis were performed by generating pooled odds ratios (ORs) and 95% confidence intervals (CIs) for determining variables associated with ED use and hospitalization among PWID. The OR was computed by a 2×2 table, and an OR of <1 demonstrated a negative correlation between ED use and hospitalization and the target characteristic. An OR of >1 (i.e., the statistical threshold for examining the correlation between ED use and hospitalization and expositive variables) reflects the positive correlation between ED use and hospitalization and independent variables. To evaluate the correlation between the studies, the Q test at $p < .05$ and I^2 statistics (with a cutoff point of $\geq 50\%$) were used as the most optimal choices. A 95%CI was considered for I^2 . However, the negative scores were considered at zero. To achieve the pooled estimation, the random-effects model was used, considering different sampling methods implemented in the studies. Egger’s publication bias test was used to identify any existing publication bias (Egger et al., 1997). Subsequently, the obtained data were illustrated in forest plots. The *R version 3.5.1* with the “meta” package was applied to perform the meta-analysis of the collected data (Viechtbauer, 2010).

Results

Study characteristics

After a detailed assessment of 17,348 outputs, a total of 19 studies were included in the present study for inclusion in the analysis (Binswanger et al., 2008; Fairbairn et al., 2012; Hope et al., 2015; Islam et al., 2013; Kerr et al., 2005; Knowlton et al., 2001; Lloyd-Smith et al., 2010, 2012; Marshall et al., 2012; McDonald et al., 2011; Nambiar, Stoové, & Dietze, 2017; Nambiar, Stoové, Hickman, et al., 2017; Nambiar et al., 2018; Olubamwo et al., 2018; Palepu et al., 1999, 2001, 2003; Stein & Anderson, 2003; Takahashi et al., 2007; Figure 1). A total of 275 studies were excluded because they did not use a quantitative methodology and/or did not consider parametric measurements such as coefficients and odd ratios of relative to ED use and/or hospitalization (37%), 127 studies did not consider ED use or hospitalization for their outcome variables, or did not have a dichotomous variable (i.e., acute care use: yes, or no) (17%). Finally, 333 studies did not meet the qualifications based on the minimum quality appraisal (45%).

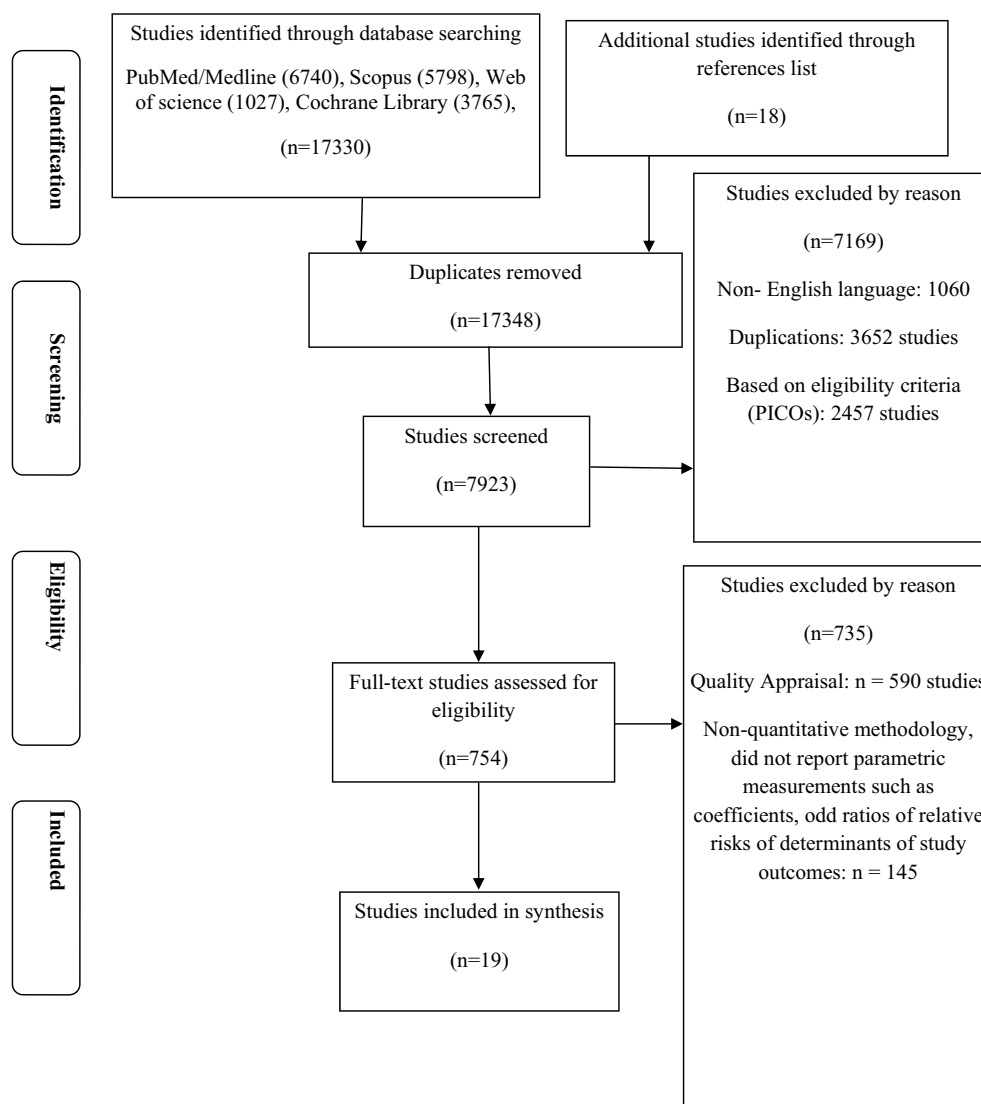


Figure 1. PRISMA flow diagram.

Study characteristics

Canada had the highest number of studies ($n = 8$, comprising 6,212 participants) followed by the United States ($n = 4$, comprising 1,051 participants) and Australia ($n = 4$, comprising 7,201 participants). All studies were conducted within high-income countries. The mean study size at the baseline was 3,142 PWID, with 147 being the lowest sample size (Takahashi et al., 2007), and 41,062 being the largest sample size (McDonald et al., 2011), respectively. Response rates varied between studies from 74% to 100%, respectively. PWID were more likely to be male in the studies (67.83%), varying from 60% to 75%, and on average were 34.82 years old. Almost all of the studies were cohort (89%), and 58% of studies were published between 2010 and 2021. Three studies assessed both ED use and hospitalization as the outcomes, using administrative databases or self-reported surveys. Nine studies assessed ED use only, and seven studies assessed hospitalization only as the outcome, using administrative databases, self-reported surveys, or both administrative databases and surveys. The main types of drug use disorders reported in the studies were polydrug use ($n = 6$ studies), heroin and cocaine use ($n = 5$ studies) and methamphetamine use ($n = 2$ studies). This suggests

that their main drug of choice is not necessarily the one that they had injected. Six studies did not report specific types of drug use disorders relating to PWID globally. Among the 19 studies included in the meta-analysis, 10 reported sociodemographic characteristics, 14 reported risky behaviors, 7 reported types of drug use, and 8 reported service use variables (Table 1).

Pooled prevalence rate of ED use and hospitalization among PWID

The pooled prevalence rate of ED use and hospitalization among PWID were 49% (95% CI, 40%–59%) (Figure 2) and 27% (95% CI, 16%–38%) (Figure 3), respectively.

Sociodemographic characteristics, risky behaviors, type of drug use, and service use variables associated with ED use and hospitalization among PWID

In four ED use studies (Fairbairn et al., 2012; Palepu et al., 1999, 2001, 2003) and three hospitalization studies (Olubamwo et al., 2018; Palepu et al., 1999; Takahashi et al.,

Table 1. Study characteristics of emergency department (ED) use and hospitalization among people who inject drugs.

ED use studies (n=9)	Authors and year of publication	Years (y.) of data collections (number) of years)	Sample at baseline	Final sample size and response rates	Country	Study Design	ED use/hospitalization/both	Diagnostic criteria used	Type of drug injection	Duration (months) of outcome measurements	Reason for ED use and hospitalization	Percentage of ED use / hospitalization		Socio-demographic determinants	Risky behaviors	Type of drug used	Service use variables	
												ED use	Hospitalization					
Fairbairn et al., 2011	2005-2011 (4 y.)	428	428	98%	Canada	Cohort	ED use (Yes/no)	ICD-9 ^e	Heroin and cocaine	12	Any reason	64%	✓✓	✓✓	✓✓	✓✓	Nonurgent visits Hospital referral Mental health services Methadone maintenance treatment Primary care services	
Marshall et al., 2012	1996 (1 y.)	427	427	100%	Canada	Cohort	ED use (Yes/no)	NA	Polydrug	12	Any reason	38%	✓✓	✓✓	✓✓	✓✓	Non-injury-related diagnosis Chronic physical illnesses Soft tissue infection HCV-positive status HIV-positive status Needle sharing Require assistance inject Duration of injection Injecting>4 times/day Incarceration	
Lloyd-Smith et al., 2012	1997-2001 (5y.)	1068	1068	99%	Canada	Cohort	ED use (Yes/no)	ICD-10 ^f	Heroin and cocaine	48	Soft tissue infection	27%	✓	✓✓	✓✓	✓	✓	Non-injury-related diagnosis Chronic physical illnesses Soft tissue infection HCV-positive status HIV-positive status Needle sharing Require assistance inject Duration of injection Injecting>4 times/day Incarceration
Palepu et al., 2003	2011 (1 y.)	350	350	79%	Canada	Cohort	ED use (Yes/no)	CAGE ^g	Polydrug	6	Alcohol use reason	29%	✓✓	✓✓	✓✓	✓✓	✓✓	Non-injury-related diagnosis Chronic physical illnesses Soft tissue infection HCV-positive status HIV-positive status Needle sharing Require assistance inject Duration of injection Injecting>4 times/day Incarceration
Knowlton et al., 2001	2006-2008 (3 y.)	287	287	100%	USA	Cohort	ED use (Yes/no)	NA	NA	6	HIV/AIDS infection	33%	✓✓	✓✓	✓✓	✓✓	✓✓	Non-injury-related diagnosis Chronic physical illnesses Soft tissue infection HCV-positive status HIV-positive status Needle sharing Require assistance inject Duration of injection Injecting>4 times/day Incarceration
Islam et al., 2013	2013 (1 y.)	2395	2395	100%	Australia	Cross section	ED use (Yes/no)	NA	Polydrug	NA	Any reason	78%	✓	✓	✓	✓	✓	Non-injury-related diagnosis Chronic physical illnesses Soft tissue infection HCV-positive status HIV-positive status Needle sharing Require assistance inject Duration of injection Injecting>4 times/day Incarceration
Nambiar et al., 2017	2005-2007 (3 y.)	757	757	100%	Australia	Cohort	Frequent ED use (Yes/no) ^a	ICD-10 ^f	NA	12	Any reason	64%	✓	✓	✓	✓	✓	Non-injury-related diagnosis Chronic physical illnesses Soft tissue infection HCV-positive status HIV-positive status Needle sharing Require assistance inject Duration of injection Injecting>4 times/day Incarceration
Nambiar et al., 2017	2008-2013 (6 y.)	612	612	89%	Australia	Cohort	Frequent ED use (Yes/no) ^a	AUDIT-C ^h	Poly drug	12	Any reason	58%	✓	✓	✓	✓	✓	Non-injury-related diagnosis Chronic physical illnesses Soft tissue infection HCV-positive status HIV-positive status Needle sharing Require assistance inject Duration of injection Injecting>4 times/day Incarceration
Kerr et al., 2004	2004-2008 (5 y.)	883	883	94%	Canada	Cohort	Frequent ED use (Yes/no) ^b	NA	Methamph etamine	24	Any reason	60%	✓✓	✓✓	✓✓	✓✓	✓✓	Non-injury-related diagnosis Chronic physical illnesses Soft tissue infection HCV-positive status HIV-positive status Needle sharing Require assistance inject Duration of injection Injecting>4 times/day Incarceration

(Continued)

Table 1. (Continued).

ED use and hospitalization studies	Authors and year of publication	Years (y.) of data collections (number) of years	Sample at baseline	Final sample size and response rates	Country	Study Design	ED use/hospitalization/both	Diagnostic criteria used	Type of drug injection	Duration (months) of outcome measurements	Reason for ED use and hospitalization	Percentage of ED use / hospitalization	
												Hospitalization	ED use
Hospitalization studies (n=7)	Hope et al., 2015	2001-2002 (2 y.)	855 100%	UK	Cross section	Hospitalization (Yes/no)	NA	polydrug	12	Soft tissue infections or injuries	9.5%	31.9	
	Olubamwo et al., 2018	1997-2013 (16 y.)	4817 100%	Finland	Cohort	Hospitalization (Yes/no)	ICD-10	Polydrug	1	pneumonia	55%	40%	
	Binswanger et al., 2008	2004-2008 (5 y.)	156 74%	USA	Cohort	Hospitalization (Yes/no)	ICD-10 ASI	NA	12	Soft tissue infection	9%	8.1%	
	Takahashi et al., 2006		136 92%	USA	Cohort	Hospitalization (Yes/no)	ICD-10 ASI	NA	12	Soft tissue infection	29%		
	Lloyd-Smith et al., 2010		901 83%	Canada	Cohort	Hospitalization (Yes/no)	ICD-10	NA	48	Soft tissue infection			
	McDonald et al., 2011		41062 100%	UK	Cohort	Hospitalization (Yes/no)	ICD-9	NA	6	Alcohol use reason			
	Nambiar et al., 2017	1995-2006 (12 y.)	2106 90%	Australia	Cohort	Frequent Hospitalization (Yes/no)	ICD-10	Heroin or methamphetamine	12	Any reason			

(Continued)

Table 1. (Continued).

ED use and hospitalization studies	Authors and year of publication	Years (y.) of data collections (number of years)	Sample at baseline	Final sample size and response rates	Country	Study Design	ED use/hospitalization/both	Diagnostic criteria used	Type of drug injection	Duration (months) of outcome measurements	Reason for ED use and hospitalization	Percentage of ED use / hospitalization	
												Hospitalization	ED use
Stein & Anderson, 2003	2001-2002 (2 y.)	472 100%	USA	Cohort	ED use and hospitalization (Yes/no)	Heroin and cocaine	DSM-III ^j	Any reason	34.5 %	13.4 %	34.5 %	13.4 %	
Palepu et al., 1999	2001 (1 y.)	1103 100%	Canada	Cohort	ED use and hospitalization (Yes/no)	Heroin and cocaine	NA	Any reason	45 %	21 %	45 %	21 %	
Palepu et al., 2001	1997-1998 (2 y.)	598 100%	Canada	Cohort	Frequent ED use and hospitalization (Yes/no)	cocaine	NA	Any reason	60.2 %	56.2 %	60.2 %	56.2 %	

✓: All variables extracted from studies.

✓✓: Variables are retained in the final model after their inclusion in the meta-analysis.

a: Frequent ED use is defined as 3+ visits in a 12-month period.

b: Frequent ED use is defined as 3+ visits in a 2-years period.

c: Frequent hospitalizations is defined as 2+ stays in a 12-month period.

d: Frequent ED use is defined as 3+ visits and frequent hospitalizations as 2+ stays in the 3-year study period.

e: International Classification of Diseases, Ninth Revision.

f: International Classification of Diseases, Tenth Revision.

g: Screening tool for diagnosis of alcohol use disorders.

h: The Alcohol Use Disorders Identification Test-Concise.

i: Addiction Severity Index.

j: Diagnostic and Statistical Manual of Mental Disorders, Third Edition.

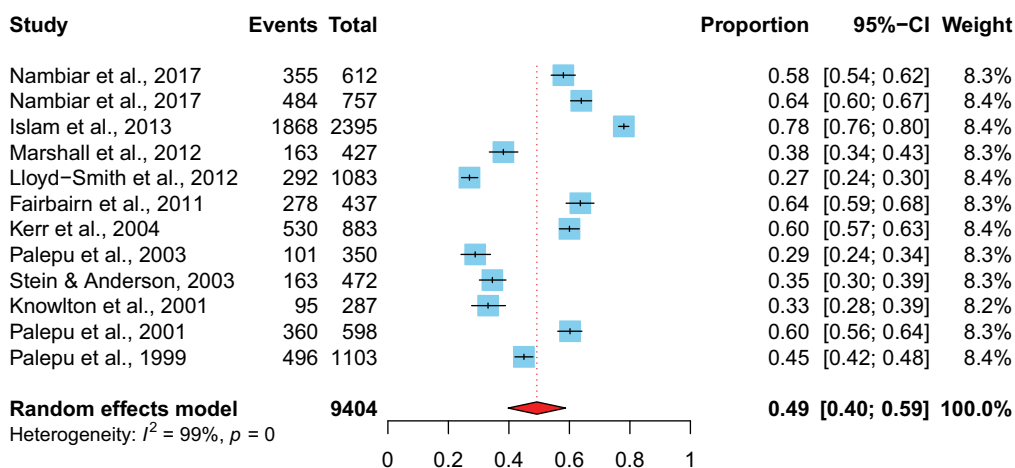


Figure 2. The pooled prevalence of emergency department use among people who inject drugs.

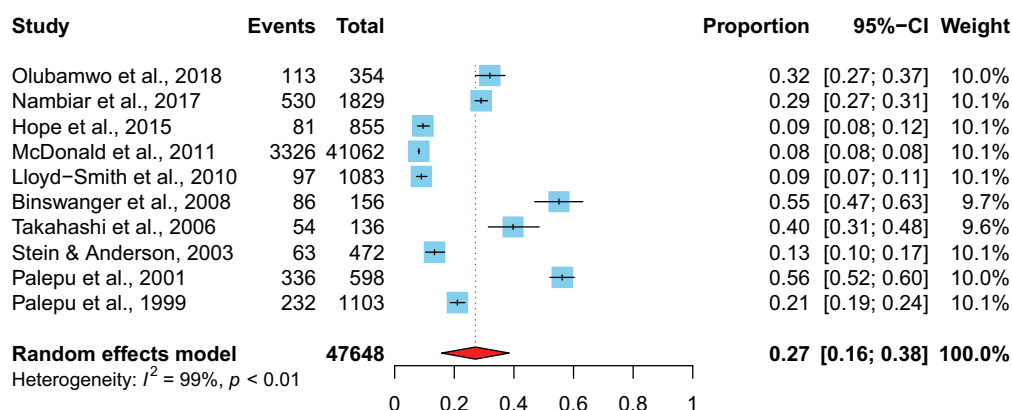


Figure 3. The pooled prevalence of hospitalization among people who inject drugs.

2007), those who had a history of homelessness were reported to use EDs or to be hospitalized 1.52 and 1.63 times more than non-homeless individuals, respectively (OR = 1.52, 95% CI = 1.29–1.78) (OR = 1.63, 95% CI = 1.34–1.97). In two studies (Fairbairn et al., 2012; Kerr et al., 2005), those who had a history of physical abuse were 1.38 times more likely to report ED use (OR = 1.38, 95% CI = 1.12–1.69). In three studies (McDonald et al., 2011; Palepu et al., 1999, 2001), PWID who were women were 1.54 times more likely to have been hospitalized (OR = 1.54, 95% CI = 1.34–1.78). In five ED use studies (Kerr et al., 2005; Knowlton et al., 2001; Lloyd-Smith et al., 2012; Palepu et al., 1999, 2001) and three hospitalization studies (Lloyd-Smith et al., 2010; Palepu et al., 1999, 2001), those who had HIV infection were reported to use EDs or to be hospitalized 1.66 and 2.37 times more than who did not have HIV infection, respectively (OR = 1.66, 95% CI = 1.42–1.95) (OR = 2.37, 95% CI = 1.07–5.26). In two ED use studies (Palepu et al., 2001; Stein & Anderson, 2003) and two hospitalization studies (Olubamwo et al., 2018; Stein & Anderson, 2003), those who injected drugs more than four times per day were reported to use EDs or to be hospitalized 1.29 and 1.39 times more than those who did not, respectively (OR = 1.29, 95% CI = 1.05–1.57) (OR = 1.39, 95% CI = 1.15–1.69). In two studies (Binswanger et al., 2008; Stein & Anderson, 2003), those who had chronic physical illnesses were 1.55 times

more likely to be hospitalized compared to those who did not (OR = 1.55, 95% CI = 1.23, 1.96). In three ED use studies (Kerr et al., 2005; Marshall et al., 2012; Nambiar, Stoové, & Dietze, 2017) and three studies related to ED use (Palepu et al., 1999, 2001; Stein & Anderson, 2003), PWID who used methamphetamine were 2.10 times more likely to have ED use (OR = 2.10, 95% CI = 1.39–3.16), and PWID who used cocaine were 1.48 times more likely to have ED use, respectively (OR = 1.48, 95% CI = 1.23–1.79). Finally, in four ED use studies (Fairbairn et al., 2012; Kerr et al., 2005; Nambiar, Stoové, Hickman, et al., 2017; Palepu et al., 1999), those who reported using primary care services were 1.87 times more likely to have ED use than those who did not (OR = 1.87, 95% CI = 1.49–2.35) (Figures 4 and 5).

Publication bias

To identify the probable publication bias, Egger’s test (Egger et al., 1997) and the graph were performed. According to Egger’s test, a significant publication bias among studies was noted (coefficient = 3.43, $p < .001$). Therefore, metatrim analysis was performed in order to remove the effect of publication bias on the pooled OR. The meta-trim analysis showed that the pooled OR was 0.15 (95% CI: 0.11–0.19) in the random effect model.

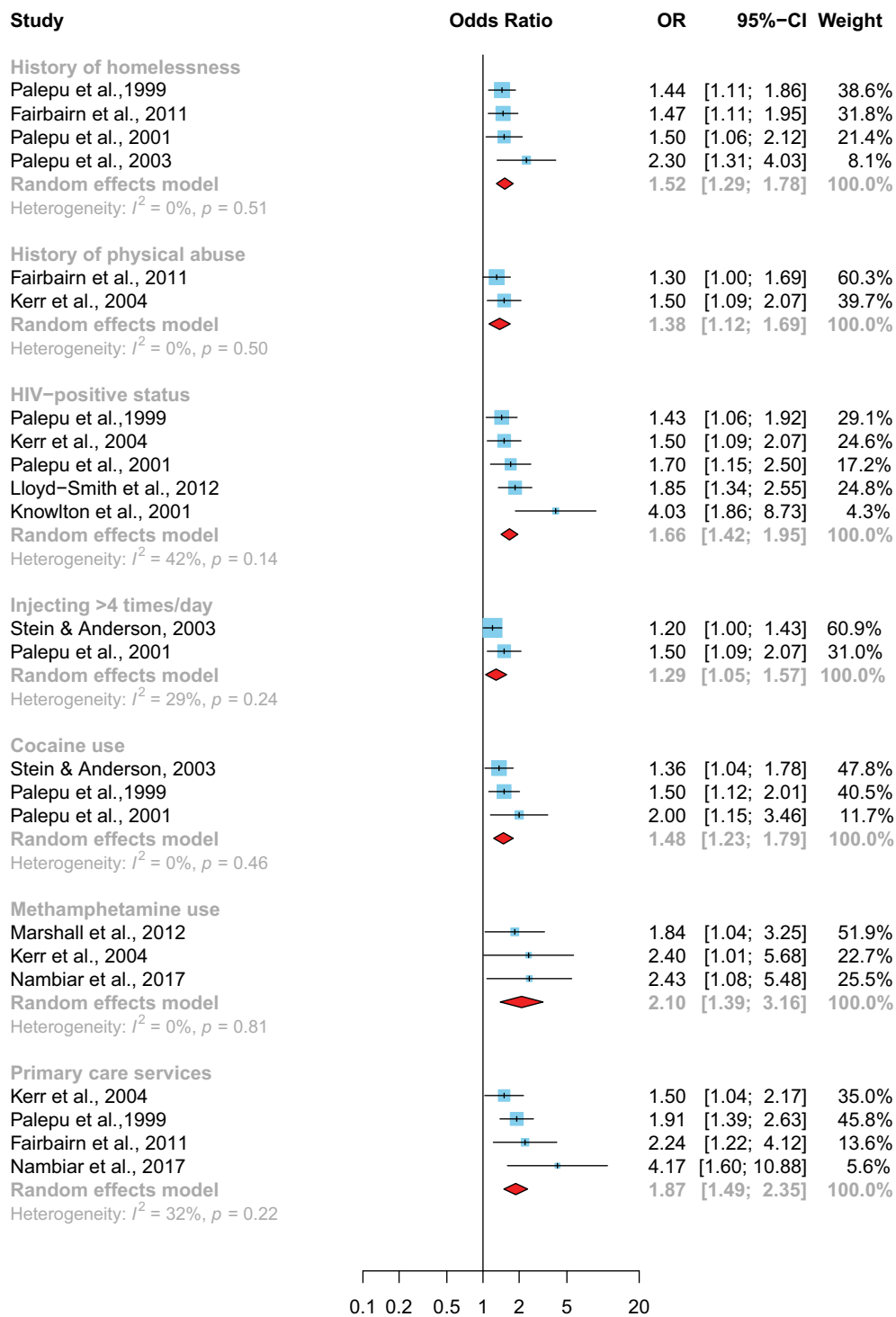


Figure 4. Pooled odds ratio of variables associated with emergency department use among people who inject drugs.

Discussion

Findings from the meta-analysis indicated that among people who inject drugs (PWID), the pooled rate for ED use was 49% and the pooled rate for hospitalization was 27%. No pooled prevalence for acute care has previously been reported in relation to PWID. Some of the reasons for this may be because PWID have high rates of injection frequency that may increase the risk of HIV infection, soft-tissue infections, and pneumonia, as well as being engaged with a risky behavior that has

a high association with various suicidal behaviors (e.g., suicide ideations, suicide attempts) (Armoon, Fleury, et al., 2022; Armoon, Higgs, et al., 2021; Moradi-Joo et al., 2019; Rezaei et al., 2020), all of which would increase the chances of needing acute care. PWID with history of homelessness and HIV-positive status were the most at risk of being both ED users and being hospitalized. Using methamphetamine and cocaine, as well as using primary care services also increased the risk of ED use only, while being women who injected drugs increased the risk of hospitalization only.

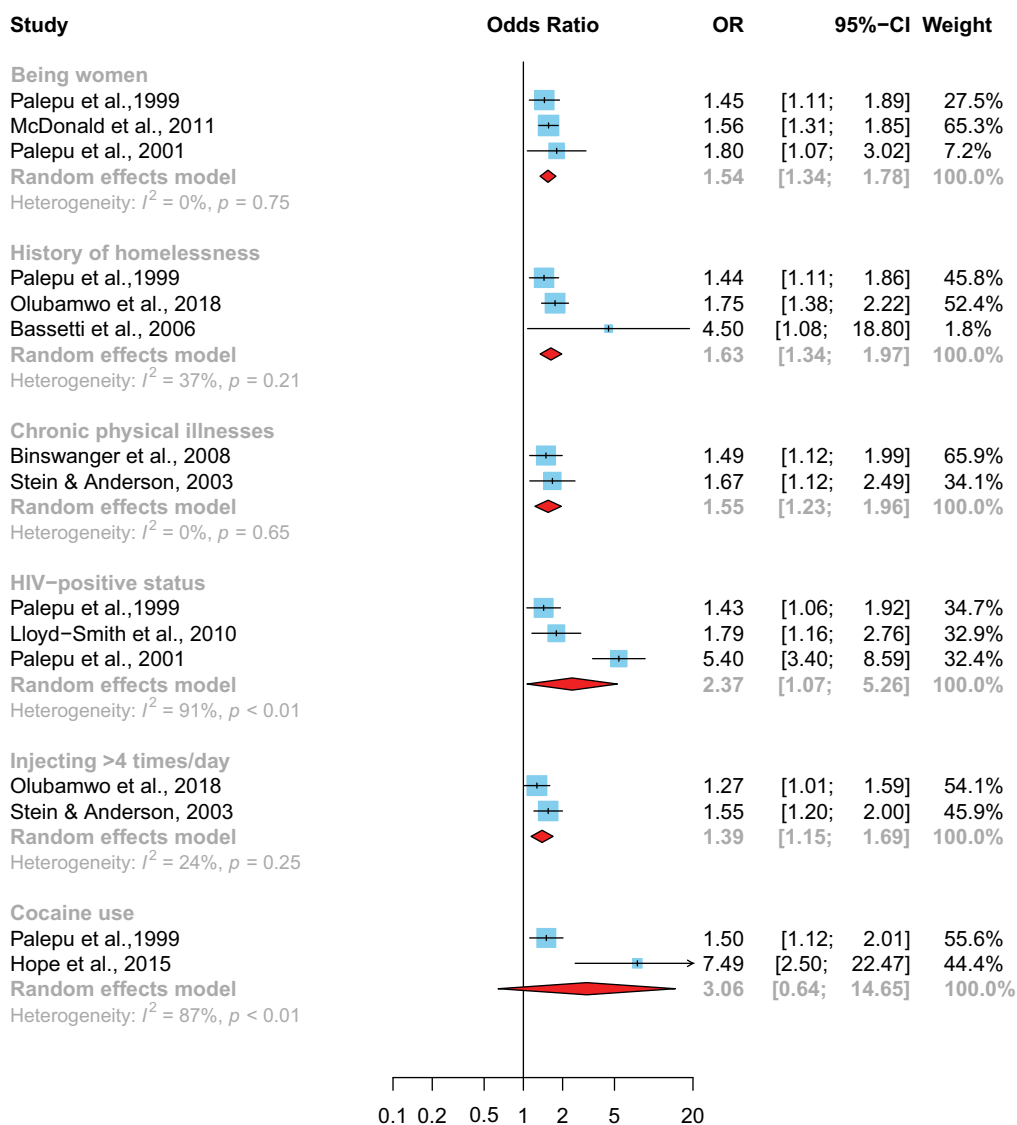


Figure 5. Pooled odds ratio of variables associated with hospitalization among people who inject drugs.

Having a history of homelessness was the only sociodemographic determinant associated with both ED use and hospitalization. More specifically, homelessness elevated the risk of ED use and hospitalization by 1.52 and 1.63, respectively. Studies have indicated that 40% (Palepu et al., 2003) to 69% (Fairbairn et al., 2012) of PWID who are homelessness have used EDs and that 24% (Takahashi et al., 2007) to 66% (Palepu et al., 1999) have been hospitalized. The association between homelessness and acute care services was found previously in studies conducted with PWID (McGeary & French, 2000; Nambiar et al., 2018). According to the literature, individuals with a history of homelessness are more likely to have severe infections (Takahashi et al., 2007), acute illnesses (Rickards et al., 2010), mental disorders (Latimer et al., 2017), substance-related disorders (Magwood et al., 2020), injuries (Mackelprang et al., 2014), and suicidal behaviors (Gentil et al., 2021).

The association between ED use and a history of physical abuse has also been found in previous studies (Kerr et al., 2003;

Tyndall et al., 2002). According to the literature, individuals who have a history of physical abuse have a higher risk of injection drug initiation, which may lead to ED use (Prangnell et al., 2020). Previous studies have reported that between 21% (McDonald et al., 2011) and 43% (Palepu et al., 2001) of women who inject drugs are likely to be hospitalized. According to the literature (Shapiro et al., 1999; Solomon et al., 1998), compared to men, women are more likely to be hospitalized and to show adverse outcomes associated with substance-related disorders (Beaudoin et al., 2015; John & Wu, 2017; Trillo et al., 2012), which may also explain their higher risk of hospitalization in the present study.

The risk of ED use and hospitalization was especially elevated among PWID who have HIV positive status, being 1.66 and 2.37 higher, respectively. Studies have indicated that 13% (Knowlton et al., 2001) to 54% (Palepu et al., 2001) of those with HIV positive status used EDs and that 28% (Palepu et al., 1999) to 39% (Palepu et al., 2001) of them are hospitalized. Previous studies have found that drug injection increases the

risk of infection by HIV (Ball et al., 2019; Mathers et al., 2008), which might increase the risk of ED use or hospitalization (Archibald et al., 1998).

Studies have reported that 32% (Stein & Anderson, 2003) to 35% (Palepu et al., 2001) of PWID who inject drugs more than four times a day have used EDs and 32% (Stein & Anderson, 2003) to 47% (Olubamwo et al., 2018) among this group have been hospitalized. Higher injection frequency increases the risk of overdose (Armoon, Bayani, et al., 2022), which can lead to ED use and hospitalization (Stein & Anderson, 2003). Unsurprisingly, chronic physical illnesses increased the expected odds of hospitalization (by a factor of 1.55). A previous study reported that 58% of PWID with chronic physical illnesses had been hospitalized (Binswanger et al., 2008). PWID had an elevated risk of contributing to or causing concurrent medical conditions (e.g., diabetes, high blood pressure, cardiovascular diseases and infective endocarditis; Binswanger et al., 2008; Rudasill et al., 2019; Stein & Anderson, 2003), which helps explain hospitalization.

The main type of drugs associated with ED use was methamphetamine use. PWID who used methamphetamine were 2.10 times more likely to use EDs. Studies have reported 11% (Nambiar, Stoové, & Dietze, 2017) to 30% (Marshall et al., 2012) of PWID who use methamphetamine reported ED use. The association between ED use and methamphetamine has been reported in previous studies (Hendrickson et al., 2008; Marshall et al., 2012) and can be explained by the serious adverse consequences of methamphetamine on health and psychological functioning, which justify ED use (Sommers et al., 2006). ED use might also be explained by the lack of access to other outpatient forms of treatment modalities or the absence of suitable outpatient treatment programs for PWID who use methamphetamine (Hendrickson et al., 2008). PWID who use cocaine have been reported to have 1.48 times elevated risk of ED use. Studies have also reported that 20% (Palepu et al., 1999) to 47% (Palepu et al., 2001) of those who use cocaine are likely to report ED use. Spanish studies have previously reported a significant relationship between the odds of ED use and cocaine use (Miró et al., 2019; Sanvisens et al., 2021), with one of them reporting an 18% readmission rate among ED users due to cocaine use (Sanvisens et al., 2021). This confirms an association between cocaine use and severe complications (Butler et al., 2017; Degenhardt et al., 2011). Cocaine users have also been reported as having a higher risk of non-fatal and fatal overdose compared to those who do not use cocaine (Armoon, Mohammadi, et al., 2021; Armoon, SoleimanvandiAzar, et al., 2022). Moreover, cocaine use in recreational context may lead to accidents or aggressive behaviors that increase the risk of ED use (Fulde & Forster, 2015).

Primary care services were the only service use determinant of ED use. PWID using primary care services had an elevated risk of ED use by 1.87 compared to those who did not. Studies have reported that between 57% (Nambiar, Stoové, & Dietze, 2017) and 85% (Palepu et al., 1999) of primary care service users are ED users. This association may be explained by the frequent medical problems reported among many PWID, usually resulting in them using primary care services first. However, many of their acute problems (e.g., overdose) may not be adequately managed in primary care, which

consequently leads to referral to EDs or hospitalization. Some risky behaviors among PWID, such as non-fatal overdose and needle sharing, might also require primary health-care interventions after ED use (Kerr et al., 2005).

Methodological considerations related to results

In the present systematic review and meta-analysis, a number of methodological concerns are worth noting. First, different instruments were used in the studies to assess PWID such as the *International Classification of Diseases* (ninth and tenth revisions) in administrative database studies, and the *Addiction Severity Index* in survey studies. Therefore, it may be difficult to directly compare different types of PWID. Second, variables not reported in more than two studies were not included in the meta-analysis, such as employment status, non-fatal overdose, duration of injection, cannabis use disorders, and use of mental health services. Third, the present study integrated findings from a limited number of selected papers. Considering sociodemographic characteristics, only six studies examined a history of homelessness being associated with ED use and/or hospitalization, only three studies examined being female being associated with ED use, and only two studies examined a history of physical abuse being associated with ED use. Therefore, interpretation of the results should be exercised with caution. Considering risky behaviors associated with ED use or hospitalization, only six studies examined HIV positive status being associated with ED use and/or hospitalization, only four studies examined injecting drugs more than four times per day being associated with ED use and/or hospitalization, and only two studies examined chronic physical illnesses being associated with hospitalization. There was high heterogeneity among HIV positive status. Therefore, the associations may not be strong. Regarding risky behaviors, the number of studies were especially low, again raising the need to be cautious when interpreting the study's findings.

Considering types of drug use, four studies reported cocaine use disorder, and three studies reported methamphetamine use disorder being associated with ED use, in which high heterogeneity existed among cocaine use disorder. Therefore, this heterogeneity needs to be taken into account when considering the association between use of psychoactive substances and ED use.

Considering service use variables, only four studies were included associated with ED use. Therefore, further studies are needed to confirm the findings here. Finally, in some cases, there was high heterogeneity between studies. This meant several subgroup analyses were applied to decrease the effect of heterogeneity. However, not all sources of heterogeneity could be considered, because with more subgroup analyses, the number of studies in each subgroup decreases. In consequence, a larger number of studies are needed to establish more reliable results.

Conclusions

The present study is the first to integrate determinants related to ED use and hospitalization based on sociodemographic characteristics, risky behaviors, type of drug, and service use

determinants among PWID. The finding showed that the most important predictors of ED use or hospitalization were being HIV positive status, methamphetamine users and having a history of homelessness. A novel finding was that the use of primary care services significantly increased the risk of ED use. Therefore, better collaboration between acute and primary care services is recommended for PWID having HIV positive status or chronic physical illnesses in view to reduce their frequency of ED use. ED liaison nurses in acute care should facilitate referral to addiction treatment centers, especially for patients using cocaine and methamphetamine. ED use and hospitalization among PWID might also be reduced by developing outpatient programs with harm reduction strategies (e.g., safer injecting advice and greater accessibility to sterile needles). Finally, outreach strategies are recommended for PWID having a history of homelessness for improving their overall accessibility to outpatient health-care services.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Author contributions

BA conceived the study. BA collected all the data. RM and BA analyzed and interpreted the data. BA, EA, and AB drafted the manuscript. BA, MDG, and MJF contributed to the revised paper and were responsible for all final editing. All authors commented on the drafts of the manuscript and approved the final copy of the paper for submission.

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