

Prevalence and Risk of Heart Failure Among Older Adults Experiencing Homelessness: A Systematic Review and Meta-Analysis



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<https://doi.org/10.5770/cgj.29.938>

ABSTRACT

Background

Understanding the prevalence and risk of heart failure (HF) among older adults is crucial for informing the design and implementation of interventions and guiding equitable healthcare delivery.

Methods

A systematic search was conducted in MEDLINE, Embase, Cochrane Database of Systematic Reviews, CINAHL, and Web of Science from inception to April 2025. We included studies of adults aged 50 years or older experiencing homelessness. Outcomes included HF prevalence, risk of HF, and HF mortality. Screening, extraction, and risk-of-bias assessments were completed in duplicate. Random effects meta-analysis using generalized linear mixed models was used to estimate the prevalence of HF. The risk and mortality of HF were analyzed using random effects models, with housed older adults serving as the comparator.

Results

Thirty-four studies with 573,697 individuals experiencing homelessness were included in this study (weighted mean age: 59.0 years, weighted female percentage: 19.9%). The prevalence of HF was 12.0% (95% confidence interval (CI) 7.3–19.0; $I^2 = 99.9\%$). The odds of HF compared to housed adults (weighted mean age: 70.8 years) was 0.93 (95% CI

0.71–1.23; $I^2 = 99.7\%$). The unadjusted odds of mortality from HF was 0.40 (95% CI 0.22–0.74; $I^2 = 100\%$).

Conclusions

This meta-analysis suggests that older adults experiencing homelessness have a prevalence of HF similar to or higher than population-based studies of housed adults of a similar age. Housing status was not associated with the odds of HF and was associated with a decreased odds of mortality, although substantial heterogeneity across studies limits evidence certainty.

Key words: meta-analysis, homelessness, heart failure, health equity

INTRODUCTION

Heart failure (HF) is a leading cause of morbidity and mortality in older adults. The global prevalence of HF among adults is estimated to be approximately 3%.⁽¹⁾ It is known that the prevalence increases with age, with an estimate of 8.5% among those over the age of 65 years.^(1–3) As populations age worldwide, the burden of HF is projected to increase, making it a priority area for research, health policy, and the development of equitable care models. Understanding the epidemiology of HF remains imperative to inform resource allocation, identify high-risk populations, and tailor interventions to reduce hospitalizations and improve quality of life.⁽⁴⁾ While

HF disproportionately affects older adults, socioeconomic disparities also play a role, with lower socioeconomic status being linked to higher HF incidence, prevalence, and mortality.⁽⁵⁾ However, the burden of HF among adults experiencing homelessness is not well characterized, despite this population facing substantial structural and health inequities.^(6–8) This population is known to have higher rates of chronic diseases⁽⁹⁾ and face barriers when it comes to preventative care,⁽¹⁰⁾ medication adherence,⁽¹¹⁾ and guideline-directed medical therapy.⁽¹²⁾ These challenges are compounded by mental health comorbidities, limited continuity of care, and insufficient social support, all of which may influence the course and management of chronic conditions such as HF.⁽¹³⁾ Despite the increasing number of older adults experiencing homelessness, there is limited synthesis of data on how HF affects this subgroup of population.⁽¹⁴⁾ As such, the purpose of this systematic review and meta-analysis was to estimate the prevalence, incidence, risk, and mortality of HF among older adults experiencing homelessness.

METHODS

Reporting and Registration

We report our study according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), and the Reporting Guidelines for Meta-analyses of Observational Studies (MOOSE) (Appendix S1 and S2).⁽¹⁵⁾ Our review was registered on Open Science Framework (<https://osf.io/n924t/>).

Eligibility Criteria

We included studies that had a measure of HF prevalence, incidence, or mortality. Outcomes could be expressed as counts or a measure of risk (e.g., odds ratio (OR), rate ratio, or hazard ratio). We included randomized controlled trials and observational studies of adults aged 50 years or older who have experienced homelessness at any time and included studies with mixed populations if data for adults over 50 years of age could be extracted. We defined homelessness as absolute homelessness (e.g., living in places not designed for human habitation), shelter use, administrative codes (e.g., International Classification of Diseases (ICD) codes),⁽¹⁶⁾ or chart review. Homelessness was identified as either a current or a previous history of the condition, as this is typically how ICD codes classify homelessness.⁽¹⁶⁾ We defined older adults as 50 years of age or over due to a prevalence of comorbidities similar to adults aged over 65 years.⁽⁹⁾ HF was defined by the individual study, which included self-reported history and ICD codes.⁽¹⁷⁾ For studies that measured mortality, we included studies that reported either (i) HF mortality or (ii) all-cause mortality among HF admissions. HF mortality was included to account for studies that did not exclusively include patients with HF, but had a subgroup of mortality that could be extracted.

Information Sources and Search Strategy

We searched the following databases from inception to April 3, 2025, using a search strategy developed by a health sciences information specialist (CDC): MEDLINE, Embase, Cochrane Database of Systematic Reviews, CINAHL, and Web of Science (Figure S1 in the supplemental material). We completed a grey literature search on Google Scholar ($n = 300$ references reviewed based on previous studies of database and search engine overlap).⁽¹⁸⁾ We used backward citation searching for all included articles. Our key concepts were homelessness and HF. No language or date restrictions were applied to the search strategy.

Selection Process

Citations were imported into Covidence, a web-based review manager.⁽¹⁹⁾ After removal of duplicates, a pre-screening calibration was completed with 50 abstracts until a kappa consensus of over 90% was reached. Two reviewers then independently screened citations by title and abstract (PMH, KMK, JD, LA, and JS). Discrepancies were resolved by consensus or through a third reviewer.

Data Collection

Data extraction was completed using a predefined Microsoft Excel (Microsoft Corp®, Redmond, WA, USA) extraction form. Data were extracted independently and discrepancies were resolved through consensus (PMH, KMK, JD, LA, JS, and RA). We extracted the following study details: author, year, study design, sample size, inclusion, and exclusion criteria. We extracted the following participant demographics: mean/median age, comorbidities, race, gender, language, income level, source of income, level of education, social capital, and religion (PROGRESS-Plus), and homelessness characteristics (method of identification, first episode experiencing homelessness, number of episodes of homelessness, last housing type before homelessness). We collected the following HF characteristics: method of diagnosis, type of HF (e.g., systolic, diastolic), and measures of prevalence, incidence, risk, and mortality.

Risk of Bias

Risk of bias was assessed independently by two study reviewers (PMH, KK, JD, LA, JS, and RA). Risk of bias for prevalence was assessed using the Joanna Briggs Institute Checklist for Prevalence Studies. For the risk outcomes, we used the Risk of Bias in Non-Randomized Follow-up Studies (ROBINS-E). We used funnel plots, a Doi plot, and the Thompson and Sharp test and Egger's test to assess for publication bias for our primary outcome (i.e., HF prevalence).^(20–22)

Synthesis Methods

Study and participant descriptive statistics were calculated through counts, weighted means, and ranges. We used generalized linear mixed effects models using the logit

transformation for the meta-analysis of prevalence. We used Hartung–Knapp adjustments to calculate confidence intervals. We estimated the prediction interval around the prevalence estimate using the t-distribution. As multiple studies were included from the HOPE-HOME cohort, to avoid duplicating participants, we selected one study with the highest number of initial participants.^(21,23–27) We completed the following sensitivity analyses for the meta-analyses of prevalence: (i) excluding studies at a high risk of bias, (ii) removing studies that were not of a general representative cohort (e.g., admissions for cardiogenic shock, cancer, COVID-19, dementia), (iii) including only studies that diagnosed HF through ICD codes, and (iv) excluding abstracts. For the risk of HF and the risk of HF mortality, we pooled ORs using random effects models with generic inverse variance and estimated tau using restricted estimated maximum likelihood with the Hartung–Knapp adjustment. Measures of risk were compared to participants who were housed within a study. We conducted meta-regression for the effect of study-level age on the prevalence, risk of HF, and risk of mortality. Meta-regression for age was completed as there is (i) a known association between age and HF prevalence, and (ii) we hypothesized that this would affect estimates compared to housed adults if there was a large difference in age.^(28,29) Heterogeneity was quantified using τ , the I^2 statistic, and the Cochran Q test ($p < .05$). We used a threshold of over 75% to indicate high heterogeneity.⁽³⁰⁾ We applied the Instrument to assess the Credibility of Effect Modification Analyses (ICEMAN) tool where heterogeneous treatment effects were identified.⁽³¹⁾ We rated the quality of the evidence using the GRADE framework. Statistical analyses were conducted on R version 4.5.0 using the *meta*, *metafor*, *glmer*, *tidyverse*, *ggplot*, and *robvis* packages.⁽³²⁾

RESULTS

Study Selection

The search strategy yielded 2,421 citations, with 820 duplicates removed. Sixty-eight full-text studies were reviewed, with 21 studies meeting inclusion criteria. Backwards citation searching and the Google Scholar search identified an additional 12 studies, primarily comprising the HOPE-HOME cohort ($n = 6/32$ studies, 17.7%). This yielded a total of 34 studies. A PRISMA flow diagram is shown in Figure 1.

Study Characteristics

Studies were conducted between 1990 and 2025, primarily in the United States of America ($n = 28/34$ studies, 82.4% of studies). There were 24 cohort studies (70.6%) and 10 cross-sectional studies (29.4%), with sample sizes ranging from 39 to 285,555 among those experiencing homelessness. A total of 573,697 individuals experienced homelessness, with housed comparators contributing 46,390,207 participants. Two studies (5.9%) measured gender, two studies

(5.9%) measured participant language, seven studies (20.6%) measured income level, eight studies (23.5%) reported a level of education, and seven studies (20.6%) reported degree of social capital (social support, marital status, and loneliness). Homelessness was most commonly identified using ICD codes ($n = 9$, 26.5%), or sampling from shelters or shelter users ($n = 12$, 35.3%). The remaining studies identified homelessness from chart review, through clinics that provided care for marginalized populations, or did not specify how homelessness was measured. HF was primarily measured from ICD codes ($n = 14$, 41.2%). A diversity of study populations were represented, including emergency department users, shelter users, and cohorts with HF, diabetes, and dementia.

Participant Characteristics

Among those experiencing homelessness, the weighted mean age was 59.0 years and weighted female percentage was 19.9%. In studies that had a housed comparator, the weighted mean age was 70.8 years. In those experiencing homelessness, the psychiatric comorbidities included (median, range): anxiety disorders (45.8%, 33.2–39.5%), alcohol use disorder (18.7%, 1.7–84%), depression (35.4%, 5.0–78.7%), psychosis (8.0%, 4.4–23.6%), schizophrenia (21%, 14.2–27.8%), and substance use disorders (18.4%, 3.1–70.2%). Medical comorbidities included (median, range): atrial fibrillation (17.8%, 12.9–27.7%), coronary artery disease (13.1%, 1.1–45.1%), dyslipidemia (28.9%, 5.8–35.3%), diabetes (24.3%, 8.0–100%), hypertension (55.7%, 5.0–90.7%), stroke/transient ischemic attack (5, 0.8–12%), and peripheral vascular disease (4.8%, 2–35.8%). Study and participant characteristics are shown in Tables S1–S3 in the supplemental material.

Prevalence of HF

In 19 studies that were pooled, the prevalence of HF among older adults experiencing homelessness was 12.0% (95% confidence interval (CI) 7.3–19.1%, $I^2 = 99.9\%$) (Figure 2).^(6,9,33–49) Sensitivity analyses did not change our overall findings: (i) excluding studies from a non-representative cohort (10.3% (4.0–24.5%)), (ii) excluding studies at high risk of bias (9.9% (5.5–17.2%)), (iii) including only studies with ICD codes for diagnosis of HF (19.0% (8.0–38.9%)), and (iv) excluding abstracts (12.6% (7.3–21.0%)). Meta-regression for study-level age was not significant, with a beta-estimate of 0.11 (95% CI –0.003 to 0.22), $p > .05$. There were insufficient studies to compare prevalence differences by sex, a predefined age cut-off of 65 years, race and ethnicity, country, or type of HF. The funnel plot, Egger’s test ($p = .023$), and Doi (LFK (Luis Furuya-Kanamori) index = 1.01) test suggest the presence of small study bias toward a high prevalence of HF. The Thompson and Sharp test was negative ($p = .11$) for the presence of funnel plot asymmetry (Table S4 and Figure S2 in the supplemental material).

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases, registers, and other sources

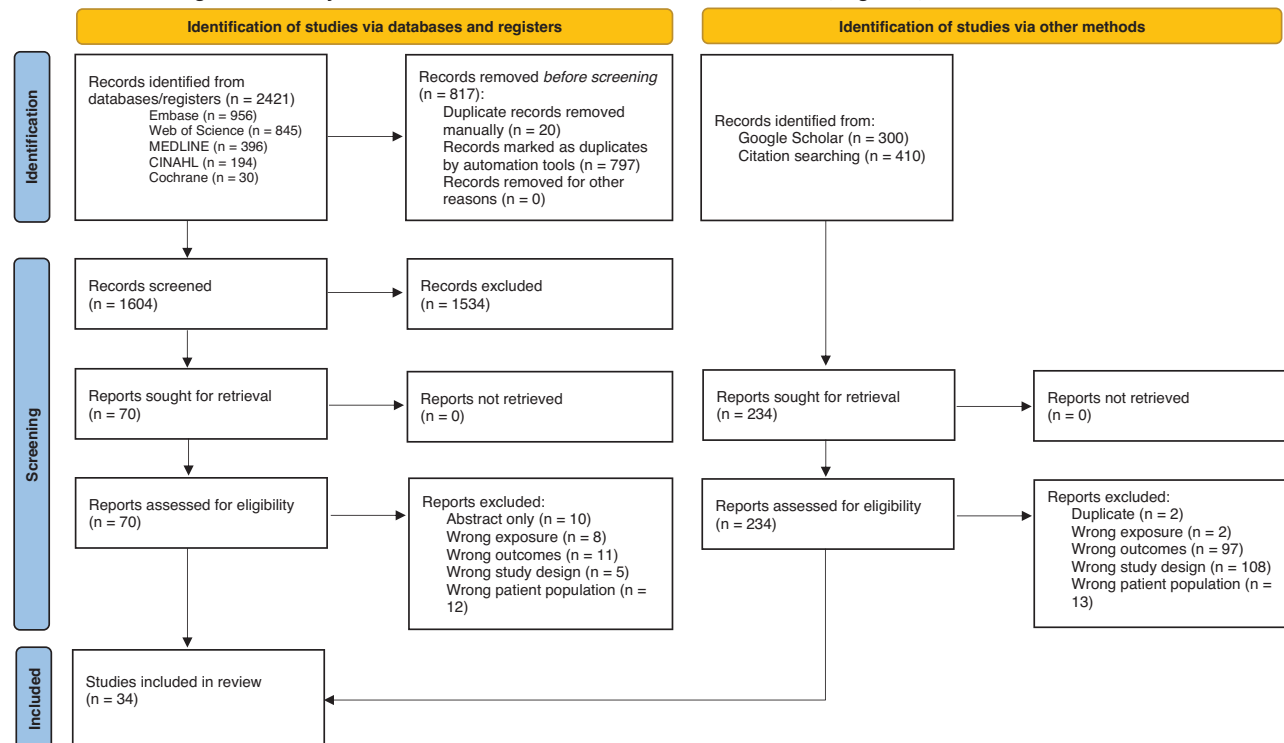


FIGURE 1. PRISMA flow diagram for the systematic review and meta-analysis of heart failure and heart failure mortality in older adults experiencing homelessness

Odds of HF, Incidence of HF, and HF Mortality

A meta-analysis of 11 studies that had a housed comparator group produced an OR of 0.93 (95% CI 0.71–1.23, $I^2 = 99.7\%$) (Figure 3).^(6,35,37–40,43,45–47,49) Excluding studies from a non-representative cohort did not change the interpretation or degree of heterogeneity (OR 0.81 (95% CI 0.24–2.73, $I^2 = 87\%$)). Meta-regression for the age difference to the risk difference of HF was non-significant ($b = -0.007$, 95% CI -0.018 to 0.003). Meta-analysis of mortality (n = 6 studies) showed an OR of 0.40 (95% CI 0.22–0.74, $I^2 = 100\%$) (Figure 4).^(6,39,46,50–52) Meta-regression for the age difference to the risk difference of HF mortality was non-significant ($b = 0.08$, 95% CI -0.13 to 0.29). No studies measured HF incidence.

Risk of Bias

Thirteen studies measuring prevalence were assessed to be at high risk of bias due to the methods in identifying HF (self-report) and several study-level non-response rates of up to 25%, which were not addressed through other statistical methods. These studies primarily consisted of the HOPE-HOME cohort, which sampled individuals from shelters. These studies would therefore have the most accurate measure of homelessness compared to the other studies using administrative data. Furthermore, many of these studies were not included in the pooled meta-analysis (to avoid duplicating participants). Nine of twelve (75%)

studies reporting a measure of risk (e.g., odds of HF or odds of HF mortality) were assessed to be at high or very high risk of bias primarily due to insufficient control for confounding. Risk-of-bias summaries are shown in Figure S3 in the supplemental material.

Assessment of Certainty (GRADE)

We had very low certainty in the prevalence estimate. The evidence is uncertain for the risk of HF and the risk of mortality (Table S5 in the supplemental material).

DISCUSSION

In this systematic review and meta-analysis of 34 studies and 573,697 older adults experiencing homelessness, the prevalence of HF was 12.0%. This prevalence is higher than population-based estimates for comparable age groups, which range from approximately 1% to 8%.^(1–3) Older adults experiencing homelessness also had a high degree of comorbidities associated with HF, including hypertension, dyslipidemia, vascular disease, atrial fibrillation, and substance use disorders. We found no association between homelessness and odds of HF (OR 0.93), and a lower odds of HF mortality (OR 0.40), though this latter finding may be an underestimation given the heterogeneous population pooled. Older adults experiencing homelessness were younger (weighted mean age: 59.0 years) than their housed counterparts (weighted mean age: 70.83

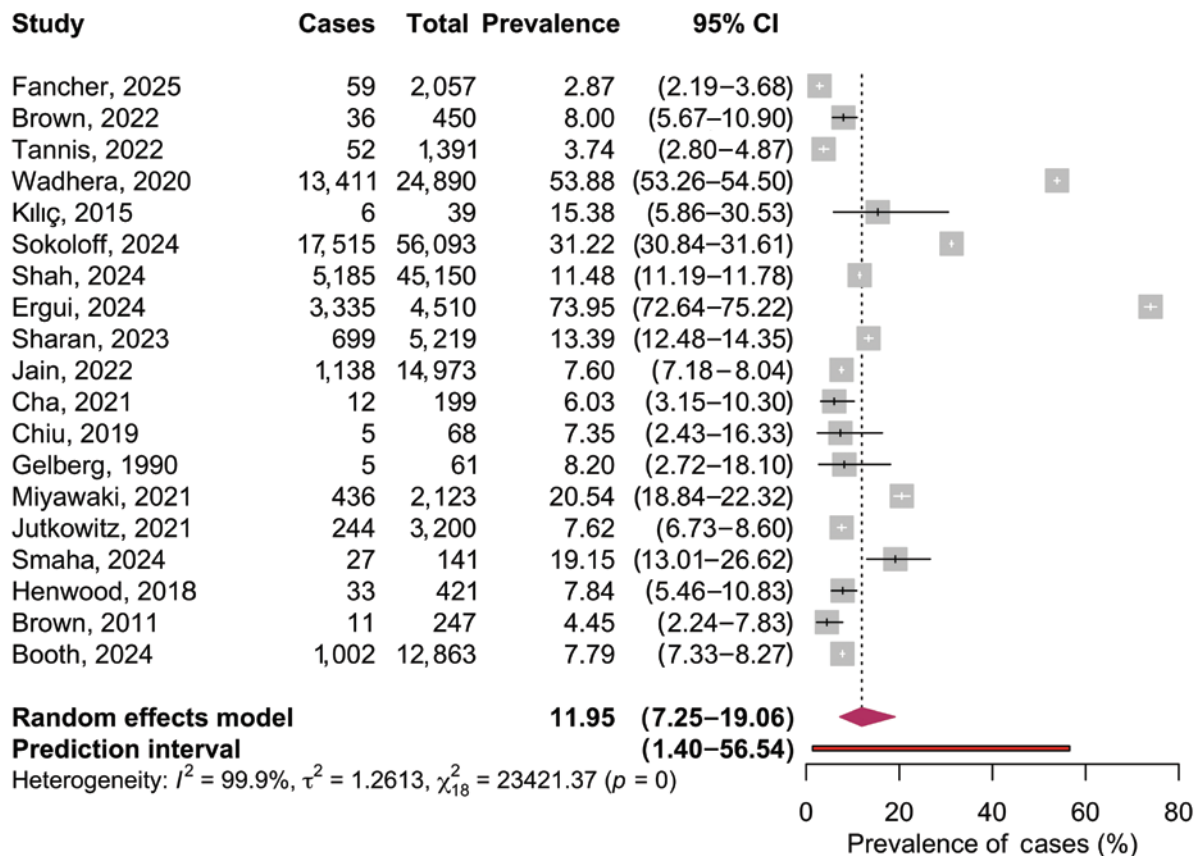


FIGURE 2. Meta-analysis of the prevalence of heart failure among older adults experiencing homelessness. Nineteen studies were pooled in the meta-analysis for the prevalence of heart failure among older adults experiencing homelessness. This figure shows that the prevalence is 11.95% (red diamond), with a 95% confidence interval from 7.25% to 19.06%. The orange line below shows the prediction interval, which is the expected outcome if another study were to be conducted in a sample similar to the included studies. CI = confidence interval

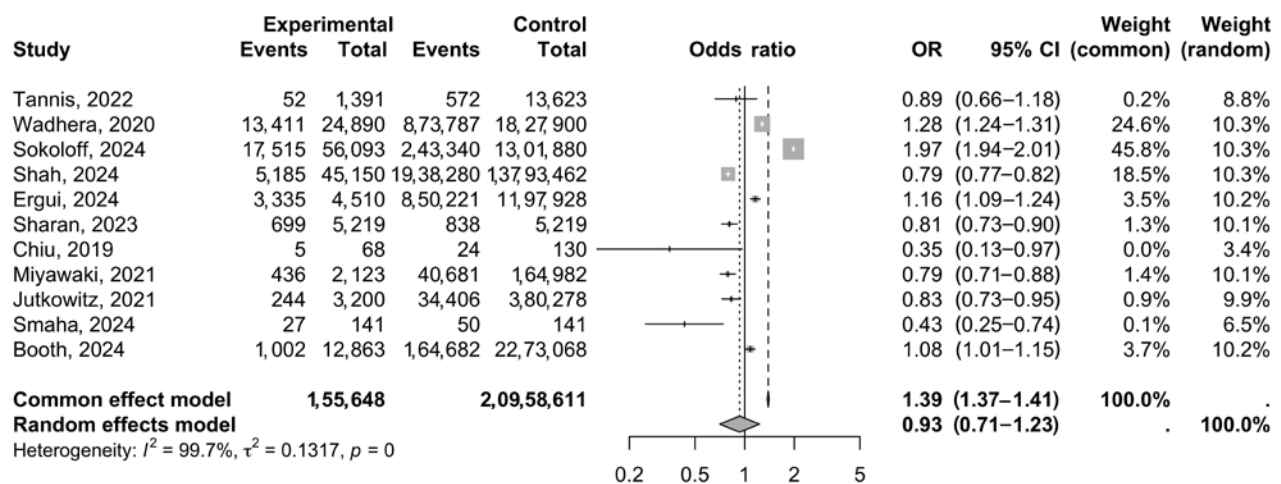


FIGURE 3. Meta-analysis of the odds of heart failure among older adults experiencing homelessness. Eleven studies were pooled in the meta-analysis for the odds of heart failure among older adults experiencing homelessness. This figure shows an odds ratio of 0.93, with a 95% confidence interval from 0.71 to 1.23. CI = confidence interval; OR = odds ratio

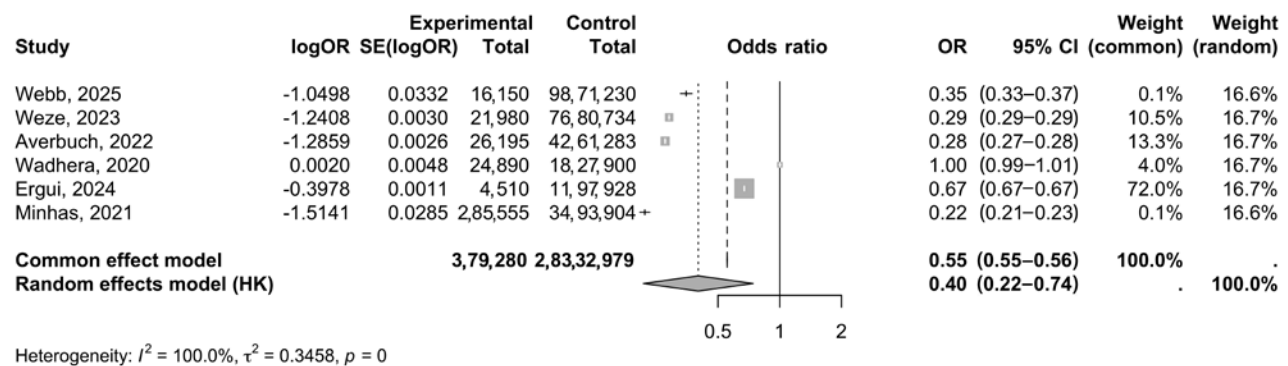


FIGURE 4. Meta-analysis of the odds of heart failure mortality among older adults experiencing homelessness. HK = Hartung-Knapp-Sidik-Jackson studies were pooled in the meta-analysis for the odds of heart failure mortality among older adults experiencing homelessness. This figure shows an odds ratio of 0.40, with a 95% confidence interval of 0.22–0.74. CI = confidence interval; OR = odds ratio; SE = standard error

years); however, meta-regression using study-level age also did not identify age as a moderator for the risk difference in HF and mortality.

This study contributes to the existing knowledge by providing an epidemiological understanding of HF burden in a population that is particularly vulnerable to health inequities. Previous studies have shown a greater risk of cardiovascular disease among homeless adults, but no study has systematically reviewed HF among housing insecure older adults.^(47,49) We expect that there may be an underestimate of HF, given that the diagnosis requires healthcare access, which may be a challenge for individuals experiencing homelessness. Our study did not identify a difference in the risk of HF and a lower risk of mortality, despite previous reviews having suggested a socioeconomic association with HF outcomes.⁽⁵⁾ We hypothesize that there may be several reasons for this. First, we included a variety of studies with different inclusion criteria to obtain a general estimate. However, this inherently leads to substantial heterogeneity in the included studies. For example, there were very few studies in the pooled risk of HF after excluding heterogeneous cohorts ($n = 3$, 27% of studies from the pooled analysis of the odds of HF). Second, despite the difference in age between the homelessness (mean age = 59.0 years) and housed (mean age = 70.8 years) cohorts, there was no association between the age difference and risk difference of HF or HF mortality through meta-regression.⁽²⁸⁾ This may be due to the aggregation of study-level data (i.e., mean age) that obscures a participant-level association, as it would otherwise be expected that those who are older are at a greater risk for HF and mortality.⁽⁵⁰⁾ Third, the causes of mortality can be prone to misclassification, and particularly in the context of competing risks, may include substance overdose, other cardiac causes (e.g., myocardial infarction and arrhythmia), and respiratory conditions (e.g., severe chronic obstructive pulmonary disease). Further, the etiology of HF may have different associations with mortality (e.g., methamphetamine-induced as compared to coronary artery disease) that differentially affect individuals experiencing

homelessness.⁽⁵¹⁾ We aimed to be as selective as possible by only including deaths among individuals admitted for HF or HF-specific mortality, recognizing that there remain misclassification limitations in these data. This would bias mortality against those experiencing homelessness. Finally, mortality may be lower due to receipt of medical care following a HF diagnosis. This may include HF-specific clinics, which have been shown to reduce hospitalizations and all-cause mortality.⁽⁵³⁾

This systematic review also highlights important gaps in the existing literature. Few studies reported income and education level, which have important implications for HF prevention and management. HF was primarily measured using ICD codes. While ICD codes are reasonably specific (positive predictive value ~98%), they do not reliably distinguish HF with reduced versus preserved ejection fraction, which dictates therapy.⁽⁵²⁾ More studies are needed to understand the causes of HF in this population to tailor prevention and treatment strategies. Very few studies outside of North America were identified and represent a need to understand geographic variations in HF epidemiology in this population.

This research has three important implications. Our findings suggest that HF is common in adults experiencing homelessness and occurs at younger ages than in the general population. Health systems and community programs should consider targeted strategies to identify and manage HF in this population, including case finding in shelters and encampments, mobile cardiology clinics, integrated primary care and case management, and pathways to ensure continuity of drug therapy. Policy approaches that improve access to stable housing and health insurance for people experiencing homelessness could also reduce the burden of HF and other chronic diseases. There is a need to establish standardized programs to identify and manage HF in this population. Second, the risk factors associated with HF in housing insecure populations require unique supports, including the management of substance use disorders, nutritional deficiencies, and equitable

access to preventative healthcare services. Third, further research is needed to understand how to engage in optimal and pragmatic guideline-directed medical therapy and advanced HF therapies in this population to improve prognosis. Future research should also prioritize longitudinal cohort studies with standardized definitions of homelessness, validated HF ascertainment (including HF subtype), and robust measurement of medication use and outcomes.⁽⁵⁴⁾ Studies from a broader range of countries are needed.⁽⁴⁾ Research should also test pragmatic interventions to improve HF diagnosis, initiation of guideline-directed medical therapy, and linkage to follow-up care among people experiencing homelessness.^(12,13,55,56)

Limitations

This review has several important limitations. Our study did not examine the degree of healthcare utilization and guideline-directed medical therapy related to HF, which is an important area for future study and an important confounder for HF mortality. We were also unable to subgroup HF-specific and all-cause mortality. We could not explain the sources of heterogeneity, though meta-analyses of prevalence often show high heterogeneity because included studies differ in case definition, sampling, setting, and measurement methods. We attempted to explain sources of heterogeneity through sensitivity analyses removing non-representative cohorts, though substantial heterogeneity remained in our pooled estimates. Our study was also unable to analyze sex differences, which is particularly important as disease burden is known to affect males more than females.⁽⁴⁾ The included studies did not differentiate HF mortality from all-cause mortality, so we could not distinctively pool these rates separately. There are also important confounding variables the included studies did not take into account (e.g., duration and severity of homelessness). Finally, many studies used ICD codes to measure housing status, which can be prone to misclassification, potentially biasing against those experiencing homelessness.

CONCLUSION

This systematic review and meta-analysis shows that older adults experiencing homelessness have a prevalence of HF higher than general population-based estimates of a similar age range. The evidence base is limited by study heterogeneity, potential bias, and a lack of longitudinal data. Priorities include improving HF detection and care delivery in housing insecure populations, standardizing exposure and outcome measurement in future studies, and evaluating pragmatic interventions to reduce HF morbidity and mortality in this vulnerable group.

ACKNOWLEDGEMENTS

The authors thank Charmaine De Castro for her support in the development and execution of the search strategy.

CONFLICT OF INTEREST DISCLOSURES

We have read and understood the *Canadian Geriatrics Journal's* policy on conflicts of interest disclosure and declare that we have none.

FUNDING

Peter Hoang and Yu Qing Huang are supported by the Clinician Scientist Training Program at the University of Toronto, the Alzheimer Society Research Program doctoral award, and the Canadian Institutes for Health Research (Vanier Canada Graduate Scholarship). The programs were not involved in any part of the study. This study was funded by the Ted Rogers Center for Heart Research, TRANSFORM HF Grant.

REFERENCES

- Emmons-Bell S, Johnson C, Roth G. Prevalence, incidence and survival of heart failure: a systematic review. *Heart*. 2022;108(17):1351-60. doi:10.1136/HEARTJNL-2021-320131
- Bozkurt B, Ahmad T, Alexander KM, Baker WL, Bosak K, Breathett K, et al. Heart failure epidemiology and outcomes statistics: a report of the Heart Failure Society of America. *J Card Fail*. 2023;29(10):1412-51. doi:10.1016/J.CARDFAIL.2023.07.006
- Redfield MM, Jacobsen SJ, Burnett JC Jr, Mahoney DW, Bailey KR, Rodeheffer RJ. Burden of systolic and diastolic ventricular dysfunction in the community: appreciating the scope of the heart failure epidemic. *J Am Med Assoc*. 2003;289(2):194-202. doi:10.1001/JAMA.289.2.194
- Shakoor A, van Maarschalkerwaart WA, Schaap J, de Boer RA, van Mieghem NM, Boersma EH, et al. Socio-economic inequalities and heart failure morbidity and mortality: a systematic review and data synthesis. *ESC Heart Fail*. 2024;12(2):927-41. doi:10.1002/EHF2.14986
- Brown RT, Kiely DK, Bharel M, Mitchell SL. Geriatric syndromes in older homeless adults. *J Gen Intern Med*. 2012;27(1):16-22. doi:10.1007/s11606-011-1848-9
- Plumb JD. Homelessness: care, prevention, and public policy. *Ann Intern Med*. 1997;126(12):973-5. doi:10.7326/0003-4819-126-12-199706150-00007
- Coe AB, Moczygemba LR, Gatewood SBS, Osborn RD, Matzke GR, Goode JVR. Medication adherence challenges among patients experiencing homelessness in a behavioral health clinic. *Res Social Adm Pharm*. 2012;11(3):e110-20. doi:10.1016/J.SAPHARM.2012.11.004
- Margolin E, Huynh T, Brann A, Greenberg B. Determinants of guideline-directed medical therapy implementation during heart failure hospitalization. *JACC Adv*. 2024;3(7):100818. doi:10.1016/J.JACADV.2023.100818
- Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *Br Med J*. 2021;372:n71. doi:10.1136/BMJ.N71
- Richard L, Hwang SW, Forchuk C, Nisenbaum R, Clemens K, Wiens K, et al. Validation study of health administrative

- data algorithms to identify individuals experiencing homelessness and estimate population prevalence of homelessness in Ontario, Canada. *BMJ Open*. 2019;9(10):e030221. doi:10.1136/BMJOPEN-2019-030221
11. McCormick N, Lacaille D, Bhole V, Avina-Zubieta JA. Validity of heart failure diagnoses in administrative databases: a systematic review and meta-analysis. *PLoS One*. 2014;9(8):e104519. doi:10.1371/journal.pone.0104519
 12. Haddaway NR, Collins AM, Coughlin D, Kirk S. The role of Google Scholar in evidence reviews and its applicability to grey literature searching. *PLoS One*. 2015;10(9):e0138237. doi:10.1371/JOURNAL.PONE.0138237
 13. Schwarzer G, Rücker G, Semaca C. LFK index does not reliably detect small-study effects in meta-analysis: a simulation study. *Res Synth Methods*. 2024;15(4):603-15. doi:10.1002/jrsm.1714
 14. Shamim MA, Dwivedi P, Padhi BK. Beyond the funnel plot: the advantages of Doi plots and prediction intervals in meta-analyses. *Asian J Psychiatr*. 2023;84:103550. doi:10.1016/j.ajp.2023.103550
 15. Thompson SG, Sharp SJ. Explaining heterogeneity in meta-analysis: a comparison of methods. *Stat Med*. 1999;18(20):2693-708. doi:10.1002/(SICI)1097-0258(19991030)18:20<2693::AID-SIM235>3.0.CO;2-V
 16. Spinelli MA, Ponath C, Tieu L, Hurstak EE, Guzman D, Kushel M. Factors associated with substance use in older homeless adults: results from the HOPE HOME study. *Subst Abuse*. 2017;38(1):88-94. doi:10.1080/08897077.2016.1264534
 17. Tong M, Tieu L, Lee CT, Ponath C, Guzman D, Kushel M. Factors associated with food insecurity among older homeless adults: results from the HOPE HOME study. *J Public Health (Oxf)*. 2019;41(2):240-9. doi:10.1093/pubmed/fty063
 18. Abbs E, Brown R, Guzman D, Kaplan L, Kushel M. Risk factors for falls in older adults experiencing homelessness: results from the HOPE HOME cohort study. *J Gen Intern Med*. 2020;35(6):1813-20. doi:10.1007/s11606-020-05637-0
 19. Garcia CM, Schrier EF, Carey C, Valle KA, Evans JL, Kushel M. Sleep quality among homeless-experienced older adults: exploratory results from the HOPE HOME study. *J Gen Intern Med*. 2024;39(3):460-9. doi:10.1007/s11606-023-08429-4
 20. Raven MC, Tieu L, Lee CT, Ponath C, Guzman D, Kushel M. Emergency department use in a cohort of older homeless adults: results from the HOPE HOME study. *Acad Emerg Med*. 2017;24(1):63-74. doi:10.1111/acem.13070
 21. Brown RT, Evans JL, Valle K, Guzman D, Chen YH, Kushel MB. Factors associated with mortality among homeless older adults in California: the HOPE HOME study. *JAMA Intern Med*. 2022;182(10):1052-60. doi:10.1001/jamainternmed.2022.3697
 22. Bozkurt B, Ahmad T, Alexander K, Baker WL, Bosak K, Breathett K, et al. HF STATS 2024: Heart failure epidemiology and outcomes statistics an updated 2024 report from the Heart Failure Society of America. *J Card Fail*. 2025;31(1):66-116. doi:10.1016/J.CARDFAIL.2024.07.001
 23. Hoang PM, Huang YQ, Jay M, Berg V, van Ballegooie C, Reppas-Rindlisbacher C, et al. Prevalence and risk of dementia among adults who have experienced homelessness, a meta-analysis. *J Am Geriatr Soc*. 2026;74(1):23-48. doi:10.1111/JGS.70072
 24. JBI Global Wiki. 4.3.10.2 Quantification of the statistical heterogeneity: I squared - JBI Manual for Evidence Synthesis - JBI Global Wiki; 2024 [accessed September 16, 2025]. Available from: <https://jbi-global-wiki.refined.site/space/MANUAL/355828547/4.3.10.2+Quantification+of+the+statistical+heterogeneity:+I+Squared>
 25. Schandelmaier S, Briel M, Varadhan R, Schmid CH, Devase-napathy N, Hayward RA, et al. Development of the Instrument to assess the Credibility of Effect Modification Analyses (ICEMAN) in randomized controlled trials and meta-analyses. *CMAJ*. 2020;192(32):E901-6. doi:10.1503/CMAJ.200077
 26. Rstudio Team. *Rstudio: Integrated Development for R*. PBC; 2020.
 27. Fancher N, Saha B, Young K, Corpuz A, Cheng S, Fontaine A, et al. An unequal distribution of the human right to health: assessing ethnic health disparities in cardiometabolic disease prevalence among Hawaii's houseless population. *Int J Hum Rights Healthc*. 2025;18(1):58-74. doi:10.1108/IJHRH-09-2023-0077
 28. Tannis C, Rajupet S. Differences in disease prevalence among homeless and non-homeless veterans at an urban VA hospital. *Chronic Illn*. 2022;18(3):589-98. doi:10.1177/17423953211023959
 29. Wadhera RK, Khatana SAM, Choi E, Jiang G, Shen C, Yeh RW, et al. Disparities in care and mortality among homeless adults hospitalized for cardiovascular conditions. *JAMA Intern Med*. 2020;180(3):357-66. doi:10.1001/jamainternmed.2019.6010
 30. Kılıç TY, Yesilaras M, Duman Atilla O, Tokar I, Temizyurek Z. Homeless patients in the emergency department. *J Acad Emerg Med*. 2015;14(2):70-4. doi:10.5152/jaem.2015.70188
 31. Sokoloff LJ, Wu J, Eberly LA, Nathan AS, Julien HM, Kobayashi TJ, et al. Association of homelessness and unstable housing with cardiovascular care utilization among Veterans. *Circ Cardiovasc Qual Outcomes*. 2024;17(11):e010993. doi:10.1161/CIRCOUTCOMES.124.010993
 32. Shah K, Santos PMG, Boe LA, Barnes JM, Tao A, Tsai CJ, et al. Inpatient care and outcomes among people with cancer experiencing homelessness. *JAMA Oncol*. 2024;10(11):1503-10. doi:10.1001/jamaoncol.2024.3645
 33. Ergui I, Salama J, Hooda U, Ebner B, Dangel M, Vincent L, et al. In-hospital outcomes in unhoused patients with cardiogenic shock in the United States: insights from the National Inpatient Sample 2011–2019. *Clin Cardiol*. 2024;47(2):e24235. doi:10.1002/clc.24235
 34. Sharan R, Wiens K, Ronksley PE, Hwang SW, Booth GL, Austin PC, et al. The association of homelessness with rates of diabetes complications: a population-based cohort study. *Diabetes Care*. 2023;46(8):1469-76. doi:10.2337/DC23-0211
 35. Jain A, Dhaduk K, Taj Shiza S, Shawl S, Raina J, Itare V, et al. Abstract 61: Major adverse cardiovascular and cerebrovascular events among homeless cancer survivors: a decade-apart nationwide hospitalizations analysis. *Circ Cardiovasc Qual Outcomes*. 2022;15(Suppl_1):A61. doi:10.1161/circoutcomes.15.suppl_1.61
 36. Cha S, Henry A, Montgomery MP, Laws RL, Pham H, Wortham J, et al. Morbidity and mortality among adults experiencing homelessness hospitalized with COVID-19. *J Infect Dis*. 2021;224(3):425-30. doi:10.1093/infdis/jiab261
 37. Chiu CA, Werge DA, Arab N, Palafox M, Minejima E. 1486: Evaluation of the impact of homelessness on presentation and outcomes of gram-negative sepsis. *Open Forum Infect Dis*. 2019;6(Suppl 2):S541. doi:10.1093/ofid/ofz360.1350
 38. Gelberg L, Linn LS, Mayer-Oakes SA. 1166: Differences in health status between older and younger homeless adults. *J Am*

- Geriatr Soc. 1990;(38):1220-9. doi:10.1111/j.1532-5415.1990.tb01503.x
39. Miyawaki A, Khullar D, Tsugawa Y. Processes of care and outcomes for homeless patients hospitalised for cardiovascular conditions at safety-net versus non-safety-net hospitals: cross-sectional study. *BMJ Open*. 2021;11(4):e046959. doi:10.1136/bmjopen-2020-046959
 40. Jutkowitz E, DeVone F, Halladay C, Hooshyar D, Tsai J, Rudolph JL. Incidence of homelessness among Veterans newly diagnosed with Alzheimer's disease and related dementias. *R I Med J* (2013). 2021;104(4):20-25.
 41. Smaha J, Falat J, Gažová A, Kužma M, Kyselovič J, Palkovič M, et al. Comparison of causes of mortality between hospitalized unsheltered homeless patients and non-homeless sex and age-matched controls: a retrospective case-control study. *Int J Public Health*. 2024;69:1607642. doi:10.3389/ijph.2024.1607642
 42. Henwood BF, Lahey J, Rhoades H, Winetrobe H, Wenzel SL. Examining the health status of homeless adults entering permanent supportive housing. *J Public Health (Oxf)*. 2018;40(2):415-8. doi:10.1093/pubmed/idx069
 43. Booth RG, Dasgupta M, Forchuk C, Shariff SZ. Prevalence of dementia among people experiencing homelessness in Ontario, Canada: a population-based comparative analysis. *Lancet Public Health*. 2024;9(4):e240-9. doi:10.1016/S2468-2667(24)00022-7
 44. Webb M, Brownell NK, Gabrielian S, Fonarow GC, Ziaean B. Examining heart failure outcomes amid housing insecurity. *J Card Fail*. 2025;31(3):511-20. doi:10.1016/j.cardfail.2024.06.005
 45. Weze K, Echols M. Hospitalization trends for patients experiencing homelessness and heart failure pre- and post-affordable care act implementation. *J Card Fail*. 2023;29(4):558-9. doi:10.1016/j.cardfail.2022.10.032
 46. Averbuch T, Mohamed MO, Islam S, Defilippis EM, Breathett K, Alkhouli MA, et al. The association between socioeconomic status, sex, race/ethnicity and in-hospital mortality among patients hospitalized for heart failure. *J Card Fail*. 2022;28(5):697-709. doi:10.1016/j.cardfail.2021.09.012
 47. Minhas A, Salah H, Shahid I, Warraich HJ, Fudim M, Nasir K, et al. Abstract 9992: Homelessness and heart failure. *Circulation*. 2021;144(Suppl_1):A9992. doi:10.1161/circ.144.suppl_1.9992
 48. Nanjo A, Evans H, Direk K, Hayward AC, Story A, Banerjee A. Prevalence, incidence, and outcomes across cardiovascular diseases in homeless individuals using national linked electronic health records. *Eur Heart J*. 2020;41(41):4011-20. doi:10.1093/EURHEARTJ/EHAA795
 49. Al-Shakarchi NJ, Evans H, Luchenski SA, Story A, Banerjee A. Cardiovascular disease in homeless versus housed individuals: a systematic review of observational and interventional studies. *Heart*. 2020;106(19):1483-8. doi:10.1136/heartjnl-2020-316706
 50. Godolphin PJ, White IR, Tierney JF, Fisher DJ. Estimating interactions and subgroup-specific treatment effects in meta-analysis without aggregation bias: a within-trial framework. *Res Synth Methods*. 2022;14(1):68-78. doi:10.1002/JRSM.1590
 51. Kevil CG, Goeders NE, Woolard MD, Bhuiyan MS, Dominic P, Kolluru GK, et al. Methamphetamine use and cardiovascular disease. *Arterioscler Thromb Vasc Biol*. 2019;39(9):1739-46. doi:10.1161/ATVBAHA.119.312461
 52. Bates BA, Akhabue E, Nahass MM, Mukherjee A, Hiltner E, Rock J, et al. Validity of International Classification of Diseases (ICD)-10 diagnosis codes for identification of acute heart failure hospitalization and heart failure with reduced versus preserved ejection fraction in a national Medicare sample. *Circ Cardiovasc Qual Outcomes*. 2023;16(2):e009078. doi:10.1161/CIRCOUTCOMES.122.009078
 53. Tran K, Butcher R. Heart function clinics for patients with heart failure. *Can J Health Technol*. 2021;1(9).
 54. Ho JE, Enserro D, Brouwers FP, Kizer JR, Shah SJ, Psaty BM, et al. Predicting heart failure with preserved and reduced ejection fraction: the International Collaboration on Heart Failure Subtypes. *Circ Heart Fail*. 2016;9(6):e003116. doi:10.1161/CIRCHEARTFAILURE.115.003116
 55. Magwood O, Hanemaayer A, Saad A, Salvalaggio G, Bloch G, Moledina A, et al. Determinants of implementation of a clinical practice guideline for homeless health. *Int J Environ Res*. 2020;17(21):7938. doi:10.3390/ijerph17217938
 56. El-Zein RS, Mohammed M, Nguyen DD, Hill CL Jr, Thomas L, Nassif M, et al. Association of medication adherence and health status in heart failure with reduced ejection fraction: insights from the CHAMP-HF registry. *Circ Cardiovasc Qual Outcomes*. 2024;17(9):e010211. doi:10.1161/CIRCOUTCOMES.123.010211

SUPPLEMENTARY MATERIALS

Supplemental material linked to the online version of the paper (<https://doi.org/10.5770/cgj.29.938>):

- **Table S1:** Study, homelessness, and heart failure characteristics
- **Table S2:** Participant characteristics
- **Table S3:** Extracted values for calculating prevalence, risk, and incidence
- **Table S4:** Publication bias assessment using Egger's test and Thompson–Sharp test
- **Table S5:** Assessment of GRADE
- **Figure S1:** Search strategy
- **Figure S2:** Funnel plots for the prevalence of heart failure and odds of heart failure
- **Figure S3:** (A) Risk-of-bias summary for the prevalence of heart failure. (B) Risk-of-bias traffic light plot for the prevalence of heart failure. (C) Risk-of-bias summary for the risk of heart failure and risk of mortality. (D) Risk-of-bias traffic light plot for the risk of heart failure and risk of mortality
- **Appendix S1:** PRISMA checklist
- **Appendix S2:** Moose checklist

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