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Comparison of the Social Determinants of Health (SDoH) in Heart Failure with Preserved Ejection Fraction (HFpEF) *vs*. Heart Failure with Reduced Ejection Fraction (HFpEF): Implication for Health Policy in the United States

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ABSTRACT

Background and Objective: Social determinants of health (SDoH) significantly influence the development, progression, and outcomes of heart failure (HF) and its subtypes. This study aimed to determine the relationship between SDoH and the diagnosis of heart failure with preserved ejection fraction (HFpEF) vs. heart failure with reduced ejection fraction (HFrEF) using the Healthcare Cost and Utilization Project - National Inpatient Sample (HCUP NIS) dataset 2020.

Methods: 844,232 (weighted) admissions with an ICD-10 code indicating a diagnosis of HFpEF or HFrEF were identified. Univariate and multivariate logistic regression were performed to determine if certain SDoH influenced the type of HF diagnosis.

Results: Univariate analysis showed that higher-income quartiles, females, older age groups, non-minority racial status, and specific chronic comorbidities were significantly associated with HFpEF compared to HFrEF ($p<0.001$). Multivariable logistic regression revealed that females had an adjusted odds ratio (aOR) of 2.151 (CI 2.131-2.171, $p<0.001$) for HFpEF, and the age group ≥82 years had an aOR of 1.917 (CI 1.887-1.948, $p<0.001$). Class 3 obesity was associated with an aOR of 2.129 (CI 2.100-2.159, $p<0.001$) for HFpEF. Lower odds of HFpEF were observed for Medicaid insurance (aOR=0.77, CI: 0.76-0.79, $p<0.001$), private HMO (aOR=0.85, CI: 0.84-0.86, $p<0.001$), and rural residents (aOR=0.98, CI: 0.97-0.99, $p<0.01$).

Conclusion: HFpEF is notably more challenging to diagnose due to its less overt symptomatology and the need for more sophisticated diagnostic tools, which are often more accessible to higher-income populations. Recognizing these challenges is crucial for vulnerable populations, who may face barriers to timely and accurate diagnoses.

Keywords: Heart Failure; Heart Failure with Preserved Ejection Fraction (HFpEF); Heart Failure with Reduced Ejection Fraction (HFpEF); Social Determinants of Health (SDoH); Health Disparities

Abbreviations: AOR: Adjusted Odds Ratio; CI: Confidence Interval; COPD: Chronic Obstructive Pulmonary Disease; COR: Crude Odds Ratio; EF: Ejection Fraction; HF:Heart Failure; HFpEF: Heart Failure with Preserved Ejection Fraction; HFrEF: Heart Failure with Reduced Ejection Fraction; HCUP:Healthcare Cost and Utilization Project; HMO: Health Maintenance Organization; ICD-10-CM: International Classification of Diseases, Tenth Revision, Clinical Modification; IRB: Institutional Review Board; NIS: National Inpatient Sample; OR: Odds Ratio; SDoH: Social Determinants of Health

Introduction

Background and Objectives

Heart failure (HF) is a global health crisis affecting 64 million people worldwide. By 2030, the United States is projected to have approximately 8 million HF cases [1]. HF has two main subtypes: heart failure with preserved ejection fraction (HFpEF) and heart failure with reduced ejection fraction (HFrEF). Ejection fraction (EF) is a crucial measure of heart function, referring to the percentage of blood pumped out of the left ventricle with each contraction. In a healthy heart, the EF typically ranges from 50% to 70% [2]. HFrEF is characterized by an EF of less than 40%, with the heart muscle weakened and unable to contract effectively. In contrast, HFpEF is defined by an EF of 50% or higher, with the heart muscle being stiff and not relaxing correctly, leading to impaired filling of the left ventricle [3]. While HFrEF rates have declined with treatment advances, the prevalence of HFpEF continues to rise and now exceeds 50% of all HF cases [4,5]. Diagnosing HFpEF remains challenging due to its complex pathophysiology and the presence of comorbidities such as hypertension, diabetes, and obesity, which can obscure its clinical presentation [6].

Patients with HFpEF often lack traditional heart failure symptoms and instead present with non-specific symptoms such as shortness of breath, which can be exacerbated by conditions such as obesity or kidney disease [7]. Due to the asymptomatic nature of early-stage HFpEF, individuals with reduced healthcare access, often from marginalized communities, are at a higher risk of late diagnosis [8]. Social determinants of health (SDoH) play a significant role in the development, progression, and outcomes of HF and its subtypes. Low socioeconomic status, as indicated by factors such as low income, limited education, and lack of health insurance, has been associated with an increased risk of developing HF and worse outcomes, including higher mortality rates and more frequent hospitalizations [9,10]. Racial and ethnic disparities have also been observed, with African Americans and Hispanics having a higher prevalence of HF and poorer outcomes compared to non-Hispanic whites [11,12]. Additionally, living in disadvantaged neighborhoods with limited access to healthy food options, safe spaces for physical activity, and quality healthcare services has been linked to an increased risk of HF [13]. While these SDoH factors have been studied in the context of HF, there is limited research on how they specifically impact the development and outcomes of HFpEF versus HFrEF.

Understanding the differential impact of SDoH on HF subtypes is crucial for developing targeted interventions and policies that can effectively address the unique needs and challenges faced by different patient populations. This study examines the differences in the relationship between social determinants of health (SDoH) and heart failure subtypes (HFpEF vs. HFrEF) using the 2020 HCUP National Inpatient Sample dataset [14,15]. By investigating the associations between income, race/ethnicity, comorbidities, primary payer status, and urban/rural residence with these subtypes, we aim to inform more equitable, patient-centered heart failure prevention, diagnosis, and management strategies. We hypothesize significant differences in the associations between these SDoH variables and HFpEF compared to HFrEF, contributing to targeted interventions and policies to reduce disparities and improve outcomes.

Methods

Study Design and Data Source

The University of Jamestown Institutional Review Board (IRB) approved this project, and due to the nature of the data, no informed consent was required. This retrospective cross-sectional study of heart failure (HF) patients from the HCUP NIS 2020 database. The HCUP NIS is the largest publicly available all-payer inpatient healthcare database in the United States, designed and weighted to be nationally representative [16]. This weighting adjusts each discharge record according to the inverse of its probability of hospital selection, accounting for factors like hospital size, location, and type, ensuring accurate reflections of the United States inpatient population and valid national extrapolations. The HCUP NIS contains data on more than 7 million (unweighted) and 35 million (weighted) hospital admissions annually, representing more than 97 percent of the target data records: all acute care discharges from non-federal hospitals in the United States. The dataset was redesigned in 2012, with revisions to the sample design, hospital definitions, and confidentiality measures [14,15]. Due to a new sampling strategy, the HCUP NIS now approximates a 20-percent stratified sample of discharges from all HCUP-participating hospitals rather than a sample of hospitals from which all discharges were retained [14,15].

The study population consisted of adult patients aged 18 years or older who had a hospitalization, emergency department visit, or inpatient procedure in 2020 with a primary or secondary diagnosis code for heart failure (HF) in the form of HFrEF (reference variable) and HFpEF. Pediatric patients under 18 were excluded due to the different HF etiology and lower prevalence than observed in adults. The multivariable model helped assess the independent contribution of each factor while accounting for the presence of others, which is crucial for reporting the study results about the drivers of HFpEF and HFrEF in the population studied.

Statistical Analysis

Statistical analyses were conducted using Stata 18.0 SE software. Cross-tabulation of descriptive statistics was used to summarize the demographic and clinical characteristics of the study population using frequency and percentile. Chi-square tests assessed the bivariate associations between categorical variables and heart failure subtypes (HFpEF and HFrEF). All statistical significance was declared at p-value <0.05 (Supplementary Table 1). Univariate and multivariable logistic regression models were employed to examine the influence of various predictors on the prevalence of heart failure subtypes (HFpEF and HFrEF). The univariate analysis was employed to select the can-

didate predictors of heart failure diagnosis type, such as age, gender, race, income, insurance status, comorbidities, and hospital characteristics. The multivariable logistic regression models were adjusted for confounders and statistical significance in the univariate analysis (with p-value < 0.05). Confounders were controlled by including them as covariates in the multivariable regression models (Supplementary Table 2). Subgroup analyses were performed to investigate whether the associations between social determinants and health outcomes differ across various demographic segments, such as age, gender, income, or ethnicity. These analyses stratified the study population by the relevant subgroups and repeated the chi-square tests and logistic regression models within each stratum (Supplementary Table 3).

Supplementary Table 1: Cross Tabular "Descriptive" Analysis of HF Subtypes from Healthcare Cost and Utilization Project National Inpatient Dataset 2020.

Variable / Category	HFrEF (N=423,236)	HFpEF (N=420,996)	Chi-Square P-value
Age			
18-61 years	116,039 (27.4%)	74,845 (17.8%)	<0.001
62-72 years	120,673 (28.5%)	109,676 (26.1%)	
73-81 years	95,087 (22.5%)	106,876 (25.4%)	
>= 82 years	91,432 (21.6%)	129,597 (30.8%)	
Sex			
Female	154,873 (36.6%)	241,505 (57.4%)	<0.001
Male	268,345 (63.4%)	179,474 (42.6%)	
Race			
White	272,884 (65.9%)	297,803 (72.2%)	<0.001
Black	84,585 (20.4%)	66,739 (16.2%)	
Hispanic	34,434 (8.3%)	28,829 (7.0%)	
Asian/Pacific Islander	8,858 (2.1%)	8,310 (2.0%)	
Native American	2,798 (0.7%)	2,206 (0.5%)	
Other	10,297 (2.5%)	8,687 (2.1%)	
Type 2 Diabetes Mellitus			
No	226,122 (53.4%)	216,843 (51.5%)	<0.001
Yes	197,114 (46.6%)	204,153 (48.5%)	
Hypertension			
No	235,785 (55.7%)	224,868 (53.4%)	<0.001
Yes	187,451 (44.3%)	196,128 (46.6%)	
COPD			
No	296,963 (70.2%)	265,648 (63.1%)	<0.001
Yes	126,273 (29.8%)	155,348 (36.9%)	
Class 2 Obesity			
No	405,341 (95.8%)	398,682 (94.7%)	<0.001
Yes	17,895 (4.2%)	22,314 (5.3%)	
Overweight			
No	414,047 (97.8%)	412,004 (97.9%)	0.265
Yes	9,189 (2.2%)	8,992 (2.1%)	
Class 1 Obesity			
No	403,117 (95.3%)	399,757 (95.0%)	<0.001
Yes	20,119 (4.8%)	21,239 (5.0%)	
Class 3 Obesity			
No	378,629 (89.5%)	343,859 (81.7%)	<0.001
Yes	44,607 (10.5%)	77,137 (18.3%)	

Note: Data were obtained from the HCUP NIS 2020 database, † Heart Failure with Preserved Ejection Fraction (HFpEF), ‡ Heart Failure with Reduced Ejection Fraction (HFrEF)

Supplementary Table 2: Uni/Multivariable Logistic Regression of HFpEF vs HFrEF.

Variable	Univariate OR (CI)	Multivariate OR (CI)
Primary Expected Payer Medicare (ref)		
Medicaid	0.55 (0.54-0.56) ***	0.77 (0.76-0.79) ***
Private HMO	0.66 (0.66-0.67) ***	0.85 (0.84-0.86) ***
Self-Pay	0.44 (0.43-0.45) ***	0.66 (0.64-0.68) ***
No-Charge	0.40 (0.36-0.45) ***	0.60 (0.53-0.68) ***
Other	0.64 (0.62-0.66) ***	0.89 (0.87-0.92) ***
Median Household Income $1 – 45,999 (ref)		
Medicaid	0.55 (0.54-0.56) ***	0.77 (0.76-0.79) ***
Private HMO	0.66 (0.66-0.67) ***	0.85 (0.84-0.86) ***
Self-Pay	0.44 (0.43-0.45) ***	0.66 (0.64-0.68) ***
No-Charge	0.40 (0.36-0.45) ***	0.60 (0.53-0.68) ***
Other	0.64 (0.62-0.66) ***	0.89 (0.87-0.92) ***
Median Household Income $1 – 45,999 (ref)		
$46,000-58,999	1.12 (1.11-1.13) ***	1.05 (1.04-1.06) ***
$59,000-78,999	1.19 (1.17-1.20) ***	1.10 (1.09-1.12) ***
>=$79,000	1.26 (1.24-1.27) ***	1.15 (1.14-1.17) ***
Urban/Rural Location Urban (ref)		
Rural	0.99 (0.98-1.00)	0.98 (0.97-0.99) **
Hospital Division Northeast (ref)		
Midwest	0.96 (0.95-0.97) ***	0.94 (0.93-0.96) ***
South	0.81 (0.80-0.82) ***	0.87 (0.86-0.88) ***
West	0.75 (0.74-0.76) ***	0.79 (0.78-0.80) ***
Sex Male (ref)		
Female	2.33 (2.31-2.35) ***	2.15 (2.13-2.17) ***
Age 18-61 years (ref)		
62-72 years	1.41 (1.39-1.43) ***	1.22 (1.21-1.24) ***
73-81 years	1.74 (1.72-1.76) ***	1.48 (1.46-1.50) ***
>= 82 years	2.20 (2.17-2.23) ***	1.92 (1.89-1.95) ***
Race White (ref)		
Black	0.72 (0.71-0.73) ***	0.84 (0.83-0.85) ***
Hispanic	0.77 (0.75-0.78) ***	0.95 (0.93-0.96) ***
Asian/Pacific Islander	0.86 (0.83-0.89) ***	1.04 (1.01-1.07) *
Native American	0.72 (0.68-0.76) ***	0.90 (0.84-0.95) ***
Other	0.77 (0.75-0.80) ***	0.88 (0.86-0.91) ***
Type 2 Diabetes Mellitus		
Yes	1.08 (1.07-1.09) ***	1.09 (1.08-1.10) ***
Hypertension		
Yes	1.10 (1.09-1.11) ***	1.10 (1.09-1.11) ***
COPD		
Yes	1.38 (1.36-1.39) ***	1.32 (1.31-1.33) ***
Class 2 Obesity		
Yes	1.27 (1.24-1.29) ***	1.16 (1.13-1.18) ***
Overweight		
Yes	0.98 (0.95-1.01)	1.06 (1.03-1.09) ***

Class 1 Obesity		
Yes	1.06 (1.04-1.09) ***	1.14 (1.11-1.16) ***
Class 3 Obesity		
Yes	1.90 (1.88-1.93) ***	2.13 (2.10-2.16) ***

Note: Data were obtained from the HCUP NIS 2020 database, † p < 0.001 ***. ‡Univariate Odds Ratio (OR), § adjusted Odds Ratio (aOR), Confidence Interval 95% (CI), ¶ Health Maintenance Organization (HMO).

Supplementary Table 3: ICD-10 Codes.

Category	ICD-10 Codes
HFpEF	I50.30, I50.31, I50.32, I50.33
HFrEF	I50.20, I50.21, I50.22, I50.23, I50.40, I50.41, I50.42, I50.43

Odds ratios (ORs) and their corresponding 95% confidence intervals (CIs) were used to measure the strength of the associations between predictors and heart failure subtypes. Interactions and confounders were checked using a change in beta coefficient with a cutoff point beta change greater than 15%. Multicollinearity for variables in the final fitted model was checked using variance inflation factor (VIF), and no multicollinearity was observed with VIF 1.33. The classifying ability (predicting power) of variables in the final fitted model was checked by the receiver observed characteristics (ROC) curve and the overall goodness of fit was checked using the Hosmer and Lemeshow chi-square test. The association between predictors and odds of heart failure type was summarized using an adjusted odds ratio, and statistical significances were tested at p-value <0.05. The confounders included in the multivariable logistic regression models were selected based on their potential influence on the relationship between SDoH factors and HF subtypes.

These confounders were identified through a comprehensive literature review and clinical expertise, considering demographics, comorbidities, and healthcare access. By adjusting for these confounders, we aimed to isolate the independent effects of the SDoH factors on the likelihood of being diagnosed with HFpEF compared to HFrEF. This study involved the secondary analysis of de-identified data and adhered to ethical data privacy, quality, and confidentiality standards. The HCUP NIS databases are consistent with the definition of limited data sets under the Health Insurance Portability and Accountability Act Privacy Rule and contain no direct patient identifiers.

Results

Descriptive Statistics

The study population consisted of 844,232 weighted discharges of heart failure (HF) patients from the 2020 HCUP Nationwide Inpatient Sample (NIS) dataset. The patient population was nearly evenly split between HF with preserved ejection fraction (HFpEF, 49.9%) and HF with reduced ejection fraction (HFrEF, 50.1%). Demographically, the majority of patients were male (53.1%), and the largest racial group was White (69.1%), followed by Black (18.3%) and Hispanic (7.7%). Most patients were aged 62 years or older (77.4%), with the largest age group being 62-72 years (27.3%). Comorbidities were common, with nearly half of the patients having Type 2 Diabetes Mellitus (47.5%) and hypertension (45.4%). Chronic Obstructive Pulmonary Disease (COPD) was present in about a third of the patients (33.4%), and (14.4%) were classified as Class 3 Obese. Examining socioeconomic factors, the majority of patients (73.1%) were insured by Medicare, with the highest proportion (32.4%) falling within the lowest household income bracket ($1-45,999). Geographically, most patients resided in urban areas (83.0%), and the Southern United States region had the highest proportion of HF discharges (39.9%) compared to the other regions.

Compared to HFrEF patients, HFpEF patients in Supplementary Table 2 were more likely to be female (57.4% vs. 36.6%, p<0.001), older (30.8% in the ≥82 years age group vs. 21.6%, p<0.001), and White (72.2% vs. 65.9%, p<0.001). HFpEF patients also had a higher prevalence of Type 2 Diabetes Mellitus (48.5% vs. 46.6%, p<0.001), hypertension (46.6% vs. 44.3%, p<0.001), COPD (36.9% vs. 29.8%, p<0.001), and Class 3 Obesity (18.3% vs. 10.5%, p<0.001).

Univariate and Multivariate Logistic Regression Analyses

Univariate Analysis

Upon univariate analysis, statistically significant variables increasing the odds of HFpEF included female sex (OR 2.33, 95% CI 2.31-2.35), older age (≥82 years: OR 2.20, 95% CI 2.17-2.23), higher income quartiles (≥$79,000: OR 1.26, 95% CI 1.24-1.27), COPD (OR 1.38, 95% CI 1.36-1.39), and Class 3 Obesity (OR 1.90, 95% CI 1.88-1.93). Conversely, factors such as Black race (OR 0.72, 95% CI 0.71-0.73) and lower primary payer categories like Medicaid (OR 0.55, 95% CI 0.54-0.56) were associated with decreased odds of HFpEF.

Multivariate Analysis

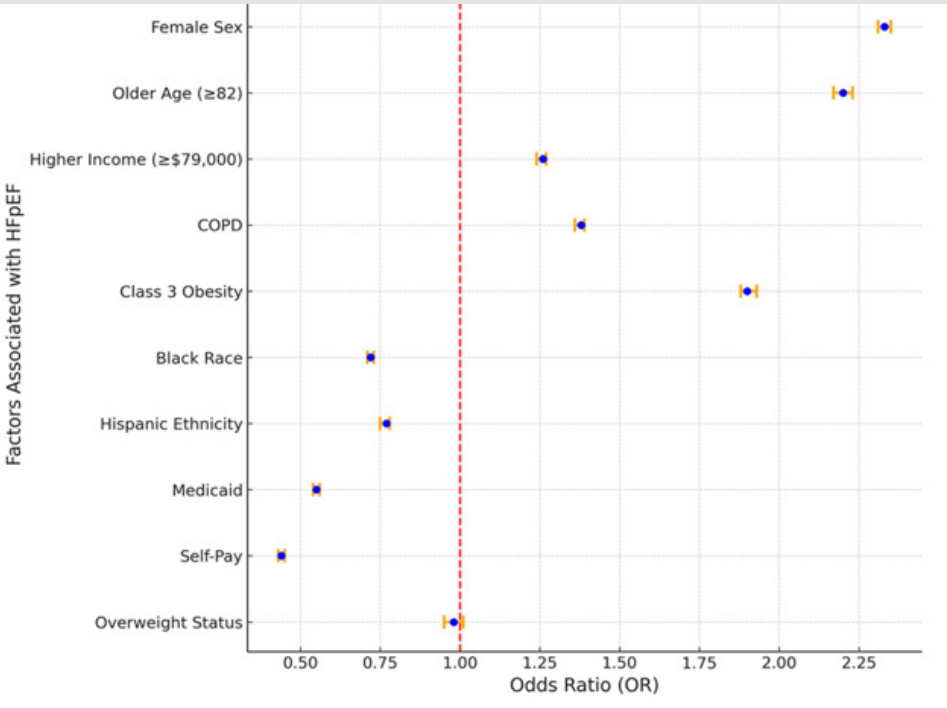
The multivariable logistic regression analysis, detailed in Supplementary Table 2 and Supplementary Figure 1, adjusted for a comprehensive set of variables to assess their independent impact on the likelihood of HFpEF. This model included:

- **Demographic variables:** age, sex, and race
- **Socioeconomic factors:** primary expected payer, median household income, and urban/rural location
- **Clinical Comorbidities:** included Type 2 Diabetes, hypertension, COPD, and obesity classifications (i.e., overweight to obesity class 1 through 3).

The model(s) controlled for interactions between age and sex, and multicollinearity was assessed to ensure robustness. Adjustments were made for confounders identified in the univariate analysis to isolate the effect of each variable on the likelihood of HFpEF. This comprehensive approach highlighted that after adjusting for potential confounders, characteristics such as female sex (aOR 2.15, 95% CI 2.13-2.17) and older age (aOR 1.92, 95% CI 1.89-1.95) and class 3 obesity (aOR 2.13, 95% CI 2.10-2.16) remained significantly associated with increased odds of HFpEF. At the same time, lower socioeconomic status indicators like Medicaid coverage continued to show decreased odds of HFpEF diagnosis. This change from the univariate to the multivariate analysis highlights that after adjusting for other variables such as socioeconomic factors, other racial categories, comorbidities, and location, the association between being Asian/Pacific Islander and the likelihood of HFpEF diagnosis shifts from negative to slightly positive (aOR 1.04, 95% CI 1.01-1.07, p-value 0.018).

Discussion

The results of this study reveal the intricate relationship and disparities in socioeconomic and clinical factors between HFpEF and HFrEF diagnoses. The likelihood of HFpEF over HFrEF diagnosis was notably higher among whites, females, and older individuals. Those with higher income levels and lower primary payer categories such as Medicaid and Self-Pay are associated with decreased odds of having HFpEF compared to HFrEF (see Supplementary Figures 1 & 2). This could suggest that individuals in these categories are likelier to have HFrEF. Medicaid providers and Self-Pay patients are less likely to diagnose HFpEF, or patients are less likely to seek specialized care, and HFpEF is underdiagnosed. Our study also substantiates other current findings that comorbidities like T2DM, HTN, Obesity, and COPD are more likely to be associated with HFpEF [17,18]. T2DM (OR 1.08, 95% CI 1.07-1.09), HTN (OR 1.10, 95% CI 1.09-1.11), COPD (OR 1.38, 95% CI 1.36-1.39), and Class 3 Obesity (OR 1.90, 95% CI 1.88-1.93) were all significantly associated with increased odds of HFpEF diagnosis. This is important clinically because the presence of the comorbidities often contributes to cardiac stress and ventricular stiffness typical of HFpEF, but also can be utilized to identify vulnerable populations that may need to be screened prior to becoming symptomatic [3].



Supplementary Figure 1: Comparison of Univariable and Multivariable Analysis of Factors Associated with HFpEF.

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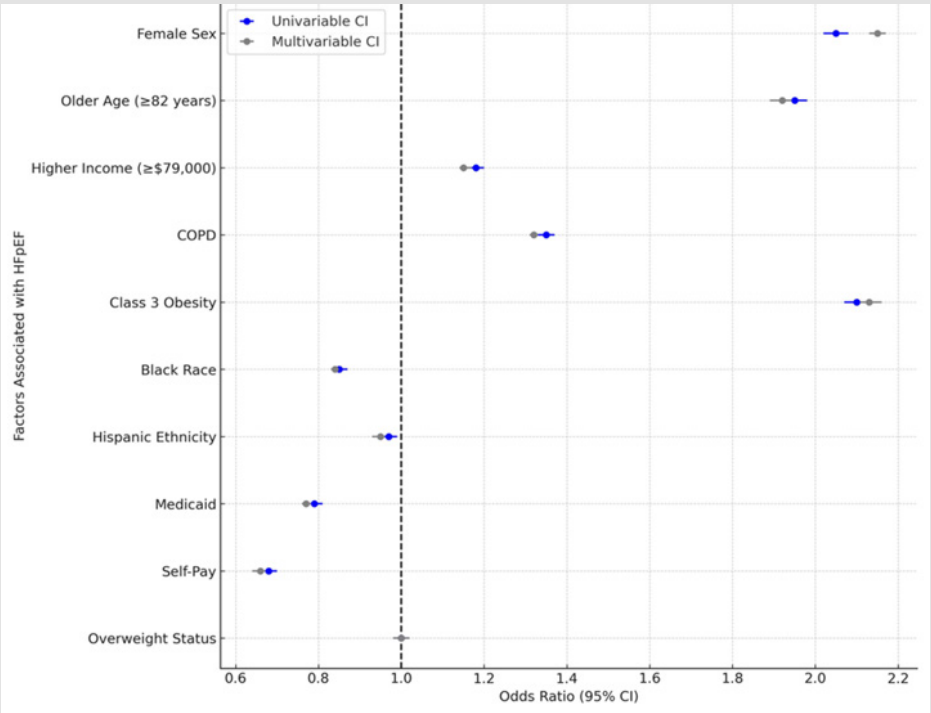

Supplementary Figure 2: Univariable Analysis of Factors Associated with HFpEF.

The relationships between the control variables and the diagnosis of HFpEF could indicate substantial disparities in examination and diagnosis of HFpEF across the HF subgroups. The variation in risk across vulnerable groups should also be considered and may suggest different predispositions or exposures leading to HFpEF or HFrEF. For example, the association between higher income levels and HFpEF diagnosis suggests that lower socioeconomic status may play a role in the possible underdiagnosis of the less symptomatic HFpEF in lower-income and minority patient populations [6,7]. Patients with higher incomes may have more access to specialty care services, including diagnostic tools not available to those with lower income levels [8]. Other potential explanations for this association include differences in lifestyle factors, access to preventive care, and chronic stress levels among lower-income individuals [9,10]. However, further research is needed to elucidate underlying mechanisms for observed disparities and develop targeted interventions, which are beyond the scope of this study. In addition, the lower odds of the more difficult to identify on clinical examination HFpEF diagnosis among non-White racial groups may reflect known underlying disparities in access to healthcare and disease management [11,12]. A study by Breathett et al. (2017) found that Black and Hispanic patients were less likely to receive guideline-recommended heart failure therapies compared to White patients, and Sharma et al. (2018) reported that women with heart failure were less likely to receive evidence-based treatments and had worse outcomes compared to men [19,20].

These disparities also may be partially attributed to differences in health literacy. A study by Kaholokula et al. (2008) found that Native Hawaiians and Pacific Islanders had lower health literacy levels compared to other racial groups, which was associated with poorer heart failure outcomes [21,22]. The association between comorbidities, such as COPD and obesity, and HFpEF underscores the complex interplay between SDoH risk factors and heart failure subtypes, highlighting the need for a multidisciplinary approach to heart failure diagnosis [23]. Practitioners who are aware of these correlations may be more likely to refer individuals with these diagnoses for HF screening earlier, even prior to the emergence of symptoms. These findings align with the growing recognition of the complex relationship between cardiovascular disease and other chronic conditions, such as diabetes and chronic kidney disease [24]. The high prevalence of comorbidities among HFpEF patients underscores the importance of developing and implementing multidisciplinary and collaborative care models that engage various health professionals and support services to optimize disease management and quality of life [25].

These models should focus on addressing the shared risk factors and pathophysiological mechanisms that contribute to the development and progression of HFpEF and its associated comorbidities. Integrating specialist care, such as pulmonology and endocrinology, into heart failure management programs can facilitate early detection and treatment of comorbid conditions and improve coordination of care across specialties [26]. The study's findings highlight the need

for healthcare providers to consider socioeconomic and demographic factors when screening, diagnosing, and managing heart failure patients. Providers should be aware of the higher prevalence of comorbidities such as diabetes, hypertension, obesity, and COPD among HFpEF patients and screen for these conditions accordingly [27]. Additionally, providers should consider the potential barriers to accessing specialty care and diagnostic tools among lower-income and minority populations. Furthermore, establishing multidisciplinary heart failure clinics integrating primary care, cardiology, and other specialties can improve care coordination and outcomes for patients with multiple comorbidities. These clinics can also serve as hubs for patient education and self-management support, promoting health literacy and empowering patients to participate actively in their care [28-30].

Our findings contribute to the growing evidence on the complex relationships between socioeconomic factors, demographic variables, heart failure subtypes, and patient identification and diagnosis. The significant combinations of OR, CI, and p-values for most variables highlight the importance of considering demographic and clinical characteristics when studying and treating different heart failure subtypes. Given our large sample size, further investigation is warranted. However, recognizing these challenges is particularly important for vulnerable populations, who may face significant barriers in accessing specialty care, resulting in timely and accurate diagnoses. To achieve earlier diagnoses in these populations, increased physician awareness and targeted training on the subtle presentations of HFpEF are crucial. Additionally, payer support for comprehensive diagnostic evaluations and the implementation of screening programs that prioritize high-risk groups can enhance early detection efforts. Focusing on early diagnosis rather than just health literacy can address the root causes of underdiagnosis, ensuring that all patients receive appropriate and timely care, ultimately improving outcomes and reducing healthcare disparities.

Limitations

The current study has several limitations that should be considered when interpreting the results. First, the use of administrative data from the HCUP NIS database may be subject to potential misclassification of HF subtypes and other variables. After carefully examining the dataset, no significant missing data or misclassification of variables were found. However, the absence of detailed clinical data in administrative databases may limit the ability to fully capture the complexity of heart failure subtypes and SDoH. Although the risk of misclassification was minimized using validated ICD-10 coding algorithms to identify heart failure cases, it cannot be entirely ruled out. Second, the study's cross-sectional design limits the ability to establish causal relationships between SDoH factors and HF subtypes. Unmeasured confounders, such as medication adherence or lifestyle factors, could affect the observed associations. The potential for residual confounding due to unmeasured variables may have influenced the associations between predictors and heart failure subtypes.

The generalizability of the findings to other populations or settings may also be limited, as the study was based on a single year of data from the United States. Robust statistical methods, sensitivity analyses, and cautious interpretation were employed to address these limitations. The potential misclassification of HF subtypes based on ICD-10 codes is another limitation of this study. While we used validated algorithms to identify HFpEF and HFrEF cases, the accuracy of these codes may vary depending on the quality of clinical documentation and coding practices. Misclassification of HF subtypes could lead to biased estimates of the associations between SDoH factors and HF subtypes. However, we expect this bias to be non-differential, which would generally attenuate the observed associations towards the null. Future studies using more detailed clinical data, such as echocardiography results and physician-adjudicated diagnoses, could help mitigate this limitation and provide more precise estimates of the relationships between SDoH factors and HF subtypes.

Ideas for Future Research

Future research should focus on conducting prospective studies with more detailed clinical data to understand better the causal pathways linking SDoH factors to heart failure risk and outcomes. For instance, longitudinal studies could provide insights into how changes in socioeconomic status over time influence heart failure progression and outcomes. Developing novel risk prediction models that incorporate SDoH factors could help identify high-risk individuals and guide targeted prevention, diagnosis, and treatment strategies. Furthermore, interventional studies that address specific SDoH, such as improving access to healthcare or enhancing patient education, could inform effective strategies to reduce health disparities in heart failure.

Conclusion

This study highlights the significant differences in SDoH profiles between HFpEF and HFrEF patients and underscores the importance of considering these factors in diagnosing, preventing, and managing heart failure. The observed disparities in HFpEF diagnosis across different socioeconomic and racial groups emphasize the need for increased physician awareness, targeted training, and comprehensive diagnostic evaluations to ensure timely and accurate diagnoses, particularly in vulnerable populations. Multidisciplinary care models can help address these disparities, improve HF outcomes, and reduce healthcare inequities.

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patients admitted to partnering hospitals in 2020 and diagnosed with heart failure. Although hospitalization for any disease process is unfortunate, this study would not have been possible without patient data, which contributed significantly to our understanding of the relationship between social determinants of health and heart failure subtypes. I personally want to thank Dr. W. Lerebo and Dr. K. Lefebrve for their dedication to this study and my success. Lastly, we thank all the individuals and organizations who contributed directly or indirectly to this research project. For more information on suggested citations for HCUP databases and tools, visit the HCUP website at https://www.hcup-us.ahrq.gov/. This study did not receive any specific grant from public, commercial, or not-for-profit funding agencies, and the authors have no conflicts of interest to disclose.

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