openheart

Cardiovascular disease burden in the homeless population

Samhita Korukonda ,[1] Nikith Erukulla,[2] Jeffrey R Harris,[3] Pranitha Kovuri,[4] Kenneth Tyler Wilcox[5]

► Additional supplemental material is published online only. To view, please visit the journal online (https://doi.org/10.1136/openhrt-2025-003190).

To cite: Korukonda S, Erukulla N, Harris JR, *et al*. Cardiovascular disease burden in the homeless population. *Open Heart* 2025;**12**:e003190. doi:10.1136/openhrt-2025-003190

Received 18 January 2025
Accepted 27 April 2025

[1]Department of Biological Sciences, Cornell University, Ithaca, New York, USA
[2]University of Illinois College of Medicine at Chicago, Chicago, Illinois, USA
[3]Health Systems and Population Health, University of Washington, Seattle, Washington, USA
[4]OSF HealthCare, Peoria, Illinois, USA
[5]Department of Statistics and Data Science, Cornell University, Ithaca, New York, USA

Correspondence to
Samhita Korukonda; sk2826@cornell.edu

ABSTRACT

Introduction The burden of cardiovascular disease (CVD) among the homeless population has been rising, driven by factors such as lack of healthcare access, rising mental health disorders and substance use. This study aims to systematically analyse the CVD burden among homeless adults and characterise its prevalence and risk factors. Additionally, our literature review revealed a significant lack of cardiac-focused interventions in this population, thus we build on existing models to propose new CVD-specific interventions.

Methods A comprehensive systematic review and meta-analysis were performed on data collected from PubMed and Scopus until 22 October 2024. All observational studies that assessed homeless populations and met inclusion criteria were analysed. The primary outcomes reported were mortality, morbidity and hospitalisation due to CVD. These measures were collectively analysed to evaluate the overall CVD burden.

Results Our search strategy identified 22 studies, of which 12 were suitable for meta-analysis. We analysed data from 226 205 adults spanning more than 1 000 000 person-years and sought to characterise CVD distribution by demographic subgroups. Our findings indicate that homeless adults experience greater morbidity and mortality due to CVD than non-homeless adults (pooled OR 2.77; 95% CI 1.93 to 3.93; p<0.001; I^2=96.2%). Subgroup analyses by age, sex and geographic region were performed, but no significant differences in CVD morbidity and mortality were found.

Conclusion Homeless adults have approximately three times greater odds of CVD than the general population. We found that the risk of CVD remains elevated regardless of demographic subgroup. Our findings emphasise the urgent need for targeted interventions within this population and highlight its associated risk factors, providing a foundation for the development of targeted interventions and policies.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ The burden of chronic disease among the homeless population has been steadily increasing, with cardiovascular disease (CVD) emerging as a major contributor to excess morbidity and mortality. Addressing CVD is crucial to improving health outcomes within this population. However, the extent, distribution and precise risk factors of CVD within the homeless population are not well understood, limiting the development of targeted interventions and management strategies.

WHAT THIS STUDY ADDS

⇒ This study elucidates the precise extent and distribution of CVDs within the homeless population, revealing that homeless individuals experience nearly a threefold increase in CVD risk. Interventions such as housing-first models, tobacco cessation programmes and health navigation services show promise in reducing CVD risk, but further research is needed to confirm their efficacy.

HOW THIS STUDY MIGHT IMPACT RESEARCH, PRACTICE, OR POLICY

⇒ Our findings highlight the urgent need for implementing cardiovascular care interventions specifically designed for this vulnerable population. Through our comprehensive analyses, public health professionals and providers can better grasp the burden and distribution of CVD among the homeless population, enabling the development of informed, targeted interventions. These efforts will ultimately lead to more effective strategies to reduce CVD risk and improve health outcomes for homeless individuals.

INTRODUCTION

In comparison with other demographic groups globally, the homeless population has been disproportionately impacted by healthcare disparities. These disparities, compounded by a myriad of social and biological risk factors, have led to a high burden of disease and mortality.[1–3] While communicable diseases such as tuberculosis and pneumonia have traditionally been the primary health concerns for homeless individuals, relatively few studies have explored the risk of cardiovascular disease (CVD). However, recent studies of homeless mortality have reported that CVDs contribute to more than a quarter of all-cause mortality, with homeless males being 40%–50% more likely to die of a heart attack than the general population.[4 5]

These observations may be attributable to the high prevalence of traditional risk factors among homeless populations. For example, approximately 70% of the homeless population reports tobacco use, a major risk factor for CVD.[6] Substance use and excessive alcohol consumption are also major risk factors among unsheltered individuals.[7] Substance use can lead to an elevated risk of hypertension and heart failure, while heavy alcohol consumption has been linked to an increased risk of cardiomyopathy.[8 9] Over 20% of the homeless population reports diabetes, and 40% reports hypertension, with a significant population having both conditions.[10] The prevalence of these chronic disease comorbidities significantly elevates CVD risk. Additionally, homeless individuals' diets, which are often high in saturated fats and cholesterol and lacking in essential nutrients, contribute to adverse lipid profiles.[11] The presence of these traditional risk factors is exacerbated by barriers to healthcare and risk factor management; together all contribute to a large CVD burden within this population.

Despite the growing body of research on the health challenges faced by the homeless population, there remains a significant knowledge gap in understanding the specific burden of CVD within this group.[12] Most existing studies have focused on individual risk factors or communicable conditions, but a recent, comprehensive, demographic analysis of the CVD burden is lacking. Given the high burden of CVD within this population, understanding the distribution and risk factors of this disease is essential for the development of effective population-level and individual-level interventions. Furthermore, understanding the demographics and progression of CVD within this population may elucidate the risk profiles of other chronic disease comorbidities such as diabetes and hypertension. These data are critical for improving overall health outcomes within this vulnerable group.

This study builds on a 6-year-old review exploring CVD mortality among the homeless population.[13] We update these findings by incorporating the most recent data and conducting detailed subgroup analyses by sex, age and geography. To the best of our knowledge, this study is the most comprehensive and recent in its field and is the only review to investigate the specific distribution of CVD within the homeless population. Additionally, we review the literature to propose specific, evidence-based approaches to preventing and managing CVD among homeless populations.

METHODS

We adhered to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines.[14] The research questions were formulated as follows: (1) Do homeless populations experience a greater CVD burden than non-homeless populations? (2) If so, how are CVDs distributed demographically within the homeless population? These research questions, constructed in the Population, Exposure, Outcome format,[15] were used to formulate the search strategy.

Data sources

PubMed and Scopus databases were systematically searched on 26 July 2023 and subsequently on 22 October 2024. The search strategy was developed using various terms relevant to 'cardiovascular disease', 'homelessness' and 'mortality' (refer to online supplemental file 1 for detailed search strategy). For the PubMed search, the search strategy was adapted to incorporate MeSH terms to generate broader results. For the Scopus search, the criteria were expanded to include grey literature. No language or time restrictions were imposed on the studies searched. For included articles, references were manually searched for potentially relevant studies; however, no additional studies were found.

Study selection

Using the inclusion criteria, two researchers independently screened article titles and abstracts and then assessed full-text articles for eligibility. All disputes were resolved through a third reviewer. Studies meeting all the following criteria were included: (1) classified as an observational study; (2) included an adult homeless cohort or population; (3) reported at least one CVD outcome; (4) included a housed control cohort/population. Studies meeting any of the following criteria were excluded: (1) classified as a non-observational study; (2) did not report quantitative CVD outcomes; (3) did not include a housed control cohort/population and (4) included a paediatric population.

Furthermore, studies meeting the following criteria were included in the meta-analysis: (1) reported outcomes using the appropriate control group; (2) quantified outcomes via effect-size measurements.

Data extraction and statistical analysis

Covidence V.2.0[16] was utilised for data extraction and quality assessment. The quality of observational studies was analysed using the Newcastle Ottawa Scale for non-randomised studies.[17] Two researchers independently assessed study quality, and disputes were resolved by a third reviewer. The following data were extracted from included studies: study characteristics (author, study type, objectives, location and study duration), homeless-cohort characteristics, control-cohort characteristics, outcome measure/index and outcome.

Jamovi V.2.3[18] was used for statistical analysis. Across studies, the primary outcomes reported were mortality, morbidity or hospital admission due to CVD. All outcome measures with 95% CIs were collected and included in the meta-analysis. Studies that reported stratified effect sizes were included in subgroup analyses of either age or sex (defined by SAGER guidelines).[19] Analyses were conducted using log effect size measures to normalise the distribution and subsequently converted to true estimates. For the primary analysis, pooled ORs and heterogeneity were estimated using both a restricted maximum-likelihood random-effects model and

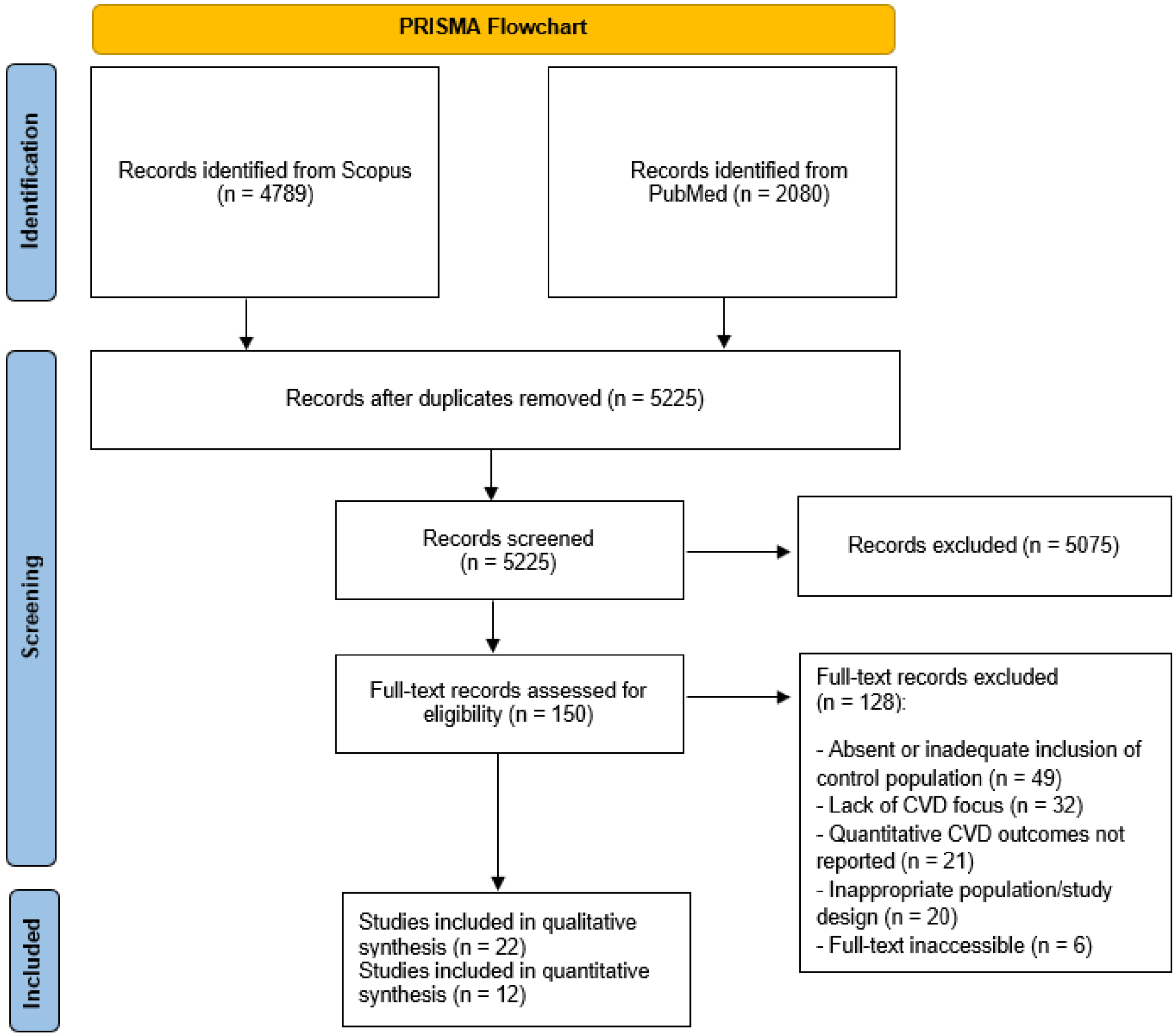

Figure 1 The Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA) flow diagram representing the systematic literature search. CVD, cardiovascular disease.

fixed-effects model; however, no significant differences were found (see online supplemental file 1).

To ensure the robustness of our findings, two sensitivity analyses were conducted. The first sensitivity analysis aimed to reduce heterogeneity by compiling studies that utilised HRs. This confirmed that the overall trend observed in the primary analysis was not influenced by variations in effect size reporting across studies. The second sensitivity analysis aimed to minimise the elevated between-study heterogeneity. Cohort studies were independently meta-analysed as they represented the largest study design category. The results of all sensitivity analyses are provided in the online supplemental file 1.

RESULTS

Study selection

Using a PRISMA flow diagram, figure 1 depicts the detailed process of data selection. From our initial search of PubMed and Scopus, 6869 records were retrieved, 5225 of which remained after duplicates were removed. In title/abstract screening, 5075 did not meet the inclusion criteria and were excluded. For full-text eligibility, 150 records were assessed, of which 128 were excluded. Reasons for exclusion at the full-text stage were: (1) absent or inadequate control population (n=49), (2) lack of CVD focus (n=32), (3) lack of quantitative outcomes (n=21), (4) inappropriate population or study design (n=20) and (5) inaccessible full-text (n=6). The reference lists of all included articles were manually searched for other potential studies; however, no additional records were found.

Study characteristics

The 22 studies included in this review were conducted across nine countries (table 1). The USA contributed the most, with 10 studies. Sweden, Canada and the UK

Table 1 Summary of studies included in the systematic review (n=22)

Study	Study design	Study population	N	% Male	Control population	Study setting	Date	Outcome	Results
Baggett 2013	Cohort	Homeless adults (18+years) enrolled in community health programme	28 033	66	General population (MA)	Boston, MA, USA	2003–2008	CVD defined by ICD-10	Male (25–44 years)—RR: 5.1 (95% CI 3.1 to 8.4) Male (45–64 years)—RR: 3.5 (95% CI 2.8 to 4.3) Female (25–44 years)—RR: 3.6 (95% CI 1.2 to 11.1) Female (45–64 years)—RR: 3.0 (95% CI 1.5 to 6.1)
Beijer 2011	Cohort	Adults (18+years) registered with Office for the Homeless	2283	77	General population (Stockholm)	Stockholm, Sweden	1995–2005	CVD defined by ICD-9	Male—RR: 2.6 (95% CI 2.1 to 3.2) Female—RR: 3.3 (95% CI 1.8 to 3.7)
Beijer 2016	Cohort	Homeless adults (20+years)	3887	76	General population (Stockholm)	Stockholm, Sweden	2000–2002	Heart disease defined by ICD-10	Male—RR: 1.64 (95% CI 1.42 to 1.89) Female—RR: 2.34 (95% CI 1.66 to 3.25)
Bertram 2022	Case–control	Homeless adults (18+years) in metropolitan cities	651	81	General population (Germany)	Hamburg/ Frankfurt/ Leipzig Germany	2021	CVD undefined	10.7% of all-cause mortality (homeless cohort) 6.5% of all-cause mortality (sheltered cohort)
*Brown 2022	Cohort	Homeless adults (18+years)	450	75	Age-matched and sex-matched controls in unspecified sheltered population	Oakland, CA, USA	2013–2018	CVD defined by ICD-10	aHR: 1.55 (95% CI 0.99 to 2.42)

Continued

Table 1 Continued

Study	Study design	Study population	N	% Male	Control population	Study setting	Date	Outcome	Results
Fowle 2024	Cohort	Homeless adults (18+years)	22 143	82.4	Unspecified general population	Washington DC, USA	2015–2020	CVD defined by ICD-10	24.2% of all-cause mortality (homeless cohort) 19% of all-cause mortality (sheltered cohort)
Hibbs 1994	Cohort	Adults (18+years) registered with Office of the Homeless	10 715	63	General population (Philadelphia)	Philadelphia, PA, USA	1985–1988	Heart disease (undefined)	19% of all-cause mortality (homeless cohort) 10.2% of all-cause mortality (sheltered cohort)
Hwang 2000	Cohort	Adult residents (18+years) of homeless shelters	8933	100	General population (Toronto)	Toronto, Ontario, Canada	1995–1997	Heart disease defined by ICD-9	RR: 25–44 years: 2.9 (95% CI 0.4 to 22.8) RR: 45–64 years: 4.9 (95% CI 2.0 to 12.3)
Hwang 1997	Cohort	Adults (18+years) enrolled in Boston Healthcare for Homeless programme	17 292	68	General population (Boston)	Boston, MA, USA	1988–1993	Heart disease ICD-9	Male (25–44 years)—RR: 3.5 (95% CI 2.1 to 5.6) Male (45–64 years)—RR: 1.5 (95% CI 1.1 to 2.1) Female (25–44 years)—RR: 2.4 (95% CI 0.7 to 7.7) Female (45–64 years)—RR: 1.2 (95% CI 0.4 to 3.3)
*Hwang 2009	Cohort	Adults (25+years) experiencing marginal housing conditions	15 100	70	Age-matched and sex-matched controls from Canadian census	Unspecified, Canada	1991–2001	Circulatory diseases (ICD-9 & ICD-10)	Male—RR: 1.7 (95% CI 1.6 to 1.8) Female—RR: 1.6 (95% CI 1.4 to 1.8)

Continued

Table 1 Continued

Study	Study design	Study population	N	% Male	Control population	Study setting	Date	Outcome	Results
*LePage 2014	Cross-sectional	Homeless veteran adults visiting North VA healthcare system	102 034	93	Matched sheltered veteran population visiting North VA healthcare system	Texas, USA	2009–2010	CVD defined by ICD-9	aOR: 0.91 (95% CI 0.80 to 1.03)
*Lewer 2019	Cross-sectional	Homeless individuals (16–64 years)	14 696	19	Age-matched and sex-matched housed comparison group	London/ Birmingham, England	2012–2015	Cardiac disease defined by ICD-10	aPR: 7 (95% CI 3.0 to 20.0)
*Morrison 2009	Cohort	Homeless adults (18+years)	18 774	65	Age-matched and sex-matched local housed controls	Glasgow, Scotland	2000–2005	Circulatory diseases (ICD-10)	aHR: 6.0 (95% CI 3.6 to 10.3)
*Nanjo 2020	Case–control	Homeless individuals (16+years)	40 626	59	Age-matched and sex-matched housed comparison group	Unspecified, UK	1998–2019	CVD defined by ICD-10	aHR: 1.64 (95% CI 1.29 to 2.08)
*Roncarati 2018	Cohort	Homeless adults (18+years) enrolled in community health programme	445	72	Sheltered control group (MA)	Boston, MA, USA	2000–2009	CVD defined by ICD-10	aSMR: 6.4 (95% CI 3.9 to 9.9)
Schinka 2016	Cohort	Homeless veteran adults (55+years) registered with Department of Veterans Affairs	4475	N/A	Matched sheltered veteran population registered with Department of Veterans Affairs	Unspecified, USA	2000–2003	CVD defined by ICD-10	33% of all-cause mortality (unsheltered cohort) 30% of all-cause mortality (sheltered cohort)
*Schinka 2018	Cohort	Homeless adults (30 to 54 years) registered with Department of Veterans Affairs	23 898	96	Matched sheltered veteran population registered with Department of Veterans Affairs	Unspecified, USA	2000–2003	CVD defined by ICD-10	aHR: 2.8 (95% CI 2.6 to 3.1)
*Slockers 2018	Cohort	Homeless adults (20+years) enrolled in healthcare programme	2130	88	General population (Rotterdam)	Rotterdam, the Netherlands	2001–2010	CVD defined by ICD-10	aSMR: 3.7 (95% CI 2.8 to 4.7)

Continued

Table 1 Continued

Study	Study design	Study population	N	% Male	Control population	Study setting	Date	Outcome	Results
Sokoloff 2024	Cohort	Homeless veteran adults (18+years) registered with the VA Medical Center (VAC)	56 093	95	Housed veteran population registered with VAC	Unspecified, USA	2017–2019	Heart failure defined by ICD-10	31.2% of all-cause mortality (unsheltered cohort) 25% of all-cause mortality (sheltered cohort)
*Stenius-Ayoade 2017	Case–control	Homeless men (18+years) residing in shelter	617	100	General population (Finland)	Helsinki, Finland	2004–2014	CVD defined by ICD-10	aHR: 2.51 (95% CI 1.67 to 3.77)
*Vuillermoz 2016	Case–control	Homeless adults (18+years)	1145	90	General population (unspecified)	Paris, France	2008–2010	CVD defined by ICD-10	RR: 1.3 (1.0–1.7)
*Zordan 2023	Cohort	Homeless adults (18+years)	6290	79	Matched sheltered population	Melbourne, Australia	2003–2004	CVD defined by ICD-10	aHR: 4.9 (95% CI 2.78 to 8.70)

Asterisk signifies inclusion of study in meta-analysis.
aHR, adjusted HR; aPR, adjusted prevalence ratio; aSMR, adjusted standard mortality ratio ; CVD, cardiovascular disease; ICD, International Classification of Diseases; N/A, not applicable; RR, relative risk.

followed with two studies each, while Scotland, Germany, France, Australia, Finland and the Netherlands each contributed one study. Most studies employed a cohort design (n=16), while the remainder used case–control (n=4) and cross-sectional (n=2) designs.

These studies spanned a period from 1985 to 2024, with most conducted after the year 2000 (n=16). All studies included a homeless cohort, whose characteristics varied considerably. Most studies were composed of predominantly male populations (n=20) with approximately one-third of the populations being over 90% male (n=8). Twelve studies included large populations of more than 5000 participants, while the remaining studies (n=10) included populations ranging in size from 445 to 4475 participants.

The control populations were heterogeneous, consisting of either the general population (n=12) or matched housed controls (n=10). The most common outcome measured was CVD mortality (n=16), followed by prevalence (n=5) and hospitalisation due to CVD (n=1). To characterise the overall burden of CVD within the homeless population, these measures were collectively analysed. The International Classification of Diseases (ICD), Tenth Revision, or earlier versions were used in most studies (n=20); however, two studies reported using a different or unspecified index. For the meta-analysis, only studies that defined CVD and homelessness according to the ICD index were included, to ensure consistency among the results. For the full ICD definition of CVD, please refer to the online supplemental file 1.

The reported effect size estimates varied across studies. They included relative risk (RR) (n=7), adjusted HR (aHR) (n=6), percentages (n=5), adjusted standard mortality ratio (n=2), adjusted OR (aOR) (n=1) and adjusted prevalence ratio (n=1). To minimise the potential impact of heterogeneity in effect size reporting, a sensitivity analysis was performed.

Risk of bias assessment

In our evaluation of 22 studies using the Newcastle Ottawa Scale, 19 studies exhibited a low risk of bias, two had a moderate risk and one study had a high risk (table 2). The mean score of the evaluated studies was 7.20, with cohort, case–control and cross-sectional studies scoring 7.62, 6.50 and 7.50, respectively. To ensure robustness of the results, only studies that had low risk of bias (≥7) were included in the meta-analysis. For detailed evaluation criteria and scale information, please refer to the online supplemental file 1.

To assess the risk of reporting bias, funnel plots were generated for each analysis. The results indicate a low risk of reporting bias for most analyses (n=4).

Meta-analysis results

Of the 22 studies included in this review, 12 provided data suitable for meta-analysis. Of the 12, most reported higher prevalence of CVD among homeless individuals compared with the control population (n=10). This observation is substantiated by the meta-analysis results, which indicate that homeless individuals experience approximately three times the risk of CVD compared with the general population but with significant heterogeneity across studies (pooled OR 2.77; 95% CI 1.93 to 3.93; p<0.001; I^2=96.2%) (figure 2).

Table 2 Risk of bias evaluation by study design using the Newcastle Ottawa Scale (NOS)

Column1	Cohort studies	Cross-sectional studies	Case–control studies	Total
Number of studies	16	2	4	22
Mean NOS score	7.62	7.5	6.5	7.20
Median NOS score	7.5	7.5	7	7
Range NOS score	3	3	4	5
% at low risk (>7)	94 (15)	50 (1)	75 (3)	86 (19)
% at moderate risk (5–6)	6 (1)	50 (1)	0	10 (2)
% at high risk (<5)	0	0	25 (1)	5 (1)

To further evaluate this result, subgroup analyses by geographic region, sex and age were performed. The analysis of geographic regions compared European and American studies, as they represented the two largest geographic cohorts. We found that European homeless cohorts (n=5) exhibited elevated CVD mortality and morbidity (pooled OR 2.53; 95% CI 1.49 to 4.30; p<0.001; I^2=52%) comparable to that of American cohorts (n=4) (pooled OR 2.55; 95% CI 1.23 to 5.31; p<0.001; I^2=95%).

The second subgroup analysis characterised the distribution of CVD by sex within homeless cohorts. The results indicate that, when compared with housed populations, homeless females (pooled OR 2.60; 95% CI 1.97 to 3.63; p<0.001; I^2=26.2%) and homeless males (pooled OR 2.14; 95% CI 1.55 to 2.97; p<0.001; I^2=82.0%) exhibit similarly elevated CVD morbidity and mortality risks (figure 3).

The third subgroup analysis characterised the distribution of CVD by age within homeless cohorts. Due to limited data from the studies included, pooled ORs were calculated for two age groups: (1) 25–44 years and (2) 45–64 years. The analysis indicates that, when compared with similarly aged, housed controls, young homeless adults (pooled OR 3.81; 95% CI 2.27 to 6.48; p<0.001, I^2=2.3%) demonstrate elevated CVD morbidity and mortality comparable to older homeless populations (pooled OR 3.30; 95% CI 2.29 to 4.57; p<0.001, I^2=7.0%).

Finally, two sensitivity analyses were performed to ensure the robustness of the results. The aim of the first analysis was to verify that the observed trend remained consistent irrespective of the effect size measures utilised among studies. Specifically, the sensitivity analysis included studies (n=6) that reported outcomes via aHRs, as this was a common effect size measure among the meta-analysis cohort. The sensitivity analysis produced a pooled measure closely aligned with the overall OR (pooled HR 2.66; 95% CI 1.95 to 3.59; p<0.001; I^2=5.7%), validating the study's results.

The next sensitivity analysis aimed to verify our results under low heterogeneity conditions by independently meta-analysing cohort studies, as they were the

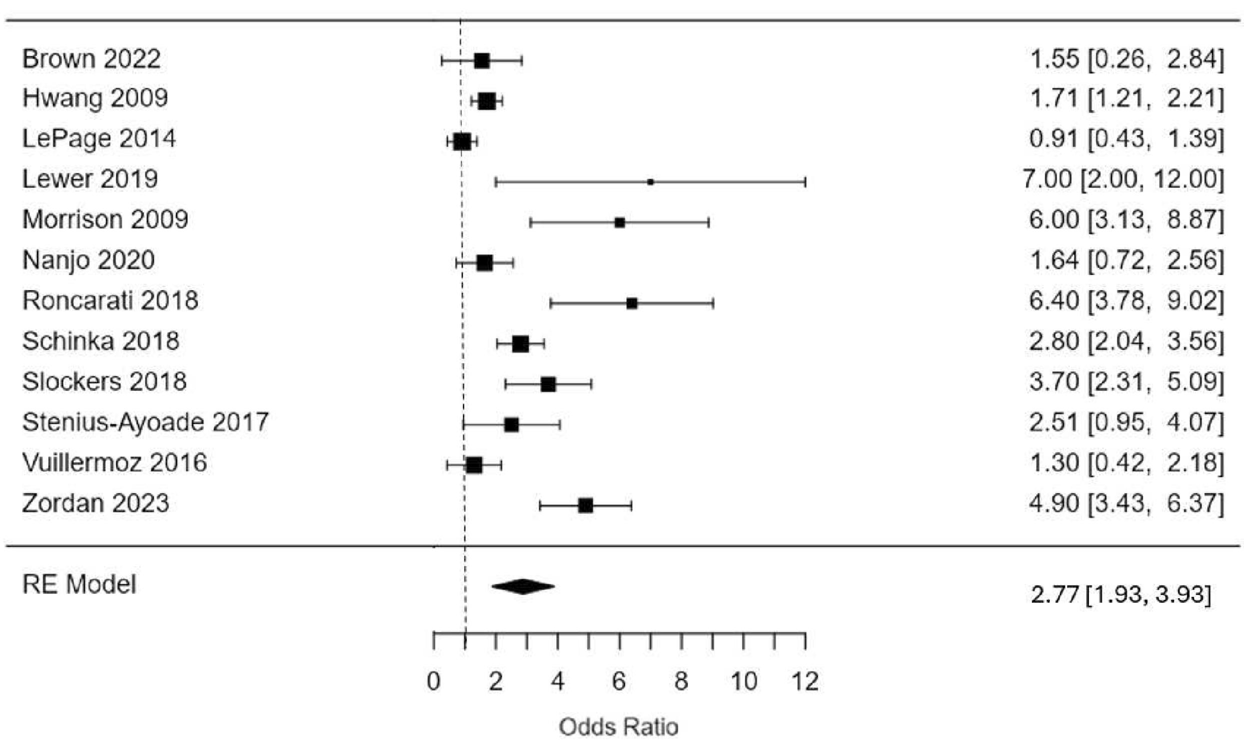

Figure 2 Results of overall meta-analysis (n=12).

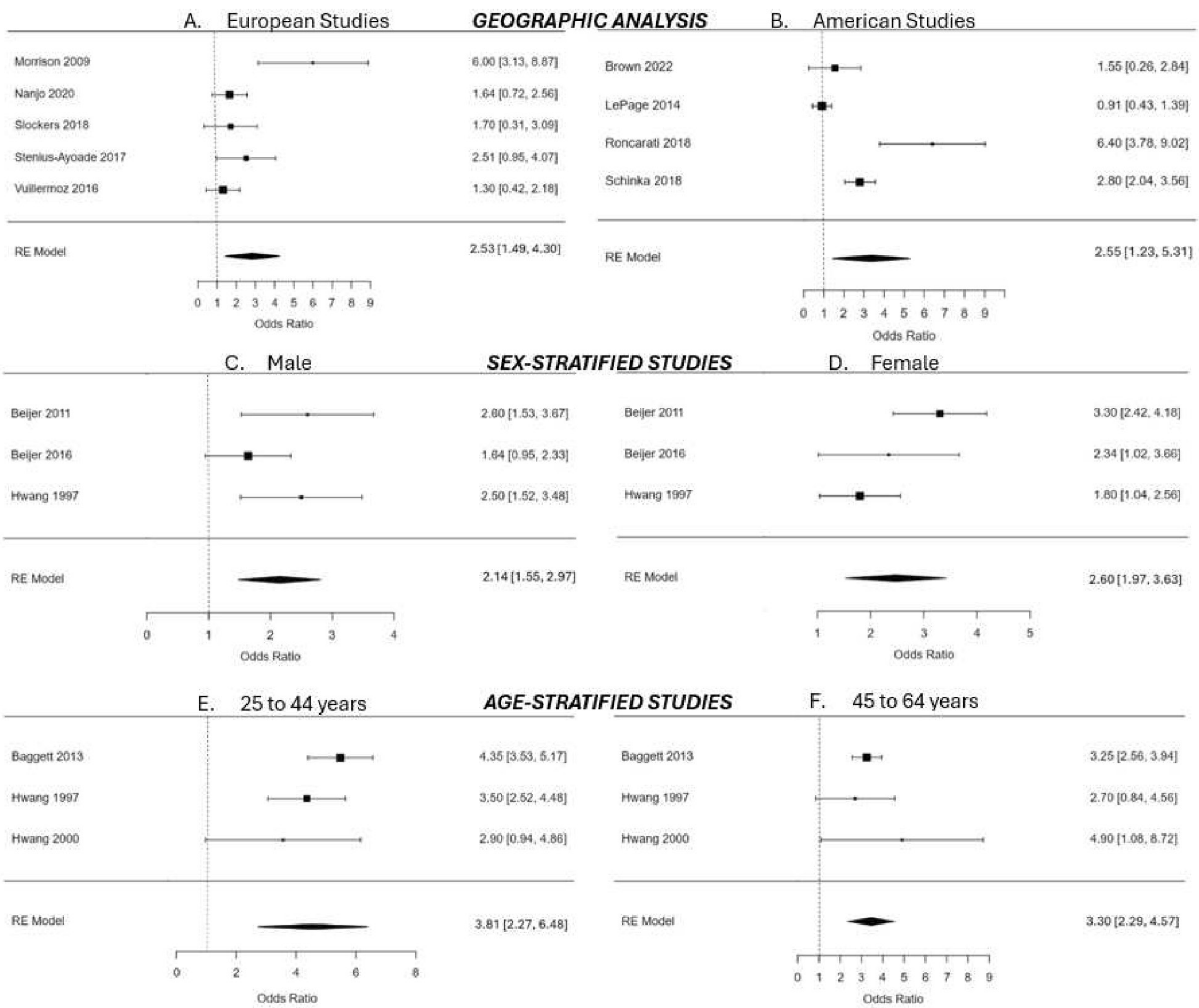

Figure 3 Results of all subgroup analyses (geographic, sex, and age analyses).

most-represented study design. This analysis generated a pooled effect measure closely aligned to the overall OR but under reduced heterogeneity (pooled OR 2.85; 95% CI 1.98 to 4.13; p<0.001; I^2=41.6%).

DISCUSSION

This study explored the risk of CVD within homeless populations. The findings underscore four key points: (1) homeless individuals bear a higher burden of CVD morbidity and mortality than the general population, (2) both homeless males and females exhibit heightened CVD morbidity and mortality, (3) young homeless adults exhibit a CVD risk comparable to older homeless adults and (4) homeless European and American cohorts display similarly elevated risks.

Our finding that the CVD risk in homeless populations is three times that of the general population aligns with recent studies that indicate a twofold-to-fourfold increase in CVD burden[20 21] and parallels a previous review that generated a pooled OR of 2.96 (95% CI 2.80 to 3.13).[13] This association between CVD and homelessness can be attributed to a complex interplay of social and biological determinants. Several behavioural risk factors, including high use of tobacco, alcohol and illicit drugs, are known to amplify CVD risk among the homeless population. Tobacco use is a particularly prominent risk, accounting for a large proportion of deaths from ischaemic heart disease among homeless populations.[22] While mild alcohol consumption has been associated with protective effects, over 30% of homeless individuals report CAGE scores indicative of alcohol use disorder.[23] Heavy drinking has been linked to increased risk of cardiomyopathy and congestive heart failure.[24] Substance use, although not a standard consideration in CVD risk assessment, has been associated with elevated levels of CVD biomarkers such as high-sensitivity troponin 1 (cTn1) and ST2.[21] More than a quarter of homeless individuals report recent use of drugs such as cocaine, heroin and amphetamine, which have been previously linked to atherosclerosis and myocardial ischaemia.[25–27]

Social determinants of health, such as limited health-care access, may also contribute to an excess CVD burden. Poor healthcare access among homeless individuals can result from lack of insurance, transportation difficulties and affordability.[28] In one study, lack of insurance emerged as a contributor to care hesitancy in half of homeless individuals polled.[29] Prior research suggests that insurance status is correlated with a homeless individual's ability to seek non-urgent care.[30] However, in chronic conditions such as CVD and hypertension, which rely on continuous management and non-urgent care visits, homeless adults may be unable to seek care until progression and thus be at risk for poor outcomes.[31]

Additionally, biological risk factors contribute to an elevated CVD risk. Approximately 40% of the homeless population reports hypertension, and 14% report high cholesterol, both significant risk factors of CVD.[10] While these rates tend to align with the general population, they often go undiagnosed and untreated, resulting in poor management and further complications. For example, in a study analysing a group of 56 homeless individuals with a clinical history of high LDL cholesterol, only one reported taking cholesterol-lowering medication.[23] Other risk factors such as mental health disorders and psychological distress are highly prevalent in homeless populations and could contribute to CVD. Specifically, post-traumatic stress disorder and severe depression, present in almost a quarter of the population, have previously been associated with CVD and may also affect access to care.[32–35]

Limitations

This study has several limitations. First, although no language or temporal restrictions were imposed during the search, most studies were conducted in high-income nations, and a quarter of them were published before 2010. Hence, caution should be taken when generalising the results for certain populations (for example, homeless populations in low-income nations). Future research should aim to evaluate homeless populations across a wider geographic region.

Second, the primary analysis generated an elevated heterogeneity measure (I^2=96.2%). To address the elevated heterogeneity, we utilised two sensitivity analyses. The first sensitivity analysis aimed to reduce heterogeneity by compiling studies that utilised HRs. The second sensitivity analysis sought to minimise between-study heterogeneity by independently analysing cohort studies, allowing us to identify design-specific factors that might influence the results. Our analysis of cohort studies generated a pooled estimate closely aligned to our overall estimate under significantly less heterogeneous conditions (I^2=41.6%). This indicates that study design might be a major factor in accounting for the high heterogeneity of the primary analysis. Our study mainly analyses three primary study designs (cohort, cross-sectional and case–control). Cohort studies typically have larger sample sizes and longer follow-up periods, which can lead to more stable and reliable estimates. In contrast, cross-sectional and case–control studies often have smaller sample sizes and shorter durations, potentially contributing to variability in the findings.

Additional factors that may contribute to the heterogeneity of the primary analysis include variations in time points—most of our studies (n=16) were analysed across a time period ranging 2000 to 2024. Causes of population mortality and CVD risk factors are likely to shift across this period. As more data arise on this issue, future studies will be able to better control these variables.

Strengths

Our study also has several strengths. While most homeless healthcare research has historically focused on communicable diseases, this study is among the few that explore the increasing burden of chronic disease. To the best of our knowledge, this is the only review to investigate the burden of CVD among sex, age and geographical subgroups of the homeless population. Our findings documenting the increased CVD risk across all population subgroups stress the urgency of integrating CVD prevention and management into existing and upcoming public health strategies. This approach not only addresses immediate health issues but also contributes to long-term health improvement by preventing the onset of other chronic conditions associated with CVD.

Additionally, our study has several methodological strengths. The studies included in our meta-analysis cohort were of relatively high quality, with most published after the year 2010. To address heterogeneity in the overall analysis, subgroup analyses were conducted and yielded similar estimated odds of CVD, suggesting that our findings are likely robust. In addition, we executed a systematic search across multiple extensive databases at two distinct time points to ensure a thorough and current review of the available literature. This rigorous methodology ensures the comprehensiveness of this study.

Interventions to address CVD among homeless populations

Since the relationship between homelessness and CVD is influenced by multiple behavioural, social and biological risk factors, addressing this issue effectively requires multifaceted interventions. First, permanent housing programmes have shown considerable growth and promise in the past. These programmes emphasise a holistic approach by providing rapid housing, comprehensive healthcare access and substance use disorder treatment. Some studies report a reduction in healthcare-related expenditures by 40% following implementation, largely due to their comprehensive healthcare services that address both immediate and underlying health issues. However, their potential in addressing CVD warrants further investigation.[36] Second, comprehensive tobacco cessation programmes have demonstrated considerable efficacy in reducing cardiovascular risk. Recent studies have reported that these interventions result in an approximately 39% reduction of CVD risk within 5 years; however, these interventions are yet to be evaluated for cardiac outcomes within homeless communities.[37 38]

Third, a significant proportion of homeless individuals grapple with unmanaged diabetes and hypertension, which markedly increases their susceptibility to CVDs. Numerous barriers, including medication access and cost, contribute to low levels of disease management. Medication-adherence programmes encompass a spectrum of interventions aimed at improving patient adherence by increasing medication access and implementing reminder systems. Recent studies have reported that mobile adherence programmes greatly improved patient health and outcomes, with one systematic review reporting a 25% increase in medication adherence using mHealth systems.[39 40] Additionally, patient navigation teams can connect low-income and homeless patients to permanent primary care services. Studies of the Homeless Patient Aligned Care Team (HPACT), which connects homeless veterans to primary care and mental health counselling, have shown a significant increase in primary care utilisation and a decrease in Emergency Department visits.[41] The expansion of permanent primary care services could better manage CVD risk factors and underlying comorbidities, preventing progression into CVD. Furthermore, early risk factor screening facilitated by these services can significantly reduce the incidence of severe cardiovascular conditions, particularly among young homeless populations.[42]

The causes of homelessness are highly heterogeneous across populations, encompassing factors such as unemployment, lack of affordable housing, mental health issues and substance use.[43 44] Preventive measures to address homelessness can, in turn, reduce CVD risk. For example, interventions that focus on substance use recovery, job training programmes and mental health support can mitigate some of the underlying causes of homelessness and subsequently lower CVD risk. In this literature review, we primarily discuss factors related to CVD prevention within homeless populations. However, it is important to recognise that the most effective method for reducing CVD risk is likely a combination of CVD-specific interventions and traditional homelessness prevention methods.[45] These combined efforts can create a more comprehensive approach to improving cardiovascular health among homeless populations.

CONCLUSION

Historically, the research emphasis on the health of homeless populations has been predominantly on communicable diseases. However, with the rising prevalence of chronic diseases such as CVD, it is imperative to shift our focus and address these emerging health challenges. Several interventions such as housing-first models and expanded primary services have already demonstrated potential in addressing CVD among the homeless population. Although large-scale studies are needed to address these issues comprehensively, this review serves as a first step towards enhancing care for one of society's most vulnerable groups.

Contributors SK and JRH conceptualised the review. Data search and extraction were conducted by SK, NE and PK. KTW oversaw the statistical analysis. The preliminary draft was written by SK. All authors contributed to the critical review of this manuscript. SK is the guarantor.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement statement This meta-analysis synthesizes findings from previously published studies and, as such, did not involve direct recruitment of patients or members of the public for new data collection.

Patient consent for publication Not applicable.

Ethics approval Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information. Not applicable.

ORCID iD

Samhita Korukonda http://orcid.org/0009-0005-6909-0803

REFERENCES

1 Aldridge RW, Menezes D, Lewer D, *et al*. Causes of death among homeless people: a population-based cross-sectional study of linked hospitalisation and mortality data in England. *Wellcome Open Res* 2019;4:49.
2 Romaszko J, Cymes I, Dragańska E, *et al*. Mortality among the homeless: Causes and meteorological relationships. *PLoS ONE* 2017;12:e0189938.
3 Pribish A, Khalil N, Mhaskar R, *et al*. Chronic Disease Burden of the Homeless: A Descriptive Study of Student-Run Free Clinics in Tampa, Florida. *J Community Health* 2019;44:249–55.
4 Hwang SW, Orav EJ, O'Connell JJ, *et al*. Causes of death in homeless adults in Boston. *Ann Intern Med* 1997;126:625–8.
5 Hwang SW. Mortality among men using homeless shelters in Toronto, Ontario. *JAMA* 2000;283:2152–7.
6 Lanham JS, White P, Gaffney B. Care of People Experiencing Homelessness. *Am Fam Physician* 2022;106:684–93.
7 McCarty D, Argeriou M, Huebner RB, *et al*. Alcoholism, drug abuse, and the homeless. *Am Psychol* 1991;46:1139–48. Available: https://doi.org/10.1037/0003-066X.46.11.1139
8 Roerecke M. Alcohol's Impact on the Cardiovascular System. *Nutrients* 2021;13:3419. Available: http://dx.doi.org/3390/nu13103419
9 Hoek AG, Oort S, Mukamal KJ, *et al*. Alcohol consumption and cardiovascular disease risk: placing new data in context. *Curr Atheroscler Rep* 2022;51–9. Available: http://dx.doi.org/1007/s11883-022-00992-1
10 Yen F-S, Wei JC-C, Chiu L-T, *et al*. Diabetes, hypertension, and cardiovascular disease development. *J Transl Med* 2022;20:9.
11 Luder E, Ceysens-Okada E, Koren-Roth A, *et al*. Health and nutrition survey in a group of urban homeless adults. *J Am Diet Assoc* 1990;90:1387–92.
12 Mitchell E, Waring T, Ahern E, *et al*. Predictors and consequences of homelessness in whole-population observational studies that used administrative data: a systematic review. *BMC Public Health* 2023;23:1610.

13 Al-Shakarchi NJ, Evans H, Luchenski SA, *et al*. Cardiovascular disease in homeless versus housed individuals: a systematic review of observational and interventional studies. *Heart* 2020;106:1483–8.
14 Moher D, Shamseer L, Clarke M, *et al*. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Syst Rev* 2015;4:1.
15 Grindlay DJ, Karantana A. Putting the “systematic” into searching - tips and resources for search strategies in systematic reviews. *J Hand Surg Eur Vol* 2018;43:674–8.
16 Covidence systematic review software. Veritas Health Innovation, Available: www.covidence.org
17 Zeng X, Zhang Y, Kwong JSW, *et al*. The methodological quality assessment tools for preclinical and clinical studies, systematic review and meta-analysis, and clinical practice guideline: a systematic review. *J Evid Based Med* 2015;8:2–10.
18 Computer Software; The jamovi project, 2022. Available: https://www.jamovi.org
19 Heidari S, Babor TF, De Castro P, *et al*. Sex and Gender Equity in Research: rationale for the SAGER guidelines and recommended use. *Res Integr Peer Rev* 2016;1:2.
20 Slockers MT, Nusselder WJ, Rietjens J, *et al*. Unnatural death: a major but largely preventable cause-of-death among homeless people? *Eur J Public Health* 2018;28:248–52.
21 Riley ED, Kazi DS, Coffin PO, *et al*. Impact of multiple substance use on circulating ST2, a biomarker of adverse cardiac remodelling, in women. *Biomarkers* 2022;27:802–8.
22 Goodwin JF. Alcohol and the heart: alcoholic cardiomyopathy. *J R Coll Physicians Lond* 1977;12:5–11.
23 Lee TC, Hanlon JG, Ben-David J, *et al*. Risk factors for cardiovascular disease in homeless adults. *Circulation* 2005;111:2629–35.
24 Gonçalves A, Claggett B, Jhund PS, *et al*. Alcohol consumption and risk of heart failure: the Atherosclerosis Risk in Communities Study. *Eur Heart J* 2015;36:939–45.
25 Magwood O, Salvalaggio G, Beder M, *et al*. The effectiveness of substance use interventions for homeless and vulnerably housed persons: A systematic review of systematic reviews on supervised consumption facilities, managed alcohol programs, and pharmacological agents for opioid use disorder. *PLoS ONE* 2020;15:e0227298.
26 McCarty D, Argeriou M, Huebner RB, *et al*. Alcoholism, drug abuse, and the homeless. *Am Psychol* 1991;46:1139–48.
27 Dettmeyer R, Friedrich K, Schmidt P, *et al*. Heroin-associated myocardial damages--conventional and immunohistochemical investigations. *Forensic Sci Int* 2009;187:42–6.
28 Murphy ER. Transportation and homelessness: a systematic review. *J Soc Distress Homeless* 2019;28:96–105.
29 Kushel MB, Vittinghoff E, Haas JS. Factors associated with the health care utilization of homeless persons. *JAMA* 2001;285:200–6.
30 Carmichael C, Schiffler T, Smith L, *et al*. Barriers and facilitators to health care access for people experiencing homelessness in four European countries: an exploratory qualitative study. *Int J Equity Health* 2023;22:206.
31 Franco A, Meldrum J, Ngaruiya C. Identifying homeless population needs in the Emergency Department using Community-Based Participatory Research. *BMC Health Serv Res* 2021;21:428.
32 Gutwinski S, Schreiter S, Deutscher K, *et al*. The prevalence of mental disorders among homeless people in high-income countries: An updated systematic review and meta-regression analysis. *PLoS Med* 2021;18:e1003750.
33 Noble NC, Merker JB, Webber TK, *et al*. PTSD and depression severity are associated with cardiovascular disease symptoms in trauma-exposed women. *Eur J Psychotraumatol* 2023;14:2234810.
34 Osborne MT, Shin LM, Mehta NN, *et al*. Disentangling the Links Between Psychosocial Stress and Cardiovascular Disease. *Circ Cardiovasc Imaging* 2020;13:e010931.
35 Chikwava F, Cordier R, Ferrante A, *et al*. Trajectories of homelessness and association with mental health and substance use disorders among young people transitioning from out-of-home care in Australia. *Child Abuse Negl* 2024;149:106643.
36 Jacob V, Chattopadhyay SK, Attipoe-Dorcoo S, *et al*. Permanent Supportive Housing With Housing First: Findings From a Community Guide Systematic Economic Review. *Am J Prev Med* 2022;62:e188–201.
37 Duncan MS, Freiberg MS, Greevy RA, *et al*. Association of Smoking Cessation With Subsequent Risk of Cardiovascular Disease. *JAMA* 2019;322:642–50.
38 Braucht GN, Reichardt CS, Geissler LJ, *et al*. Effective Services for Homeless Substance Abusers. *J Addict Dis* 1996;14:87–109.
39 Peng Y, Wang H, Fang Q, *et al*. Effectiveness of Mobile Applications on Medication Adherence in Adults with Chronic Diseases: A Systematic Review and Meta-Analysis. *J Manag Care Spec Pharm* 2020;26:550–61.
40 Pérez-Jover V, Sala-González M, Guilabert M, *et al*. Mobile Apps for Increasing Treatment Adherence: Systematic Review. *J Med Internet Res* 2019;21:e12505.
41 Tsai J, Havlik J, Howell BA, *et al*. Primary Care for Veterans Experiencing Homelessness: a Narrative Review of the Homeless Patient Aligned Care Team (HPACT) Model. *J Gen Intern Med* 2023;38:765–83.
42 Surey J, Veitch M, Rogers S, *et al*. Cardiovascular Disease Screening in homeless: A Feasibility Study. *J Am Heart Assoc* 2024;13:e034413.
43 Mago VK, Morden HK, Fritz C, *et al*. Analyzing the impact of social factors on homelessness: a fuzzy cognitive map approach. *BMC Med Inform Decis Mak* 2013;13:94.
44 Mabhala M, Esealuka WA, Nwufo AN, *et al*. Homelessness Is Socially Created: Cluster Analysis of Social Determinants of Homelessness (SODH) in North West England in 2020. *Int J Environ Res Public Health* 2021;18:3066.
45 Chum A, Wang R, Nisenbaum R, *et al*. Effect of a Housing Intervention on Selected Cardiovascular Risk Factors Among Homeless Adults With Mental Illness: 24-Month Follow-Up of a Randomized Controlled Trial. *J Am Heart Assoc* 2020;9:e016896.