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SYSTEMATIC REVIEW AND META-ANALYSIS

Influence of Social Determinants of Health on Heart Failure Outcomes: A Systematic Review

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BACKGROUND: Prior research suggests an association between clinical outcomes in heart failure (HF) and social determinants of health (SDoH). Because providers should identify and address SDoH in care delivery, we evaluated how SDoH have been defined, measured, and evaluated in studies that examine HF outcomes.

METHODS AND RESULTS: Following Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines, databases were searched for observational or interventional studies published between 2009 and 2021 that assessed the influence of SDoH on outcomes. Selected articles were assessed for quality using a validated rating scheme. We identified 1373 unique articles for screening; 104 were selected for full-text review, and 59 met the inclusion criteria, including retrospective and prospective cohort, cross-sectional, and intervention studies. The majority examined readmissions and hospitalizations (k=33), mortality or survival (k=29), and success of medical devices and transplantation (k=8). SDoH examined most commonly included race, ethnicity, age, sex, socioeconomic status, and education or health literacy. Studies used a range of 1 to 9 SDoH as primary independent variables and 0 to 7 SDoH as controls. Multiple data sources were employed and frequently were electronic medical records linked with national surveys and disease registries. The effects of SDoH on HF outcomes were inconsistent because of the heterogeneity of data sources and SDoH constructs.

CONCLUSIONS: Our systematic review reveals shortcomings in measurement and deployment of SDoH variables in HF care. Validated measures need to be prospectively and intentionally collected to facilitate appropriate analysis, reporting, and replication of data across studies and inform the design of appropriate, evidence-based interventions that can ameliorate significant HF morbidity and societal costs.

Key Words: heart failure ■ social determinants of health ■ systematic review

Heart failure (HF) is a growing public health epidemic that is expected to affect >8 million Americans aged ≥18 years and cost the US health system nearly $69.7 billion by 2030.[1,2] Although the major clinical risk factors for HF are well known,[3,4] the prevalence of these factors vary based on social determinants of health (SDoH). SDoH, defined as the conditions in which people are born, live, learn, work, play, worship, and age, are generally grouped into the following 5 domains: economic stability, education access and quality, healthcare access and quality, neighborhood and built environment, and social and community context.[5] For example, economic instability (eg, poverty, unemployment) is associated with reduced ability to afford the resources needed to manage HF, such as healthy foods, stable housing, and working utilities. Poverty is also associated with increased toxic stress and related adverse health

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CLINICAL PERSPECTIVE

What Is New?

- The association between social determinants of health (SDoH) and heart failure outcomes has been extensively studied, yet the findings from this systematic review suggest that substantial gaps exist in our understanding of the ways in which SDoH influence heart failure outcomes.
- The wide variability of SDoH constructs and proxy measures used across studies may account for the differences in reported results.

What Are the Clinical Implications?

- The use of validated SDoH measures that are standardized across studies is necessary to inform the design of evidence-based interventions that support patient-centered management of heart failure.
- Future research should focus on prospectively and intentionally collecting SDoH data in a way that facilitates appropriate analysis, reporting, and replication of data across heart failure studies.

Nonstandard Abbreviations and Acronyms

EMR electronic medical record
SDoH social determinants of health

effects (eg, high blood pressure, inflammation).[5] Poor education is associated with limited health literacy and numeracy, skills needed to self-manage HF.[5] Lack of access to high-quality health care is associated with limited receipt of timely preventive care and treatment for chronic illness.[5] Neighborhoods with unsafe air or water or limited access to parks and sidewalks are not only associated with greater exposure to health and safety risks but also reduced opportunities for physical activity.[5] Social and community context, characteristics of the relationships among people and the settings in which they interact, are associated with mental health outcomes, health behaviors, morbidity, and mortality. Supportive social networks, for example, are associated with reduced depression and anxiety, improved ability to cope with health issues, transportation and caregiving support, and overall better health. Social cohesion and civic engagement are associated with reducing the negative health impacts of structural racism, discrimination, and implicit bias (eg, stress, depression).[5] These upstream SDoH are factors, in addition to traditional physiological characteristics, that are associated with the risk that a person will be adversely affected by a wide range of downstream health outcomes.[6,7] Prior research suggests that SDoH may contribute ≈30% to 55% to health outcomes (World Health Organization, 2021)[8] and be a direct cause of acute exacerbations of chronic diseases by influencing lifestyle, behavior, stress, and environmental exposures.[9] The American Heart Association has highlighted the importance of focusing on individual- and neighborhood-level SDoH in facilitating self-care and navigation across the healthcare system and in developing interventions to improve the health outcomes of patients with HF.[10]

During the past decade, US policy makers have accelerated attempts to address adverse HF outcomes, such as mortality, readmissions, and higher costs, through reimbursement models that link Medicare and Medicaid payments to outcomes (eg, Hospital Readmissions Reduction Program, Accountable Care Organizations). In response to this pressure, providers are increasingly exploring models of care that address both clinical risk factors and SDoH for patients with HF. Impediments to such efforts include challenges in measuring and evaluating the influence of SDoH in HF care and, subsequently, developing risk-stratification models that address or control for the influence of SDoH on HF outcomes. Such information can be used in US health policy and healthcare decision making to improve risk adjustment in value-based care models and develop and evaluate evidence-based interventions that improve HF care.

Therefore, although a top-level summary of SDoH data was performed in the American Heart Association's Scientific Statement, we conducted a systematic and critical review using Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines and recent findings relevant to US settings. The objective of this study was to summarize how SDoH have been included, defined, measured, and evaluated in studies that examine outcomes in HF. Our specific aims were to (1) characterize the constructs of SDoH included in research that examines HF outcomes and (2) summarize the current state of evidence about the influence of SDoH on HF outcomes.

METHODS

As a systematic review based on data from published studies, this work does not require approval from an ethical standards committee. The authors declare that all supporting data are available in the article (and its online supplementary files). The protocol for this review is consistent with the PRISMA[11] and the PRISMA Equity 2012 extension[12] statements. Inclusion and exclusion criteria, information sources, and data collection procedures were defined a priori.

Search Strategy and Study Selection

A research librarian searched PubMed, Cumulative Index to Nursing and Allied Health Literature, Scopus, ABI/INFORM, and Web of Science for articles that met the inclusion criteria and were published from January 2009 through March 2021. The start date was selected to align with the beginning of national policy discussions about healthcare reform and the Affordable Care Act. In general, the following words and related Medical Subject Headings terms were used to search relevant databases: "heart failure," "hospitalization," "hospital readmission," "emergency service," "mortality," "complications," "predict," and "factor." The full search strategy for each database is detailed in Table S1. The search retrieved observational and interventional studies that focused on patients with HF and had the primary or secondary objective of examining or addressing SDoH risk factors related to adverse HF outcomes. The reference lists of relevant systematic reviews and gray literature were searched manually for additional articles.

To be eligible for inclusion, studies must have been available as a full-text article, written in English, and published in a peer-reviewed journal. In addition, the studies must have been original investigations, reported quantitative data, and featured documentation and discussion of the influence of SDoH on HF outcomes. Results could be reported at the patient, hospital, or community level. We excluded studies in which SDoH were used only to adjust for potentially confounding effects in statistical models, with no discussion of their association with HF outcomes. We limited our review to studies conducted in US populations considering important differences between the United States and other countries in healthcare and social welfare policies and infrastructures. Reviews, editorials, and opinion articles were also excluded.

A total of 2 reviewers independently screened all titles and abstracts for eligibility based on the inclusion and exclusion criteria. Following this procedure, the full texts of articles eligible for further review were examined in detail. The reviewers were not blinded to the authors, journals, or funding sources. Disagreements regarding eligibility were resolved by consensus or intervention of a third team member.

Data Extraction and Quality Assessment

Data from included studies were abstracted by at least 2 reviewers, independently and in duplicate, using a standardized electronic form developed for this review. The abstracted data included study type (observational: retrospective, prospective, cross-sectional, or intervention), geographic location, population (sample size and unique characteristics), data sources, measured outcomes, SDoH predictors, intervention characteristics (if applicable), and results. Study authors were not contacted for additional data. Results are reported for adjusted models only. For cases in which multiple cohorts were studied (eg, acute myocardial infarction or community-acquired pneumonia in addition to HF), we limited the reporting of results to the HF cohort only. CIs are reported at $\alpha=0.05$ unless otherwise indicated. Results were not analyzed across studies because of the heterogeneity of the interventions, study designs, and outcomes.

A total of 2 reviewers independently assessed study quality using a modified Oxford Centre for Evidence-Based Medicine rating scheme and evaluated for interrater comparability. Using this methodology, studies were rated 1 (highest quality) to 5 (lowest quality). Studies receiving the highest rating were properly powered and conducted randomized controlled trials, well-designed controlled trials without randomization or prospective comparative cohort trials were rated 2, case control and retrospective cohort studies were rated 3, case series and cross-sectional studies were rated 4, and opinion and case reports (rating 5) were not included in this review. Disagreements were resolved by consensus.

RESULTS

Study Characteristics

The search identified 1373 unique records for title/abstract screen; 104 were selected for full-text review. The PRISMA study flow diagram summarizing the article screening process is depicted in Figure S1. In total, 59 articles met the criteria for inclusion (Table S2).[13–71] The studies were published from 2009 to 2021 and included observation periods that spanned from 1987 to 2018.

The study characteristics are summarized in Table 1. These included retrospective cohort (k=30), prospective cohort (k=19), cross-sectional (k=5), and intervention (k=5) studies. A total of 24 studies evaluated nationally representative samples of patients with HF, whereas others were conducted in regional or state urban/suburban (k=25), urban/suburban and rural (k=8), or rural only (k=2) hospitals or clinics. The studies used multiple data sources, including electronic medical records (EMRs; k=25), national surveys (k=16), research studies (k=14), Medicare claims (k=13), patient questionnaires (k=10), disease registries (k=8), state or national death indices (k=6), and health exchanges or administrative data (k=6). Only 1 study analyzed state-level data,[55] whereas all other studies analyzed patient-level data (k=58). The primary outcomes measured were mortality or survival (k=29), readmissions (k=33), and medical device and transplantation use and complications (k=8). Other use outcomes were measured less frequently (eg, hospital length of stay, emergency department visits, postdischarge follow-up visits).

Table 1. Characteristics of Included Studies (k=59)

Characteristic	No. (%)*	Studies
Study type		
Retrospective cohort	30 (51)	13,17–19,21,22,25–30,38,40,41,43,46,47,49,52,55–57,64–66,70,71
Prospective cohort	19 (32)	14,15,20,23,31–33,39,42,44,48,50,51,53,58,59,63,67–69
Cross-sectional	5 (8)	34,36,54,61,62
Intervention	5 (8)	16,24,35–37,45,60
Study setting		
National	24 (41)	18,21–23,26,27,30,34,38,40,41,47–49,53,55,56,59,61–63,66,70,71
Regional or state		
Urban	25 (42)	13,15–17,20,24,25,28,31–33,35–37,42,43,45,46,51,52,54,57,58,60,65
Urban/rural	8 (14)	14,29,39,44,50,64,67,69
Rural	2 (3)	19,68
Level of analysis		
Patient	58 (98)	13–54,56–71
State	1 (2)	55
Data source†		
Electronic medical record	25 (42)	13,15–17,19,24,25,28,33,39,40,43,45,46,51–54,57–60,62,65,69
National surveys	16 (27)	13,14,26,27,29,32,47,50,55,56,59,61,62,70,71
Study data	14 (24)	14,16,18,31,32,35,36,39,42,46,53,59,67,68
Medicare claims	13 (22)	22,23,26,27,38,39,41,47,55,56,59,62,63
Patient questionnaires	10 (17)	15,20,24,33,35,37,42,44,51,58
Disease registries	8 (14)	13,21,27,30,41,48,63,64
Data exchange and/or administrative data	6 (10)	42,44,49,50,66,69
Death index	6 (10)	28,34,40,43,57,58
Other data†	7 (12)	39,42,53–56,69
Outcomes analyzed		
Mortality or survival	29 (49)	30 d[15,26–28,40,52,56,57,62,63] 60 d[57] 90 d[40,59] 180 d[13,40,43,63] 1 y[63] Other[21,30,32,34,35,39,42,44,46,51,57,58,62,64,65,70]
Readmissions	33 (56)	13,15–17,19–24,26–28,32,33,35,38,40,43,45–47,49,50,52,55–57,60,61,63,65,66
Medical device or transplantation, including complications	8 (14)	13,21,29–31,48,61,70
Other‡	26 (44)	13,40,63,64,70,71

*Percentages may not equal 100% because of rounding.

†Percentages may not equal 100% because of rounding or inclusion of >1 data source. Other data sources include patient and family interviews (k=5), Kaiser Family Foundation reports (k=1), Dartmouth Atlas (k=1), content analysis of obituaries (k=1), and medication event monitoring system (k=1).

‡Other use included postdischarge follow-up (k=5),[22,24,41,64,66] length of stay (k=5),[13,40,63,64,70] hospitalizations (k=5),[18,44,68,71] emergency department visits (k=4),[20,22,44,46,53] financial penalties or costs (k=2), self-care (k=2), evidence-based care processes (k=2), and hospice (k=1).

Social Determinants of Health

The frequencies of SDoH examined as primary and control factors in the studies are illustrated in the Figure and referenced in Table S3. On average, the 59 studies examined 3.5 SDoH as primary regressors of interest (SD, 2.1; range, 1–9) and controlled for 2.5 sociodemographic factors (SD, 2.1; range, 0–7). The SDoH most commonly examined were age (k=55), race and ethnicity (k=55), and sex (k=54). A majority of studies examined multiple socioeconomic status (SES) constructs as primary contributors to HF outcomes, including insurance status (k=27), income or wealth (k=14), education or health literacy (k=13), employment (k=2), urban/rural residence (k=9), social instability (k=3), and composite measures of individual- or neighborhood-level SES (k=12). For example, studies measured social (in) stability by calculating the number of home address or zip code changes by an individual or in a neighborhood and measured neighborhood SES using the Area Deprivation Index or median household income. Social support was measured directly through self-report (k=8) and via proxy: marital status (k=11), living status (k=6), and children (k=1). The cultural constructs of language (k=3) or spirituality (k=3) were also examined. In total, 19 studies used a validated scale to measure specific SDoH domains (Table S4).

Association Between SDoH and HF Outcomes

Mortality or Survival

The included studies measured mortality rate as the percentage of people in the observation group who died of HF during a specific period of time (eg, 30 days, 60 days, 1 year); the survival rate measured the percentage of people in the group who were still alive for a specific period of time after they were diagnosed with or started treatment for HF. The 29 studies that examined mortality or survival are presented in Table 2. In these studies, Black race (compared with White race) was associated with both decreased[26–28,63] and increased[52,59,70] mortality or survival; similarly, Hispanic ethnicity (compared with non-Hispanic White ethnicity) was associated with decreased[27,63] and increased mortality risk.[52,59,70] Older age (compared with younger age groups) was associated with increased HF mortality risk in several studies,[42,43,46,51] whereas younger (compared with older) age was associated with increased in-hospital mortality risk in a study examining cardiogenic shock unrelated to acute coronary syndrome.[70] In 1 study, no significant association between age and mortality was found.[28] In 2 studies, female sex (compared with male sex) was associated with increased[70] and decreased[43] mortality risk; in 2 other studies, no significant association was found.[28,44] Although 1 study found that having an educational

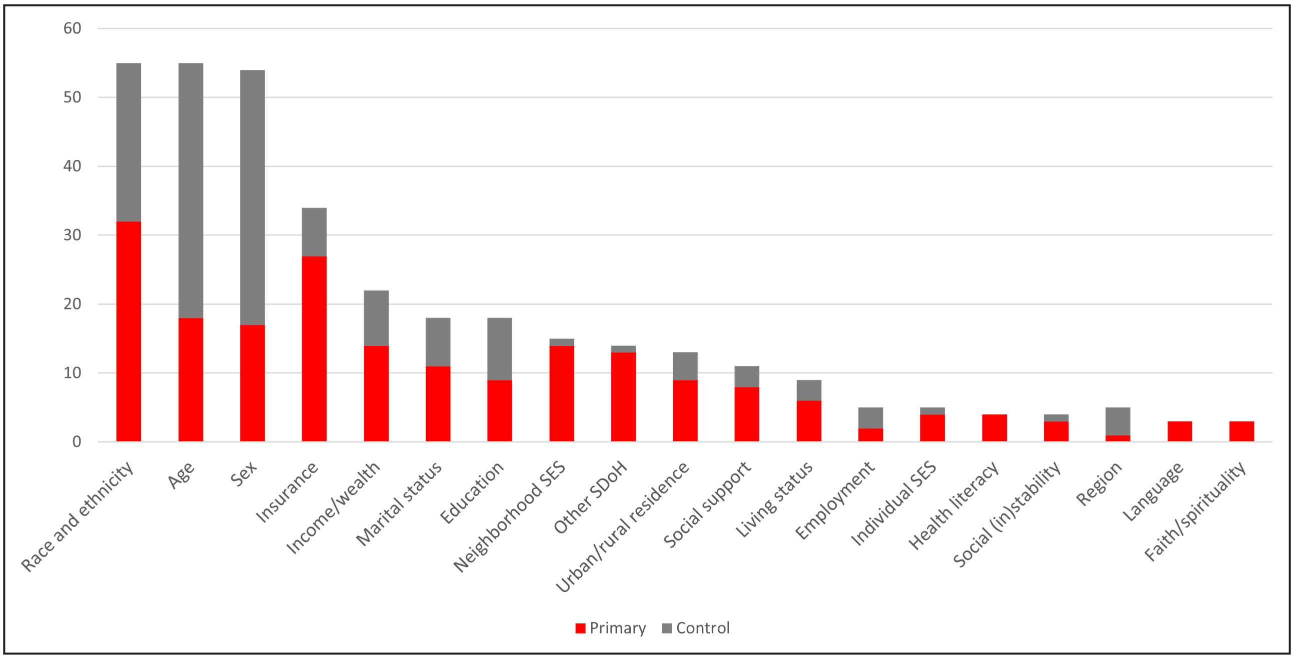

Figure. Summary of SDoH analyzed in the studies (k=59).
Other SDoH: access to care (k=3), veteran priority group (k=2), other psychosocial risk (k=2), cumulative SDoH burden (k=2), children (k=1), SHS exposure (k=1), hospice (k=1), public health infrastructure (k=1), and self-efficacy (k=2). SDoH indicates social determinants of health; SES, socioeconomic status; and SHS, second hand smoke.

attainment of high school or less (compared with at least some college) and lower (compared with higher) health literacy were associated with increased mortality risk,[46] education was not significantly associated with mortality risk in 4 studies.[13,27,56,59] Primary language spoken at home was not significantly associated with mortality risk.[28] No significant association between insurance status and HF mortality risk was observed,[13,28,32,42,64] with the exception of 1 study, where lack of insurance was associated with decreased mortality risk.[42] Marital status was an inconsistent influence: being married was associated with increased[58] or decreased mortality risk[43]; in 2 studies,[13,65] no significant association between marital status and mortality risk was found. Faith/spirituality was associated with decreased mortality risk,[51] whereas a lack of faith identification was associated with increased mortality risk.[40] In 3 studies, no significant association between neighborhood SES and mortality was observed[28,40,42]; in 1 study, it was associated with increased HF mortality risk.[38] Compared with limited access, greater access to cardiology services was also associated with decreased HF mortality risk.[57]

Table 2. Effect of Social Determinants of Health on Mortality or Survival, k=29 Studies

Social determinants of health	Increased risk	Decreased risk	No statistically significant association found
Black race	52,59,70	26–28,63	…
Hispanic ethnicity	52,59,70	27,63	…
Age	Older[42,43,46,51] Younger[70]	…	28
Sex	70	43	28,44
Education	Low[46]	…	13,27,56,59
Language	…	…	28
Insurance	…	Lack[42]	13,28,32,64
Married marital status	58	43	13,65
Faith/spirituality	Lack[40]	51	…
Neighborhood socioeconomic status	38	…	28,40,42
Access to cardiology	…	57	…

Readmissions

The studies examined hospital readmissions as an unplanned episode in which a patient who had been discharged from a hospital is admitted again in a certain period of time (eg, 30, 60, 90 days) after the index admission for HF. The 33 studies that examined readmissions are presented in Table 3. Factors associated with increased readmissions included Black race[22,23,26,49,52,63] and Hispanic ethnicity[22,63] (compared with other or unknown[23] or Asian, Hawaiian or Pacific Islander, Native American, other, or mixed[56] race and ethnicity), Medicare[15,22,52] and Medicaid[32] (compared with private insurance), male sex (compared with female sex),[15] older age (compared with younger age),[23] unmarried (compared with married),[15] or disabled (compared with those without a disability).[17,38] Additional factors included poverty[38] or lower neighborhood-level income (compared with higher income),[32] low neighborhood SES (compared with medium and high income),[38,50] higher (compared with lower) proportion of neighborhood-level white collar workers,[27] social (housing) instability (compared with higher stability),[15,38] education (high school or less compared with more than high school),[27] and low (compared with high) social support.[21] Factors associated with decreased readmissions included several from the preceding list, including Black race[23] or Non-White race (Asian, Hawaiian or Pacific Islander, Native American, other, or mixed) race (compared with White race)[56] and older age (compared with younger age).[28,49] Others included private (compared with public)[22,49,61] or no insurance (compared with private or public insurance),[61] female sex (compared with male sex),[23,49] married (compared with unmarried), independently living with family (compared with living alone or in a nursing facility),[43] and having children (compared with

Table 3. Effect of Social Determinants of Health on Readmissions, k=33 Studies

Social determinants of health	Increased risk	Decreased risk	No statistically significant association found
Black race	[22,23,26,49,52,63]	Black race[23] Non-White race (Asian, Hawaiian or Pacific Islander, Native American, other, or mixed) [56]	…
Hispanic ethnicity	[22,63]	…	Individual[17,19,27,28,47,57] State level[55]
Insurance	Medicare[15,22,52] Medicaid[32]	Private[22,49,61] No[61]	Any[13,17] Medicaid[22,47]
Sex	Male[15]	Female[23,49]	[17,19,22,55,61]
Older age	[23]	[28,49]	[17,19,22,43,61]
Marital status	Unmarried[15]	Married[43]	[13,17,19,43,47,65]
Disabled	[17,38]	…	…
Poverty	[38]	…	…
Neighborhood income	Low[32]	High[47,56]	[26,27,56]
Neighborhood socioeconomic status	[38,50]	…	[15,40]
Neighborhood-level white collar workers	[27]	…	…
Social instability	[15,38]	…	…
Education	High school or less[27]	Bachelor's or higher[56]	[13]
Social support	[21]	…	…
Children	…	[47]	…
Access to cardiology	…	[16,24,45]	…
Living status	…	…	[19,47]
Individual income	…	…	[13]
Neighborhood-level home value	…	…	[27]
Urban or rural	…	…	[13,28,40]
Language	…	…	Individual[19]
Faith/spirituality	…	…	[40]
Health literacy	…	…	[46]
State-level language	[55]	…	…
State-level median household income	[55]	…	…

no children).[47] Educational attainment of a bachelor's degree or higher (compared with high school or less),[56] higher (compared with lower) neighborhood-level income,[47,56] and access to cardiology[28,57,60] or navigation services (compared with limited or no access to these services) were also associated with decreased readmissions.[16,24,45] In several studies, some of these same factors, as well as others, were not associated with readmissions: individual-level[17,19,27,28,47,57] or state-level race and ethnicity[55]; insurance status,[13,17] including Medicaid[22,47]; sex[17,19,22,55,61]; age[17,19,22,43,61]; marital status[13,17,19,43,47,65]; living status[19,47]; individual-level[13] and neighborhood-level income[26,27,56]; neighborhood-level SES[15,40]; neighborhood-level home value[27]; urban or rural residence[13,28,40]; education[13]; language[19]; faith/spirituality[40]; and low health literacy.[46]

In 1 state-level study, states with greater proportions of residents speaking a primary language other than English at home (compared with speaking English) were associated with decreased probability of ranking "worse" on readmissions compared with other states. States with higher median incomes were associated with increased probability to be "worse" than the US national rate.[55]

Medical Devices or Transplantation

A total of 8 studies examined implantation of manufactured medical devices, including a continuous flow left ventricular assist device as bridge-to-transplant or destination therapy for patients with HF, implantable cardioverter-defibrillator implantation, mechanical circulatory support devices, or heart transplantation (Table 4). Some studies also examined complications related to these procedures, such as device-related infection, gastrointestinal bleeding, device thrombosis, stroke, or any cause rehospitalization. In these studies, younger age (compared with older age),[70] male sex (compared with female sex),[30,48,70] and state Medicaid expansion (compared with nonexpansion)[29] were associated with increased probability of device implantation or transplantation. Black race (compared with White race),[30,48] older age (compared with younger age),[48] female sex (compared with male sex),[61] and being uninsured (compared with public or private insurance)[48] were associated with decreased probability of device implantation or transplantation. In 6 studies, race and ethnicity,[29,31,70] age,[61] education,[13,30,31] income,[13,31] insurance status,[13,30,31,61] urban/rural residence,[13] and neighborhood-level SES[30] were not significantly associated with medical device implantation or transplantation.

Other Outcomes

Other outcomes examined with similar variability in the findings included hospital length of stay[13,40,63,64,70]; hospitalizations other than readmissions, such as index hospitalizations for HF (eg, hospitalization for which the *International Classification of Diseases Ninth Revision* [ICD-9] clinical modification discharge code for HF was used as the first listed discharge code)[18,44,68,71]; emergency department visits not resulting in hospitalization[20,22,44,46,53]; and postdischarge planned follow-up visits, such as primary care visits in a certain time frame.[22,24,41,64,66]

Quality of Evidence

Of the 59 studies, 1 was rated as 1 (randomized clinical trial), 22 were rated 2 (well-designed controlled trials without randomization, prospective comparative cohort trials), 30 were rated 3 (case-control studies, retrospective cohort studies), and 6 were rated 4 (case series with or without intervention, cross-sectional studies).

DISCUSSION

This systematic review of HF literature suggests that substantial gaps exist in our understanding of the

Table 4. Effect of Social Determinants of Health on Medical Devices or Transplantation, k=8 Studies

Social determinants of health	Increased risk	Decreased risk	No statistically significant association found
Age	Younger[70]	Older[48]	[61]
Sex	Male[30,48,70]	Female[61]	…
State Medicaid expansion	[29]	…	…
Black race	…	[30,48]	…
Uninsured	…	[48]	[13,30,31,61]
Race and ethnicity	…	…	[29,31,70]
Education		…	[13,30,31]
Income	…	…	[13,31]
Urban/rural	…	…	[13]
Neighborhood-level socioeconomic status	…	…	[30]

ways in which SDoH are measured and the relationship of SDoH to HF outcomes. Of 59 studies meeting criteria, including data derived from retrospective and prospective cohorts, cross-sectional designs, and interventions, the majority examined mortality/survival and hospital readmissions. Studies used a wide range of SDoH as primary independent variables and as controls, with data derived from multiple sources, often EMRs linked with national surveys, disease registries, or data from large national studies. SDoH most commonly evaluated included race and ethnicity, age, and sex, whereas socioeconomic status, social support, educational status, and health literacy were assessed less frequently. However, we found that studies investigating the influence of SDoH on HF outcomes produced disparate results. Consistent with a systematic review of articles published between 1981 and 2008,[72] this finding highlights the need for more targeted research to clarify the impact of SDoH on HF, particularly in light of the rapid evolution of SDoH data collection and use during the past 25 years. Indeed, the heterogeneity of study designs, target populations, SDoH constructs, covariates used to adjust the statistical models, and HF outcomes in published studies are underlying reasons for differences in the reported results. However, recent imperatives, such as the proliferation of value-based payment models and Medicare readmissions penalties, drive the need to better understand and address SDoH in conjunction with clinical risk factors for patients with HF and other chronic diseases.

Specifically, many of the measured SDoH lacked construct validity. For example, in assessing social support and its relationship to HF readmissions, proxy EMR variables were used, including marital status and whether the patient had a child. The degree to which these proxies have been validated is not clear. Few studies used accepted measures of social support or social isolation. Because variables listed as SDoH may be poor proxies for SDoH constructs, they may not be well suited for understanding potentially policy-responsive effects of SDoH on HF outcomes. For example, race and ethnicity were the most commonly included SDoH. Although these variables are easy to measure and routinely included in EMRs and disease registries, other variables potentially more relevant to poor health outcomes exist (eg, racism, discrimination, provider uncertainty, implicit bias) and can be measured using validated instruments and approaches (eg, Everyday Discrimination Scale, Experiences of Discrimination Measure, Patient Experience Measures from the Consumer Assessment of Healthcare Providers & Systems Clinician & Group Survey). Our results are also consistent with recent studies that call for greater clarity in conceptualizing and more specificity in measuring SDoH to support improved clinical and shared decision making and patient self-care.[10,73,74] Moreover, our findings regarding the inconsistent definitions and lack of construct validity in SDoH measures help to explain, in part, the differences in results across studies that investigate the effect of SDoH on HF mortality and readmissions.[75,76] The use of standardized SDoH measures and covariates across studies could help to produce more consistent results and enable researchers to conduct robust meta-analyses.

The heterogeneity of data sources and SDoH constructs employed across studies may also explain the lack of consistent results. Most studies were secondary, retrospective analyses of EMRs, which may have data quality issues and, more important, were not designed to specifically address SDoH. Furthermore, most studies focus on readmissions and mortality, which are publicly reported measures, rather than on the relationship between SDoH, processes of care (eg, length of stay, follow-up visits), and patients' self-reported outcomes. Indeed, researchers and policy makers use what is available, and the focus on collecting and documenting SDoH in EMRs and other data repositories is relatively new. However, some social constructs (such as language and spirituality) may be important but difficult to assess and include in studies. Conversely, larger-scale community factors (eg, county characteristics) are measured in more standardized ways and are publicly available.

Another potentially important finding is that significant gaps remain in our understanding of how various pathways, and interactions among various SDoH in those pathways, may explain differences in results regarding specific SDoH across studies. Although some studies focused on a target population or reported stratified results based on a specific SDoH (eg, race and ethnicity), none of the studies explored interactions between SDOH domains to examine the potential role of intersectionality on HF outcomes. For example, race by sex or race by income are potentially important interactions that warrant investigation. These overlapping socioeconomic identities may combine to exacerbate or ameliorate discrimination or privilege. Such knowledge would help to disentangle the degree to which specific SDoH mediate or moderate outcomes or whether the cumulative or intersectional impact of SDoH explain greater, lesser, or no effect of SDoH on HF outcomes.

Our systematic review has limitations that might limit generalizability. We purposefully did not include studies outside the United States. Although these studies may give additional insight, differences in lifestyles, behaviors, social structure, and healthcare delivery systems limit their applicability to the US setting. Furthermore, in the United States, there has been increased attention paid to SDoH in large part because of the recognition of health inequities in the American healthcare system. Our search may have excluded studies that do not identify variables as SDoH. Despite our efforts to identify a comprehensive set of articles, it is possible that our search missed relevant studies that fit our inclusion criteria. We attempted to minimize this possibility by reviewing reference lists of included articles and related systematic reviews. We did not contact the study authors, so we may have missed some information. Publication and potential researcher bias in establishing study inclusion criteria may also have been present in our study.

In conclusion, a critical and systematic assessment of studies reporting on the influence of SDoH on HF outcomes reveals significant shortcomings in the measurement and deployment of SDoH variables. Although the problem may be generic and not specific to HF, additional investigations may be warranted (eg, in diabetes care) to identify standardized measures that can be applied across conditions and studies.

Given the limitations of EMRs for measuring SDoH, which may have constrained studies in the past, significant redesign may be required not only in its structure but also in the facilitation of data collection by providers. Ultimately, validated SDoH measures need to be prospectively and intentionally collected in a way that is analyzable, reportable, and actionable in health policy and healthcare decision making. A key challenge will be to figure out how SDoH modules in EMRs can be individualized by disease state and can be incorporated in a way that will not disturb current workflows. We suggest that 1 way to move forward will be to launch a series of demonstration projects using a relatively parsimonious list of key variables that are selected based on expert consensus opinion. These variables should go beyond the demographic variables commonly used to adjust for confounding effects in statistical models (eg, age, sex, race and ethnicity) to include variables, and interactions between variables, for which the demographic variables may serve as proxies. We also recommend that researchers clearly define SDoH variables and provide a rationale for their use, particularly in cases when proxies for SDoH are included. We argue that having common definitions and an understanding of SDoH will reduce the variability in the findings of future studies. The data derived from such projects will facilitate the design of appropriate risk adjustment models and interventions that can effectively influence outcomes, thereby supporting the dissemination and implementation of evidence-based care and providing additional meaning to the concept of patient-centered management of HF.

ARTICLE INFORMATION

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Supplemental Material

Tables S1–S4
Figure S1

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Supplemental Material

Table S1. Literature Search Strategies.

Database	Search Strategy
PubMed	((((("Time Factors"[MeSH Terms] AND Journal Article[ptyp] AND hasabstract[text] AND "last 10 years"[PDat] AND Humans[Mesh] AND English[lang])) OR ("Predictive Value of Tests"[MeSH Terms] AND Journal Article[ptyp] AND hasabstract[text] AND "last 10 years"[PDat] AND Humans[Mesh] AND English[lang])) AND Journal Article[ptyp] AND hasabstract[text] AND "last 10 years"[PDat] AND English[lang])) AND (((("United States"[Mesh] AND Journal Article[ptyp] AND hasabstract[text] AND "last 10 years"[PDat] AND Humans[Mesh] AND English[lang])) AND (((((((("Hospitalization"[Mesh]) OR "Patient Readmission"[Mesh]) OR "Emergency Service, Hospital"[Mesh]) OR ("mortality"[All Fields] OR "mortality"[MeSH Terms])) OR complications)) AND "Heart Failure"[Mesh]) AND Journal Article[ptyp] AND hasabstract[text] AND "last 10 years"[PDat] AND Humans[Mesh] AND English[lang])) AND Journal Article[ptyp] AND hasabstract[text] AND "last 10 years"[PDat] AND Humans[Mesh] AND English[lang]) Filters: Journal Article; Abstract; published in the last 10 years; English
SCOPUS	((TITLE-ABS-KEY (heart AND failure)) AND (TITLE-ABS-KEY (hospitalization OR patient AND readmission OR (emergency AND service, AND hospital) OR mortality OR complications OR hospital AND emergency AND department))) AND ((TITLE-ABSKEY ("Predictive Value of Tests") OR TITLE-ABS-KEY (time AND factors))) AND (LIMITTO (AFFILCOUNTRY , "United States"))
Cumulative Index to Nursing and Allied Health Literature (CINAHL)	((MH "Heart Failure+") OR "heart failure") AND (((MH "Hospitalization+") OR "hospitalization") OR ((MH "Readmission") OR "Readmission") OR (MH "Emergency Service+") OR (MH "Mortality+") OR "complications") AND ((MH "Predictive Value of Tests") OR "Predictive Value of Tests") Limiters - Abstract Available; Published Date: 20100101-20201231; English Language
ABI_INFORM	(MAINSUBJECT.EXACT("Heart failure") AND (MAINSUBJECT.EXACT("Patient admissions") OR MAINSUBJECT.EXACT("Hospitalization") OR MAINSUBJECT.EXACT("Emergency services") OR complications OR MAINSUBJECT.EXACT("Mortality"))) AND ((Predict* OR MAINSUBJECT.EXACT("Predictions")) AND Factor) AND (loc.exact("United States--US") AND at.exact("Article") AND stype.exact("Scholarly Journals"))
Web of Science	(Heart Failure) AND ((Hospitalization OR Readmission OR (Emergency Service, Hospital) OR mortality OR complications OR (Hospital emergency department)) AND ((Time Factors) OR TOPIC: ("Predictive Value of Tests")) Refined by: LANGUAGES: (ENGLISH) AND DOCUMENT TYPES:(ARTICLE OR REVIEW OR PROCEEDINGS PAPER) AND COUNTRIES/REGIONS: (USA) Indexes=SCI-EXPANDED, SSCI, A&HCI, ESCI Timespan=2010-2020

A&HCI- Arts & Humanities Citation Index

ABS- Abstract

AFFILCOUNTRY- Affiliation Country

ESCI- Emerging Sources Citation Index

KEY- Keyword

Lang- Language

MeSH- Medical Subject Headings

PDat- Publication Date

Ptyp- Publication Type

SCI-EXPANDED- Science Citation Index Expanded™

SSCI- Social Sciences Citation Index

Table S2. Detailed Description of Evidence: The Influence of SDoH on HF Outcomes.

Author (Study Type)	Setting (Obs. Dates)	Target Population	Data Source(s)	Control Variables	SDOH Variables Analyzed in Study	Outcome	Outcome Results†	QR‡
				Mortality and Survival				
Ahmed 2018[13*] (Retrospective Observational)	· University of Florida · (Jan 2008-Dec 2015)	· Population: Patients ≥18 years with LVAD implant, PS assessment, 1 year or more post-op · Sample: N=111	· EMR	· Age · Sex · Race	· Insurance · Education · Income · Marital status · Urban/ rural residence	· Survival 1 year post implant	· No statistically significant associations found	3
Foraker 2011[32*] (Prospective Observational)	· Forsyth County, NC; Washington County, MD; suburbs of Minneapolis, MN; and Jackson, MS · (1987-2004)	· Population: White and Black ARIC participants aged 45-64 years · Diagnosis: incident HFH · Sample: N=1,342	· ARIC study · US Census	· SexSex · Race · Education	· Insurance · Neighborhood SES	· Time to All-cause mortality	· Medicaid recipients: higher risk (HR 1.21, CI 1.07–1.37) · Lower HHI: higher risk (HR 1.36, CI 1.08–1.70)	2
Manemann 2018[44*] (Prospective Observational)	· Clinics and hospitals in 11 southeast Minnesota counties · (Jan 2013-Mar 2013)	· Population: ≥18 years · Diagnosis: First-ever HF diagnosis · Sample: N=3,867	· Patient-Reported Outcomes Measurement Information System Social Isolation Short Form	· Age · SexSex · Education · Marital status	· Social Support	· Time to All-cause Mortality	· High social isolation: higher risk (HR 3.74, CI 1.82-7.70)	2

			· Rochester Epidemiology Project					
McNaughton 2015[46*] (Retrospective Observational)	· Quaternary care hospital · (Nov 2010 – Jun 2013)	· Population: Discharged patients ≥18 years · Diagnosis: Acute HFH · Sample: N=2,132	· Health Literacy Screening study data · EMR	· Insurance	· Age · SexSex · Race · Education/ health literacy	· Time to all-cause Mortality	· Low health literacy (BHLS ≤9): higher risk (aHR 1.32, CI 1.05-1.66). · Age ≥65 years, nonwhite race, and less than high school education: higher risk.	3
Downing 2018[26*] (Retrospective Observational)	· US non-federal acute care hospitals · (Jan 2009-Dec 2011)	· Population: Hospitals with Medicare FFS beneficiaries ≥65 years · Principal Diagnosis: AMI or HF · Sample: N=1,265	· Medicare Standard Analytic Files · Medicare Enrollment Database · 2011 American Community Survey	· Age · SexSex	· Race and Ethnicity · Income	· Time to All-cause Mortality	· Black patients (AMI): no statistically significant association found · Black patients (HF): lower risk (RSMR: -4.7, P < .001) · Low-income neighborhood: no statistically significant association found	3

Park 2016[51] (Prospective Observational)	· Cardiologist offices in Cincinnati, OH and Northern KY · (2007-2013)	· Population: Patients <45 years · Diagnosis: CHF · Sample: N=191	· EMR · Patient survey	· SexSex · Marital status	· Age · Faith/ spirituality · Social support	· Time to All-cause Mortality	· Age: lower risk (HR 1.06, CI 1.03-1.09). · Spiritual: lower risk (HR 0.795, CI 0.67-0.95). · Social support: no statistically significant association found	2
Shen 2017[58] (Prospective Observational)	· Cardiology OP clinic at the University of Miami Medical Center · (2005- 2009)	· Population: Patients aged ≥18 years · Principal Diagnosis: HF · Sample: N=220	· EMR · Patient survey · SSDI	· Age · SexSex	· Marital Status · Social Support	· Time to All-cause Mortality	· Not married or partnered: higher odds (OR 2.80, CI 1.38-5.70) · Social support: no statistically significant association found	2
Kostelanetz 2021[42] (Prospective Observational)	· Vanderbilt University AMC · (Oct 2011-Dec 2015)	· Population: Adult admissions aged ≥18 years · Principal Diagnosis: HF · Sample: N=1120	· Patient questionnaire · Patient interviews · Billing data	· Age · SexSex · Race and Ethnicity	· Neighborhood SES · HHI · Education · Insurance	· Time to All-cause Mortality	· No insurance: lower risk (HR 0.43 CI: 0.24-0.77) · Neighborhood and household below FPL and completed HS: no statistically significant association found ·	2

He 2019[34] (Cross-sectional)	· National · (1988-Dec 2011)	· Nonsmoking adults ≥18 years · Diagnosis: HF · Sample: N=572	· NHANES III Public-Use Mortality Linked File · National Death Index	· Age · SexSex · Race · Region · Urban/Rural · Education · HHI	· Secondhand smoke exposure	· All-cause Mortality	· Exposure: higher risk (HR 1.4, CI 1.07–1.84)	4
Kaiser 2020[39] (Prospective Observational)	· Forsyth County, NC; Sacramento County, CA; Washington County, MD; and Pittsburgh, PA · (1989-Jun 2015)	· Medicare eligible adults ≥65 years · Sample: N=529	· Cardio-vascular Health Study · Medicare claims · EMR	· Age · SexSex · Race · Marital Status · Disability	· Social Support	· Survival after incident HF	· No statistically significant association found	2

Eapen 2015[27*] (Retrospective Observational)	· US hospitals, including community and large tertiary centers · (Jan 2005-Dec 2011)	· Population: FFS CMS beneficiaries ≥65 years old · Principal Diagnosis: HF · Sample: N=48,338	· GWTG HF Registry · CMS claims data · County-level SES AHRF data	· Age · SexSex · Urban/rural residence	· Race and Ethnicity · Education · Employment · Income · County level SES	· All-cause Mortality, 30d ·	· HISP and Black: lower odds (HISP: OR 0.70, CI 0.58 - 0.83) (Black: OR 0.57, CI: 0.50–0.65) · Education: no statistically significant association found · Employment no statistically significant association found · HHI: reduces with unit increases in HHI (OR 0.97, CI 0.95-1.00) · County level SES: no statistically significant association found	3

Eberly 2019[28*] (Retrospective Observational)	· Brigham and Women's Hospital, Boston, MA · (Sep 2008-Nov 2017)	· Population: Black, White, Latinx patients admitted to general medicine or cardiology from ED ≥18 years · Principal Diagnosis: HF · Sample: N=1,967	· EMR · MA Death Registry	· None	· Race and Ethnicity	· All-cause Mortality, 30d	· Black Race: lower risk (HR, 0.52, CI: 0.30-0.91) · Latinx (GM admission): no statistically significant association found	3
Patel 2020[52*] (Retrospective Observational)	· Emory Health Care system, Atlanta, GA · (2010-2018)	· Population: Admitted Black or White patients ≥18 years · Diagnosis (primary or secondary): acute HF · Sample: N=30,630	· EMR	· Age · Sex · Insurance	· Race · Neighborhood SES (EM)	· All-cause Mortality, 30d	· Black patients: higher risk (RR: 1.17, CI 1.10-1.25). · Lower neighborhood SES: no effect modification found for Black patients	3

Trivedi 2020[62] (Cross-sectional)	· National: Veteran's Affairs Medical Centers · (2012-2014)	· Hospitalized Veterans ≥66 years · Diagnosis: HF · Sample: N=42,892	· VA health system's Corporate Data Warehouse · CMS Medicare Master Beneficiary Summary File · Minimum Data Set · US Census	· Age · Sex	· Neighborhood Disadvantage · Race and Ethnicity · Living Status · Urban/Rural · Reason for Medicare Eligibility · Insurance Status	· All-Cause Mortality, 30d	· No statistically significant associations found	
Sterling 2020[59] (Prospective Observational)	· 48 US states and DC · (2003-2014)	· Population: REGARDS study participants who were Medicare Part A beneficiaries ≥65 years and discharged · Diagnosis: HF · Sample: N=598	· REGARDS study · EMR · American Hospital Association annual survey · Medicare's Hospital Compare	· Age · Sex · Region	· Race and Ethnicity · Education · Income · Neighborhood SES · Social Support · Urban/rural residence	· All-cause Mortality, 90d	· 1 SDOH: higher risk (HR 2.78, CI 1.37-5.62) · ≥2 SDOH: higher risk (HR 2.57, CI 1.19-5.54)	2

Knighton 2018[40*] (Retrospective Observational)	· Intermountain Healthcare System in Utah · (2010 and 2014)	· Population: Inpatient aged ≥18 years · Diagnosis: HF · Sample: N=4,737	· EMR · State death certificate data	· Age · Sex · Race and Ethnicity · Marital status · Insurance	· Neighborhood deprivation · Faith (EM) · Urban/rural residence (EM)	· All-cause Mortality: 30d, 90d, 180d, and 365d	Deprived areas and faith/ spirituality: · 30d lower odds (OR 0.35, CI 0.12–0.98) · 90d, lower odds (OR 0.49, CI 0.30-0.90) · 180 d, lower odds: (OR 0.52, CI 0.35-0.76) · 365d: no statistically significant association found	3
Lu 2016[43*] (Retrospective Observational)	· Einstein Medical Center, Philadelphia, PA · (Jan 2011 – Feb 2013)	· Population: AA patient admissions aged >20 years · Diagnosis: ADHF · Sample: N=611	· EMR · SSDI	· Age · Sex	· Marital status · Living status	· All-cause Mortality, 30d, 90d, 1y	· 30d, Married: no statistically significant association found · 1y, Married: lower odds (OR 0.50, CI 0.31 - 0.90) · 30d, Living alone: higher odds (OR 2.86, 1.59-5.14) · 1y, Living alone: no statistically significant association found	3

Selim 2015[57*] (Retrospective Observational)	· 3 hospitals within the Montefiore Medical Center health system in the Bronx, NY · (Jan 2001-Dec 2010)	· Population: Hospitalized low SES patients aged ≥18 years · Diagnosis: ADHF · Sample: N=7,516	· EMR · Social Security Death Registry	· Age · Sex	· Access to Cardiologist · Race and Ethnicity (EM)	· All-cause Mortality, 30d, 60d	· Access to cardiology 30d: no statistically significant association found · Access to Cardiology services (60d): lower risk (HR: 0.70, CI 0.52-0.96) · Race and Ethnicity (30d, 60d): no statistically significant association found	3
Vivo 2014[63*] (Prospective Observational)	· 213 hospitals participating in GWTG-HF · (Jan 2005-Dec 2011)	· Population: Medicare FFS patients ≥65 years · Principal Diagnosis: HF · Sample: N=47,149	· GWTG-HF registry · Medicare inpatient claims data	· Age · Sex · Income · Education	· Race and Ethnicity	· All-cause Mortality (post discharge), 30d, 1y	· Black, HISP, /Asian (30d): no statistically significant association found · Black (1y): reduced risk (HR 0.93, CI 0.87-1.00) · HISP, Asian (1y): no statistically significant association found	2

Wadhera 2018[64*] (Retrospective Observational)	· 391 GWTG registry sites across 40 states · (Jan 2010-Jun 2017)	· Population: Low-income patients <65 years, not eligible for Medicare · Diagnosis: HFH · Sample: N=58,804	· GWTG HF Registry	· Age · Sex · Race and Ethnicity	· Medicaid Expansion	· In-Hospital Mortality	· Medicaid expansion: no statistically significant association found	3
Watkins 2013[65*] (Retrospective Observational)	· Northwestern Louisiana tertiary care teaching hospital · (Jun 2003-Dec 2008)	· Population: Patients admitted ≥18 years · Diagnosis: HF · Sample: N=357	· EMR	· Age · Sex · Race and Ethnicity · Insurance	· Marital Status	· In-Hospital Mortality	· No statistically significant association found	3

Yandrapalli 2019[70*] (Retrospective Observational)	· Acute care hospitals · (2005 – 2014)	· Population: Patients ≥18 years without concomitant ACS · Diagnosis: HFH · Sample: N=8,333,752	· HCUP NIS	· None	· Age · Sex · Race and Ethnicity	· In-hospital Mortality	· Age: older had higher rates (≥80 years (41.4); 65-79 (29.2); 45-64 (20.6); 18-44 (17.7) · Females: higher (30.6 v. 25.4, p<0.001) · Race: White had highest rates (White (28.8); HISP (25.8); Black (22.3)	3
Readmission[§]								
DeFilippis 2020[21] (Retrospective Observational)	· INTERMACS registry (2008-2017)	· Population: Patients ≥18 years with continuous flow LVAD · Sample: N=15,403	· INTERMACS	None	·PS Risks	· Time to All-cause Readmission	· Any PS risk: higher risk (HR 1.14, CI 1.08-1.19)	3
Foraker 2011[32*] (Prospective Observational)	· Forsyth County, NC; Washington County, MD; suburbs of Minneapolis, MN; and Jackson, MS · (1987-2004)	· Population: White and Black ARIC participants aged 45-64 · Diagnosis: incident HFH · Sample: N=1,342	· ARIC study · US Census	· Sex · Race · Education	· Insurance · Neighborhood SES	· Time to All-cause Readmission	· Medicaid recipients: higher risk (HR 1.19, CI 1.05–1.36) · · Lower neighborhood HHI: higher risk (HR 1.40, CI 1.10–1.77)	2

McNaughton 2015[46*] (Retrospective Observational)	· Quaternary care hospital · (Nov 2010 – Jun 2013)	· Population: Patients discharged from an acute HFH · Sample: N=2,132	· Health Literacy Screening study data · EMR	· Insurance · · Age · Sex · Race	· Education/ health literacy	· Time to All-cause Readmission	· Low health literacy: higher risk: (aHR 1.32, CI 1.05-1.66, P=0.02)	3
Watkins 2013[65*] (Retrospective Observational)	· Northwestern Louisiana tertiary care teaching hospital · (Jun 2003-Dec 2008)	· Population: Patients admitted · Diagnosis: HF · Sample: N=357	· EMR	· Age · Sex · Race Ethnicity · Insurance	· Marital Status	· Time to All-cause Readmission	· No statistically significant association found	3
Ahmed 2018[13*] (Retrospective Observational)	· University of Florida · (Jan 2008- · Dec 2015)	· Population: Patients ≥18 years with LVAD implant, PS assessment, 1 year or more post-op · Sample: N=111	· EMR	· Age · Sex · Race	· Insurance · Education · Income · Marital status · Urban/ rural residence	· All-cause Readmission, 30d	· No statistically significant associations found	3
Amarasingham 2010[15] (Prospective Observational)	· Parkland Memorial Hospital, Dallas, TX · (Jan 2007 - Aug 2008)	· Population: Patients ≥18 discharged · Principal Diagnosis: HF · Sample: N=1,372	· EMR	· None	· Age · Sex · Race and Ethnicity · Marital Status · Insurance · Neighborhood SES	· All-cause Readmission, 30d	· Age: No statistically significant association found · Male sex: higher odds (OR 1.37, CI 1.02 - 1.84) · Race: Black race higher odds OR 1.47, CI 1.03-2.08); HISP no statistically significant association found	2

					· Social Instability		· Single: higher odds (OR 1.47, CI 1.08 - 2.01) · Medicare insurance: higher odds (OR 1.59, CI 1.17 - 2.17). · Lowest neighborhood SES: higher odds (OR 1.30, CI 0.98 - 1.74) · Social instability: higher odds (OR 1.13, CI 1.07 - 1.19)	
DeLia 2014[22*] (Retrospective Observational)	· Hospitals and clinics · (2007-2010)	· Population: Medicare enrollees ≥65 years · Diagnosis: ≥1 HFH · Sample: N=233,641	· MPCD	· None	· Age · Sex · Race and Ethnicity · Insurance · Region	· All-cause Readmission, 30d	· Older age statistically significant association with higher risk (HR NR) · Sex: no statistically significant association found · Black and HISP associated with higher risk · Medicare Advantage: statistically significant association with higher risk (HR NR) · Northeast and Midwest: statistically significant association with lower risk (HR NR)	3

Di Palo 2017[24*] (Intervention)	· Montefiore Medical Center, Bronx, NY · (Jun 2015-Dec 2015)	· Population: Inpatients · Diagnosis: HF · Sample: N=94	· EMR · Intake assessment	· Age · Sex	· Social support (NT program)	· All-cause Readmission, 30d	· Intervention group: 17.6% · Control group: 25.6%	2
Downing 2018[26*] (Retrospective Observational)	· US non-federal acute care hospitals · (Jan 2009-Dec 2011)	· Population: Hospitals with Medicare FFS beneficiaries ≥65 years · Principal Diagnosis: AMI or HF · Sample: N=1,265	· Medicare Standard Analytic Files · Medicare Enrollment Database · 2011 American Community Survey	· Age · Sex	· Race and Ethnicity · Income/ wealth	· All-cause Readmission, 30d	· Black patients: higher risk (HF- RSRR: 2.8%; P < .001) · Low-income neighborhood: No statistically significant association found	3
Eapen 2015[27*] (Retrospective Observational)	· US hospitals, including community and large tertiary centers · (Jan 2005-Dec 2011)	· Population: FFS CMS beneficiaries ≥65 years old · Principal Diagnosis: HF · Sample: N=48,338	· GWTG HF Registry · CMS claims data · County-level SES AHRF data	· Age · Sex · Urban/Rural residence	· Race and Ethnicity · Education · Employment · Income/ wealth · SES (County level)	· All-cause Readmission, 30d	· Race: Black race higher odds (OR 1.10, CI 1.01-1.19); HISP higher odds (OR 1.14, CI 1.02-1.28) · ≥ High school diploma: lower odds (OR 0.95, CI 0.91–0.99) · White-collar workers: higher odds (OR 1.06, CI 1.01-1.11) · Income: No statistically significant association found · County-level SES: No statistically significant association found	3

Gilotra 2017[33] (Prospective Observational)	· Urban: academic center · (Jul 2014-2015)	· Admitted patients ≥18 years requiring intravenous diuretics · Principal Diagnosis: decompensated HF · Sample: N=94	· EMR · Patient survey	· Age · Sex · Race · Education Level	· Health Literacy	· All-cause Readmission, 30d	· Health literate: Lower odds (OR 0.31, CI 0.10–0.91).	2
Joynt Maddox 2019[38] (Retrospective Observational)	· Inpatient and OP care · (Dec 2012 – Nov 2015)	· Population: FFS Medicare beneficiary admissions ≥65 years old · Diagnosis: AMI, CHF, or pneumonia · Sample: CHF N=2,874	· Medicare 100 percent Research Identifiable Files · CMS Master Beneficiary Summary File · CMS Vital Records File · 2017 Inpatient Prospective Payment System final rule impact file	· Age · Sex · Race	· Housing instability · Neighborhood SES · Insurance · Hospital Safety-Net Status	· All-cause Readmission, 30d (CHF only)	· Housing instability: (aOR 1.39, CI 1.29-1.49) · Disadvantaged neighborhood: higher odds (aOR 1.03, CI 1.01-1.04) · Medicaid: higher odds (aOR 1.22, CI 1.21-1.24) · Safety-net hospitals: higher rate: (1.037 v. 0.997)	3
Knighton 2018[40*] (Retrospective Observational)	· Inter-mountain Healthcare System in Utah · (2010 and 2014)	· Population: inpatient. Age inclusion criteria NR · Diagnosis: HF · Sample: N=4,737	· EMR · State death certificate data	· Age · Sex · Race and Ethnicity · Marital Status	· Neighborhood SES · Faith/ Spirituality · Urban/Rural Residence	· All-cause Readmission, 30d	· No statistically significant association found	3

				· Insurance				
Lu 2016[43*] (Retrospective Observational)	· Einstein Medical Center, Philadelphia, PA · (Jan 2011 – Feb 2013)	· Population: AA patient admissions aged >20 years · Diagnosis: ADHF · Sample: N=611	· EMR · SSDI	· Age · Sex	· Marital status · Living status	· All-cause Readmission, 30d	· Married: no statistically significant association found · Living alone: higher odds (OR 2.86, CI 1.59-5.14)	3
McKinley 2018[45] (Intervention)	· WellStar Atlanta Medical Center, Atlanta, GA · (May 2012- Dec 2015)	· Population: Admission of AA men · Diagnosis: HF (primary or secondary) · Sample: N=132	· EMR	· Age · Race and Ethnicity	· HF intervention	· All-cause Readmission, 30d	· Intervention: statistically significant association with lower readmission rates	2
Meddings 2017[47] (Retrospective Observational)	· Hospitals · (Jun 1996- Jun 2012)	· Population: Admission of Patients > 50 years · Diagnosis: HF · Sample: N=2,068	· HRS-CMS data · ACS-HCUP data (FL, WA)	· Age · Sex	· Race · Social support · Individual SES · Insurance	· All-cause Readmission, 30d	· Black race: higher odds (OR 1.17, CI 1.06-1.29) · Social support: Having children (social support): lower odds (OR = 0.66, CI 0.44-0.98); married partnered no statistically significantly association found · Highest quartile of wealth: lower (OR = 0.53, CI = 0.35-0.79) Public insurance: no statistically	3

							significantly association found	
Mirkin 2017[49] (Retrospective Observational)	· Pennsylvania hospitals · (2011-2012)	· Population: Discharged patients aged ≥18 years · Diagnosis: CHF · Sample: N=155,146	· State-wide multi-hospital data set	· None	· Age · Sex · Race and Ethnicity · Insurance	· All-cause Readmission, 30d	· ≥65 years: lower odds (aOR 0.86-0.93) · Female: lower odds (aOR 0.94, CI 0.92-0.97) · Black: higher odds (aOR 1.16, CI 1.12-1.21) · Insurance: no statistically significantly association found	3
Nagasako 2014[50] (Prospective Observational)	· Non-federal acute care and critical-access hospitals in Missouri · (Jun 2009-May 2012)	· Population: Discharged Medicare FFS patients ≥65 years · Principal Diagnosis: HF · Sample: N=22,433	· Administrative hospital discharge data · Truven Health Analytics · Nielsen Pop-Facts data	· Age · Sex · Race · Income · Education · Employment	· Neighborhood SES	· All-cause Readmission, 30d	· No statistically significant association found	2
Schopfer 2012[56] (Retrospective Observational)	· US hospitals · (Jan 2008-Dec 2008)	· Population: Hospitals that admitted patients aged ≥18 years · Diagnosis: HF · Sample: N=3,655	· Dartmouth Atlas · US Census	· Age	· Race and Ethnicity · Income · Education Urban/Rural residence	· All-cause Readmission, 30d	· White race: higher odds (OR 1.04, CI 1.01-1.02) · Income: no statistically significant association found · Bachelor's degree or higher: higher odds	3

							(OR 1.10, CI 1.01-1.02) · Urban/rural: no statistically significant association found	
Selim 2015[57*] (Retrospective Observational)	· 3 hospitals within the Montefiore Medical Center health system in the Bronx, NY · (Jan 2001-Dec 2010)	· Population: Hospitalized low SES patients aged ≥18 years · Diagnosis: ADHF · Sample: N=7,516	· EMR · Social Security Death Registry	· Age · Sex	· Race and Ethnicity · Access to Cardiologist	· All-cause Readmission, 30d, 60d	· White (30d): lower risk (HR 0.49, CI 0.29-0.83) · White (60d): lower risk (HR 0.58, CI 0.39-0.87) · Seen by cardiologist (30d): lower risk (HR 0.76, CI 0.66-0.89, P=0.002) · Seen by cardiologist (60d): lower risk (HR 0.81, CI 0.72-0.92)	3
Tabit 2017[60] (Retrospective Observational)	· University of Chicago Medical Center · (Jan 2015-Dec 2015)	· Population: Discharged low SES patients aged ≥18 years · Diagnosis: ADHF · Sample: N=784	· EMR · Patient survey	· Age · Sex · Race/ Ethnicity · Income	· Education/ health literacy · Consultation before discharge	· All-cause Readmission, 30d, 90d	· Intervention group (received consultation, 30d): lower odds (OR 0.592, CI 0.40-0.87) · · Intervention group (received consultation, 90d): lower odds (OR NR)	3
Tripathi 2018[61*] (Cross-sectional)	· HCUP NRD · (2013 and 2014)	· Population: Patients aged ≥18 years admitted to hospitals for LVAD implantation	· HCUP · NRD	· None	· Age · Sex · Insurance	· All-cause Readmission, 90d ·	· Age: no statistically significant association found · Sex: no statistically significant association found	4

		· Sample: N=4,693					· Private insurance: lower odds (OR 0.75, CI 0.66-0.86) · Self-pay: lower odds (OR 0.58, CI 0.42-0.81)	
Vivo 2014[63*] (Prospective Observational)	· 213 hospitals participating in GWTG-HF · (Jan 2005-Dec 2011)	· Population: Medicare FFS patients ≥65 years · Principal diagnosis: HF · Sample: N=47,149	· GWTG-HF registry · Medicare inpatient claims data	· Age · Sex · Income · Education	· Race and Ethnicity	· All-Cause Readmission, 30d, 1y ·	· Black/HISP/Asian (30d): no statistically significant association found · Black (1y): increased risk (HR 1.10 CI: 1.04-1.16) · HISP/Asian (1y): no statistically significant association found	2
Bradford 2017[17] (Retrospective Observational)	· Sharp Memorial Hospital-San Diego, CA · (Oct 2008 – Nov 2014)	· Population: Discharged patients aged ≥18 years · Diagnosis: HF · Sample: N=2,420	· EMR	· None	· Age · Sex · Race and Ethnicity · Marital status · Employment · Insurance	HF Readmission, 30d ·	· Employment (Retired): higher odds (OR 2.30; CI 1.08-4.90) · Employment (Disabled): higher odds (OR 2.48; CI, 1.14-5.37). · Age, sex, race/ethnicity, marital status, and insurance status: no statistically significant association found	3
Carlson 2019[19] (Retrospective Observational)	· Community hospital near California-Mexico border	· Population: Primarily HISP, low SES patients discharged aged ≥65 years	· EMR	· Income · Length of stay	· Age · Sex · Race and Ethnicity	· HF Readmission, 30d	· No statistically significant association found	3

	· (Oct 2013 – Sep 2015)	· Principal Diagnosis: HF · Sample: N=189			· Language · Marital Status · Living Status			
Patel 2020[52*] (Retrospective Observational)	· Emory Health Care System, Atlanta, GA · (2010-2018)	· Population: Admitted AA or White patients ≥18 years · Diagnosis: acute · HF · Sample: N=30,630	· EMR	· Age · Sex · Insurance	· Race · HHI	· HF Readmission, 30d	· Black patients: higher risk (RR: 1.45, CI: 1.37-1.54) · HHI: no statistically significant association found	3
Schmeida 2012[55] (Retrospective Observational)	· Acute Inpatient hospitals · (2006-2009)	· Population: US states with data on discharged Medicare FFS patients aged ≥65 years · Diagnosis: HF · Sample: N=50	· CMS · US Census · Kaiser Family Foundation	· None	· Sex · Race and Ethnicity · Income · Language · Insurance	· HF Readmission, 30d	· Sex, race: no statistically significant association found · Income: positive association (β 0.000046, P=0.006) · Language: negative association (β -0.362255, P=0.50) · Prescription coverage (insurance): positive association (β 0.001, P=<0.001)	3
Dharmarajan 2013[23] (Retrospective Observational)	· Acute care hospitals · (2007-2009)	· Population: Medicare FFS beneficiaries ≥65 years readmitted within 30 days	· Medicare claims	· None	· Age · Sex · Race	· CVD Readmission, 30d	· Age >=85: higher odds (OR 1.07, CI 1.05-1.10) · Female: higher odds (OR 0.96, CI 0.95-0.98)	3

		after index hospitalization · Diagnosis: HF · Sample: N=1,330,157 ·					· Black: higher odds (OR 1.22, CI 1.19-1.25)	
Eberly 2019[28*] (Retrospective Observational)	· Brigham and Women's Hospital, Boston, MA · (Sep 2008-Nov 2017)	· Population: Black, White, Latinx patients admitted to general medicine or cardiology from ED aged ≥18 years · Principal Diagnosis: HF · Sample: N=1,967	· EMR · MA Death Registry	· Insurance · Neighborhood SES · · Language	· Age · Sex · Race and Ethnicity	· CVD Readmission, 30d	· Older age: lower risk 50-75 (HR: 0.61, CI: 0.49-0.76); >75 (HR: 0.54, CI 0.43-0.69) · Race: no statistically significant association found ·	3
Asthana 2018[16] (Intervention)	· Ben Taub Hospital Harris County Hospital, Houston, TX · (Jul 2015-Dec 2015)	· Population: Un- and under-insured patients in ED aged ≥18 years · Diagnosis: HF · Sample: N=94	· EMR	· Age · Sex · Race and Ethnicity · Insurance	· Education	· HF Hospital Readmission, 30d, 90d · HF ED Revisits, 30d, 90d	· Hospital readmission 30d, 90d: no statistically significant changes found (30d and 90d) · ED 30d RRR 59% (4.80-82.5) · ED 90d RRR 43.7% (9.51-64.9)	2
Medical Devices and Transplantation								
Ahmed 2018[13*] (Retrospective Observational)	· University of Florida (Jan 2008-Dec 2015)	· Population: Patients ≥18 years with LVAD implant, PS	EMR	· Age · Sex	· Insurance · Education	· Readmission, 30d	· No statistically significant association found	3

		assessment, 1 year or more post-op · Sample: N=111		· Race	· Income · Marital status · Urban/ rural residence			
Ehsan 2019[29] (Retrospective Observational)	· Three states that underwent Medicaid expansion (KY, NJ, and MD) and two states that did not expand (FL and NC) · (2012-2015)	· Population: Patients aged 18-64 years discharged with continuous-flow LVAD and covered by Medicaid · Sample: N=624	· State Inpatient Database · American Hospital Association Survey · AHRF	· Age · Sex · Income · Urban/rural residence · Sex · Income	· Race and Ethnicity · Insurance	· LVAD utilization	· Race: no statistically significant association found · Medicaid expansion states & public insurance: increased utilization (IRR: 5.26; CI:1.23-22.57).	3
Flint 2021[31] (Prospective Observational)	· 6 LVAD programs in the Midwest, East and Intermountain West · (2015 and 2017)	· Population: Patients who were actively being considered for destination therapy LVAD aged ≥18 years · Sample: N=212	· DECIDE-LVAD Trial	· None	· Race and Ethnicity · Marital Status · Insurance · Education · Income	· LVAD implantation	· Partnered (marriage status): higher odds (OR: 2.33, CI 1.12-4.85). · Income, race, educational attainment, or insurance status: No statistically significant associations found	2
Tripathi 2018[61*] (Cross-sectional)	· HCUP NRD · (2013 and 2014)	· Population: Patients aged ≥18 years admitted to hospitals for LVAD implantation · Sample: N=4,693	· HCUP · NRD	· None	· Age · Sex · Insurance	· Complications	· Age: unit increases increased odds (OR 1.01, CI 1.01-1.02) · Female: lower odds (OR 0.73, CI 0.62-0.85)	

							· Insurance: no statistically significant association found	
Emani 2017[30] (Retrospective Observational)	· Organ sharing registry · (Jun 2006 - Mar 2015)	· Population: First-time HTx candidates ≥18 and <65 years who had BTT LVAD support while wait-listed · Sample: N=3,353	· United Network of Organ Sharing registry	· Age · Sex · · Race	· Education · Insurance · Neighborhood SES	· Transplantation Probability	· Education: no statistically significant association found · Medicaid: higher risk SHR: 1.56, CI: 1.14-2.14) · Neighborhoods in the second-lowest SES quintile: higher risk (SHR: 1.62; CI: 1.01-2.58).	3
Mehra 2009[48] (Prospective Observational)	· OP cardiology and multi-specialty practices · (2005-2007)	· Population: Patients enrolled in IMPROVE HF aged ≥18 years · Sample: N=3,659	· IMPROVE HF registry	· None	· Age · Sex · Race · Insurance	· ICD Utilization	· Older ages: lower odds (OR 0.87 per 10 years, CI 0.82- 0.93) · Men: higher odds (OR 1.4, CI 1.22-1.61) · Black race: lower odds (OR 0.75, CI 0.60-0.94) · No insurance: lower odds (OR 0.45, CI 0.26-0.78)	2
Yandrapalli 2019[70*] (Retrospective Observational)	· Acute care hospitals · (2005 – 2014)	· Population: patients ≥18 years without concomitant ACS · Diagnosis: HFH · Sample: N=8,333,752	· HCUP NIS	· None	· Age · Sex · Race and Ethnicity	· Mechanical circulatory support device utilization	· Age: older had higher rates (≥80 years (41.4); 65-79 (29.2); 45-64 (20.6); 18-44 (17.7); (p<0.001) · Females: higher (30.6 v. 25.4, p<0.001)	3

							· Race: White had highest rates (white (28.8); HISP (25.8); Black (22.3); patients p<0.001)	
Russell 2019[54*] (Cross-sectional)	· NYC · (2013-2017)	· Hospice patients ≥18 years · Diagnosis: HF · Sample: N=1.498	· EMR · Interviews	· None	· Age · Sex · Race and Ethnicity · Marital Status · Insurance Status	· Loss Of Eligibility	· HISP: higher odds (AOR 2.32, CI 1.23–4.34) · Age, sex, race, marital status, insurance status: no statistically significant associations	4
Other[ǀǀ]								
Ahmed 2018[13*] (Retrospective Observational)	· University of Florida · (Jan 2008-Dec 2015)	· Population: Patients ≥18 years with LVAD implant, PS assessment, 1 year or more post-op · Sample: N=111	· EMR	· Age · Sex · Race	· Insurance · Education · Income · Marital status · Urban/ rural residence	· LOS	· No statistically significant associations found	3
Knighton 2018[40*] (Retrospective Observational)	· Inter-mountain Healthcare System in Utah · (2010 and 2014)	· Population: inpatient. Age inclusion criteria NR · Diagnosis: HF · Sample: N=4,737	· EMR · State death certificate data	· Age · Sex · Race and Ethnicity · Marital Status · Insurance	· Neighborhood SES · Faith · Urban/Rural residence	· Index encounter LOS	· No statistically significant associations found	3

Russell 2019[54*] (Cross-sectional)	· NYC · (2013-2017)	· Hospice patients ≥18 years · Diagnosis: HF · Sample: N=1.498	· EMR · Interviews	· None	· Age · Sex · Race and Ethnicity · Marital Status · Insurance Status	· Acute hospitalization	· Age: 18 to 74 (AOR 2.10, CI 1.34–3.28) and 75 to 84 (AOR 1.79, CI 1.24–2.62) · HISP (AOR 2.99, CI 1.99–4.50), African American (AOR 2.06, CI 1.31–3.24), and Asian/other patients (AOR 1.96, CI 1.08–3.57) · Sex, marital status, insurance status: no statistically significant associations found	4
Akwo 2016[14] (Prospective Observational)	· Urban/rural: 12 southeastern states · (2002-2010)	· AA and non-HISP White low SES patients aged 40-79 years covered by Medicare or Medicaid and participating in SCCS · Sample N=27,078	· SCCS · US Census	· Age · Sex · Race and Ethnicity · HHI · Education Level	· Neighborhood SES	· Incident HF	· Risk increased with unit increases in neighborhood deprivation (HR 1.12, CI 1.07-1.18	
Breathett 2021[18] (Retrospective Observational)	· WHI Study · (1993-2018)	· Population: Post-menopausal AA and HISP women in WHI study with ≥1 HF risk factors and a high HF genetic risk score. Age	· WHI study	· Sex · Race and Ethnicity · Age · Education · Income	· PS factors	· Incident HFH	· No statistically significant association found	3

		inclusion criteria NR. · Sample: N=11,327		· Insurance				
Pinheiro 2020[53] (Prospective Observational)	· 48 US states and DC · (2003-Dec 2016)	· Population: REGARDS study participants (community-dwelling black and white men and women ≥45 years from 48 US states and DC) · Diagnosis: at risk for HF · Sample: N=25,790	· REGARDS study data · Phone interviews · EMR	· Age · Sex · Region	· Race and Ethnicity · Education · Income · Insurance · Neighborhood SES	· Incident HFH	· Black race: higher risk (aHR: 1.23, CI 1.09-1.40) · < High school education higher risk (aHR 1.75, CI 1.50-2.03) · <$35,000 income: higher risk (aHR: 1.78, CI 1.55-2.03) · No insurance: higher risk (aHR 1.68, CI 1.29-2.19) · Neighborhood >25% below poverty (aHR: 1.21, CI 1.05-1.40)	2
Wadhera 2018[64*] (Retrospective Observational)	· 391 GWTG registry sites across 40 states · (Jan 2010-Jun 2017)	· Population: Low-income patients <65 years, not eligible for Medicare · Diagnosis: HFH · Sample: N=58,804	· GWTG HF Registry	· Age · Sex · Race/ Ethnicity	· Medicaid expansion	· HF inpatient care (defect free care)	· Expansion states (defect free care): higher odds (aOR: 1.06, CI 1.03-1.08)	3
Ziaeian 2017[71] (Retrospective Observational)	· Acute care hospitals · (2002-2013)	· Population: Patients ≥18 years	· HCUP NIS	· Age	· Sex · Race and Ethnicity	· HFH	· Black men and women: higher compared with whites	3

		· Diagnosis: HF · · Sample: N=12,783,478					(229% and 240%, respectively) · HISP men and women: higher rates, (men: 32% to 4%, p trend=0.047; women: 55% to 43%)	
Wu 2013[67] (Prospective Observational)	Academic medical center · (NR)	· Population: Patients ≥18 · Diagnosis: HF · Sample: N=218	· REMOTE-HF study data	· Age · Sex · Race and Ethnicity · Living Status	· PSS and Medication Adherence	· Time to CV event	· Low PSS and nonadherence: higher risk (HR 2.50, CI 1.20-5.30)	2
Wu 2016[68] (Prospective Observational)	· Rural US areas in of CA, NV, KY · (NR)	· Population: Patients ≥18 living independently · Diagnosis: HFH in the past 12 months · Sample: N=575	· REMOTE-HF study data	· Sex · Race/ Ethnicity · Income · Marital status · Employment	· Age · Health literacy	· Time to CV event	· Older patients: higher risk (HR 1.491, CI, 1.12–1.99) · Low health literacy: higher risk (HR: 1.84, CI: 1.40–2.43)	2
Wu 2010[69] (Prospective Observational)	· OP cardiology clinics and inpatient cardiology units in central Kentucky · (NR)	· Patients ≥18 years · Diagnosis: with diagnosis of CHF patients · Sample: N=136	· Patient/ family interviews · EMR · Hospital administrative data · Medication Event Monitoring System	· Age · Race and Ethnicity · Marital Status · Perceived Social Support	· Urban/Rural Status	· Time to CV event	· Rurality: lower risk (HR 0.56, CI NR)	2

Heisler 2013[35] (Intervention)	· Non-profit community-based teaching hospital · (May 2007-Oct 2010)	· Patients ≥18 years · Diagnosis: HF · Sample: N=266	· Hospital administrative data · Survey	· Age · Sex · Race and Ethnicity·	· Nurse care management (NCM) v. reciprocal peer support (RPS) program	· Time to CVD event	· No statistically significant association found	1
Cox 2017[20] (Prospective Observational)	· Large quaternary health system Texas Medical Center, Houston, TX · (NR)	· Population: Hospitalized patients ≥18 years · Diagnosis: HF · Sample: N=264	· Primary survey data	· Age · Sex · Race · Marital Status · Insurance · Education · Employment	· Health literacy	· Healthcare use (Readmission + ED visit), 30d	· Low health literacy (BHLS ≤9): higher odds (OR: 1.80, CI: 1.04 - 3.11)	2
DeLia 2014[22*] (Retrospective Observational)	Hospitals and clinics (2007-2010)	· Population: Medicare enrollees >=65 years · Diagnosis: >=1 HFH · Sample: N=233,641	· MPCD	· None	· Age · Sex · Race and Ethnicity · Insurance · Region	· Treat and release, 30d	· No statistically significant change in readmission rates found	3
Kociol 2011[41] (Retrospective Observational)	· 225 hospitals participating in OPTIMIZE or GWTG-HF registries · (Jan 2003 – Dec 2006)	· Population: Patients ≥65 years admitted to hospital for worsening symptoms or discharged	· Medicare FFS claims · OPTIMIZE · GWTG-HF registries	· None	· Age · Sex · Race · Urban/rural residence	· Early physician follow-up	· Age 70-74: higher odds (OR 1.12, CI 1.03-1.22); >75 (OR · Women: lower odds (OR 0.87, CI 0.83 - 0.91)	3

		· Primary Diagnosis: HF · Sample: N=30,136			· Income · Physician density		· Black patients: lower odds (OR 0.84, CI 0.77 - 0.92) · Rural areas: lower odds (OR 0.84, CI 0.78 - 0.91) · Lower SES: lower odds (OR 0.79, CI 0.74-0.85) · Living near high physician concentration: higher odds (OR 1.29, CI 1.12 - 1.48)	
Manemann 2018[44*] (Prospective Observational)	· Clinics and hospitals in 11 southeast Minnesota counties · (Jan 2013-Mar 2013)	· Population: ≥18 years · Diagnosis: first-ever HF diagnosis · Sample: N=3,867	· Patient-Reported Outcomes Measurement Information System · Social Isolation Short Form · Rochester Epidemiology Project	· Age · Sex · Education · Marital Status	· Social Support	· ED visits	· High social isolation: higher risk (HR 1.5, CI, 1.09–2.27)	2
McNaughton 2015[46*] (Retrospective Observational)	· Quaternary care hospital · (Nov 2010 – Jun 2013)	· Population: Patients discharged from an acute HFH aged ≥18 years	· Health Literacy Screening study data · EMR	· Insurance	· Age · Sex · Race · Education/ health literacy	· ED visit, 90d	· No statistically significant association found	3

		· Sample: N=2,132						
Distelhorst 2018[25] (Retrospective Observational)	· Urban: 3 community hospitals within the Cleveland Clinic Health System in Northeast Ohio · 19-months dates NR	· Population: Patients discharged with de-compensated HF aged ≥18 years · Sample: N=701	· EMR	· None	· Age · Sex · Race and Ethnicity · Insurance status · Marital status · Social support · Access to care	· Appointment Adherence	· Age, sex, insurance status, marital status, social support, access to care: no statistically significant associations found · Nonwhite race higher odds (OR 1.85; CI, 1.08-3.16)	3
Wray 2019[66] (Retrospective Observational)	· VHA hospitals and clinics · (2011-2012)	· Population: Veterans ≥65 years · Diagnosis: HFH and CHF · Sample: N=1,500	· VHA chart abstraction	· None	· Age · Race/Ethnicity · Social support · Housing · Living status	· Missed clinic visits	· Older age: lower odds (OR 0.96, CI 0.94–0.98) · Black race: higher odds (OR 2.71, CI 1.38–5.75) · Social support: no statistically significant association found · Marginal housing: higher odds (OR 5.69, CI 2.28-14.73) · Living alone: higher odds (OR 1.58, CI 1.10-2.24)	3
Irani 2019[36]	· Cardiology practices in	· Patients aged 50-85 years	· HEART ABC study data	· Sex	· Age	· HF Self-Care Maintenance	· Age, living arrangements: no	4

(Cross-sectional)	two major hospitals · (August 2010 and October 2013)	· Sample: N=370		· Race and Ethnicity	· Living Arrangement · Social Support · Self-Efficacy		statistically significant associations found · Social support (β = .129, P = .008) · Self-efficacy (β = .337, P <.001)	
Johansson 2020	· Pinellas County, FL · NR	· Patients ≥55 years with HF and enrolled in Program of All-Inclusive Care for the Elderly · Sample: N=51	· Patient surveys	· Age · Sex · Race · Living Status · Social Support	· Nurse-led telephone support intervention supplemented with mobile phone SMS text messages	· HF Self-Care · HF Knowledge · Medication Adherence · Physical and · Mental Health	· Improved HF self-care maintenance (t49=0.66; P=.01) · Improved HF knowledge (t49=0.71; P=.01) · Improved medication adherence (t49=0.92; P=.01) · Improved physical and mental health (t49=0.81; P=.01)	4
Russell 2019[54*] (Cross-sectional)	· NYC · (2013-2017)	· Hospice patients ≥18 years · Diagnosis: HF · Sample: N=1.498	· EMR · Interviews	· None	· Age · Sex · Race and Ethnicity · Marital Status · Insurance Status	· Elective Revocation	· Age 75 to 84 years: higher odds (AOR 1.99, CI 1.18–3.38) · Sex, Race and Ethnicity, marital status, insurance status: no statistically significant associations found	4
Russell 2019[54*] (Cross-sectional)	· NYC · (2013-2017)	· Hospice patients ≥18 years · Diagnosis: HF	· EMR · Interviews	· None	· Age · Sex · Race and Ethnicity	· Transfer	· HISP: higher odds (AOR 2.25, CI 1.10–4.62) · Asian/other: higher odds (AOR 2.25 CI 1.04–6.18)	4

		· Sample: N=1.498			· Marital Status · Insurance Status		· Age, sex, marital status, insurance status: no statistically significant associations found	

*More than one HF outcome

† Statistical method to interpret results vary by study. The effect of the SDOH variable on the given outcome is addressed in this column

‡ QR, quality rating was assigned based on a modified Oxford Centre for Evidence-based Medicine (cebm.net) rating scheme and evaluated for interrater comparability. Using this methodology, studies were rated 1 (highest quality) to 5 (lowest quality). Studies receiving the highest rating were properly powered and conducted randomized clinical trials (RCTs); well-designed controlled trials without randomization or prospective comparative cohort trials were rated 2; case control and retrospective cohort studies were rated 3; case series and cross-sectional studies were rated 4; opinion and case reports (5 rating) were not included in this review.

§ A hospital readmission is an unplanned episode in which a patient who had been discharged from a hospital is admitted again within a certain period of time (e.g., 30-, 60-, 90-days) after the index admission for HF.

‖ A heart failure hospitalization refers to a hospitalization for which the International Classification of Diseases (ICD) clinical modification discharge code for HF was used as the first listed discharge code.

AA- African American
ACS- Acute Coronary Syndrome
ACS HCUP - American Community Survey Healthcare Cost and Utilization Project
ADHF- Acute Decompensated Heart Failure
aHR- Adjusted Hazard Ratio
AHRF - Area Health Resource File
AMI- Acute Myocardial Infarction
aOR- Adjusted Odds Ratio
ARIC- Atherosclerosis Risk in Communities
BHLS- Brief Health Literacy Screen
BTT- Bridge to Transplant
CA - California
CHF- Chronic Heart Failure
CI- Confidence Interval
CMS- Centers for Medicare & Medicaid Services
CV- Cardiovascular
DECIDE-LVAD- Shared Decision Support Intervention for Patients and their Caregivers Offered Destination Therapy for End-Stage Heart Failure
ED- Emergency Department
EM- Effect Modifier
EMR- Electronic Medical Record
FL - Florida
FFS- Fee for Service
GM- General Medicine
GWTG HF- Get with The Guidelines-Heart Failure
HCUP-Healthcare Cost and Utilization Project
HF- Heart Failure
HFH- Heart Failure Hospitalization
HHI- Household Income
HISP- Hispanic
HRS- Health and Retirement Study
HTx- Heart Transplant
ICD- Implantable Cardioverter-Defibrillators

	IMPROVE HF- Improve the Use of Evidence-Based Heart Failure Therapies in the Outpatient Setting INTERMACS- Interagency Registry for Mechanically Assisted Circulatory Support IRR- Incidence Rate Ratio KY - Kentucky LOS- Length of Stay LVAD- Left Ventricular Assist Device MA - Massachusetts MD - Maryland MHI- Median Household Income MN - Minnesota MPCD- Multi-Payer Claims Database MS - Mississippi NC – North Carolina NDI- Neighborhood Deprivation Index NHANES- US National Health and Nutrition Examination Surveys NIS- National Inpatient Sample nINC- Neighborhood Median Household Income NJ – New Jersey NR- Not Reported NRD- US Nationwide Readmission Database NV - Nevada NYC – New York City OH - Ohio OP- Outpatient OPTIMIZE- Organized Program to Initiate Lifesaving Treatment in Hospitalized Patients with Heart Failure OR- Odds Ratio PS- Psychosocial REGARDS- Reasons for Geographic and Racial Differences in Stroke REMOTE-HF- Rural Education to Improve Outcomes in Heart Failure RRR- Relative Risk Reduction RSMR-Risk-Standardized Mortality Ratio RSRR- Risk-Standardized Readmission Rate RS- Risk standardized SCCS- Southern Community Cohort Study SES- Socioeconomic Status SHR- Subhazard Ratios SSDI- Social Security Death Index TX - Texas

	VHA- Veterans Health Affairs WHI- Women’s Health Initiative 30d- 30 day 1y- 1 year 90d- 90 days

Table S3. Summary of SDoH Analyzed in Studies (K=59).

Social Determinant of Health	Studies
Race and Ethnicity	13-20,22,23,25-43,45-50,52-57,59,60,62-71
Age	13-20,22-30,33-54,56-71
Sex	13-20,22-30,32-55,57-71
Insurance	13,15-17,22,23,25,27-32,38,41,42,47-50,53-55,59,61-63
Income/wealth	13,26,27,30,31,38,41,42,47,53,55,56,59,64
Marital status	13,15,17,19,25,31,43,47,54,58,65
Education/health literacy	13,20,27,30,31,33,42,46,53,56,59,68
Individual/neighborhood socioeconomic status	14,15,28,32,38,40,42,50,52,53,59,62
Urban/rural residence	13,40,41,47,56,59,62,68,69
Social support	21,25,39,44,58,59,66,67
Living status	18,19,43,47,59,62,66
Employment	17,27
Social (in)stability	15,38,66
Language	19,28,55
Faith/spirituality	18,40,51
Children	47

SDoH – Social Determinants of Health

Table S4. Scales Utilized in Studies.

Social Determinant of Health	Scale/Measure	Studies
Neighborhood Socioeconomic Status	Area Deprivation Index	28,38,40.42,62
	Social Deprivation Index	52
	Neighborhood Deprivation Index	14
Health literacy	Brief Health Literacy Screen	20,46
	Short Test of Functional Health Literacy in Adults	68
Spirituality/Faith	Brief Multidimensional Measure of Religiousness and Spirituality	51
Social support	Medical Outcome Study Social Support	16,58
	Psychosocial Assessment of Candidates for Transplantation	21
	Functional Social Support Questionnaire	37
	Lubben Social Network Scale	39
	Interpersonal Support Evaluation List	39
	Patient-Reported Outcomes Measurement Information System Social Isolation Short Form 4a v2.0.13	44
	Enhancing Recovery In Coronary Heart Disease patients Social Support Instrument	51
	Multidimensional Perceived Social Support Scale	67

Figure S1. PRISMA study flow diagram.