Characteristics and outcomes for patients with heart failure diagnosed according to the universal definition and classification of heart failure. Data from a single-center registry

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ABSTRACT

Background: There are no data on the characteristics and outcomes for patients with heart failure (HF) with reduced (HFrEF), mildly reduced (HFmrEF), and preserved (HFpEF) ejection fraction diagnosed according to the universal definition and classification of HF.

Aims: We used the universal HF definition to compare baseline characteristics, hospital readmission and mortality rates in individuals with HFrEF, HFmrEF, and HFpEF diagnosed retrospectively.

Results: The study was designed as a single-center retrospective analysis of all consecutive 40732 hospital admissions between 2013 and 2021 in a tertiary department of cardiology. All patients with HF, defined according to the universal definition and classification of HF, were identified. The study included 8471 patients with a mean age of 65.1 (12.8) years, of whom 2823 (33.3%) were females. Most individuals had a prior diagnosis of HF (76.3%) and elevated N-terminal pro-B-type natriuretic peptide levels (99.0%) with a median of 1548 (629–3786) pg/ml. Mean ejection fraction (EF) was 36.2 (14.9)%. The median follow-up was 39.1 (18.1–70.5) months. The most frequent type of HF was HFrEF (n = 4947; 58.4%), followed by HFpEF (n = 1138; 28.2%) and HFmrEF (n = 2386; 13.4%). Urgent HF readmissions and all-cause deaths were highest in HFrEF (40.8% and 42.7%), followed by HFmrEF (25.4% and 31.5%) and HFpEF (15.2% and 23.8%, respectively).

Conclusions: The highest rates of urgent HF readmissions and all-cause mortality were observed in patients with HFrEF, followed by HFmrEF and HFpEF. In all HF groups, the all-cause mortality rate was higher than the rates of urgent HF readmission.

Key words: epidemiology, heart failure, heart failure with mildly reduced ejection fraction, heart failure with preserved ejection fraction, heart failure with reduced ejection fraction

INTRODUCTION

Although heart failure (HF) is considered to be a civilization disease of the 21st century, there are still significant gaps in the underlying characteristics, pathophysiology, and outcomes in heart failure with mildly reduced (HFmrEF) and preserved (HFpEF) ejection fraction [1]. Most of the studies have been conducted in a well-described population of HF patients with reduced ejection fraction (HFrEF), while populations of patients with HFmrEF and HFpEF are underresearched. HFpEF patients are considered to be older and more frequently female, and they are more likely to suffer from atrial fibrillation (AF), chronic kidney disease (CKD), and non-cardiovascular diseases [1, 2]. At the same time, there is no consensus on differences in mortality rates between HFrEF and HFpEF. In some trials, mortality in HFpEF was similar to HFrEF, but

WHAT'S NEW?

We compared baseline characteristics, hospital readmission and mortality rates in individuals with heart failure (HF) with reduced (HFrEF), mildly reduced (HFmrEF), and preserved (HFpEF) ejection fraction diagnosed according to the universal definition and classification of HF. To our knowledge, this is the first publication that used the universal definition and classification of HF to classify HF groups. Moreover, HF screening was performed in all patients hospitalized in our cardiac department, regardless of previous HF diagnosis. Our study showed that all-cause mortality was higher than urgent HF readmission rates in all HF groups, regardless of the left ventricular ejection fraction.

in others, patients with HFpEF had lower mortality than those with HFrEF [1]. Some studies showed differences in the structure of the causes of death, with more prevalent non-cardiovascular causes of death in HFpEF [1, 3]. The differences in the prevalence of comorbidities and mortality between HF groups were often described by comparing data from clinical trials and registries that utilized different criteria for HF diagnosis, including the classification of HFrEF, HFmrEF, and HFpEF. Therefore, we aimed to analyze and compare baseline characteristics with hospital readmission and mortality rates in individuals with HFpEF, HFmrEF, and HFrEF in the same cohort of patients with HF diagnosed retrospectively using the universal definition and classification of heart failure [4].

METHODS

Data source

The database was designed and developed in the 3rd Department of Cardiology, Faculty of Medical Sciences in Zabrze of the Medical University of Silesia in Katowice. The records of all consecutive patients hospitalized between 2013 and 2021 were exported from the hospital's digital records into the external database. The final database contained data on 40732 patients hospitalized in the 3rd Department of Cardiology for any reason. Medical history and post-discharge follow-up were obtained from the Polish National Insurer database. It included all medical procedures reported to the insurer, all hospital admissions with the primary diagnosis, and all-cause mortality. Hospital readmissions for HF were defined as any hospital readmission with the primary diagnosis of HF (I50 according to ICD-10 classification) reported as an urgent admission.

Heart failure definition and classification

The database was retrospectively searched for patients who fulfilled the criteria for HF according to the universal definition and classification of heart failure [4]. The criteria included the symptoms and/or signs of HF, structural and/or functional cardiac abnormality, and at least one of the following: elevated natriuretic peptide levels or objective evidence of cardiogenic pulmonary or systemic congestion. In our study, signs and/or symptoms of HF were defined as NYHA class II, III, IV, or dyspnea during exercises (data from the medical records). Structural and/or functional cardiac abnormality was defined according to the echocardiographic criteria listed in the universal definition and classification of heart failure or the European Society of Cardiology guidelines for heart failure. They included ejection fraction (EF) below 50%, relative wall thickness >0.42, left ventricular mass indexed to body surface area ≥95 g/m^2 for women and ≥115 g/m^2 for men, E <0.9 m/s, E/A <0.8 or E/A >2.0, E/e' >9, and estimated systolic pulmonary pressure (SPAP) >35 mm Hg. Additionally, patients with enlargement of the left atrium with a dimension >40 mm (lack of left atrial volume in most of the transthoracic echocardiography examinations) and at least moderate valvular dysfunction (regurgitation or stenosis) as the structural cardiac abnormality were included. Elevated N-terminal pro B-type natriuretic peptide levels were >125 pg/ml for sinus rhythm and >365 pg/ml for AF patients [1, 4]. Objective evidence of cardiac pulmonary or systemic congestion was edema or congestion found by the physician during the physical examination on hospital admission (Figure 1). The study group included patients with both previously and newly diagnosed HF.

According to the CHAMPIT acronym (acute Coronary syndrome/Hypertension emergency, Arrhythmia/acute Mechanical cause/Pulmonary embolism/Infections/Tamponade), patients with reversible causes of acute HF, such as acute coronary syndrome, hypertension emergency with systolic blood pressure above 200 mm Hg, arrhythmia (ventricular fibrillation or flutter), mechanical causes (myocardial rupture, chest trauma, aortic dissection), pulmonary embolism, infections (endocarditis, sepsis), or cardiac tamponade were excluded.

The cut-off values of EF for HFrEF, HFmrEF, and HFpEF were ≤40%, 41%–49%, and ≥50%, respectively [1, 4].

Comorbidities

The following comorbidities were defined and included in the analyses: coronary artery disease, hypertension, diabetes mellitus (DM), obesity, anemia, AF, prior stroke/transient ischemic attack, peripheral arterial disease, CKD, and chronic obstructive pulmonary disease. Hypertension was defined as systolic blood pressure >140 mm Hg and/or diastolic blood pressure >90 mm Hg on admission or reported hypertension. Diagnosis of obesity was established by the physician on hospital admission and/or when the body mass index was ≥30 kg/m^2. Coronary artery disease was defined as a history of acute coronary syndrome, percutaneous coronary intervention, or coronary artery

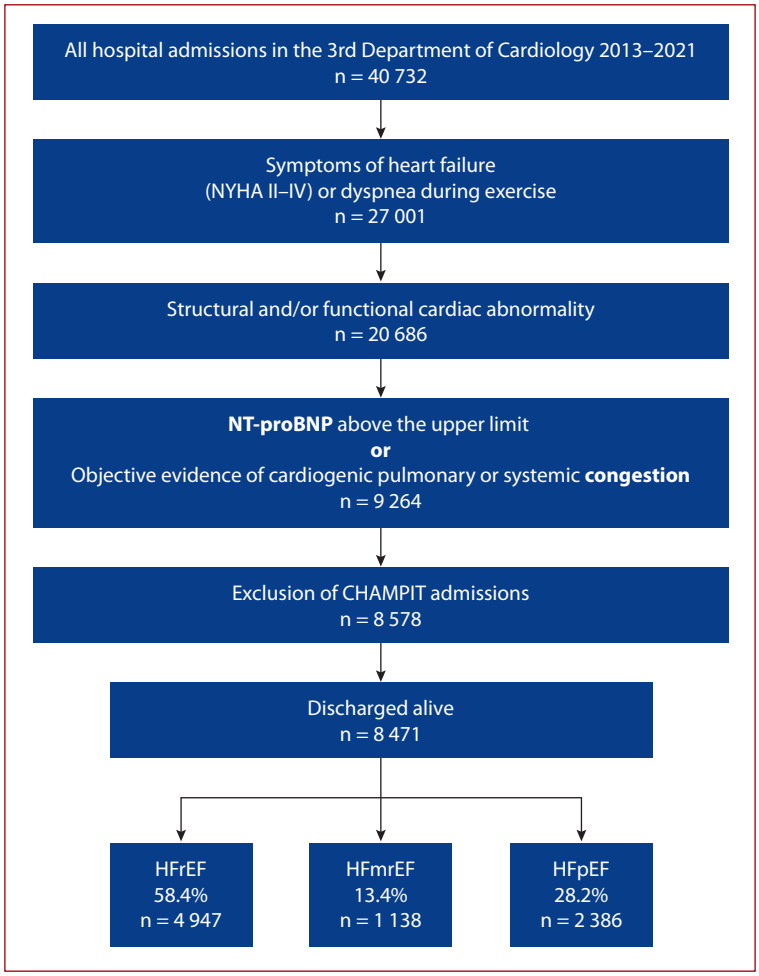

Figure 1. Diagnostic criteria of heart failure — study flowchart

Abbreviations: Table 1

bypass grafting in the past. Chronic kidney disease was defined as an estimated glomerular filtration rate below 60 ml/kg/1.73 m^2 during the hospital stay, according to the Cockcroft-Gault formula or reported CKD. Anemia was defined as hemoglobin below 13 g/dl or 8.0 mmol/l for men and below 12.0 g/dl or 7.45 mmol/l for women during the hospital stay (units of hemoglobin used in the hospital were changed during the study). Other diseases were defined as reported on the hospital admission or diagnosis reported to the National Health Fund in the past, according to a proper ICD-10 code: DM (E08–E13), peripheral arterial disease (I73–I75), chronic obstructive pulmonary disease (J44–J45), and stroke/transient ischemic attack (I60–I69).

Statistical analysis

Categorical variables were presented as numbers and percentages (No. [%]). Continuous variables with normal distribution were presented as means with standard deviations and those with other than normal distribution — as medians with interquartile ranges. A comparison between groups was carried out using pairwise multiple comparison tests for ANOVA or the Kruskal–Wallis rank sum test for non-parametric variables. Follow-up from hospital discharge was analyzed, including overall and 12-month all-cause mortality, overall and 12-month urgent HF hospital admission rates, and death without prior urgent HF hospitalization. Mortality was compared with the log-rank test, and Kaplan–Meier curves were drawn. Statistical significance was defined as $P < 0.05$. All statistical analyses were performed using TIBCO Statistica software (TIBCO Statistica, v. 13.3.0, TIBCO Software Inc, Palo Alto, CA, US).

Ethics approval

This study was performed in line with the principles of the Declaration of Helsinki. The Bioethical Committee of the Medical University of Silesia has confirmed that no ethical approval was required.

RESULTS

The study included 8471 patients hospitalized in the cardiology department who fulfilled the HF diagnostic criteria according to the universal HF definition and were discharged alive [4]. The mean age was 65.1 (12.8) years, and 2823 (33.3%) patients were females. Most of the patientshad a prior diagnosis of HF (76.3%) and elevated N-terminal pro B-type natriuretic peptide levels (99.0% of measurements available for 6526 patients) with a median of 1548 (629–3786) pg/ml. Mean EF was 36.2 (14.8)%. The median follow-up was 1175 (543–2115) days, while data on the 12-month follow-up were available for 7404 pa-

tients. The distribution and baseline characteristics of patients with HFpEF, HFmrEF, and HFrEF are presented in Table 1. The most frequent type of HF was HFrEF (58.4%), followed by HFpEF (28.2%) and HFmrEF (13.4%). All-cause mortality after 12 months and at the end of the follow-up was higher in the HFrEF (15.7% and 42.9%, respectively) than in HFmrEF (9.4% and 31.6%, respectively) and HFpEF (7.4% and 24.1%, respectively) patients (Table 2, Figure 3). In all HF groups, more patients died during the mean follow-up period than were urgently hospitalized for HF.

DISCUSSION

Our study analyzed all patients hospitalized in the tertiary cardiology department between 2013 and 2021 to identify patients with HF according to the universal definition and classification of heart failure [4]. We found that the most prevalent type of HF was HFrEF, followed by HFpEF and HFmrEF. Similar proportions were described by Rywik et al. [5, 6]. These findings differ from the ESC Heart Failure Long-Term Registry data, where HFmrEF (24.2%) was found more often than HFpEF (16.0%), with 59.8% of HFrEF patients [7]. In the Swedish Heart Failure Registry, 56% of patients had HFrEF, 21% had HFmrEF, and 23% had HFpEF [8]. Utilizing the universal definition of HF might result in a higher percentage of HFmrEF and HFpEF diagnosis, as impaired EF will not be the main echocardiographic criterion. Most of the studies included patients according to the clinical diagnosis of HF, probably excluding some patients fulfilling HF criteria according to the universal definition and classification of HF without obvious clinical symptoms or clinical presentation of congestion. In a systematic review of 18 papers, including 164 419 HF patients, 48.3% had HFrEF, 15.6% had HFmrEF, and 36.1% had HFpEF. Contrary to our expectations, more patients were diagnosed with HFpEF in the systematic review (36.1%) than in our cohort (27.8%). Although the distribution of HF types was similar to our study, the baseline characteristics of patients differed significantly [9]. Patients included in our analyses were younger compared to the preliminary results of the Polish multicentre study HF-POL, in which patients with HF and LVEF >40% were 72.9 (11.2) years old [10]. In the Swedish Heart Failure Registry patients were also older (72 [12] vs. 74 [12] vs. 77 [11] years for HFrEF, HFmrEF, and HFpEF, respectively) than in our study. In a systematic review of 18 studies on HF patients, the mean age was 71.9, and in only four articles, patients younger than 70 years old (mean or median) were analyzed [9]. In the ESC Heart Failure Long-Term Registry, which was based mainly in the major cardiology departments, the

Table 1. Baseline laboratory, and echocardiographic characteristics with treatment on discharge in heart failure patients with reduced (HFrEF), mildly-reduced (HFmrEF), and preserved (HFpEF) ejection fraction

	HFrEF n = 4947	HFmrEF n = 1138	HFpEF n = 2386	*P*-value HFmrEF vs. HFrEF	*P*-value HFpEF vs. HFrEF	*P*-value HFmrEF vs. HFpEF
Clinical characteristics						
Age, mean (SD), years	63.2 (12.5)	68.5 (12.3)	67.3 (13.1)	<0.001	<0.001	0.04
Female sex, n (%)	938 (19.0)	415 (36.5)	1470 (61.6)	<0.001	<0.001	<0.001
Body mass index, mean (SD), kg/m^2	28.6 (5.3)	30.1 (5.6)	29.5 (5.5)	<0.001	<0.001	0.07
Systolic blood pressure, mean (SD), mm Hg	119.0 (17.4)	127.8 (18.4)	128.0 (17.1)	<0.001	<0.001	0.98
Diastolic blood pressure, mean (SD), mm Hg	74.0 (19.6)	75.8 (11.3)	75.3 (11.)5	<0.001	<0.001	1.0
Heart rate, mean (SD), bpm	75.6 (14.2)	74.4 (13.4)	73.9 (12.9)	0.48	0.006	1.0
Urgent hospital admission, n (%)	1639 (33.1)	378 (33.2)	621 (26.0)	0.95	<0.001	<0.001
Length of hospital stay, median (IQR), days	6.2 (4.0–11.0)	5.1 (3.2–8.0)	4.6 (2.3–7.1)	<0.001	<0.001	<0.001
NYHA class I, n (%)	318/4764 (6.7)	149/1065 (14.0)	398/2239 (17.8)	<0.001	<0.001	<0.001
NYHA class II, n (%)	1427/4764 (30.0)	426/1065 (40.0)	879/2239 (39.3)			
NYHA class III, n (%)	2440/4764 (51.2)	433/1065 (40.7)	866/2239 (38.7)			
NYHA class IV, n (%)	579/4764 (12.1)	57/1065 (5.3)	96/2239 (4.2)			
Prior heart failure, n (%)	4640 (93.8)	748 (65.7)	1077 (45.1)	<0.001	<0.001	<0.001
Prior shock, n (%)	32 (0.6)	3 (0.3)	1 (0.04)	1.0	1.0	1.0
Prior pulmonary edema, n (%)	200 (4.0)	21 (1.8)	24 (1.0)	0.7	0.1	0.4
Prior VT/VF, n (%)	791 (16.0)	73 (6.4)	107 (4.5)	<0.001	<0.001	1.0
Prior pulmonary embolism, n (%)	117 (2.4)	36 (3.2)	96 (4.0)	1.0	0.75	1.0
Coronary artery disease, n (%)	3304 (66.8)	703 (61.8)	1092 (45.8)	0.02	<0.001	<0.001
Prior myocardial infarction, n (%)	1421 (28.7)	232 (20.4)	252 (10.6)	<0.001	<0.001	<0.001
Prior PCI, n (%)	1947 (39.4)	362 (31.8)	456 (19.1)	<0.001	<0.001	<0.001
Prior CABG, n (%)	499 (10.1)	133 (11.7)	133 (5.6)	1.0	<0.001	0.01
Prior valvular surgery, n (%)	357 (7.2)	99 (8.7)	130 (5.4)	1.0	0.66	0.35
Prior pacemaker, n (%)	284 (5.7)	185 (16.3)	191 (8.0)	<0.001	0.35	<0.001
Prior ICD implantation, n (%)	1384 (28.0)	54 (4.7)	103 (4.3)	<0.001	<0.001	1.0
Prior CRT implantation, n (%)	957 (19.3)	29 (2.5)	12 (0.5)	<0.001	<0.001	0.98
Prior cardiac ablation, n (%)	355 (7.2)	59 (5.2)	87 (3.6)	0.88	0.04	1.0
Hypertension, n (%)	3414 (69.0)	930 (81.7)	1886 (79.0)	<0.001	<0.001	0.59

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Table 1. cd. Baseline laboratory, and echocardiographic characteristics with treatment on discharge in heart failure patients with reduced (HFrEF), mildly-reduced (HFmrEF), and preserved (HFpEF) ejection fraction

	HFrEF n = 4947	HFmrEF n = 1138	HFpEF n = 2386	*P*-value HFmrEF vs. HFrEF	*P*-value HFpEF vs. HFrEF	*P*-value HFmrEF vs. HFpEF
Diabetes mellitus, n (%)	1721 (34.8)	461 (40.5)	780 (32.7)	0.008	0.43	<0.001
Obesity, n (%)	1660 (33.6)	433 (38.0)	930 (39.0)	0.054	<0.001	1.0
Atrial fibrillation, n (%)	1733 (35.0)	515 (45.3)	825 (34.6)	<0.001	1.0	<0.001
Prior stroke/TIA, n (%)	637 (12.8)	143 (12.6)	235 (9.8)	1.0	0.11	0.57
Peripheral arterial disease, n (%)	178 (3.6)	51 (4.5)	81 (3.4)	1.0	1.0	1.0
Chronic kidney disease, n (%)	2739 (55.4)	547 (48.1)	960 (40.2)	<0.001	<0.001	<0.001
Chronic obstructive pulmonary disease, n (%)	876 (17.7)	214 (18.8)	420 (17.6)	1.0	1.0	1.0
Laboratory parameters						
NT-proBNP, median (IQR), pg/ml	2132 (917–4971)	1063 (466–2271)	699 (320–1671)	<0.001	<0.001	<0.001
NT-proBNP above the upper limit, n (%)	4235/4257 (99.5)	766/779 (98.3)	1460/1491 (97.9)	1.0	1.0	1.0
eGFR, mean (SD), ml/min 1.73 m^2	50.9 (9.6)	50.5 (12.1)	51.0 (10.5)	0.34	0.60	1.0
Hemoglobin, mean (SD), mmol/l	8.1 (1.6)	7.9 (1.7)	8.0 (1.5)	<0.001	0.001	0.71
hs-CRP, median (IQR), mg/l	7.3 (2.4–24.9)	5.7 (2.0–20.7)	3.9 (1.5–16.4)	<0.001	<0.001	<0.001
Transthoracic echocardiography parameters						
EF, mean (SD), %	25.2 (8.2)	45.4 (2.3)	54.6 (4.1)	<0.001	<0.001	<0.001
RWT >0.42, n (%)	493/4376 (86.3)	267/645 (11.3)	532/752 (70.7)	<0.001	<0.001	<0.001
LVMI ≥95 g/m^2 (females) or ≥115 g/m^2 (males), n (%)	1879/2352 (79.9)	200/335 (59.7)	327/458 (71.4)	<0.001	<0.001	<0.001
E <0.9, n (%)	1265/2301 (55.0)	188/333 (56.5)	261/463 (56.4)	0.61	0.58	0.98
E/A <0.8 or >2.0, n (%)	894/1490 (60.0)	126/211 (59.7)	172/360 (47.8)	0.19	<0.001	<0.001
E/e' >9, n (%)	829/1145 (72.4)	97/165 (58.8)	222/303 (73.3)	<0.001	0.84	<0.001
sPAP >35 mm Hg, n (%)	2013/3811 (52.8)	251/563 (75.0)	320/663 (48.3)	<0.001	<0.001	<0.001
LA dimension >40 m	4125/4825 (85.5)	504/706 (71.4)	553/796 (69.5)	<0.001	<0.001	0.42
Severe MR, n (%)	634 (12.8)	46 (4.0)	68 (2.8)	<0.001	<0.001	1.0
Severe/massive TR, n (%)	419 (8.5)	74 (6.5)	130 (5.4)	0.9	0.1	1.0
Severe AS, n (%)	74 (1.5)	39 (3.4)	143 (6.0)	0.9	0.005	0.66
Treatment at discharge						
Beta-blockers, n (%)	4801 (97.0)	1067 (93.8)	2094 (87.8)	<0.001	<0.001	0.004
ACEI/ARB/ARNI, n (%)	4254 (86.0)	898 (78.9)	1709 (71.6)	<0.001	<0.001	0.001
MRA, n (%)	2901 (58.6)	366 (32.2)	531 (22.3)	<0.001	<0.001	<0.001
SGLT2i, n (%)	59 (1.2)	2 (0.2)	1 (0.01)	1.0	1.0	1.0
Diuretics, n (%)	4487 (90.7)	833 (73.2)	1518 (63.6)	<0.001	<0.001	<0.001
Digoxin, n (%)	763 (15.4)	92 (8.1)	126 (5.3)	<0.001	<0.001	0.53
Ivabradine, n (%)	463 (9.4)	17 (1.5)	22 (0.9)	<0.001	<0.001	1.0
Amiodarone, n (%)	797 (16.1)	74 (6.5)	87 (3.6)	<0.001	<0.001	<0.001
ASA, n (%)	2246 (45.4)	570 (50.1)	1112 (46.6)	0.004	0.2	0.08
VKA, n (%)	1650 (33.4)	328 (28.8)	457 (19.1)	0.003	<0.001	<0.001
NOAC, n (%)	839 (17.0)	220 (19.3)	416 (17.4)	0.06	0.61	0.17

Abbreviations: ACEI, angiotensin-converting enzyme inhibitors; ARB, angiotensin receptor blocker; ARNI, angiontensin receptor neprilysin inhibitor; AS, aortic stenosis; ASA, acetylosalycylic acid; CABG, coronary arterial bypass graft; CRT, cardiac resynchronization therapy; EF, ejection fraction; eGFR, estimated glomerulal fitration rate; HFmrEF, heart failure with mildly reduced ejection fraction; HFpEF, heart failure with preserved ejection fraction; HFrEF, heart failure with reduced ejection fraction; hs-CRP, high-sensitive C-reactive protein; ICD, implantable cardioverter-defibrilator; IQR, interquartile range; LA, left atrium; LVMI, left ventricular mass index; MR, mitral regurgitation; MRA, aldosterone receptor antagonists; NOAC, non-vitamin K antagonist oral anticoagulants; NT-proBNP, N-terminal pro-B-type natriuretic peptide; NYHA, New York Heart Association; PCI, percutaneous coronary intervention; RWT, relative wall thickness; SD, standard deviation; SGLT2i, sodium-glucose cotransporter-2 inhibitors; sPAP, systolic pulmonary artery pressure; TIA, transient ischemic attack; TR, tricuspid regurgitation; VF, ventricular fibrillation; VKA, vitamin K antagonists; VT, ventricular tachycardia

Table 2. Hospital readmissions and mortality in 12-month and overall follow-up in heart failure patients with reduced (HFrEF), mildly-reduced (HFmrEF), and preserved (HFpEF) ejection fraction

	HFrEF n = 4947	HFmrEF n = 1138	HFpEF n = 2386	*P*-value HFmrEF vs. HFrEF	*P*-value HFpEF vs. HFrEF	*P*-value HFpEF vs. HFmrEF
Follow-up, median (IQR), months	33.9 (15.9–60.4)	42.6 (18.7–76.5)	52.4 (25.2–79.7)	<0.001	<0.001	<0.001
Urgent HF admission in 12 months, n (%)	1086/4323 (25.1)	138/978 (14.1)	118/2103 (5.6)	<0.001	<0.001	<0.001
Urgent HF hospital admission, n (%)	2018 (40.8)	289 (25.4)	362 (15.2)	<0.001	<0.001	<0.001
All-cause death in 12 months, n (%)	769 (15.5)	105 (9.2)	171 (7.2)	0.003	<0.001	0.96
All-cause death, n (%)	2110 (42.7)	359 (31.5)	567 (23.8)	<0.001	<0.001	<0.001
Death without prior urgent HF hospitalization, n (%)	908 (18.4)	198 (17.4)	487 (16.2)	1.0	0.41	1.0

Abbreviations: HF, heart failure; other — see Table 1

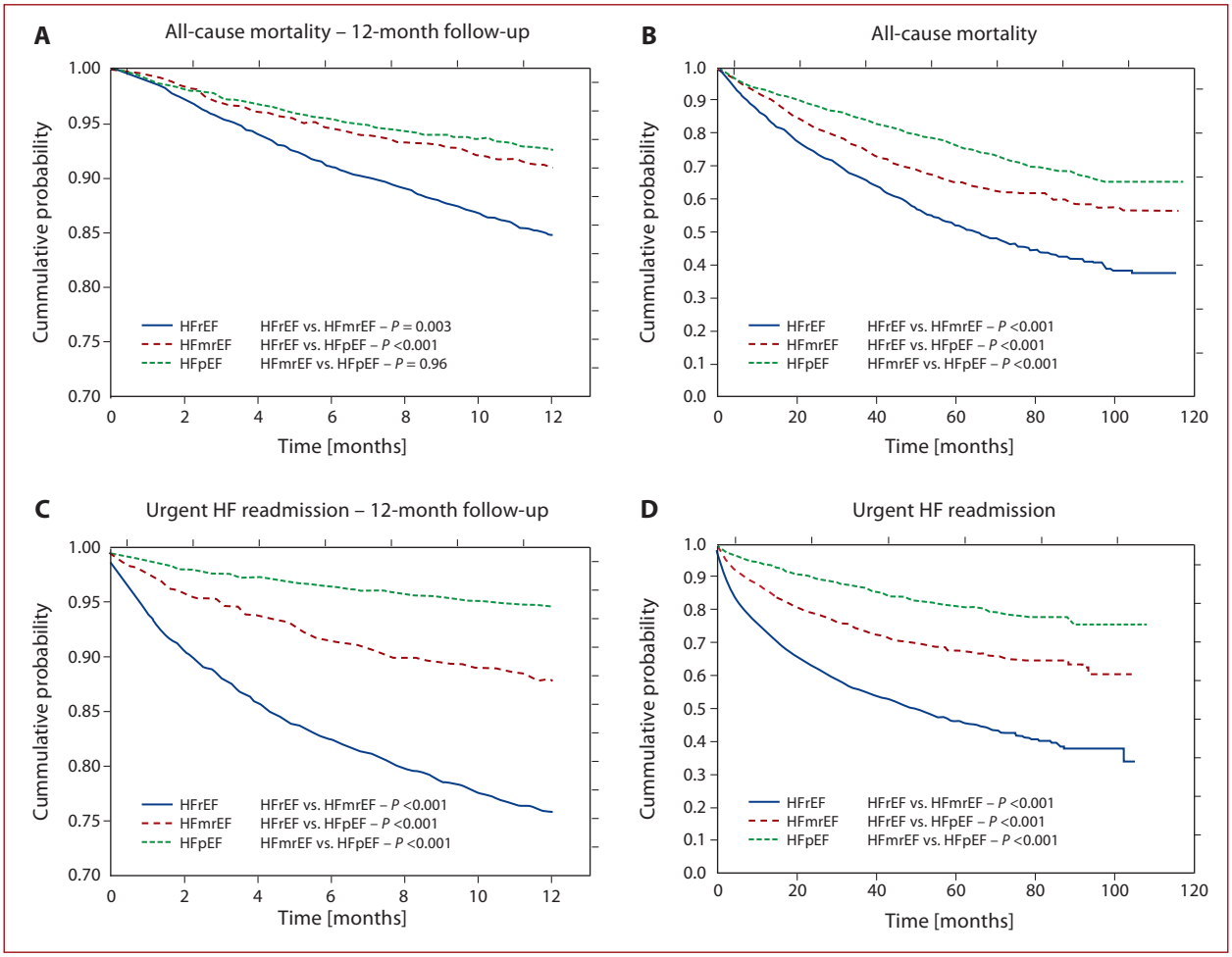

Figure 3. Kaplan-Meier curves for 12-month (**A**) and overall (**B**) mortality and urgent hospital readmissions for heart failure in 12-month (**C**) and overall (**D**) follow-up

age of patients with HFrEF (64.0 [12.6] years) and HFpEF (68.6 [13.7] years) was similar to our study, while patients with HFmrEF (64.2 [14.2] years) were younger than in our analysis. Among patients included in our study, the percentage of females differed significantly between groups. In the ESC Registry, these proportions were 21.6% vs. 31.5% vs. 47.9%, while in the Swedish Registry, 29% vs. 39% vs. 55%, respectively. In the systematic review of 18 HF studies, the proportion of females in the cohort was 39.5% in HFrEF, 31% in HFmrEF, and 59.6% in HFpEF [9]. Although some differences exist between the studies, the most significant proportion of females in all studies was reported in the HFpEF group.

HFpEF patients are considered to be older and more frequently female, and they are more likely to suffer from AF, CKD, and non-cardiovascular diseases than those with HFrEF [1, 2, 8]. In the ESC Registry, there were no significant differences between HF groups in the prevalence of CKD and some non-cardiovascular diseases (DM, depression). The prevalence of some comorbidities in patients with HFrEF/HFmrEF/HFpEF might depend on the diagnostic criteria for HF and the medical center where patients were treated. There could be more hospital admissions for cardiac ablations or cardiac resynchronization therapy in tertiary centers than in other hospitals.

All-cause mortality in our study was highest in HFrEF patients, followed by HFmrEF and HFpEF. No differences in one-year mortality between HFmrF and HFpEF patients were found, which was confirmed in another study conducted in the Polish population by Rywik et al. [5, 6]. It may be explained by the differences in death causes between HF groups. Most deaths in HFrEF patients are caused by cardiac disorders, while in patients with HFmrEF and HFpEF — by non-cardiac diseases, mainly comorbidities [3]. However, in systematic reviews and meta-analyses published in recent years, the all-cause mortality rates in HF groups were different. In patients with a mean follow-up period of 31 ± 5 months, Lauritsen et al. [11] showed that all-cause mortality was higher in HFpEF patients (31%) compared to 29.5% in HFmrEF and 26.8% in HFrEF. Guo et al. [12], in a meta-analysis of 19 studies, showed that patients with HFmrEF had the lowest all-cause mortality rate (30.94%) in the mean follow-up period of 3.6 (2.5) year. Altaie et al. [13] confirmed this finding in their meta-analysis of 25 studies, which showed that HFmrEF patients had a lower rate of all-cause death than those with HFrEF (relative risk [RR], 0.9;

95% confidence interval [CI], 0.85–0.94). Patients with HFpEF showed a higher rate of cardiac mortality than patients with HFmrEF (RR, 1.09; 95% CI, 1.02–1.16), while individuals with HFrEF had a higher rate of non-cardiac mortality than those with HFmrEF (RR, 1.31; 95% CI, 1.22–1.41). Vergaro et al. [3] showed that HFrEF patients have higher all-cause mortality than those with HFmrEF and HFpEF in the median follow-up period of 39 months. They also demonstrated that the difference is caused by cardiac deaths, as no differences in non-cardiac survival between groups were found. However, non-cardiac deaths were similarly distributed between patients with HFmrEF and HFpEF (54% and 62%, respectively; $P = 0.4$), whereas they were less prevalent in HFrEF patients (35%; $P < 0.001$ vs. HFpEF and HFmrEF). Unfortunately, our database had no data on the cause of death. Therefore, we could not compare cardiovascular vs. non-cardiovascular causes of death between the HF groups.

In our study, the highest rates of urgent HF rehospitalizations were found in HFrEF patients, followed by HFmrEF and HFpEF. In the meta-analysis by Lauritsen et al. [11], the differences between HF groups in HF hospital readmissions in the mean follow-up period of 31 (5) months were smaller, with 27.6% in HFrEF, 23.9% in HFmrEF and 23.3% in HFpEF patients. Guo et al. [12] showed the lowest rate of HF hospital readmissions in the mean follow-up period of 3.6 (2.5) years in HFmrEF patients (26.36%), while the risks for patients with HFmrEF were higher than HFpEF patients but lower than HFrEF patients.

Study limitations

Our database included patients from a single tertiary center in Poland. Therefore, our results cannot be extrapolated to other populations enrolled in hospitals with different patient profiles. Moreover, we enrolled only Caucasian individuals with Polish citizenship. Our follow-up did not contain the causes of death. The data was collected between 2013 and 2021, which resulted in differences in the diagnostic procedures and HF treatment, including low utilization of angiotensin receptor neprilysin inhibitor and sodium-glucose cotransporter-2 inhibitors. Not all diastolic parameters were available for each individual, which may have resulted in HFpEF underdiagnosis.

To summarize, our study is the first extensive analysis of patients with HF, defined by the universal definition and classification of HF. The diagnosis was confirmed in each case, regardless of the prior clinical diagnosis of HF.

In conclusion, reselection and reclassification of patients with heart failure according to the current universal definition and classification showed that more than half of patients had reduced EF and less than one-third — preserved EF. The highest rates of urgent heart failure readmissions and all-cause mortality were observed in patients with heart failure with reduced EF, followed by patients with mildly reduced and preserved EF. In all heart failure groups, all-cause mortality was higher than urgent heart failure readmission rates.

Article information

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