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Suicidal Behaviors and Risk Taking Among Homeless Individuals: A Systematic Review and Meta-Analysis

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Abstract
The present systematic review and meta-analysis study aimed to determine sociodemographic characteristics, risky behaviors, mental health disorders, and substance use disorders associated with suicide behaviors including suicidal ideation and suicide attempts among homeless individuals. *PubMed, Scopus, Web of Science,* and *Cochrane Library* databases were searched to identify the relevant studies published between January 1, 1995 and November 1, 2022. After initial evaluation of 9,094 papers, a total of 23 studies met the eligibility criteria. Results of the present study showed that chronic physical illnesses, violent behaviors, mood and psychotic disorders, and substance use disorders were significantly associated with both suicidal ideation and suicide attempts, while being older, having a history of physical abuse, and having mood and post-traumatic stress disorders were associated with suicide attempts only. The present study's findings suggest a crucial need for facilitating access to mental healthcare plans and promoting mental healthcare seeking among homeless individuals.

Keywords Suicidal ideation · Suicide attempts · Substance use disorders · Post-traumatic stress disorders · Homeless individuals

Introduction

The life expectancy among individuals experiencing homelessness has decreased due to various psychosocial characteristics such as psychological factors (e.g., increased mental health disorders) and social factors (e.g., decreased social support) (Bickley et al., 2006; Schinka et al., 2018). Compared to the general population, suicidal ideation, suicide attempts, and suicide-induced deaths are higher among homeless individuals (HIs) (Bickley et al., 2006). A previous meta-analysis in North America reported that the pooled prevalence rate of suicide attempt among HIs was 31.83% (Xiang et al., 2021). Also, according to the results of a systematic review and meta-analysis concerning HIs, including 27497 participants from 20 studies (Ayano et al., 2019), there was a pooled current prevalence rate of 18% for suicidal ideation (13%-38%) and 9% for

suicide attempts (4%-33%). Moreover, individuals with past experiences of suicide attempts are at greater risk of homelessness (Nilsson et al., 2019). In other words, the determinants underlying suicidal ideation and suicide attempts (i.e., suicidal behavior) and homelessness appear to be similar (Tsai et al., 2019).

Mood disorders, such as depressive disorder and bipolar disorder contribute to suicidal ideation and suicide attempts among homeless groups (Aquin et al., 2017; Tsai et al., 2019). In addition, depressive disorders (Tinland et al., 2018; Tsai et al., 2019), post-traumatic stress disorder (PTSD) (Aquin et al., 2017; Tinland et al., 2018), anxiety disorders (Lee et al., 2017), personality disorders (Tsai et al., 2019), and psychotic disorders (Eynan et al., 2002; Goldstein et al., 2012) are among other factors associated with suicidal behaviors. Moreover, substance use disorders (SUDs) (Aquin et al., 2017; Noël et al., 2016), mental disorders (Coohey et al., 2015; Patterson et al., 2012), and a history of suicide attempts (Coohey et al., 2015) have been reported to trigger suicidal ideation. Concurrent generalized anxiety disorder and SUD have been reported as the most significant factors associated with suicide attempts among individuals with concurrent homelessness and SUD (Gentil et al., 2021). Previous studies have reported a positive and significant relationship between some suicide behaviors and socio-demographic characteristics, such as female gender (Lee et al., 2017; Tsai et al., 2019), younger age (Aquin et al., 2017; Desai et al., 2003; Prigerson et al., 2003), lesbian, gay, bisexual (Rhoades et al., 2018), low socio-economic class (Goldstein et al., 2012), and limited interpersonal network (Goldstein et al., 2012; Lee et al., 2017), as well as a significant negative relationship between occupational status (Benda, 2003; Lee et al., 2017), religious status, and marital status (Benda, 2003) among HIs (i.e., HIs were more likely to be unemployed, unmarried, and atheist).

To the best of the present authors' knowledge, there are only two meta-analyses that have reported the pooled prevalence of suicidal ideation and suicide attempts among HIs (Ayano et al., 2019; Xiang et al., 2021). However, previous meta-analyses (i) only reported pooled prevalence of suicidal behaviors, (ii) did not report variables associated with each suicidal behavior (ideation or attempts), and (iii) did not perform sensitivity analysis to reduce heterogeneity between studies. Moreover, there is no previous meta-analysis study examining suicide behaviors including suicidal ideation/suicide attempts and their correlates with sociodemographic characteristics, risky behaviors, mental health disorders, and SUD among HIs. Therefore, the present systematic review and meta-analysis study aimed to determine sociodemographic characteristics, risky behaviors, mental health disorders, and SUD correlated with suicide behaviors among HIs.

Materials and methods

Registration and protocol

The present meta-analysis protocol was based on the Protocols of Systematic Reviews and Meta-Analyses (Page et al., 2021).

Search strategy

PubMed, Scopus, Web of Science, and *Cochrane Library* databases were searched to identify the relevant studies. Every field within records was used. Medical Subject Headings (MeSH) terms in the explored databases were also applied to expand the search. The initial keywords included *"(suicidal ideation), (suicide attempts), (suicidal behaviors), (homeless Youth), (homeless individuals), (homeless persons)".* The authors developed and adjusted search strategy with respect to each database using essential Boolean operators (AND/OR). Eventually, authors hand searched the references of the included papers to check if any further related studies

could be found (**Supplementary File 1)**. Two authors (AB and BA) independently reviewed related papers published between January 1, 1995 and November 1, 2022.

Inclusion and exclusion criteria

Every selected paper met the criteria of PECOS (population, exposures, comparison, outcome, and study design). HIs comprised the "population". Positive and protective associations of the sociodemographic characteristics, risky behaviors, mental health disorders, and SUDs of HIs on suicide behaviors in their lifetime comprised the "exposures". Individuals experiencing homelessness but with no lifetime suicide behaviors comprised the "comparison" group. Lifetime suicidal behaviors, including suicidal ideation and suicide attempts among individuals who were homelessness comprised the "outcomes". In terms of "study design", cohort or case-control or integrated cross-sectional studies were included. Any qualitative papers, secondary investigations lacking primary data, systematic reviews, and meta-analysis, were excluded. Studies comprising too much significant heterogeneity from the study aims were excluded. Variables that were reported in only one study were omitted from the meta-analysis. Variables that were reported in at least two or more studies were included being that a minimum of two studies is considered enough to include in meta-analysis (Ryan, 2016).

Screening and data extraction

EndNote X7 software (*Thomson Reuters*) was used for data management. First, duplicated titles/abstracts were removed (89% agreement). Two of the authors (AB and BA) independently reviewed the titles and abstracts of the selected papers, considering the PECOS criteria. Unweighted kappa (the agreement beyond chance) were applied to evaluate the quality assessment procedure developed by BA and AB. The agreements were rated as poor, slight, fair, moderate, substantial, or almost perfect level by the values 0, 01–0.02, 0.021–0.04, 0.041–0.06, 0.061–0.08,

or 0.081-1.00 (Landis et al., 1977). Any disagreements about the included papers were resolved by a third co-author (EA), who also provided necessary input when required. In the next step, two authors (AB and BA) reviewed the full texts of the obtained papers, based on the inclusion and exclusion criteria of the study using the PECOS framework. Any missing key data or lack of access to full texts were also considered as exclusion criteria. *Microsoft Excel* software was applied for the extraction and management of the retained data. The authors systematically recoded the following data: publication year, the study location, the authors' names, the design of the study, the statistical analysis method, the study sample size, the key statistical data, and any outcome measures.

Quality appraisal of studies

Study quality was assessed using the Newcastle-Ottawa Scale (NOS) (Ghiasvand et al., 2020; Ghiasvand et al., 2019; Peterson et al., 2011). The NOS comprises the following three aspects (i) selection (three items for cross-sectional investigations; four items for cohort explorations). This aspect comprises the representativeness of the exposed group, the selection of the non-exposed group, as well as the ascertainment of exposure; (ii) comparability (one item for both cross-sectional and cohort studies). This aspect reflects the comparability of study groups concerning the design or analytic approach; and (iii) exposure/outcome (one item for cross-sectional research; three items for cohort studies). This aspect involves evaluating the outcome. A study meeting each item was given one point. By adding the items, study quality scores up to a maximum of 5 (for cross-sectional studies) and 8 (for cohort studies) were calculated. Moreover, for cross-sectional studies, total scores were rated as "unsatisfactory" (0-2) "satisfactory" (3) "good" (4) or "very good" (5). Ten studies were rated as being of high quality (Aquin et al., 2017; Bommersbach, 2020; Fitzpatrick et al., 2007; Fulginiti et al., 2022; Goldstein et al., 2012; Hadland et al., 2015; Lee et al., 2017; Sakai-Bizmark et al., 2022; Schinka et al., 2018; Tsai et al., 2019), eleven studies

were rated as being of good quality (Barr et al., 2017; Dietz, 2011; Eynan et al., 2002; Frederick et al., 2012; Gentil et al., 2021; Kidd, 2006; Molnar et al., 1998; Okamura et al., 2014; Oppong Asante et al., 2017; Panadero et al., 2018; Prigerson et al., 2003), and two studies were rated as being of satisfactory quality (Noël et al., 2016; Vázquez et al., 2019). **(Supplementary File 2)**.

Data synthesis and statistical analysis

The meta-analysis was performed by generating pooled odds rations (ORs) and 95% confidence intervals (CIs) on determining characteristics associated with suicide behaviors among HIs. The OR was calculated using a 2 × 2 table. An OR <1 represents a positive correlation between independent variables and suicidal ideation and suicide attempts, whereas an OR >1 represents a negative correlation between variables. In order to calculate summary effect sizes, an inverse variance weighting was employed. Regression coefficients were considered to indicate these values in the multivariate analyses. Additionally, studies with random effects models indicated variations in actual effect sizes. Accordingly, in order to run model selection and determine publication bias meta-analyses, a random-effects model was implemented. Here, two uncertainty sources were outlined as follows: within-study sampling error and between-study variance. To represent the heterogeneity in true effect sizes across the papers, large Cochran's Q statistics with small *p*-values and large I^2 statistics were used. The subgroup analyses were applied based on sample size and geographic regions to identify the sources of heterogeneity (with at least two papers minimum reporting data on the variable under consideration within each stratum). To detect possible publication bias, Egger's and Begg's tests (Begg et al., 1994; Egger et al., 1997) were used. Sensitivity analysis was also performed using a random effect model using Baujat plots to identify influential effects in which each study was excluded from the research to evaluate the

effect of that study on the overall estimate. A p-value <0.05 was considered statistically significant. R 3.5.1 with the *"meta"* package was used to perform the meta-analysis.

Results

Study characteristics

Initially, 9,094 papers were found through the four database searches. After paper duplicates were excluded (n=6,524), the title and abstracts of 2,581 papers were screened. Of these, 395 were found to be related to the study's aim. After a full text review, 372 studies were excluded. The main reasons for exclusion were as follows: 12 studies did not meet the quality appraisal score (3%), and 260 studies utilized a non-quantitative methodology or did not report parametric measurements such as coefficients or odd ratios of relative risks of determinants of study outcomes (97%). Following these exclusions, 23 studies remained for meta-analysis (Aquin et al., 2017; Barr et al., 2017; Bommersbach, 2020; Dietz, 2011; Eynan et al., 2002; Fitzpatrick et al., 2007; Frederick et al., 2012; Fulginiti et al., 2022; Gentil et al., 2021; Goldstein et al., 2012; Hadland et al., 2015; Kidd, 2006; Lee et al., 2017; Molnar et al., 1998; Noël et al., 2016; Okamura et al., 2014; Oppong Asante et al., 2017; Panadero et al., 2018; Prigerson et al., 2003; Sakai-Bizmark et al., 2022; Schinka et al., 2012; Tsai et al., 2019; Vázquez et al., 2019) **(Figure 1).**

Selected studies were from four World Health Organization regions (19 from the America region [n=104,261 participants], two from the European region [n=322 participants], one from African region [n=227 participants], and one from the Western Pacific region [n=423 participants]). The USA had the highest number of included studies, with 13 studies (n=99,974). Considering country income level, 22 studies were conducted in high-income countries (n=104,034), and one study was conducted in a lower-middle-income country (n=227). Study size at baseline had a mean of 4,533 participants, with 138 being the lowest sample size (Vázquez et

al., 2019), and 60,515 being the largest sample size (Tsai et al., 2019). Response rates between studies varied from 60% to 100%. Participants had a mean age of 33.4 years and were more likely to be male (mean 63.3%), varying from 0% to 98%. Almost all studies were cross-sectional (20 studies). Eighteen studies were published between 2010 and 2021. Nine studies assessed both suicidal ideation and suicide attempts as the outcomes, taken from either administrative databases or self-report surveys. Eight studies assessed suicidal ideation only, and six studies assessed suicide attempts only as the outcome measure. Six studies used the Diagnostic and Statistical Manual of Mental Disorders diagnostic criteria (third, fourth or fifth editions) for assessing HIs. Most studies (18 studies) used a simple question for assessing suicide behaviors among HIs (e.g., *"Have you ever thought about suicide?"* and/or *"Have you ever attempted suicide?"*). Approximately half of the studies (48%) considered homeless who lived on the street as HIs. Among the 23 studies included in the meta-analysis, 10 reported sociodemographic variables among HIs, 14 reported risky behaviors, 12 reported mental health disorders and 11 reported SUDs (**Table 1**).

Table 1

Sociodemographic characteristics, risky behaviors, mental health disorders and substance use disorders associated with suicidal behaviors among homeless individuals

Older HIs (≥35 years) were 0.97 times less likely than younger HIs to report lifetime suicide attempts (OR=0.97, 95%CI=0.95-0.99). Those who had chronic physical illnesses (compared to those without) were (i) 2.05 times more likely to have lifetime suicidal ideation (OR=2.05, 95%CI=1.13-3.74) and (ii) 1.71 times more likely to have lifetime suicide attempts (OR=1.71, 95%CI=1.16-2.53). HIs who experienced violent behaviors (compared to those without) were (i) 3.10 times more likely to have lifetime suicidal ideation (OR=3.10, 95%CI=1.50-

6.42) and (ii) 3.59 times more likely to have lifetime suicide attempts (OR=3.59, 95%CI=1.04-12.39). Those who had history of physical abuse (compared to those without) were 2.21 times more likely to have lifetime suicide attempts (OR=2.21, 95%CI=1.50-3.26). HIs with mood disorders (compared to those without) were (i) 2.84 times more likely to have lifetime suicidal ideation (OR=2.84, 95%CI=2.28-3.53) and (ii) 1.82 times more likely to have lifetime suicide attempts (OR=1.82, 95%CI=1.46-2.27). Those who had psychotic disorders (compared to those without) were (i) 2.31 times more likely to have lifetime suicidal ideation (OR=2.31, 95%CI=1.71-3.10) and (ii) 3.10 times more likely to have lifetime suicide attempts (OR=3.10, 95%CI=1.61-5.99). HIs with personality disorders (compared to those without) were 2.28 times more likely to have lifetime suicide attempts (OR=2.28, 95%CI=2.27-2.29). Also, HIs with PTSD were 1.65 times more likely to have lifetime suicide attempts compared to those without (OR=1.65, 95%CI=1.64-1.65). Finally, HIs with SUDs (compared to those without) were (i) 2.38 times more likely to have lifetime suicidal ideation (OR=2.38, 95%CI=1.07-5.28) and (ii) 3.28 times more likely to have lifetime suicide attempts (OR=3.28, 95%CI=1.71-6.30) (**Figures 2, 3**).

Figures 2 and 3

Publication bias and sensitivity analysis

To identify potential publication bias, Egger's and Begg's tests were performed for each variable. Considering the symmetry assumption, there was no significant publication bias in the reviewed studies selected for inclusion **(Supplementary Files 3-13)**. A sensitivity analysis was performed and Baujat plots were used to identify influential effects. Effects on the right part indicated studies contributed much to the heterogeneity. After performing sensitivity analysis, studies that had the most contributions to the heterogeneity were removed. Moreover, several

sensitivity analyses were performed for each variable which had high heterogeneity and it was found that the sensitivity analysis could did not reduce the heterogeneity between studies for almost all variables (e.g., being older, violent behaviors, history of physical abuse, chronic physical illnesses) **(Supplementary Files 14-29)**.

Subgroup analysis

In the present study in order to find the main source of heterogeneity, several subgroup analyses were performed for each variable based on sample size and geographical location but no sources of heterogeneity were found. Participants' gender and other variables that were not evaluated may be sources of heterogeneity **(Supplementary File 30).**

Discussion

The present meta-analysis explored variables associated with suicidal behaviors among HIs. The results of the present study showed that chronic physical illnesses, violent behaviors, mood and psychotic disorders, and SUDs were significantly associated with both suicidal ideation and suicide attempts. Being older, having a history of physical abuse, having a personality disorder, and having PTSD were associated with suicide attempts only.

Regarding sociodemographic characteristics, older individuals (≥35 years) had a decreased risk of suicidality, relative to younger populations. This may be because older individuals have learned to manage their feelings regarding previous traumatic experiences (Aquin et al., 2017). As individuals get older, they may develop more adaptive coping strategies and increase resilience, leading to decreased risk of suicidal behaviors among individuals encountering homelessness. In this respect, it has been observed that suicide attempts are less common among HIs in older age groups compared to younger ones (Cleverley et al., 2011; Kidd et al., 2007).

Considering risky behaviors, consistent with the findings of prior investigations (Fernández-Montalvo et al., 2019; Jakubczyk et al., 2014), it was found that past experiences of sexual and physical abuse significantly contributed to elevated risks of suicide behaviors. Moreover, previous research has shown that histories of childhood stress and trauma are substantially and negatively associated with the brain development, which may expose the affected individuals to psychopathological malfunction (Leeb et al., 2011; Twardosz et al., 2010). Importantly, internalizing issues are much higher among younger individuals with a history of abuse, potentially leading to the development of mood disorders and elevated risk of suicidality (Flach et al., 2022). Genetic, clinical, and epidemiological evidence has clarified the etiological mechanisms underlying the relationship between childhood traumatic experiences and exacerbated risk of suicidality (Marshall et al., 2013). Also, the findings of the present study showed that a history of childhood and adulthood violence was associated with a higher risk of suicide behaviors. This is consistent with other study findings performed in other populations (e.g., females, individuals who live in poverty) (Guillén et al., 2015; Vázquez et al., 2010).

Mental health disorders, including depression have also been identified as risky determinants of suicidal behaviors. More than 90% of completed suicide cases have been previously diagnosed with at least one or more psychiatric condition, such as mood disorders (Isometsä, 2014), anxiety disorders (Sareen et al., 2005), personality disorders (Bertolote et al., 2004), and schizophrenia (Hor et al., 2010). In addition, aggressiveness and impulsiveness traits, as well as recent substance or alcohol use elevate the risk of suicide among individuals with mental ill-heath (Fleury et al., 2022; Forray et al., 2021; Gentil et al., 2021). A higher risk of suicidal ideation can also derive from isolation, limited social support, and decreased personal functioning, resulting from mood disorders and alcohol use disorders. The present study found that PTSD was

positively associated to the presence of suicide attempts. Suicide behaviors and PTSD may be related by multiple underlying psychosocial and biological mechanisms (Johnson et al., 2008; O'Connor et al., 2018). Existing theories in this respect mainly outline failure or lack of power (Sloman et al., 2000), the perception of inability to cope with distressing and unpleasant conditions (Gilbert et al., 1998), and a sense of defeat, as key characteristics associated with the initiation of suicidal ideation. Individuals with PTSD often perceive the recurrent symptoms of nightmares, flashbacks, and intrusive thoughts to be inevitable, potentially leading to states of entrapment and defeat (Panagioti et al., 2012). Once reflecting on the experienced trauma, physiological responses may be intensified among individuals with PTSD (Bedi et al., 2007). This biological state may have consequences such as the persistence of regular entrapment, threat, or defeat when co-occurring with autonomic hyperarousal (Selaman et al., 2014). The consequences of entrapment, defeat, and hyperarousal have been largely reported by empirical research. For instance, a study highlighted a significant correlation between aggravated suicidal risks and hyperarousal symptoms among Israeli males (Ben-Ya'acov et al., 2004). Additionally, other studies have indicated higher defeat and entrapment among individuals with PTSD (Panagioti et al., 2012), where the association between PTSD symptoms and suicidality was mediated by defeat and entrapment (Panagioti et al., 2013), predicting alternations in the extent of suicidal ideation (Panagioti et al., 2015). Early detection is the gold standard for suicide prevention. Moreover, suicidal behaviors can be prevented by psychosocial and pharmacological interventions among individuals with co-occurring mood disorders and SUDs. Programs like assertive community treatment and intensive case management have been implemented to minimize suicidality among this vulnerable group (Wang et al., 2015).

Previous studies have highlighted associations between SUDs and suicidal ideation (Aquin et al., 2017; Desai et al., 2003; Noël et al., 2016) as well as suicide attempt (Benda, 2003). In both the general population and individuals experiencing homelessness, there are substantial associations between suicide attempts and suicide-induced death as well as SUDs (Desai et al., 2003; Lee et al., 2017). Help-seeking and receiving health services is limited among individuals with concurrent homelessness and SUD (Armoon et al., 2022; Dietz, 2011; Fazel et al., 2008), resulting in enhanced risk of suicidal ideation and suicide attempts (Fazel et al., 2008) among this vulnerable population. Moreover, individuals with polydrug use (Armoon et al., 2021; Noël et al., 2016) or comorbid mental health disorders -SUD (Lee et al., 2017) often face a higher suicide risk. Moreover, alcohol or substances may be consumed by this group to self-medicate for their mental health disorders (Dietz, 2011; Thibodeau et al., 2013). The decreased inhibition typical of SUDs, involving higher suicide risk may be the reason for the more significant relationship with suicide attempts versus suicidal ideation in this regard. As reported in a previous study (Lee et al., 2017), more than 19.3 million HIs required interventions for substance use issues worldwide. However, such treatments were not provided to them, due to various challenges (e.g., difficulties with transportation, lack of identity documentation, and lack of health insurance). Furthermore, federal prevention and intervention services fail to include various conditions and necessities of the homeless population which require improvement. For example, federal services are expected to provide integrated prevention and management programs (i.e., consisting of monitoring, referring, case management, and treating) to address the special needs of this group (Lee et al., 2017). One critical domain to consider among HIs is mental health disorders and substance use-related problems. Providing useful training, assisting with transportation, and health insurance are among

the services that case management providers are suggested to consider for HIs (Didenko et al., 2007).

Implications for practice and future research

Individuals who are homeless face various complexities. Consequently, healthcare services are expected to provide comprehensive programs covering their necessities (Hong et al., 2018). Moreover, healthcare professionals encounter further challenges associated with dual diagnosis, complicating service provision in the lack of adequate assistance from psychiatrists. Therefore, it is crucial to facilitate feasible and broad access to mental healthcare plans for HIs. Future research is therefore recommended to address the existing gap in this respect and involve all relevant resources (such as policies) to present a clear picture of challenges and barriers to providing/accessing healthcare services in this population (Murray et al., 2021). Future planning for this group should comprehensively consist of engaging all stakeholders including healthcare-related parties, such as primary care services, mental health and substance use treatment providers, organizations providing services for homeless populations, and even the affected individual's social network.

Limitations and strengths of the study

The present study was naturally associated with some limitations with respect to the designs and methods applied by the included studies as well as the characteristics of the explored variables. First, a considerable number of the included studies implemented convenience sampling methods and recruited participants from specific agencies providing social services. Therefore, the reported data may not be generalizable to other groups experiencing homelessness, as not all HIs seek support from social care providers. Second, the main variables of the included studies were of different operational definitions, with some lacking a clear definition. An actual suicide attempt

and other types of self-injury were not properly differentiated among the studied participants in terms of the specifier “attempted suicide” (Kamieniecki, 2001).

Third, “abuse” was presented with multiple and interchangeable operational definitions in the included studies. Generally, victimization, neglect, sexual and physical abuse, histories of domestic violence when homeless or housed, as well as harm or death threats were among the included terms in this respect (Dietz, 2011; Goldstein et al., 2012; Hadland et al., 2015; Kidd, 2006). Fourth, homelessness, as a situational criterion, was also defined differently across studies. More specifically, being expelled from household by family, accessing temporary accommodation/shelters, the extent of access to social support services, the duration of homelessness, and level of interactions with family were among the characteristics considered for this criterion.

Fifth, a significant proportion of the papers applied highly valid and reliable measurement tools for assessing mental health disorders and substance use disorders. However, some studies did not utilize measures with strong psychometric properties. More specifically they evaluated the relevant risk and protective characteristics by the means of very brief non-validated questionnaires. Sixth, almost all studies only used single item questions to assess suicide behaviors. Seventh, the present review aimed to include global research data without considering any geographical restrictions. However, only a few empirical papers explored multicultural contexts, such as cultural characteristics, ethnicity, and national origin essentially attributable to suicidal behaviors among individuals facing homelessness. Eighth, the present review only included studies published in English language. Ninth, some variables were not assessed because there was only one study for some variables such as ethnicity, educational level, emergency department use, hospitalization, and using psychiatric services.

There was high heterogeneity for many of the variables associated with suicidal behaviors among HIs because of the low number of studies examining these specific variables. More specifically, this included (i) sociodemographic variables such as older age (six studies); (ii) risky behaviors such as history of physical abuse (five studies), violent behavior (six studies), and chronic physical illnesses (seven studies); (iii) mental health disorders such as mood disorders (11 studies), psychotic disorder (eight studies), personality disorder (two studies), and PTSD (four studies); and (iv) substance use disorders (11 studies). associated with suicidal behaviors. In all of these variables, the associations were relatively weak and caution is advised when interpreting the results.

A strength of the present study was a comprehensive database search across a lengthy amount of time. Furthermore, a comprehensive keyword search was performed resulting in a large number of studies followed by a rigorous screening process. Two expert academic librarians contributed to the search strategy regarding substance use disciplines during the search. Two authors conducted the title and abstract screening independently. Three authors also carried out the full-text screening, in addition to hand-searching the reference lists. Meetings were held to prevent missing any related studies that could be included.

Conclusions

The present study is the first known meta-analysis to identify variables associated with suicidal behavior among HIs. Several innovative variables, such violent behavior, PTSD, psychotic and personality disorders, and substance use disorders were assessed. Also, as far as the authors are aware, the present study is the first to perform sensitivity analysis for each variable

associated with suicidal behaviors among HIs. The present study's findings highlight the urgent necessity to provide impactful and accessible suicide interventions as well as other mental healthcare services along with the provision of stable accommodations, like housing, to homeless populations. Such programs are recommended to mainly concentrate on developing and improving beneficial skills, such as coping strategies, interpersonal relationship empowerment, and family support. Suicide-specific education, addressing all necessities of the target group should be formally presented to those providing services to individuals experiencing homelessness and suicidality. It was found that suicidality (suicidal ideations and suicide attempts) was associated with violence encountered by homeless young individuals. Therefore, health-promoting interventions are required for this high-risk group. Such programs can include providing training in identifying and avoiding violence-provoking conditions to this group. In addition, treatment planning for these individuals must also attend to the negative outcomes of past experiences of sexual and physical abuse. There exists a strong association between suicidal behaviors and mental health disorders. The present study's findings also suggest a crucial need for facilitating access to mental healthcare plans and promoting mental healthcare seeking among individuals. Such measures also require eliminating the stigma concerning mental ill-heath as well as increasing the mental healthcare quality, to pave the way for the improvement of their health conditions. A beneficial measure in this regard could be developing a screening tool to evaluate the risk determinants presented in the present review. Consequently, various service providers, such as shelters, drop-in centers, and outreach teams can consistently and reliably monitor suicide-related risks among populations encountering homelessness. Furthermore, the use of such risk assessment tools by healthcare professionals can be beneficial when referring the target group to most optimal and relevant services, if needed. Motivational therapy and suicide-specific interventions can be

considered when referring these individuals for further support. Finally, mobile outreach teams, as well as public or community-based psychosocial programs can play a significant role in providing timely suicide-specific interventions for individuals experiencing homelessness.

Abbreviations

CIs: Confidence intervals

HIs: Homeless individuals

NOS: The Newcastle–Ottawa Scale

ORs: Odds ratios

PECOS: Population, exposures, comparison, outcome, and study design

PTSD: Post-traumatic stress disorder

SUD: Substance use disorder

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Fig. 1 PRISMA flow diagram

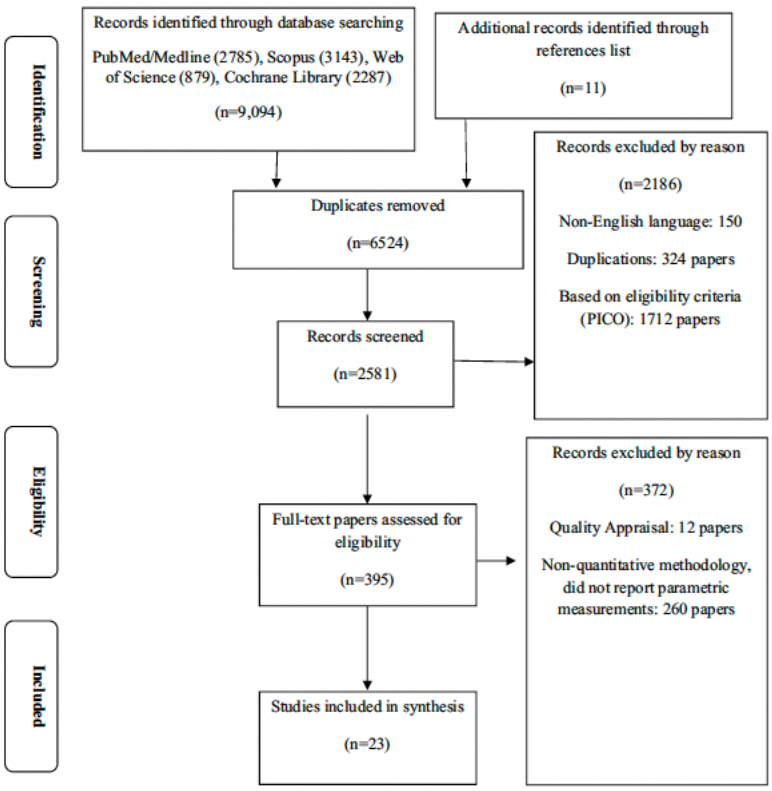

Table 1 Characteristics of studies for suicidal behaviors among homeless individuals

Authors (year)	Years (y) of data collections (number)	Country	Sample at baseline	Final sample (response rate%)	Study design	Data collection source	Diagnostic criteria used	Mean age	Male %	Female %	Suicidal behaviors measurement	Lifetime suicide ideations
Authors (year)	Years (y) of data collections (number	Country	Sample at baseline	Final sample (response rate%)	Study design	Data collection source	Diagnostic criteria used	Mean age	Male %	Female %	Suicidal behaviors measurement	Lifetime suicide ideations
Fulginiti et al. (2022)	2011–13 (3 y)	USA	1047	859 (82)	Cross-section	Survey	NR[a]	21	72	38	A question about suicidal behaviors	NR[a]
Sakai-Bizmark et al. (2022)	2009–14 (6 y)	USA	1097	1097 (100)	Case–control	Administrative database	ICD-9[b]	14.25	51	49	ICD-9[b]	√
Gentil et al. (2021)	2017 (1 y)	Canada	455	455 (100)	Cross-section	Survey	NR[a]	NR[a]	60	40	M.I.N.I International Neuropsychiatric Interview	√
Bommersbach et al. (2020)	2012–13 (2 y)	USA	36,127	36,127 (100)	Cross-section	Survey	DSM-5[c]	42.7	30	70	A question about suicidal behaviors	√
Juan Vázquez and Panadero (2019)	2019 (1 y)	Spain	138	138 (100)	Cross-section	Survey	NR[a]	45.5	0	100	A question about suicidal behaviors	NR[a]
Tasi and Cao (2019)	2012–13 (2 y)	USA	60,515	36,309 (60)	Cross-section	Survey	DSM-5[c]	NR[a]	NR[a]	NR[a]	A question about suicidal behaviors	NR[a]
Panadero et al. (2018)	2018 (1 y)	Spain	188	182 (96)	Cross-section	Survey	NR[a]	47.5	84	16	NR[a]	NR[a]
Lee et al. (2017)	2009	USA	156	156 (100)	Cross-section	Survey	NR[a]	41	66	34	A question about suicidal behaviors	√
Oppong Asante and Meyer-Weitz (2017)	2010	Ghana	265	227 (86)	Cross-section	Survey	NR[a]	12.58	54	46	A question about suicidal behaviors	√

Table 1 (continued)

Authors (year)	Years (y) of data collections (number)	Country	Sample at baseline	Final sample (response rate%)	Study design	Data collection source	Diagnostic criteria used	Mean age	Male %	Female %	Suicidal behaviors measurement	Lifetime suicide ideations
Aquin et al. (2017)	2009–13 (5 y)	Canada	2255	2221 (98)	Cohort	Survey	NR[a]	40.89	68	32	A question about suicidal behaviors	√
Barr et al. (2017)	2011–13 (3 y)	USA	398	398 (100)	Cross-section	Survey	DSM-I[d]	21.38	71	29	A question about suicidal behaviors	√
Noe¨l et al. (2016)	2016 (1 y)	Canada	497	471 (94)	Cross-section	Survey	NR[a]	40.8	73	27	A question about suicidal behaviors	√
Hadland et al. (2015)	2005–13 (9 y)	Canada	1002	660 (65)	Cohort	Administrative database	NR[a]	21.5	68	32	A question about suicidal behaviors	√
Okamura et al. (2014)	2010–11 (2 y)	Japan	423	423 (100)	Cross-section	Survey	NR[a]	60.6	92	8	A question about suicidal behaviors	√
Goldstein et al. (2012)	2001–03 (3 y)	USA	3595	3595 (100)	Cross-section	Survey	DSM-IV[d]	NR[a]	NR[a]	NR[a]	A question about suicidal behaviors	√
Frederick et al. (2012)	2005–6 (2 y)	Canada	150	150 (100)	Cross-section	Survey	DSM-I[d]	19.2	50	50	A question about suicidal behaviors	√
Schinka et al. (2012)	2003–9 (7 y)	USA	10,111	10,111 (100)	Cross-section	Survey	NR[a]	59.4	98	2	A question about suicidal behaviors	√
Dietz (2011)	1996 (1 y)	USA	4207	2974 (70)	Cross-section	Survey	NR[a]	38	65	35	A question about suicidal behaviors	√
Fitzpatrick et al. (2007)	2005 (1 y)	USA	161	141 (88)	Cross-section	Survey	NR[a]	NR[a]	64	36	A question about suicidal behaviors	√

Table 1 (continued)

Authors (year)	Years (y) of data collections (number)	Country	Sample at baseline	Final sample (response rate%)	Study design	Data collection source	Diagnostic criteria used	Mean age	Male %	Female %	Suicidal behaviors measurement	Lifetime suicide ideations
Kidd (2006)	2003–4 (2 y)	USA and Canada	208	208 (100)	Cross-section	Survey	NR[a]	20.2	59	41	A question about suicidal behaviors	NR a
Prigerson et al. (2003)	1994–96 (2 y)	USA	7224	7224 (100)	Cross-section	Survey	SCID[e]	38.6	62	38	A question about suicidal behaviors	√
Eynan et al. (2002)	2002 (1 y)	Canada	330	330 (100)	Cross-section	Survey	DSM-III[f]	33.1	78	22	Diagnostic Interview Schedule, Fourth Edition	√
Molnar et al. (1998)	1992–93 (2 y)	USA	775	775 (100)	Cross-section	Survey	NR[a]	17.5	65	35	NR[a]	NR[a]

Authors (year)	Lifetime suicide attempts	Type of homelessness	Sociodemographic variables	Risky behaviors			Mental health disorders				Substance use disorder
			Older age	History of physically abuse	Violent behavior	Chronic physical illnesses	Mood disorder	Psychotic disorders	Personality disorder	Post-traumatic stress disorder	
Fulginiti et al. (2022)	√	Currently homeless	*			*					
Sakai-Bizmark et al. (2022)	NR[a]	Currently homeless									*
Gentil et al. (2021)	√	Former and currently homeless						*			*
Bommersbach et al. (2020)	NR[a]	Living on the street	*					*			
Juan Vázquez and Panadero (2019)	√	Living on the street		*		*		*			*
Tasi and Cao (2019)	√	Living on the street	*			*		*	*	*	*
Panadero et al. (2018)	√	Living in shelter or on the street		*		*		*			*

Table 1 (continued)

Authors (year)	Lifetime suicide attempts	Type of homelessness	Sociodemographic variables	Risky behaviors			Mental health disorders				Substance use disorder
			Older age	History of physically abuse	Violent behavior	Chronic physical illnesses	Mood disorder	Psychotic disorders	Personality disorder	Post-traumatic stress disorder	
Lee et al. (2017)	√	Shelter									*
Oppong Asante and Meyer-Weitz (2017)	√	Living on the street			*						*
Aquin et al. (2017)	NR[a]	Former and currently homeless	*				*			*	*
Barr et al. (2017)	√	NR[a]								*	
Noe¨l et al. (2016)	NR[a]	Former and currently homeless					*				*
Hadland et al. (2015)	NR[a]	Living on the street		*							
Okamura et al. (2014)	NR[a]	Living on the street				*		*			
Goldstein et al. (2012)	√	Former and currently homeless	*		*		*	*	*	*	*
Frederick et al. (2012)	√	Living on the street			*						
Schinka et al. (2012)	NR[a]	NR[a]					*				
Dietz (2011)	√	Former and currently homeless		*		*					*
Fitzpatrick et al. (2007)	NR[a]	Living in shelter or on the street			*						
Kidd (2006)	√	Living in shelter or on the street		*	*						
Prigerson et al. (2003)	√	NR[a]	*								

Table 1 (continued)

Authors (year)	Lifetime suicide attempts	Type of homelessness	Sociodemographic variables	Risky behaviors			Mental health disorders				Substance use disorder
			Older age	History of physically abuse	Violent behavior	Chronic physical illnesses	Mood disorder	Psychotic disorders	Personality disorder	Post-traumatic stress disorder	
Eynan et al. (2002)	√	Living in shelter					*	*			
Molnar et al. (1998)	√	Living on the street		*							

[a]Not reported

[b]International Classification of Diseases, Ninth Revision

[c]Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition

[d]Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition

[e]Structured Clinical Interview for Diagnosis

[f]Diagnostic and Statistical Manual of Mental Disorders, Third Edition

*Variables that are included in the meta-analysis

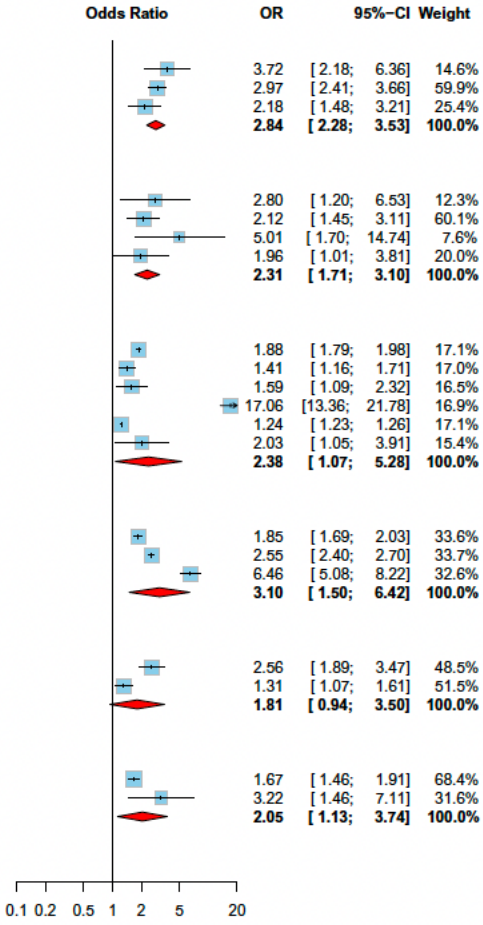

Fig. 2 Pooled odds ratio of socio-odemographic characteristics, risky behaviors, mental health disorders and substance use disorders associated with suicidal ideation among homeless individuals

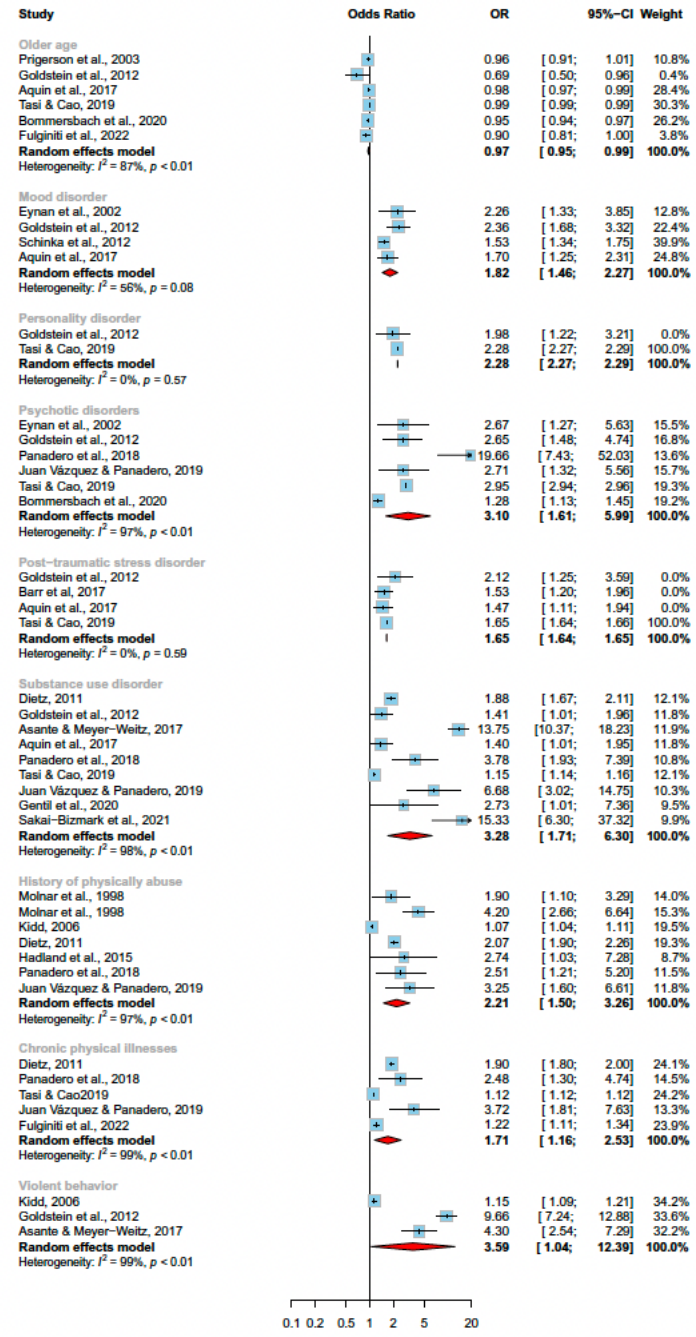

Fig. 3 Pooled odds ratio of sociodemographic characteristics, risky behaviors, mental health disorders and substance use disorders associated with suicide attempts among homeless individuals