

## RESEARCH ARTICLE

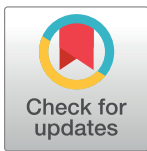
# The prevalence of mental disorders among homeless people in high-income countries: An updated systematic review and meta-regression analysis

Stefan Gutwinski<sup>1</sup>, Stefanie Schreiter<sup>1,2</sup>, Karl Deutscher<sup>1</sup>, Seena Fazel<sup>3\*</sup>

**1** Department of Psychiatry and Psychotherapy, Charité—Universitätsmedizin Berlin, Freie Universität Berlin and Humboldt-Universität zu Berlin, Berlin, Germany, **2** Biomedical Innovation Academy, Berlin Institute of Health, Berlin, Germany, **3** Department of Psychiatry, University of Oxford, Oxford, United Kingdom

☞ These authors contributed equally to this work.

\* [Seena.Fazel@psych.ox.ac.uk](mailto:Seena.Fazel@psych.ox.ac.uk)



## Abstract

### OPEN ACCESS

**Citation:** Gutwinski S, Schreiter S, Deutscher K, Fazel S (2021) The prevalence of mental disorders among homeless people in high-income countries: An updated systematic review and meta-regression analysis. *PLoS Med* 18(8): e1003750. <https://doi.org/10.1371/journal.pmed.1003750>

**Academic Editor:** Vikram Patel, Harvard Medical School, UNITED STATES

**Received:** February 2, 2021

**Accepted:** August 2, 2021

**Published:** August 23, 2021

**Peer Review History:** PLOS recognizes the benefits of transparency in the peer review process; therefore, we enable the publication of all of the content of peer review and author responses alongside final, published articles. The editorial history of this article is available here: <https://doi.org/10.1371/journal.pmed.1003750>

**Copyright:** © 2021 Gutwinski et al. This is an open access article distributed under the terms of the [Creative Commons Attribution License](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

**Data Availability Statement:** All relevant data are within the manuscript and its [Supporting Information](#) files.

## Background

Homelessness continues to be a pressing public health concern in many countries, and mental disorders in homeless persons contribute to their high rates of morbidity and mortality. Many primary studies have estimated prevalence rates for mental disorders in homeless individuals. We conducted a systematic review and meta-analysis of studies on the prevalence of any mental disorder and major psychiatric diagnoses in clearly defined homeless populations in any high-income country.

## Methods and findings

We systematically searched for observational studies that estimated prevalence rates of mental disorders in samples of homeless individuals, using Medline, Embase, PsycInfo, and Google Scholar. We updated a previous systematic review and meta-analysis conducted in 2007, and searched until 1 April 2021. Studies were included if they sampled exclusively homeless persons, diagnosed mental disorders by standardized criteria using validated methods, provided point or up to 12-month prevalence rates, and were conducted in high-income countries. We identified 39 publications with a total of 8,049 participants. Study quality was assessed using the JBI critical appraisal tool for prevalence studies and a risk of bias tool. Random effects meta-analyses of prevalence rates were conducted, and heterogeneity was assessed by meta-regression analyses. The mean prevalence of any current mental disorder was estimated at 76.2% (95% CI 64.0% to 86.6%). The most common diagnostic categories were alcohol use disorders, at 36.7% (95% CI 27.7% to 46.2%), and drug use disorders, at 21.7% (95% CI 13.1% to 31.7%), followed by schizophrenia spectrum disorders (12.4% [95% CI 9.5% to 15.7%]) and major depression (12.6% [95% CI 8.0% to 18.2%]). We found substantial heterogeneity in prevalence rates between studies, which was partially explained by sampling method, study location, and the sex distribution of

**Funding:** The Wellcome Trust (<https://wellcome.org>) granted the submission fee for this review to SF (grant number 202836/Z/16/Z). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

**Competing interests:** The authors have declared that no competing interests exist.

**Abbreviations:** CI, confidence interval; DSM, Diagnostic and Statistical Manual of Mental Disorders; PI, prediction interval.

participants. Limitations included lack of information on certain subpopulations (e.g., women and immigrants) and unmet healthcare needs.

## Conclusions

Public health and policy interventions to improve the health of homeless persons should consider the pattern and extent of psychiatric morbidity. Our findings suggest that the burden of psychiatric morbidity in homeless persons is substantial, and should lead to regular reviews of how healthcare services assess, treat, and follow up homeless people. The high burden of substance use disorders and schizophrenia spectrum disorders need particular attention in service development. This systematic review and meta-analysis has been registered with PROSPERO (CRD42018085216).

## Trial registration

PROSPERO [CRD42018085216](https://doi.org/10.1111/CRD4.12516).

## Author summary

### Why was this study done?

- Homelessness continues to affect a large number of people in high-income countries and is associated with an increased risk of mental disorders.
- To guide service development, further research, and public policy, reliable estimates on the prevalence of mental disorders among homeless individuals are needed.
- Many primary investigations into rates of mental disorders have been published since a previous comprehensive quantitative synthesis in 2008.

### What did the researchers do and find?

- We performed a systematic database search, extracted data from primary reports, and assessed their risk of bias, resulting in a sample of 39 studies including information from over 8,000 homeless individuals in 11 countries.
- We conducted random effects meta-analyses of 7 common diagnostic categories. Prevalence estimates were all increased in homeless individuals compared with those in the general population. Alcohol use disorders had the highest absolute rate, at 37%, with substantially elevated proportional excesses compared to the general population for schizophrenia spectrum disorders and drug use disorders as well.
- There was substantial between-study variation in prevalence estimates, and meta-regression analyses found that sampling method, participant sex distribution, and study country explained some of the heterogeneity.

### What do these findings mean?

- The high burden of substance use disorders and severe mental illness in homeless people represents a unique challenge to public health and policy.
- Future research should prioritize quantification of unmet healthcare needs, and how they can be identified and effectively treated. Research on subgroups, including younger people and immigrant populations, is a priority for prevalence work.

## Introduction

Homelessness is recognized by the United Nations Economic and Social Council as an issue of global importance [1]. In high-income countries, around 2 million people have been homeless over the past decade [2]. In the US, the lifetime prevalence of homelessness is estimated at 4.2% [3], with around 550,000 individuals lacking fixed, regular, and adequate residence on any given night [4]. Patterns over time have differed by country, although homelessness has increased in many high-income countries in recent years, including in the US and UK since 2017 [2].

There has been an increasing recognition of the public health importance of homeless persons, with many studies reporting high rates of acute hospitalization, chronic diseases, and mortality [5–13]. Comorbidities increase these risks, particularly mental disorder comorbidities. For example, in a Danish population study, comorbidity of psychiatric disorders increased mortality rates by 70% [14]. Furthermore, mental illness among homeless individuals has been associated with elevated rates of criminal behavior and victimization [15,16], prolonged courses of homelessness [17,18], and perceived discrimination [19]. Mental disorders among homeless individuals are mostly treatable and represent an important opportunity to address health inequalities.

Information on the overall extent and pattern of mental disorders among homeless people is necessary to inform resource allocation and service development, and to allow researchers, clinicians, and policymakers to consider evidence gaps. The large number of primary studies, of varying quality and samples, means that systematic reviews are required to clarify and synthesize the evidence, underscore main findings, and consider implications. According to a recent umbrella review, there have been at least 7 systematic reviews with quantitative data synthesis in the past 2 decades [20]; however, most of them focused on individual diagnostic categories [21–24], examined specific age bands [24,25], or were limited to a single country [26]. The last meta-analysis to our knowledge that provided a comprehensive account of the prevalence of major mental disorders in homeless adults in high-income countries completed its search in 2007 [27], and since then, a considerable number of primary studies have been published [28,29]. Thus, we conducted an updated systematic review and meta-analysis on the prevalence of mental disorders among homeless people in high-income countries, and added the diagnostic categories of any mental disorder and bipolar disorder.

## Methods

### Search strategy

We searched for studies that determined prevalence rates for at least 1 of the following disorders among homeless persons: (1) schizophrenia spectrum disorders, (2) major depressive

disorder, (3) bipolar disorder, (4) alcohol use disorders, (5) drug use disorders, (6) personality disorders, and (7) any current mental disorder (Axis I disorders in the Diagnostic and Statistical Manual of Mental Disorders [DSM] multi-axial system [30]).

We have updated an earlier review [27] that was based on a search for articles published up until December 2007, so we targeted new primary studies published between 1 January 2008 and 1 April 2021. We searched Embase via OvidSP, Medline via OvidSP and via PubMed, and PsycInfo via EBSCOhost. Additionally, we searched Google Scholar using a search query and screened all literature citing the previous review. Finally, we screened reference lists of relevant publications. Each search employed a specific combination of search terms designed to fit the databases' respective syntaxes and thesaurus systems (S1 Table). Articles written in languages other than English or German were translated by professional translators. The protocol for this systematic review and meta-analysis has been published (PROSPERO CRD42018085216). We followed Meta-analysis of Observational Studies in Epidemiology (MOOSE) guidelines for extracting and assessing data [31]. This systematic review adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (see S2 Table) [32].

### Eligibility criteria and study selection

Inclusion criteria were as follows: (1) homelessness status of study participants was validated by an operationalized definition or a sampling method that specifically targeted homeless population; (2) standardized criteria for the psychiatric disorders specified above, based on the International Classification of Diseases (ICD) or DSM, were applied; (3) psychiatric diagnoses were made by clinical examination or interviews using validated semi-structured diagnostic instruments; (4) for any psychiatric disorders except for personality disorders (where lifetime rates were used), prevalence rates were reported within 12 months; and (5) study location was a high-income country according to the classification of the World Bank [33].

Surveys that reported a response rate of less than 50% or exclusively sampled from selected subpopulations (such as elderly homeless, homeless youth, or homeless single parents) were excluded.

In order to assess all results from the bibliographic search process, researchers SS, SG, and KD each carried out a multilevel screening process independently from one another. Any differences between results were resolved by consensus between all the authors.

### Data collection and quality assessment

Information from included surveys was extracted on study location, year of diagnostic assessment, operational definition of homelessness status, sampling method, diagnostic procedures, diagnostic criteria, professional qualification of interviewers, response rate, dropout rate, number of participants by sex, sample mean age, current accommodation of participants, sample mean duration of homelessness, and number of participants diagnosed with schizophrenia spectrum disorders, major depressive disorder, bipolar disorder, alcohol- and drug-related disorders, personality disorders, and any primary diagnosis of a mental disorder apart from personality and developmental disorders (i.e., Axis I disorders in DSM). If data regarding any of these categories were unclear in the published study, we corresponded with the primary study authors.

Each included publication was rated on methodological quality by 2 sets of criteria specifically designed to assess prevalence studies: the JBI critical appraisal tool for prevalence studies [34] and a risk of bias tool [35]. This process was carried out by SS, SG, and KD independently, and any differences were resolved by discussion.

## Statistical analysis

Random effects meta-analyses and meta-regression analyses were performed on each diagnostic category independently—prevalence data for alcohol misuse/abuse and alcohol dependence were both entered into the single category of alcohol use disorders, in accordance with current diagnostic approaches. All analyses were done in R, version 4.0.4 [36]. The package “metafor,” version 2.4–0, was utilized for meta-analysis and meta-regression analysis, supplemented by “glmulti,” version 1.0.8, for multivariable model selection and “mice”, version 3.13.0, for multivariate imputation [37–39].

Prevalence estimates were transformed on the double arcsine function in order to avoid variance instability and confidence intervals (CIs) exceeding the interval ( $0 \leq x \leq 1$ ) in which prevalence proportions can be meaningfully defined [40]. We calculated random effects models, which we deemed appropriate considering sampling differences. The Paule–Mandel estimator was chosen to measure between-study variance due to its reliability for different types of models [41]. A Q-test for heterogeneity was conducted. To quantify measures of between-study heterogeneity, we report the test statistic  $Q_E$  and corresponding  $p$ -value as well as the  $I^2$  statistic. Additionally, we calculated 95% prediction intervals (PIs) for all meta-analytical models [42]. Because the “metafor::predict.rma” function unrealistically assumed that the model variance  $\tau^2$  was a known value [43], we instead implemented a method proposed by Higgins and colleagues that accounts for  $\tau^2$  being an estimate with limited precision ([44], expression 12).

Additional meta-analyses were carried out in each diagnostic category for low-risk-of-bias studies, assigned during quality assessment [35]. Subgroup analyses comparing low-risk-of-bias and moderate-risk-of-bias studies were performed through a Q-test. In cases of significant between-subgroup difference, a meta-regression model with risk of bias assessment as a single independent variable was computed to estimate the proportion of variance explained by disparities in methodological quality.

For each diagnostic category, meta-regression analyses were performed to investigate potential sources of heterogeneity. Continuous independent variables for single factor meta-regression were number of participants, sex distribution (female/all), and final year of diagnostic assessments. Categorical independent factors were diagnostic method (structured/semi-structured interview versus non-structured clinical evaluation), sampling method (randomized versus non-randomized sampling methods), and study location (US, UK, or Germany). The 3 study locations were prespecified as predictor variables due to a preponderance of primary studies in each of these countries.

Multivariable meta-regression models were also calculated. The respective independent variables were chosen through automated, information-criterion-based model selection with generalized linear models [38]. For models with 20 or more included studies, the Akaike information criterion (AIC) was used; for models with fewer than 20 included studies, we utilized the corrected version for small sample sizes (AIC<sub>c</sub>) to avoid over-fitting.

The proportion of variance of prevalence estimates explained by any meta-regression model was estimated by the  $R^2$  statistic [45].

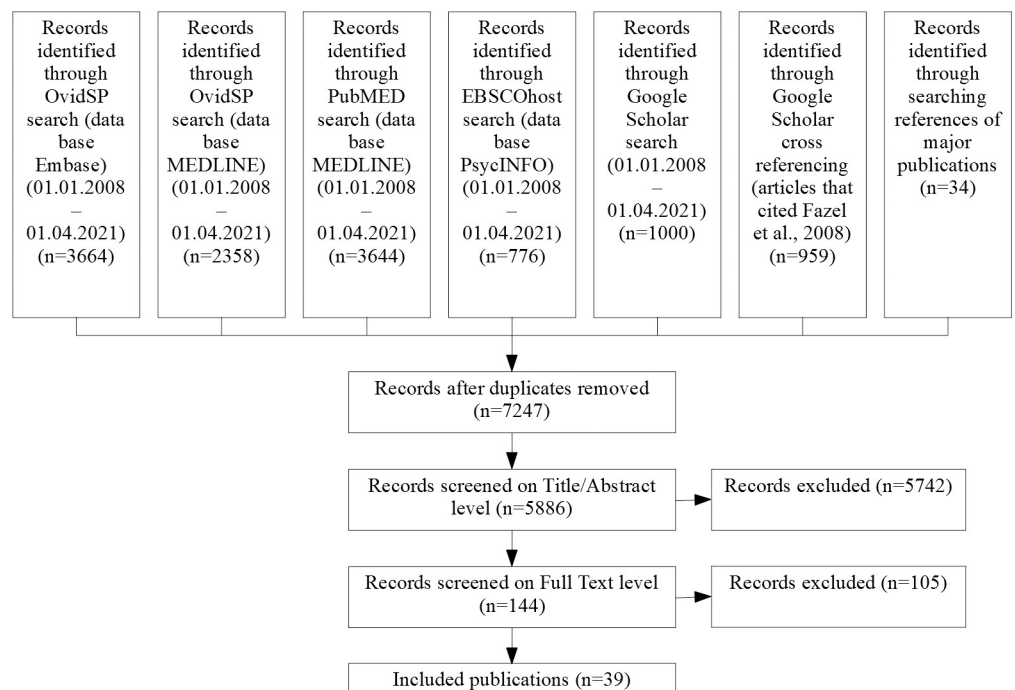
We assumed that missingness was at random [46], so missing values in independent variables (that were missing despite requests for additional information to primary study authors) were replaced through multiple imputation by chained equations [47]. For models including incomplete predictor variables, results of meta-regression on imputed data are presented as the primary analysis; meta-regression results on only complete cases are provided as sensitivity analyses [48].

## Results

### Description of included studies

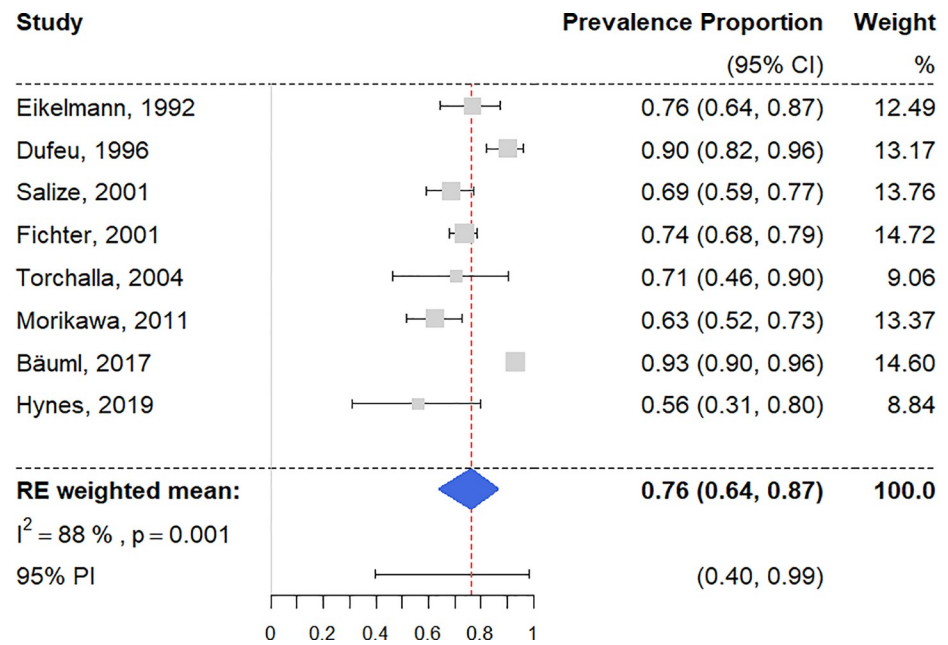
The systematic literature search returned 5,886 distinct records, of which 144 full texts were assessed (see [S3 Table](#) for reasons for exclusion). We identified a total of 39 studies comprising data on 8,049 homeless individuals [28,29,49–85] (see [Fig 1](#) for flow chart of screening process). This included 10 additional studies for this update [28,29,53–55,57,59,62,75,76], and 2 previous investigations were further clarified [81,83].

Out of the 39 included studies, 27 publications reported age (mean of 41.1 years) [28,49–57,59,64,65,67,70–73,75,76,78–82,84,85], and the proportion of women was 22.3% (based on 38 studies) [28,29,49–65,67–85]. Eleven studies [52,56,68,71–74,80,82,83,85] investigated male-only samples, and 5 studies [59,65,78,81,84] solely women. Of the 39 studies, 27 were from 3 countries: 11 from the US ( $n = 2,694$  participants) [57,59,60,64,69,75,77,79,83–85], 7 from the UK ( $n = 1,390$  participants) [49,61,66,67,70,78,82], and 9 from Germany ( $n = 936$  participants) [28,50,51,56,65,71–73,80,81]. Six studies were from other European countries ( $n = 2,301$  participants) [29,52,55,58,62,76], 1 study was from Canada ( $n = 60$  participants) [69], 2 were from Japan ( $n = 194$  participants) [53,54], and 2 were from Australia ( $n = 667$  participants) [63,74]. Fourteen studies reported a response rate of 85% or above [49,60,65,66,69–73,78,81,82,84,85], 20 studies reported a response rate below 85% [28,29,50–52,54–56,58,59,61–64,68,74,76,79,80,83], and 5 did not report participation rate [53,57,67,75,77]. In 13 studies, participants were accommodated in shelters, hostels, or residential care when assessed [28,49,63,66,70,72,74,76–78,81–83] while in 3 they were rough sleeping [54,62,67]; 22 studies had mixed samples regarding accommodation or provided incomplete information [29,50–53,55–61,64,65,68,69,71,73,75,79,80,84,85]. [S4 Table](#) provides further information on methodological and sample characteristics. For quality ratings, see [S5](#) and [S6 Tables](#). [S7 Table](#) provides all extracted data that meta-analyses and meta-regression analyses were based on.



**Fig 1. Screening process.**

<https://doi.org/10.1371/journal.pmed.1003750.g001>



**Fig 2. Forest plot of prevalence estimates of any current mental disorder.** Analytic weights are from random effects meta-analysis. Grey boxes represent study estimates; their size is proportional to the respective analytical weight. Lines through the boxes represent the 95% CIs around the study estimates. The blue diamond represents the mean estimate and its 95% CI. The vertical red dashed line indicates the mean estimate. CI, confidence interval; PI, prediction interval.

<https://doi.org/10.1371/journal.pmed.1003750.g002>

### Any current mental disorders

There were 8 surveys reporting on homeless people having at least 1 diagnosis of a current mental disorder [28,51,54,62,71–73,81], with a random effects pooled prevalence estimated at 76.2% (95% CI 64.0% to 86.6%) (Fig 2). Individual study prevalence rates ranged from 56.3% to 93.3%, with substantial heterogeneity ( $I^2 = 88\%$  [95% CI 72% to 97%]). The 95% PI was 40% to 99%. Univariable meta-regression analysis revealed that studies with randomized sampling procedures reported significantly higher prevalence estimates than ones with other sampling procedures, accounting for a large proportion of heterogeneity ( $R^2 = 59\%$ ) (see S8 Table). Sampling procedure was chosen as the only predictor variable by multivariable model selection (see Table 1).

In a subgroup analysis of 4 low-risk-of-bias studies [62,71,73,81], the random effects prevalence was 75.3% (95% CI 50.2% to 93.6%;  $I^2 = 81\%$  [95% CI 32% to 99%]). There was no significant difference between quality subgroups ( $Q = 0.03$ ,  $p = 0.87$ ).

### Schizophrenia spectrum disorders

There were 35 surveys reporting on any schizophrenia spectrum disorder [28,29,49,51–58,60–74,76–78,80–85], and the random effects prevalence was 12.4% (95% CI 9.5% to 15.7%) (Fig 3), with substantial heterogeneity ( $I^2 = 93\%$  [95% CI 89% to 96%]; 95% PI 0% to 34%). Primary investigation estimates ranged between 2.0% and 42.2%. No single model coefficient in univariable meta-regression was statistically significant. A multivariable model with sample size, proportion of female participants, and study location in Germany accounted for a small share of the heterogeneity ( $R^2 = 16\%$ ). The latter model indicated that studies with smaller samples had significantly higher prevalence rates, but only when based on imputed values (see Table 1).

Table 1. Study-level factors associated with between-study heterogeneity in multivariable meta-regression.

Model	$\beta$ (standard error) and p-value, by factor						
	Any current mental disorder <sup>a,b</sup>	Schizophrenia spectrum disorders	Major depression	Bipolar disorder	Alcohol use disorders <sup>b</sup>	Drug use disorders	Personality disorders <sup>a,b</sup>
Imputed model	—	<b>With <math>R^2 = 16\%</math></b>	<b>With <math>R^2 = 32\%</math></b>	<b>With <math>R^2 = 54\%</math></b>	—	<b>With <math>R^2 = 42\%</math></b>	—
	—	Sample size (continuous): > -0.01 (<0.01) <b><math>p = 0.04</math></b>	Randomized sampling versus other: <b>0.17 (0.07)</b> <b><math>p = 0.03</math></b>	Randomized sampling versus other: <b>-0.11 (0.04)</b> <b><math>p = 0.03</math></b>	—	Randomized sampling versus other: <b>-0.39 (0.12)</b> <b><math>p &lt; 0.01</math></b>	—
		Sex distribution (female/all): 0.13 (0.07) $p = 0.09$	Sex distribution (female/all): 0.14 (0.09) $p = 0.15$	Sex distribution (female/all): <b>0.15 (0.06)</b> <b><math>p = 0.04</math></b>		UK versus other locations: <b>-0.48 (0.18)</b> <b><math>p = 0.01</math></b>	
		Germany versus other locations: -0.09 (0.05) $p = 0.11$					
Complete case analysis	<b>With <math>R^2 = 59\%</math></b>	<b>With <math>R^2 = 13\%</math></b>	<b>With <math>R^2 = 32\%</math></b>	<b>With <math>R^2 = 50\%</math></b>	<b>With <math>R^2 = 27\%</math></b>	<b>With <math>R^2 = 51\%</math></b>	<b>With <math>R^2 = 15\%</math></b>
	Randomized sampling versus other: <b>0.23 (0.08)</b> <b><math>p = 0.03</math></b>	Sample size (continuous): > -0.01 (<0.01) $p = 0.07$	Randomized sampling versus other: <b>0.18 (0.08)</b> <b><math>p = 0.03</math></b>	Randomized sampling versus other: <b>-0.12 (0.04)</b> <b><math>p = 0.03</math></b>	Germany versus other locations: <b>0.33 (0.10)</b> <b><math>p &lt; 0.01</math></b>	Randomized sampling versus other: <b>-0.39 (0.10)</b> <b><math>p &lt; 0.01</math></b>	North America versus other locations: 0.30 (0.17) $p = 0.10$
		Sex distribution (female/all): 0.14 (0.08) $p = 0.08$	Sex distribution (female/all): 0.18 (0.10) $p = 0.10$	Sex distribution (female/all): 0.12 (0.06) $p = 0.09$	North America versus other locations: <b>0.20 (0.10)</b> <b><math>p = 0.04</math></b>	UK versus other locations: <b>-0.72 (0.20)</b> <b><math>p &lt; 0.01</math></b>	
		Germany versus other locations: -0.09 (0.05) $p = 0.11$					

Statistically significant values given in bold.

<sup>a</sup>A univariable model was chosen in model selection, so only 1 variable is presented.

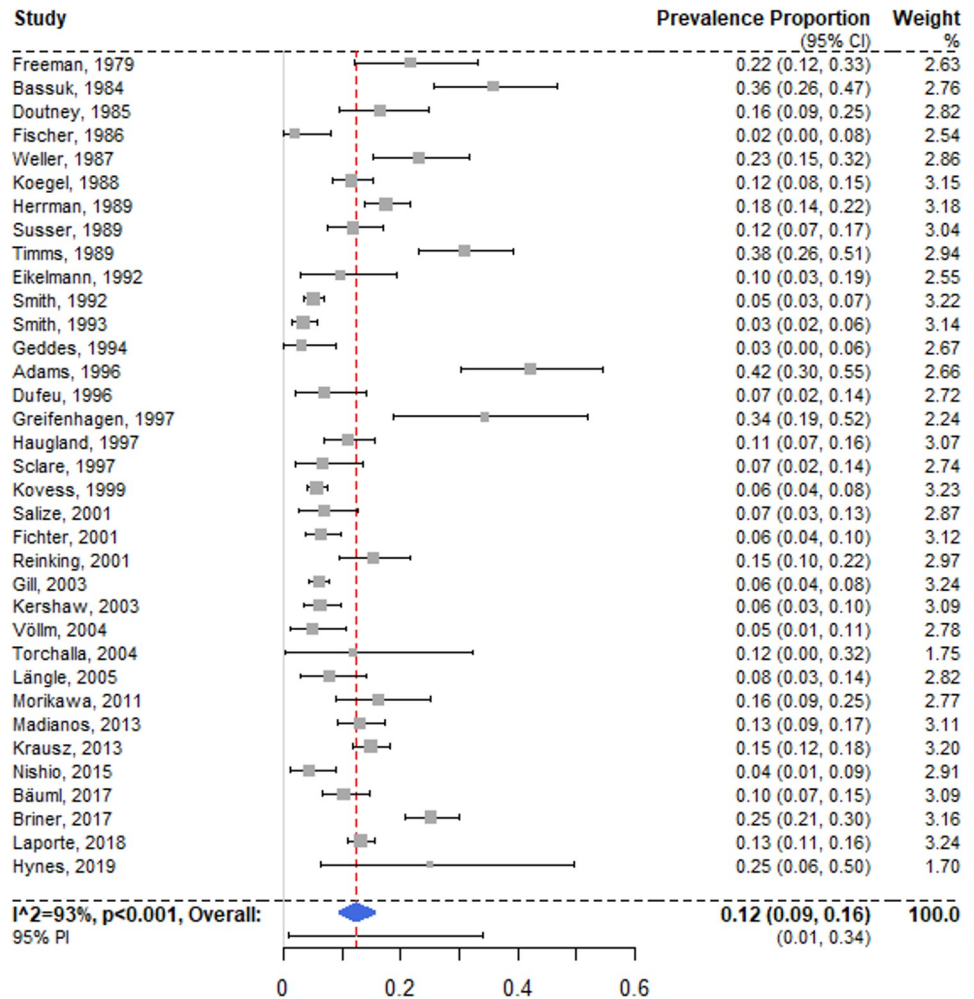
<sup>b</sup>All variables in the multivariable model were complete, so no imputation was needed.

<https://doi.org/10.1371/journal.pmed.1003750.t001>

A subgroup analysis of 17 low-risk-of-bias studies [29,49,52,55,58,60,62,65,67,69,71,73,78,80,81,84,85] revealed a random effects pooled prevalence of 10.5% (95% CI 6.2% to 15.7%;  $I^2 = 94\%$  [95% CI 88% to 98%]). The subgroup difference between low-risk-of-bias and moderate-risk-of-bias studies was non-significant, with the low-risk group resulting in a marginally lower weighted mean ( $Q = 1.59$ ,  $p = 0.21$ ).

## Major depression

We identified 18 studies reporting prevalence estimates on major depressive disorder [28,49,52,55,57–60,62,63,65,67,71,77,80,81,84,85], with a random effects pooled prevalence of 12.6% (95% CI 7.9% to 18.2%) (Fig 4). Individual study estimates ranged between 0% and 40.6% and showed substantial heterogeneity ( $I^2 = 95\%$  [95% CI 90% to 98%]; 95% PI 0% to 40%). Univariable meta-regression analysis produced no significant models (see S8 Table). For multivariable regression, independent variable sampling procedure and proportion of female participants were selected; the model indicated that studies with randomized sampling reported significantly higher prevalence rates (see Table 1).



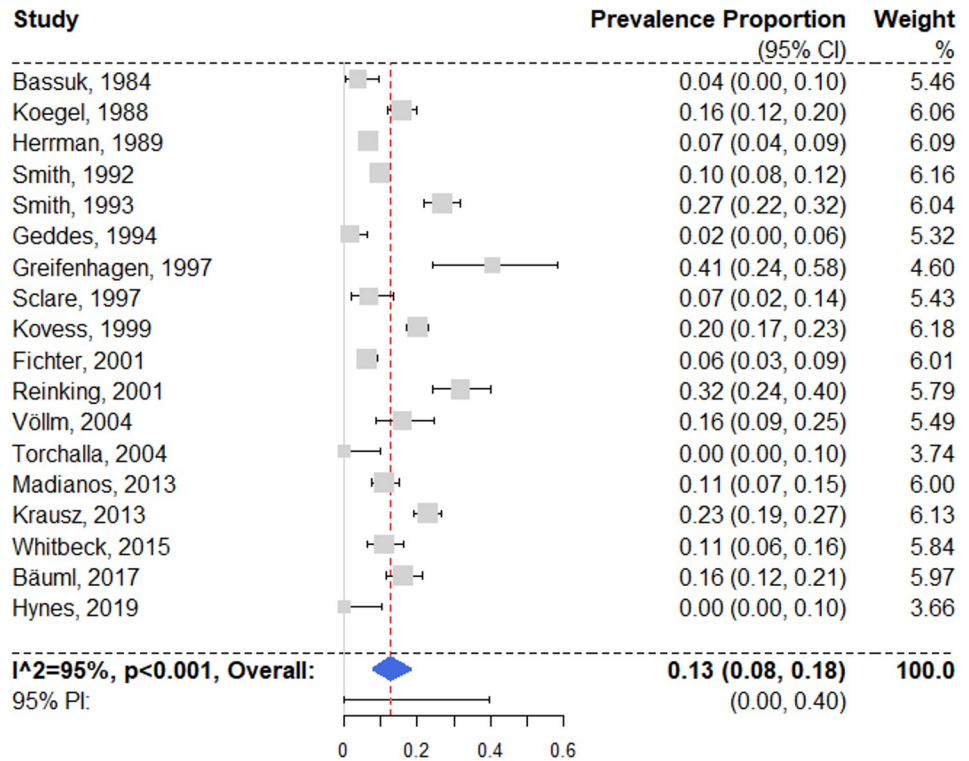
**Fig 3. Forest plot of prevalence estimates of schizophrenia spectrum disorders.** Analytic weights are from random effects meta-analysis. Grey boxes represent study estimates; their size is proportional to the respective analytical weight. Lines through the boxes represent the 95% CIs around the study estimates. The blue diamond represents the mean estimate and its 95% CI. The vertical red dashed line indicates the mean estimate. CI, confidence interval; PI, prediction interval; RE, random effects.

<https://doi.org/10.1371/journal.pmed.1003750.g003>

In a subgroup analysis of 13 low-risk-of-bias studies [49,52,55,58,60,62,65,67,71,80,81,84,85], the random effects pooled prevalence was 13.0% (95% CI 6.7% to 20.9%;  $I^2 = 96%$  [95% CI 90% to 99%]). There were no significant differences in between risk of bias subgroups ( $Q = 0.09, p = 0.76$ ).

### Bipolar disorder

Fourteen surveys with prevalence estimates on bipolar disorder were identified [28,49,55,57–59,62,63,65,67,71,77,84,85]. Three studies reported on solely type I bipolar disorder [49,57,85], 4 examined all bipolar disorder subtypes [28,59,65,71], and 7 did not specify [55,58,62,63,67,77,84]. The random effects pooled prevalence was 4.1% (95% CI 2.0% to 6.7%) (Fig 5), with substantial heterogeneity ( $I^2 = 89%$  [95% CI 77% to 96%]; 95% PI 0% to 16%). Individual estimates ranged from 1.0% to 13.5%. Univariable regression models indicated that studies with higher proportions of female participants reported significantly higher rates of



**Fig 4. Forest plot of prevalence estimates of major depression.** Analytic weights are from random effects meta-analysis. Grey boxes represent study estimates; their size is proportional to the respective analytical weight. Lines through the boxes represent the 95% CIs around the study estimates. The blue diamond represents the mean estimate and its 95% CI. The vertical red dashed line indicates the mean estimate. CI, confidence interval; PI, prediction interval; RE, random effects.

<https://doi.org/10.1371/journal.pmed.1003750.g004>

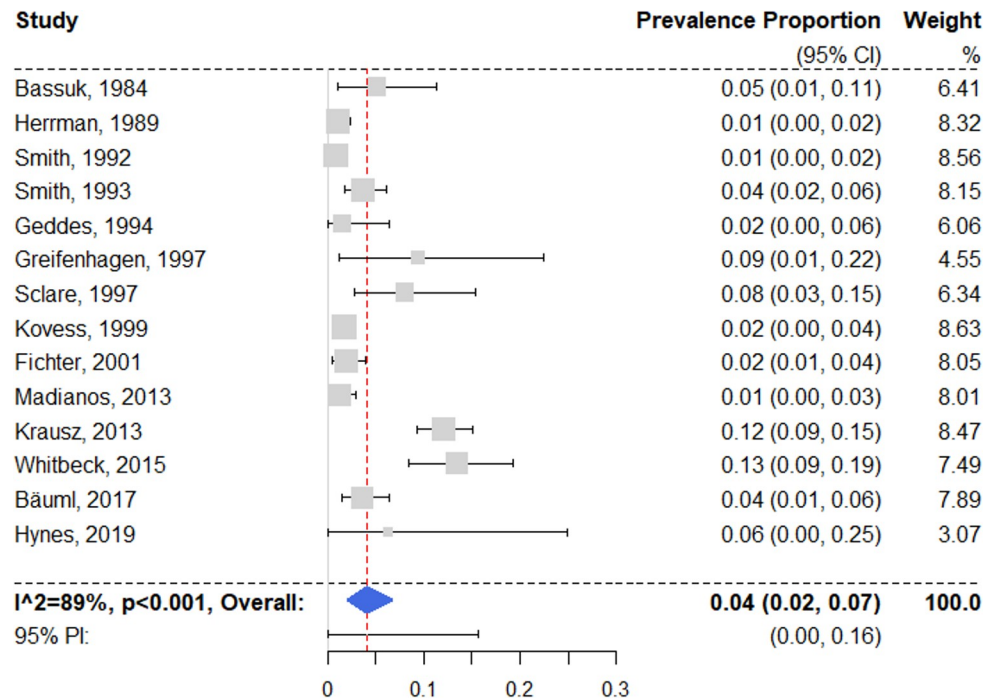
bipolar disorder (see S8 Table). In the multivariable model, prevalence estimates from studies with randomized sampling were significantly lower than those from studies with other sampling methods (see Table 1).

A subgroup analysis of 9 low-risk-of-bias surveys [49,55,58,62,65,67,71,84,85] resulted in a random effects pooled prevalence of 2.6% (95% CI 1.0% to 4.9%), with moderate heterogeneity ( $I^2 = 78%$  [95% CI 29% to 96%]). The difference between low-risk-of-bias and moderate-risk-of-bias studies was non-significant ( $Q = 2.29, p = 0.13$ ).

Findings for any affective disorder (which included depression and bipolar disorder) are reported in S1 Text and S6 Table.

### Alcohol use disorders

Estimates on alcohol use disorders could be extracted from 29 surveys [28,29,51–66,68,71–73,76,77,79–81,84,85]. The random effects pooled prevalence was 36.7% (95% CI 27.7% to 46.2%) (Fig 6), with individual study estimates ranging from 5.5% to 71.7%, and with substantial between-study heterogeneity ( $I^2 = 98%$  [95% CI 97% to 99%]; 95% PI 2% to 85%). Univariable meta-regression models indicated that studies with smaller samples and studies from Germany (compared to other locations) reported significantly higher rates of alcohol use disorders (see S8 Table). In multivariable analysis, the best selected model included only study location as a predictor variable, with higher prevalences reported in Germany and North America (see Table 1).



**Fig 5. Forest plot of prevalence estimates of bipolar disorder.** Analytic weights are from random effects meta-analysis. Grey boxes represent study estimates; their size is proportional to the respective analytical weight. Lines through the boxes represent the 95% CIs around the study estimates. The blue diamond represents the mean estimate and its 95% CI. The vertical red dashed line indicates the mean estimate. CI, confidence interval; PI, prediction interval; RE, random effects.

<https://doi.org/10.1371/journal.pmed.1003750.g005>

In a subgroup analysis of 14 low-risk-of-bias studies [29,52,55,58,60,62,65,71,73,79–81,84,85], the random effects pooled prevalence was 36.9% (95% CI 21.1% to 54.3%;  $I^2 = 99%$  [95% CI 98% to 100%]). There was no significant difference between risk of bias subgroups ( $Q < 0.01$ ,  $p = 0.96$ ).

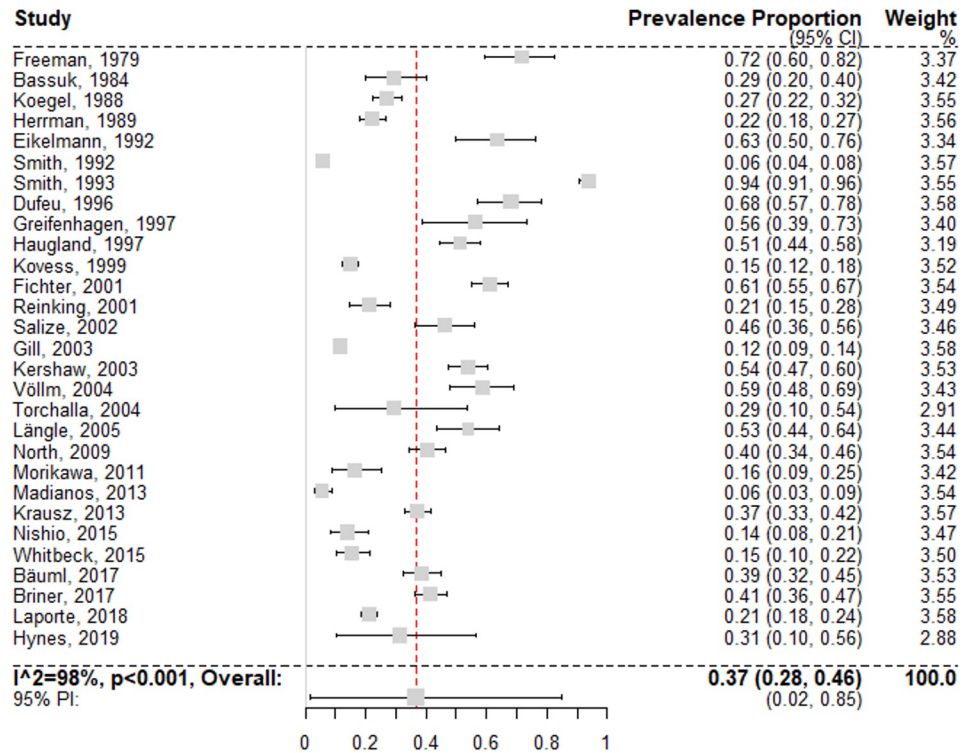
### Drug use disorders

We identified 23 surveys reporting prevalence estimates on drug use disorders [28,29,52,53,55–65,71,73,76,79,80,82,84,85] (Fig 7). A random effects pooled prevalence of 21.7% (95% CI 13.1% to 31.7%) was found, with very high heterogeneity ( $I^2 = 99%$  [95% CI 98% to 99%]; 95% PI 0% to 74%); individual estimates ranged between 0% and 72.1%. According to univariable meta-regression, studies with randomized sampling (as opposed to other sampling methods) estimated significantly lower prevalence rates (see S8 Table). The selected multivariable model showed that studies from the UK reported lower prevalence rates. These results were confirmed by a secondary complete case analysis.

A subgroup analysis of 13 low-risk-of-bias studies [29,52,55,58,60,62,65,71,73,79,80,84,85] resulted in a random effects pooled prevalence of 18.1% (95% CI 10.5% to 27.2%), with substantial heterogeneity ( $I^2 = 97%$  [95% CI 94% to 99%]). The difference between subgroups was not significant ( $Q = 0.65$ ,  $p = 0.42$ ).

### Personality disorders

Fourteen studies reported prevalence estimates on lifetime personality disorders [28,51–53,62,64,67,75–77,80,82,84,85], with a random effects pooled prevalence of 25.4% (95% CI



**Fig 6. Forest plot of prevalence estimates of alcohol use disorders.** Analytic weights are from random effects meta-analysis. Grey boxes represent study estimates; their size is proportional to the respective analytical weight. Lines through the boxes represent the 95% CIs around the study estimates. The blue diamond represents the mean estimate and its 95% CI. The vertical red dashed line indicates the mean estimate. CI, confidence interval; PI, prediction interval; RE, random effects.

<https://doi.org/10.1371/journal.pmed.1003750.g006>

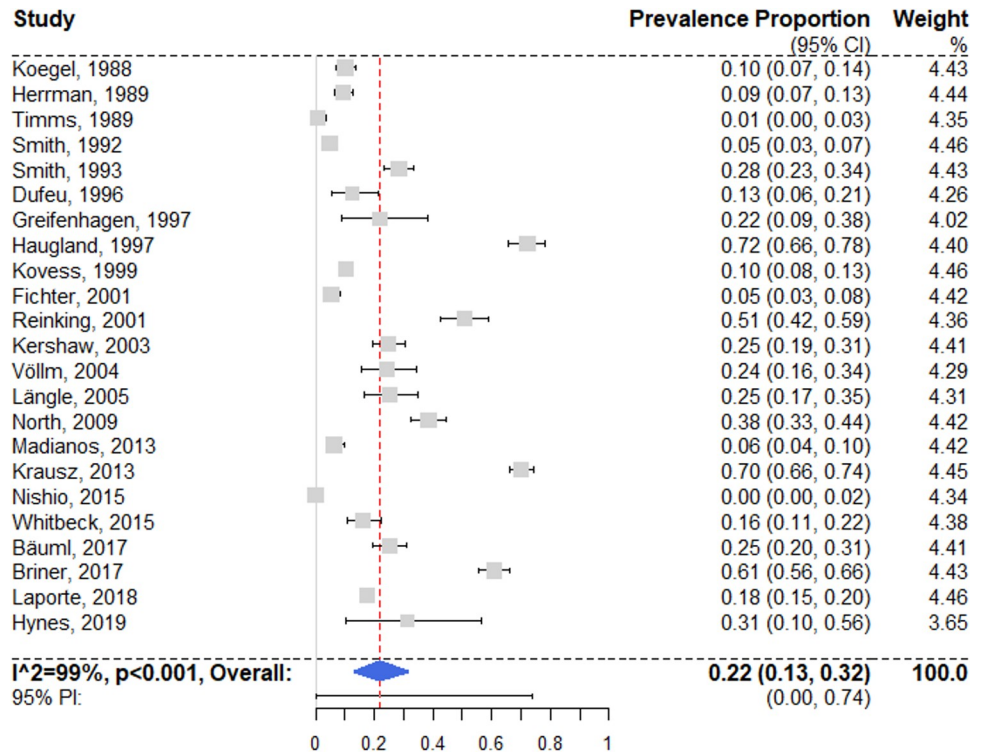
10.9% to 43.6%) (Fig 8). Individual estimates ranged between 0% and 98.3%, resulting in substantial heterogeneity ( $I^2 = 99%$  [95% CI 97% to 99%]; 95% PI 0% to 91%). Univariable regression models did not yield significant results (see S8 Table), and neither did the selected multivariable model (see Table 1).

In a subgroup analysis of 6 low-risk-of-bias studies [52,62,67,80,84,85], the random effects pooled prevalence was 21.0% (95% CI 4.7% to 44.5%), with substantial heterogeneity ( $I^2 = 97%$  [95% CI 92% to 100%]). The difference between subgroups was not significant ( $Q = 0.32$ ,  $p = 0.57$ ).

## Discussion

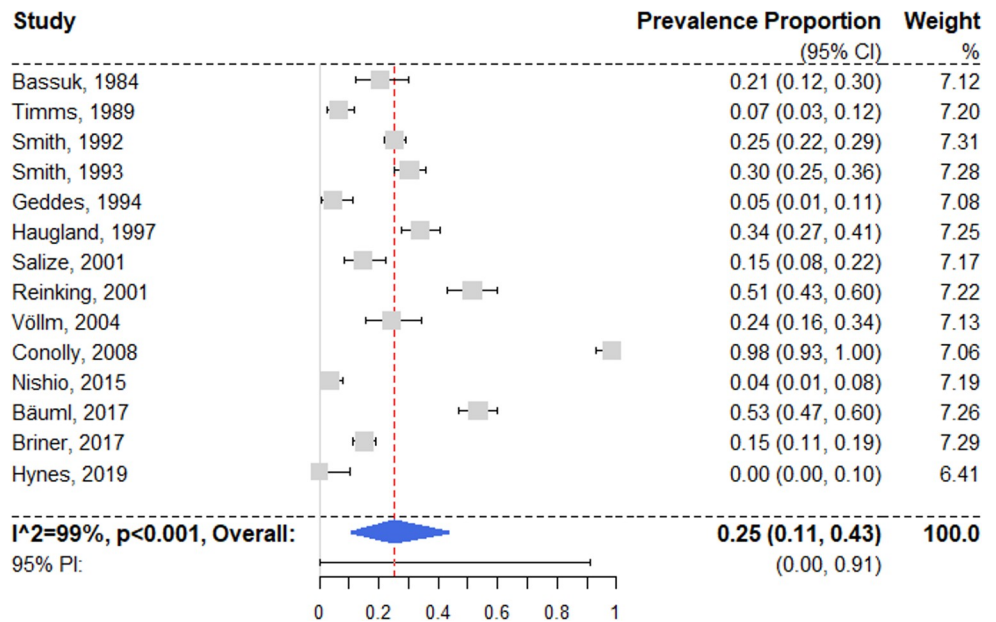
This systematic review and meta-analysis of the prevalence of mental illness among homeless people in high-income countries included 39 studies comprising a total of 8,049 participants. We investigated 7 common psychiatric diagnoses, and examined possible explanations for the between-study heterogeneity. We report 3 main findings.

With a pooled prevalence of around 37%, alcohol-related disorders were the most prevalent diagnostic category. This prevalence estimate is around 10-fold greater than general population estimates: An EU study reported a 12-month prevalence of 3.4% in the general population [86]. Correspondingly, drug-related disorders were the second most common current mental disorder, with a pooled prevalence of 22% (which can be compared with the 12-month prevalence in the US general population of 2.5% [87]). We found substantial variation between the



**Fig 7. Forest plot of prevalence estimates of drug use disorders.** Analytic weights are from random effects meta-analysis. Grey boxes represent study estimates; their size is proportional to the respective analytical weight. Lines through the boxes represent the 95% CIs around the study estimates. The blue diamond represents the mean estimate and its 95% CI. The vertical red dashed line indicates the mean estimate. CI, confidence interval; PI, prediction interval; RE: random effects.

<https://doi.org/10.1371/journal.pmed.1003750.g007>



**Fig 8. Forest plot of prevalence of personality disorders.** Analytic weights are from random effects meta-analysis. Grey boxes represent study estimates; their size is proportional to the respective analytical weight. Lines through the boxes represent the 95% CIs around the study estimates. The blue diamond represents the mean estimate and its 95% CI. The vertical red dashed line indicates the mean estimate. CI, confidence interval; PI, prediction interval; RE, random effects.

<https://doi.org/10.1371/journal.pmed.1003750.g008>

individual studies contributing to these estimates, with individual study estimates ranging from 5.5% to 71.7% for alcohol-related disorders; this variation was partially accounted for by study location. Particularly, German-based samples typically had higher prevalence rates of alcohol use disorders than those from other nations. This might highlight geographical differences regarding the affordability and availability of substances, including a comparatively low alcohol tax in Germany [88]. Irrespective of this moderating factor, the strong association between homelessness and substance abuse reflects a bidirectional relationship: Alcohol and drug use represent possible coping strategies in marginalized housing situations. At the same time, substance abuse and other psychiatric disorders precede the onset of homelessness in many people, with alcohol use disorders in particular emerging at an earlier point in life compared to age-matched non-homeless comparisons [89], suggesting that substance use might contribute to the deterioration of an individual's housing situation. Such deterioration is consistent with the links between substance use disorders and excess mortality in homeless people [11], homelessness chronicity, psychosocial problems [90], and poorer long-term housing stability [91].

A second main finding was that some study characteristics consistently explained the variations in prevalence. In 5 diagnostic groups, methods were important, specifically the number of included participants and the sampling procedure. Unexpectedly, the latter had differential effects by diagnostic group. In bipolar disorder and drug use disorders, randomization was associated with lower prevalence estimates, whereas for any current mental disorder and major depression, it was associated with higher estimates. These findings underline the importance of standardized methodological procedures for homelessness research. We recommend that new research studies should base their inclusion criteria on a standardized definition of homelessness based on ETHOS criteria [92] and use randomized sampling, standardized diagnostic instruments, and trained interviewers with clinical backgrounds (including nurses, psychologists, and medical doctors).

Our third main finding was high prevalence rates for treatable mental illnesses, with 1 in 8 homeless individuals having either major depression (12.6%) or schizophrenia spectrum disorders (12.4%). This represents a high rate of schizophrenia spectrum disorders among homeless people, and a very large excess compared to the 12-month prevalence in the general population, which for schizophrenia is estimated around 0.7% in high-income countries [86]. For major depression, the difference from the general population is not marked, as the 12-month prevalence in the US general population is estimated at 10% [93], although comparisons would need to account for the differences in age and sex structure between the samples contributing to this review and the general population. Depression remains important because it is modifiable, and because of its effects on adverse outcomes. In addition, a recent cohort study based in Vancouver, Canada, found that substance use disorders were associated with worsening of psychosis in homeless people, underscoring the links between these mental disorders, and the importance of treatment in mitigating their effects directly and indirectly [13]. This study also found elevated risks of mortality in those with psychosis and alcohol use disorders [13].

Overall, our findings underscore the importance of mental health problems among homeless individuals. This review is complemented by other research on the often precarious financial and housing situation of psychiatric patients, for whom high rates of homelessness, indebtedness, and lack of bank account ownership have been reported [94–97]. Being homeless and having mental disorders are therefore closely interrelated. Fragmented and siloed services will therefore be typically unable to address these linked psychosocial and health problems. The mental disorders reported in this study are typically associated with unmet needs in the homeless population [51,98–100], which further indicates the need for integrated

approaches. Many different initiatives to address these needs have been researched over the last decade, among them Housing First, Intensive Case Management, Assertive Community Treatment, and Critical Time Intervention. Randomized controlled studies using these approaches have generally resulted in positive effects on housing stability, but only moderate or no effects on most indicators of mental health in comparison to usual care, including for substance use [101–104]. Therefore, further improvements in management and treatment are necessary that focus on these common mental disorders.

The COVID-19 pandemic has put homeless people at particular risk of infection and further marginalization [105]. But it has shown what is possible—government agencies and charity organizations managed to quickly provide accommodation to a large number of rough-sleeping homeless people in some European regions [106,107].

Some limitations to this review need to be considered. We searched a limited number of databases, so it is possible that we missed certain primary reports, although this possibility was minimized by searching through reference lists and Google Scholar citations. Furthermore, despite the high rate of multimorbidity in homeless populations [108,109], included studies lacked information on comorbidity. With most of the primary studies reporting prevalence rates of more than 1 of the investigated diagnostic categories, effects from the same sample were in many cases entered into multiple meta-analytical models. This may have led to measurement error and overestimation if diagnostic criteria overlap, but without diagnostic validity studies specific to homeless persons, this remains uncertain. We limited the number of demographic variables that we conducted heterogeneity analyses on, because of variations in measurement and reporting detail. Future work, including individual participant meta-analysis, could standardize information on age, socioeconomic background, and ethnicity, for example.

The present review focuses on high-income countries because sample and diagnostic heterogeneity would presumably increase if a wider range of countries was included. It is important to note, however, that homeless populations in low- and middle-income countries need investigation, and may have higher rates of trauma-related symptoms [110,111]. The prevalence of the mental disorders reported in the current review does not consider unmet health-care needs or treatment provision, which are additional elements to consider in developing services. Finally, several subpopulations were underrepresented: migrants and refugees (individuals who did not speak the local language were excluded from some study samples), the “hidden homeless” population (e.g., “couch-surfers”) [112] (sampling procedures were often not able to identify this group), and, importantly, homeless women. Twenty-two percent of participants in the included studies were female, lower than most estimates of the proportion of women among homeless populations, which range between 25% and 40% [4,113].

In summary, we found high prevalence of mental disorders among homeless people in high-income countries, with around three-quarters having any mental disorder and a third having alcohol use disorders. Future research should focus on integrated service models addressing the identified needs of substance use disorders, schizophrenia spectrum disorders, and depression in homeless individuals as a priority. In addition, new work could consider focusing on underrepresented subpopulations like homeless women and migrants. Furthermore, longitudinal studies could examine mechanisms linking homelessness and mental disorders in order to develop more effective preventive measures.

## Supporting information

### S1 Table. Database search strings.

(DOCX)

**S2 Table. PRISMA 2009 checklist.**

(DOCX)

**S3 Table. Studies excluded at full-text screening, with reasons.**

(DOCX)

**S4 Table. Study characteristics.**

(DOCX)

**S5 Table. JBI checklist for prevalence studies.**

(DOCX)

**S6 Table. Risk of bias tool.**

(DOCX)

**S7 Table. Data basis for meta-analyses and meta-regression analyses.**

(DOCX)

**S8 Table. Univariable regression models.**

(DOCX)

**S9 Table. Results of single factor meta-regression models for affective disorders (pooled).**

(DOCX)

**S10 Table. Results of multiple factor meta-regression for affective disorders (pooled).**

(DOCX)

**S1 Text. Affective disorders.** Results of meta-analysis and meta-regression analysis.

(DOCX)

## Acknowledgments

We are grateful to authors of included and non-included publications who provided additional details about their studies: C. Adams, H.-J. Salize, A. Greifenhagen, C. Vazquez, U. Beijer, C. Siegel, and G. Gilchrist. We are also grateful to the professional translator N. Spennemann for assistance with Japanese studies.

## Author Contributions

**Conceptualization:** Stefan Gutwinski, Stefanie Schreiter, Seena Fazel.

**Data curation:** Stefan Gutwinski, Karl Deutscher.

**Formal analysis:** Karl Deutscher.

**Funding acquisition:** Seena Fazel.

**Methodology:** Stefan Gutwinski, Stefanie Schreiter, Karl Deutscher, Seena Fazel.

**Project administration:** Stefan Gutwinski, Seena Fazel.

**Software:** Karl Deutscher.

**Supervision:** Stefan Gutwinski, Stefanie Schreiter, Seena Fazel.

**Visualization:** Karl Deutscher.

**Writing – original draft:** Stefan Gutwinski, Stefanie Schreiter, Karl Deutscher.

**Writing – review & editing:** Stefan Gutwinski, Stefanie Schreiter, Karl Deutscher, Seena Fazel.

## References

1. United Nations Commission for Social Development. Affordable housing and social protection systems for all to address homelessness. Report of the Secretary-General. E/CN.5/2020/3. New York: United Nations Commission for Social Development; 2019 Nov 27 [cited 2020 May 10]. Available from: <https://undocs.org/en/E/CN.5/2020/3>.
2. Directorate of Employment, Labour and Social Affairs. HC3.1 Homeless population. Paris: Organisation for Economic Co-operation and Development; 2020 [cited 2020 May 3]. Available from: <https://www.oecd.org/els/family/HC3-1-Homeless-population.pdf>.
3. Tsai J. Lifetime and 1-year prevalence of homelessness in the US population: results from the National Epidemiologic Survey on Alcohol and Related Conditions-III. *J Public Health (Oxf)*. 2018; 40(1):65–74. <https://doi.org/10.1093/pubmed/fox034> PMID: 28335013
4. Henry M, Mahathay A, Morrill T, Robinson A, Shivji A, Watt R. The 2018 Annual Homeless Assessment Report (AHAR) to Congress. Part 1: point-in-time estimates of homelessness. Washington (DC): US Department of Housing and Urban Development; 2018 Dec [cited 2020 May 10]. Available from: <https://www.huduser.gov/portal/sites/default/files/pdf/2018-AHAR-Part-1.pdf>.
5. Williams SP, Bryant K. Sexually transmitted infection prevalence among homeless adults in the United States: a systematic literature review. *Sex Transm Dis*. 2018; 45(7):494–504. <https://doi.org/10.1097/OLQ.0000000000000780> PMID: 29465661
6. Topolovec-Vranic J, Ennis N, Colantonio A, Cusimano MD, Hwang SW, Kontos P, et al. Traumatic brain injury among people who are homeless: a systematic review. *BMC Public Health*. 2012; 12(1):1059. <https://doi.org/10.1186/1471-2458-12-1059> PMID: 23216886
7. Nusselder WJ, Sloekers MT, Krol L, Sloekers CT, Looman CWN, van Beeck EF. Mortality and life expectancy in homeless men and women in Rotterdam: 2001–2010. *PLoS ONE*. 2013; 8(10):e73979. <https://doi.org/10.1371/journal.pone.0073979> PMID: 24098329
8. Fazel S, Geddes JR, Kushel M. The health of homeless people in high-income countries: descriptive epidemiology, health consequences, and clinical and policy recommendations. *Lancet*. 2014; 384(9953):1529–40. [https://doi.org/10.1016/S0140-6736\(14\)61132-6](https://doi.org/10.1016/S0140-6736(14)61132-6) PMID: 25390578
9. Bernstein RS, Meurer LN, Plumb EJ, Jackson JL. Diabetes and hypertension prevalence in homeless adults in the United States: a systematic review and meta-analysis. *Am J Public Health*. 2014; 105(2):46–60.
10. Beijer U, Wolf A, Fazel S. Prevalence of tuberculosis, hepatitis C virus, and HIV in homeless people: a systematic review and meta-analysis. *Lancet Infect Dis*. 2012; 12(11):859–70. [https://doi.org/10.1016/S1473-3099\(12\)70177-9](https://doi.org/10.1016/S1473-3099(12)70177-9) PMID: 22914343
11. Baggett TP, Hwang SW, O'Connell JJ, Porneala BC, Stringfellow EJ, Orav EJ, et al. Mortality among homeless adults in Boston: shifts in causes of death over a 15-year period. *JAMA Intern Med*. 2013; 173(3):189–95. <https://doi.org/10.1001/jamainternmed.2013.1604> PMID: 23318302
12. Aldridge RW, Story A, Hwang SW, Nordentoft M, Luchenski SA, Hartwell G, et al. Morbidity and mortality in homeless individuals, prisoners, sex workers, and individuals with substance use disorders in high-income countries: a systematic review and meta-analysis. *Lancet*. 2018; 391(10117):241–50. [https://doi.org/10.1016/S0140-6736\(17\)31869-X](https://doi.org/10.1016/S0140-6736(17)31869-X) PMID: 29137869
13. Jones AA, Gicas KM, Seyedin S, Willi TS, Leonova O, Vila-Rodriguez F, et al. Associations of substance use, psychosis, and mortality among people living in precarious housing or homelessness: a longitudinal, community-based study in Vancouver, Canada. *PLoS Med*. 2020; 17(7):e1003172. <https://doi.org/10.1371/journal.pmed.1003172> PMID: 32628679
14. Nielsen SF, Hjorthøj CR, Erlangsen A, Nordentoft M. Psychiatric disorders and mortality among people in homeless shelters in Denmark: a nationwide register-based cohort study. *Lancet*. 2011; 377(9784):2205–14. [https://doi.org/10.1016/S0140-6736\(11\)60747-2](https://doi.org/10.1016/S0140-6736(11)60747-2) PMID: 21676456
15. Perron BE, Alexander-Eitzman B, Gillespie DF, Pollio D. Modeling the mental health effects of victimization among homeless persons. *Soc Sci Med*. 2008; 67(9):1475–9. <https://doi.org/10.1016/j.socscimed.2008.07.012> PMID: 18703266
16. Roy L, Crocker AG, Nicholls TL, Latimer EA, Ayllon AR. Criminal behavior and victimization among homeless individuals with severe mental illness: a systematic review. *Psychiatr Serv*. 2014; 65(6):739–50. <https://doi.org/10.1176/appi.ps.201200515> PMID: 24535245
17. Caton CLM, Dominguez B, Schanzer B, Hasin DS, Shrout PE, Felix A, et al. Risk factors for long-term homelessness: findings from a longitudinal study of first-time homeless single adults. *Am J Public Health*. 2005; 95(10):1753–9. <https://doi.org/10.2105/AJPH.2005.063321> PMID: 16131638
18. Patterson ML, Somers JM, Moniruzzaman A. Prolonged and persistent homelessness: multivariable analyses in a cohort experiencing current homelessness and mental illness in Vancouver, British Columbia. *Ment Health Subst Use*. 2012; 5(2):85–101.

19. Skosireva A, O'Campo P, Zerger S, Chambers C, Gapka S, Stergiopoulos V. Different faces of discrimination: perceived discrimination among homeless adults with mental illness in healthcare settings. *BMC Health Serv Res*. 2014; 14(1):376. <https://doi.org/10.1186/1472-6963-14-376> PMID: 25196184
20. Hossain MM, Sultana A, Tasnim S, Fan Q, Ma P, McKyer ELJ, et al. Prevalence of mental disorders among people who are homeless: an umbrella review. *Int J Soc Psychiatry*. 2020; 66(6):528–41. <https://doi.org/10.1177/0020764020924689> PMID: 32460590
21. Ayano G, Tesfaw G, Shumet S. The prevalence of schizophrenia and other psychotic disorders among homeless people: a systematic review and meta-analysis. *BMC Psychiatry*. 2019; 19(1):370. <https://doi.org/10.1186/s12888-019-2361-7> PMID: 31775786
22. Ayano G, Tsegay L, Abraha M, Yohannes K. Suicidal ideation and attempt among homeless people: a systematic review and meta-analysis. *Psychiatr Q*. 2019; 90(4):829–42. <https://doi.org/10.1007/s11126-019-09667-8> PMID: 31463733
23. Depp CA, Vella L, Orff HJ, Twamley EW. A quantitative review of cognitive functioning in homeless adults. *J Nerv Ment Dis*. 2015; 203(2):126–31. <https://doi.org/10.1097/NMD.0000000000000248> PMID: 25594792
24. Embleton L, Mwangi A, Vreeman R, Ayuku D, Braitstein P. The epidemiology of substance use among street children in resource-constrained settings: a systematic review and meta-analysis. *Addiction*. 2013; 108(10):1722–33. <https://doi.org/10.1111/add.12252> PMID: 23844822
25. Bassuk EL, Richard MK, Tsertsvadze A. The prevalence of mental illness in homeless children: a systematic review and meta-analysis. *J Am Acad Child Adolesc Psychiatry*. 2015; 54(2):86–96. <https://doi.org/10.1016/j.jaac.2014.11.008> PMID: 25617249
26. Schreiter S, Bempohl F, Krausz M, Leucht S, Rössler W, Schouler-Ocak M, et al. The prevalence of mental illness in homeless people in Germany. *Dtsch Arztebl Int*. 2017; 114(40):665–72. <https://doi.org/10.3238/arztebl.2017.0665> PMID: 29070426
27. Fazel S, Khosla V, Doll H, Geddes J. The prevalence of mental disorders among the homeless in western countries: systematic review and meta-regression analysis. *PLoS Med*. 2008; 5(12):e225. <https://doi.org/10.1371/journal.pmed.0050225> PMID: 19053169
28. Bäuml J, Brönner M, Baur B, Pitschel-Walz GG, Jahn T, Bäuml J. Die SEEWOLF-Studie: seelische Erkrankungsrate in den Einrichtungen der Wohnungslosenhilfe im Großraum München. *Archiv für Wissenschaft und Praxis der sozialen Arbeit*. Freiburg im Breisgau: Lambertus-Verlag; 2017.
29. Laporte A, Vandentorren S, Detrez M-A, Douay C, Le Strat Y, Le Mener E, et al. Prevalence of mental disorders and addictions among homeless people in the greater Paris area, France. *Int J Environ Res Public Health*. 2018; 15(2):241. <https://doi.org/10.3390/ijerph15020241> PMID: 29385053
30. Williams JBW. The multi-axial system of DSM-III: where did it come from and where should it go?: II. Empirical studies, innovations, and recommendations. *Arch Gen Psychiatry*. 1985; 42(2):181–6. <https://doi.org/10.1001/archpsyc.1985.01790250075010> PMID: 3883940
31. Stroup DF, Berlin JA, Morton SC, Olkin I, Williamson GD, Rennie D, et al. Meta-analysis of observational studies in epidemiology: a proposal for reporting. *JAMA*. 2000; 283(15):2008–12. <https://doi.org/10.1001/jama.283.15.2008> PMID: 10789670
32. Moher D, Liberati A, Tetzlaff J, Altman DG, PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Med*. 2009; 6(7):e1000097. <https://doi.org/10.1371/journal.pmed.1000097> PMID: 19621072
33. World Bank. World Bank country and lending groups. Washington (DC): World Bank; 2020 [cited 2020 Sep 11]. Available from: <https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups>.
34. JBI. Critical appraisal tools. Adelaide: University of Adelaide; 2021 [cited 2021 Aug 12]. Available from: <https://jbi.global/critical-appraisal-tools>.
35. Hoy D, Brooks P, Woolf A, Blyth F, March L, Bain C, et al. Assessing risk of bias in prevalence studies: modification of an existing tool and evidence of interrater agreement. *J Clin Epidemiol*. 2012; 65(9):934–9. <https://doi.org/10.1016/j.jclinepi.2011.11.014> PMID: 22742910
36. Bates D, Chambers J, Dalgaard P, Gentleman R, Hornik K, Ihaka R, et al. R-4.0.4. Comprehensive R Archive Network; 2021 [cited 2021 Apr 21]. Available from: <https://cran.r-project.org/>.
37. Van Buuren S, Groothuis-Oudshoorn K. mice: multivariate imputation by chained equations in R. *J Stat Softw*. 2011 Dec 12. <https://doi.org/10.18637/jss.v045.i03>
38. Calcagno V, de Mazancourt C. glmulti: an R package for easy automated model selection with (generalized) linear models. *J Stat Softw*. 2010 May 31. <https://doi.org/10.18637/jss.v034.i12>
39. Viechtbauer W. Conducting meta-analyses in R with the metafor package. *J Stat Softw*. 2010 Aug 5. <https://doi.org/10.18637/jss.v036.i03>

40. Barendregt JJ, Doi SA, Lee YY, Norman RE, Vos T. Meta-analysis of prevalence. *J Epidemiol Community Health*. 2013; 67(11):974–8. <https://doi.org/10.1136/jech-2013-203104> PMID: 23963506
41. Veroniki AA, Jackson D, Viechtbauer W, Bender R, Bowden J, Knapp G, et al. Methods to estimate the between-study variance and its uncertainty in meta-analysis. *Res Synth Methods*. 2016; 7(1):55–79. <https://doi.org/10.1002/jrsm.1164> PMID: 26332144
42. Riley RD, Higgins JPT, Deeks JJ. Interpretation of random effects meta-analyses. *BMJ*. 2011; 342:964–7. <https://doi.org/10.1136/bmj.d549> PMID: 21310794
43. Viechtbauer W. Package 'metafor.' Version 2.4–0. Comprehensive R Archive Network; 2020 [cited 2021 Apr 21]. Available from: <https://cran.r-project.org/web/packages/metafor/metafor.pdf>.
44. Higgins JPT, Thompson SG, Spiegelhalter DJ. A re-evaluation of random-effects meta-analysis. *J R Stat Soc Ser A Stat Soc*. 2009; 172(1):137–59. <https://doi.org/10.1111/j.1467-985X.2008.00552.x> PMID: 19381330
45. Anderson-Sprecher R. Model comparisons and  $R^2$ . *Am Stat*. 1994; 48(2):113–7.
46. Little RJ, D'Agostino R, Cohen ML, Dickersin K, Emerson SS, Farrar JT, et al. The prevention and treatment of missing data in clinical trials. *N Engl J Med*. 2012; 367(14):1355–60. <https://doi.org/10.1056/NEJMs1203730> PMID: 23034025
47. Azur MJ, Stuart EA, Frangakis C, Leaf PJ. Multiple imputation by chained equations: what is it and how does it work? *Int J Methods Psychiatr Res*. 2011; 20(1):40–9. <https://doi.org/10.1002/mp.329> PMID: 21499542
48. Jakobsen JC, Gluud C, Wetterslev J, Winkel P. When and how should multiple imputation be used for handling missing data in randomised clinical trials—a practical guide with flowcharts. *BMC Med Res Methodol*. 2017; 17(1):162. <https://doi.org/10.1186/s12874-017-0442-1> PMID: 29207961
49. Sclare PD. Psychiatric disorder among the homeless in Aberdeen. *Scott Med J*. 1997; 42(6):173–7. <https://doi.org/10.1177/003693309704200605> PMID: 9507596
50. Salize HJ, Dillmann-Lange C, Stern G, Kentner-Figura B, Stamm K, Rossler W, et al. Alcoholism and somatic comorbidity among homeless people in Mannheim, Germany. *Addiction*. 2002; 97(12):1593–600. <https://doi.org/10.1046/j.1360-0443.2002.00235.x> PMID: 12472643
51. Salize HJ, Horst A, Dillmann-Lange C, Killmann U, Stern G, Wolf I, et al. Needs for mental health care and service provision in single homeless people. *Soc Psychiatry Psychiatr Epidemiol*. 2001; 36(4):207–16. <https://doi.org/10.1007/s001270170065> PMID: 11518035
52. Reinking DP, Wolf JR, Kroon H. Hoge prevalentie van psychische stoornissen en verslavingsproblemen bij daklozen in de stad Utrecht. *Ned Tijdschr Geneeskd*. 2001; 145(24):1161–6. PMID: 11433665
53. Nishio A, Yamamoto M, Horita R, Sado T, Ueki H, Watanabe T, et al. Prevalence of mental illness, cognitive disability, and their overlap among the homeless in Nagoya, Japan. *PLoS ONE*. 2015; 10(9):e0138052. <https://doi.org/10.1371/journal.pone.0138052> PMID: 26378447
54. Morikawa S, Uehara R, Okuda K, Shimizu H, Nakamura Y. [Prevalence of psychiatric disorders among homeless people in one area of Tokyo.] *Nihon Koshu Eisei Zasshi*. 2011; 58(5):331–9. PMID: 21905609
55. Madianos MG, Chondraki P, Papadimitriou GN. Prevalence of psychiatric disorders among homeless people in Athens area: a cross-sectional study. *Soc Psychiatry Psychiatr Epidemiol*. 2013; 48(8):1225–34. <https://doi.org/10.1007/s00127-013-0674-2> PMID: 23508368
56. Längle G, Egarter B, Albrecht F, Petrasch M, Buchkremer G. Prevalence of mental illness among homeless men in the community. *Soc Psychiatry Psychiatr Epidemiol*. 2005; 40(5):382–90. <https://doi.org/10.1007/s00127-005-0902-5> PMID: 15902408
57. Krausz RM, Clarkson AF, Strehlau V, Torchalla I, Li K, Schuetz CG. Mental disorder, service use, and barriers to care among 500 homeless people in 3 different urban settings. *Soc Psychiatry Psychiatr Epidemiol*. 2013; 48(8):1235–43. <https://doi.org/10.1007/s00127-012-0649-8> PMID: 23299926
58. Kovess V, Mangin Lazarus C. The prevalence of psychiatric disorders and use of care by homeless people in Paris. *Soc Psychiatry Psychiatr Epidemiol*. 1999; 34(11):580–7. <https://doi.org/10.1007/s001270050178> PMID: 10651176
59. Whitbeck LB, Armenta BE, Welch-Lazoritz ML. Borderline personality disorder and Axis I psychiatric and substance use disorders among women experiencing homelessness in three US cities. *Soc Psychiatry Psychiatr Epidemiol*. 2015; 50(8):1285–91. <https://doi.org/10.1007/s00127-015-1026-1> PMID: 25708192
60. Koegel P, Burnam MA, Farr RK. The prevalence of specific psychiatric disorders among homeless individuals in the inner city of Los Angeles. *Arch Gen Psychiatry*. 1988; 45(12):1085–92. <https://doi.org/10.1001/archpsyc.1988.01800360033005> PMID: 2461690

61. Kershaw A, Singleton N, Meltzer H. Survey of the health and well-being of homeless people in Glasgow. *Int Rev Psychiatry*. 2003; 15(1–2):141–3. <https://doi.org/10.1080/0954026021000046065> PMID: 12745322
62. Hynes F, Kilbride K, Fenton J. A survey of mental disorder in the long-term, rough sleeping, homeless population of inner Dublin. *Ir J Psychol Med*. 2019; 36(1):19–22. <https://doi.org/10.1017/ipm.2018.23> PMID: 30931876
63. Herrman H, McGorry P, Bennett P, van Riel R, Singh B. Prevalence of severe mental disorders in disaffiliated and homeless people in inner Melbourne. *Am J Psychiatry*. 1989; 146(9):1179–84. <https://doi.org/10.1176/ajp.146.9.1179> PMID: 2764176
64. Haugland G, Siegel C, Hopper K, Alexander MJ. Mental illness among homeless individuals in a suburban county. *Psychiatr Serv*. 1997; 48(4):504–9. <https://doi.org/10.1176/ps.48.4.504> PMID: 9090734
65. Greifenhagen A, Fichter M. Mental illness in homeless women: an epidemiological study in Munich, Germany. *Eur Arch Psychiatry Clin Neurosci*. 1997; 247(3):162–72. <https://doi.org/10.1007/BF03033070> PMID: 9224909
66. Gill B, Meltzer H, Hinds K. The prevalence of psychiatric morbidity among homeless adults. *Int Rev Psychiatry*. 2003; 15(1–2):134–40. <https://doi.org/10.1080/0954026021000046056> PMID: 12745321
67. Geddes J, Newton R, Young G, Bailey S, Freeman C, Priest R. Comparison of prevalence of schizophrenia among residents of hostels for homeless people in 1966 and 1992. *BMJ*. 1994; 308(6932):816–9. <https://doi.org/10.1136/bmj.308.6932.816> PMID: 8167488
68. Freeman SJ, Formo A, Alampur AG, Sommers AF. Psychiatric disorder in a skid-row mission population. *Compr Psychiatry*. 1979; 20(5):454–62. [https://doi.org/10.1016/0010-440x\(79\)90031-2](https://doi.org/10.1016/0010-440x(79)90031-2) PMID: 90581
69. Fischer PJ, Shapiro S, Breakey WR, Anthony JC, Kramer M. Mental health and social characteristics of the homeless: a survey of mission users. *Am J Public Health*. 1986; 76(5):519–24. <https://doi.org/10.2105/ajph.76.5.519> PMID: 3963280
70. Weller BG, Weller MP, Coker E, Mahomed S. Crisis at Christmas 1986. *Lancet*. 1987; 1(8532):553–4. [https://doi.org/10.1016/s0140-6736\(87\)90187-5](https://doi.org/10.1016/s0140-6736(87)90187-5) PMID: 2881093
71. Fichter MM, Quadflieg N. Prevalence of mental illness in homeless men in Munich, Germany: results from a representative sample. *Acta Psychiatr Scand*. 2001; 103(2):94–104. <https://doi.org/10.1034/j.1600-0447.2001.00217.x> PMID: 11167311
72. Eikelmann B, Inhester ML, Reker T. Psychische Störungen bei nichtsesshaften Männern. Defizite in der psychiatrischen Versorgung. *Sozialpsychiatr Informationen*. 1992;29–32.
73. Dufeu P, Podschus J, Schmidt LG. Alkoholabhängigkeit bei männlichen Wohnungslosen. Häufigkeit, Ausprägung und Determinanten. *Nervenarzt*. 1996; 67(11):930–4.
74. Doutney CP, Buhrich N, Virgona A, Cohen A, Daniels P. The prevalence of schizophrenia in a refuge for homeless men. *Aust N Z J Psychiatry*. 1985; 19(3):233–8. <https://doi.org/10.3109/00048678509158828> PMID: 3866566
75. Conolly AJ, Cobb-Richardson P, Ball SA. Personality disorders in homeless drop-in centre clients. *J Pers Disord*. 2008; 22(6):573–88. <https://doi.org/10.1521/pedi.2008.22.6.573> PMID: 19072678
76. Briner D, Jäger M, Kawohl W, Baumgartner-Nietlisbach G. Mental disorder and self-rated health among homeless people in Zurich: first epidemiological data from Switzerland. *Psychiatr Prax*. 2017; 44(6):339–47. <https://doi.org/10.1055/s-0042-111742> PMID: 27627115
77. Bassuk EL, Rubin L, Lauriat A. Is homelessness a mental health problem? *Am J Psychiatry*. 1984; 141(12):1546–50. <https://doi.org/10.1176/ajp.141.12.1546> PMID: 6209990
78. Adams CE, Pantelis C, Duke PJ, Barnes TRE. Psychopathology, social and cognitive functioning in a hostel for homeless women. *Br J Psychiatry*. 1996; 168(1):82–6. <https://doi.org/10.1192/bjp.168.1.82> PMID: 8770434
79. North CS, Eyrych-Garg KM, Pollio DE, Thirthalli J. A prospective study of substance use and housing stability in a homeless population. *Soc Psychiatry Psychiatr Epidemiol*. 2009; 45(11):1055–62. <https://doi.org/10.1007/s00127-009-0144-z> PMID: 19816646
80. Völlm B, Becker H, Kunstmann W. Psychiatrische Morbidität bei allein stehenden wohnungslosen Männern. *Psychiatr Prax*. 2004; 31(5):236–40. <https://doi.org/10.1055/s-2003-815014> PMID: 15243873
81. Torchalla I, Albrecht F, Buchkremer G, Längle G. Wohnungslose Frauen mit psychischer Erkrankung —eine Feldstudie. *Psychiatr Prax*. 2004; 31(05):228–35.
82. Timms PW, Fry AH. Homelessness and mental illness. *Health Trends*. 1989; 21(3):70–1. PMID: 10295816

83. Susser E, Struening EL, Conover S. Psychiatric problems in homeless men. Lifetime psychosis, substance use, and current distress in new arrivals at New York City shelters. *Arch Gen Psychiatry*. 1989; 46(9):845–50. <https://doi.org/10.1001/archpsyc.1989.01810090087012> PMID: 2774850
84. Smith EM, North CS, Spitznagel EL. Alcohol, drugs, and psychiatric comorbidity among homeless women: an epidemiologic study. *J Clin Psychiatry*. 1993; 54(3):82–7. PMID: 8468313
85. Smith EM, North CS, Spitznagel EL. A systematic study of mental illness, substance abuse, and treatment in 600 homeless men. *Ann Clin Psychiatry*. 1992; 4(2):111–20.
86. Wittchen H-U, Jacobi F. Size and burden of mental disorders in Europe—a critical review and appraisal of 27 studies. *Eur Neuropsychopharmacol*. 2005; 15(4):357–76. <https://doi.org/10.1016/j.euroneuro.2005.04.012> PMID: 15961293
87. Merikangas KR, McClair VL. Epidemiology of substance use disorders. *Hum Genet*. 2012; 131(6):779–89. <https://doi.org/10.1007/s00439-012-1168-0> PMID: 22543841
88. Adams M, Effertz T. Effective prevention against risky underage drinking—the need for higher excise taxes on alcoholic beverages in Germany. *Alcohol Alcohol*. 2010; 45(4):387–94. <https://doi.org/10.1093/alcac/agq031> PMID: 20554697
89. North CS, Pollio DE, Smith EM, Spitznagel EL. Correlates of early onset and chronicity of homelessness in a large urban homeless population. *J Nerv Ment Dis*. 1998; 186(7):393–400. <https://doi.org/10.1097/00005053-199807000-00002> PMID: 9680039
90. Stein JA, Dixon EL, Nyamathi AM. Effects of psychosocial and situational variables on substance abuse among homeless adults. *Psychol Addict Behav*. 2008; 22(3):410–6. <https://doi.org/10.1037/0893-164X.22.3.410> PMID: 18778134
91. Aubry T, Duhoux A, Klodawsky F, Ecker J, Hay E. A longitudinal study of predictors of housing stability, housing quality, and mental health functioning among single homeless individuals staying in emergency shelters. *Am J Community Psychol*. 2016; 58(1–2):123–35. <https://doi.org/10.1002/ajcp.12067> PMID: 27473922
92. Amore K, Baker M, Howden-Chapman P. The ETHOS definition and classification of homelessness: an analysis. *Eur J Homelessness*. 2011; 5(2):19–37.
93. Hasin DS, Sarvet AL, Meyers JL, Saha TD, Ruan WJ, Stohl M, et al. Epidemiology of adult DSM-5 major depressive disorder and its specifiers in the United States. *JAMA Psychiatry*. 2018; 75(4):336–46. <https://doi.org/10.1001/jamapsychiatry.2017.4602> PMID: 29450462
94. Schreiter S, Bermpohl F, Schouler-Ocak M, Krausz R, Rössler W, Heinz A, et al. Bank account ownership and access among in-patients in psychiatric care in Berlin, Germany—a cross-sectional patient survey. *Front Psychiatry*. 2020; 11:508. <https://doi.org/10.3389/fpsy.2020.00508> PMID: 32581882
95. Schreiter S, Fritz FD, Rössler W, Majić T, Schouler-Ocak M, Krausz MR, et al. [Housing Situation Among People with Substance Use Disorder in a Psychiatric Centre in Berlin, Germany—A Cross-Sectional Patient Survey.] *Psychiatr Prax*. 2021; 48:156–60. <https://doi.org/10.1055/a-1290-5091> PMID: 33232977
96. Schreiter S, Heidrich S, Heinz A, Rössler W, Krausz RM, Schouler-Ocak M, et al. [Debts, loans and unpaid bills among day patients and inpatients in psychiatric care in Berlin, Germany.] *Nervenarzt*. 2020 Oct 14. <https://doi.org/10.1007/s00115-020-01013-9> PMID: 33052424
97. Schreiter S, Heidrich S, Zulauf J, Saathoff U, Brückner A, Majic T, et al. Housing situation and health-care for patients in a psychiatric centre in Berlin, Germany: a cross-sectional patient survey. *BMJ Open*. 2019; 9(12):e032576. <https://doi.org/10.1136/bmjopen-2019-032576> PMID: 31888930
98. Currie LB, Patterson ML, Moniruzzaman A, McCandless LC, Somers JM. Examining the relationship between health-related need and the receipt of care by participants experiencing homelessness and mental illness. *BMC Health Serv Res*. 2014; 14:404. <https://doi.org/10.1186/1472-6963-14-404> PMID: 25230990
99. Desai MM, Rosenheck RA. Unmet need for medical care among homeless adults with serious mental illness. *Gen Hosp Psychiatry*. 2005; 27(6):418–25. <https://doi.org/10.1016/j.genhosppsy.2005.06.003> PMID: 16271656
100. Chondraki P, Madianos MG, Dragioti E, Papadimitriou GN. Homeless mentally ill in Athens area: a cross-sectional study on unmet needs and help-seeking. *Int J Soc Psychiatry*. 2013; 60(6):544–53. <https://doi.org/10.1177/0020764013503150> PMID: 24084471
101. Clarke GN, Herinckx HA, Kinney RF, Paulson RI, Cutler DL, Lewis K, et al. Psychiatric hospitalizations, arrests, emergency room visits, and homelessness of clients with serious and persistent mental illness: findings from a randomized trial of two ACT programs vs. usual care. *Ment Health Serv Res*. 2000; 2(3):155–64. <https://doi.org/10.1023/a:1010141826867> PMID: 11256724
102. Stergiopoulos V, Hwang SW, Gozdzik A, Nisenbaum R, Latimer E, Rabouin D, et al. Effect of scattered-site housing using rent supplements and intensive case management on housing stability

- among homeless adults with mental illness: a randomized trial. *JAMA*. 2015; 313(9):905–15. <https://doi.org/10.1001/jama.2015.1163> PMID: 25734732
103. Rosenheck R, KasproW W, Frisman L, Liu-Mares W. Cost-effectiveness of supported housing for homeless persons with mental illness. *Arch Gen Psychiatry*. 2003; 60(9):940–51. <https://doi.org/10.1001/archpsyc.60.9.940> PMID: 12963676
  104. Herman D, Opler L, Felix A, Valencia E, Wyatt RJ, Susser E. A critical time intervention with mentally ill homeless men: Impact on psychiatric symptoms. *J Nerv Ment Dis*. 2000; 188(3):135–40. <https://doi.org/10.1097/00005053-200003000-00002> PMID: 10749277
  105. Perri M, Dosani N, Hwang SW. COVID-19 and people experiencing homelessness: challenges and mitigation strategies. *CMAJ*. 2020; 192(26):e716–9. <https://doi.org/10.1503/cmaj.200834> PMID: 32601252
  106. Ministry of Housing, Communities & Local Government, Jenrick R. 6,000 new supported homes as part of landmark commitment to end rough sleeping. London: Ministry of Housing, Communities & Local Government; 2020 May 24 [cited 2021 Jan 1]. Available from: <https://www.gov.uk/government/news/6-000-new-supported-homes-as-part-of-landmark-commitment-to-end-rough-sleeping>.
  107. Deutsche Welle. Berlin opens first hostel for the homeless amid coronavirus pandemic. Deutsche Welle. 2020 Mar 31 [cited 2021 Jan 2]. Available from: <https://www.dw.com/en/berlin-opens-first-hostel-for-the-homeless-amid-coronavirus-pandemic/a-52972263>.
  108. Bowen M, Marwick S, Marshall T, Saunders K, Burwood S, Yahyouche A, et al. Multimorbidity and emergency department visits by a homeless population: a database study in specialist general practice. *Br J Gen Pract*. 2019; 69(685):e515–25. <https://doi.org/10.3399/bjgp19X704609> PMID: 31262848
  109. Raphael R-W, Caroline S, Dan L, Megan A, Briony H. Premature frailty, geriatric conditions and multimorbidity among people experiencing homelessness: a cross-sectional observational study in a London hostel. *Housing Care Support*. 2020; 23(3–4):77–91.
  110. Abdu L, Withers J, Habib AG, Mijinyawa MS, Yusef SM. Disease pattern and social needs of street people in the race course area of Kano, Nigeria. *J Health Care Poor Underserved*. 2013; 24(1):97–105. <https://doi.org/10.1353/hpu.2013.0010> PMID: 23377721
  111. Mathebula SD, Ross E. Realizing or relinquishing rights? Homeless youth, their life on the streets and their knowledge and experience of health and social services in Hillbrow, South Africa. *Soc Work Health Care*. 2013; 52(5):449–66. <https://doi.org/10.1080/00981389.2012.742483> PMID: 23701578
  112. Agans RP, Jefferson MT, Bowling JM, Zeng D, Yang J, Silverbush M. Enumerating the hidden homeless: Strategies to estimate the homeless gone missing from a point-in-time count. *J Off Stat*. 2014; 30(2):215–29.
  113. Neupert P. Statistikbericht 2017. Berlin: Bundesarbeitsgemeinschaft Wohnungslosenhilfe. 2018 [cited 2020 Jul 18]. Available from: [https://www.bagw.de/fileadmin/bagw/media/Doc/STA/STA\\_Statistikbericht\\_2017.pdf](https://www.bagw.de/fileadmin/bagw/media/Doc/STA/STA_Statistikbericht_2017.pdf).