Post-discharge prognosis of patients admitted to hospital for heart failure by world region, and national level of income and income disparity (REPORT-HF): a cohort study

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Summary

Background Heart failure is a global public health problem, affecting a large number of individuals from low-income and middle-income countries. REPORT-HF is, to our knowledge, the first prospective global registry collecting information on patient characteristics, management, and prognosis of acute heart failure using a single protocol. The aim of this study was to investigate differences in 1-year post-discharge mortality according to region, country income, and income inequality.

Methods Patients were enrolled during hospitalisation for acute heart failure from 358 centres in 44 countries on six continents. We stratified countries according to a modified WHO regional classification (Latin America, North America, western Europe, eastern Europe, eastern Mediterranean and Africa, southeast Asia, and western Pacific), country income (low, middle, high) and income inequality (according to tertiles of Gini index). Risk factors were identified on the basis of expert opinion and knowledge of the literature.

Findings Of 18 102 patients discharged, 3461 (20%) died within 1 year. Important predictors of 1-year mortality were old age, anaemia, chronic kidney disease, presence of valvular heart disease, left ventricular ejection fraction phenotype (heart failure with reduced ejection fraction [HFrEF] *vs* preserved ejection fraction [HFpEF]), and being on guideline-directed medical treatment (GDMT) at discharge (p<0·0001 for all). Patients from eastern Europe had the lowest 1-year mortality (16%) and patients from eastern Mediterranean and Africa (22%) and Latin America (22%) the highest. Patients from lower-income countries (ie, ≤US$3955 per capita; hazard ratio 1·58, 95% CI 1·41–1·78), or with greater income inequality (ie, from the highest Gini tertile; 1·25, 1·13–1·38) had a higher 1-year mortality compared with patients from regions with higher income (ie, >$12 235 per capita) or lower income inequality (ie, from the lowest Gini tertile). Compared with patients with HFrEF, patients with HFpEF had a lower 1-year mortality with little variation by income level ($p_{interaction}$ for HFrEF *vs* HFpEF <0·0001).

Interpretation Acute heart failure is associated with a high post-discharge mortality, particularly in patients with HFrEF from low-income regions with high income inequality. Regional differences exist in the proportion of eligible patients discharged on GDMT, which was strongly associated with mortality and might reflect lack of access to post-discharge care and prescribing of GDMT.

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Introduction

Worsening heart failure is a common cause of hospital admission in people aged older than 65 years and is associated with a high subsequent mortality; it is, therefore, a global health priority.[1] In the past decade, attempts to improve the outcomes of patients with acute heart failure have been largely ineffective. Despite individuals from low-income and middle-income countries being at risk of developing heart failure at a younger age (ie, <65 years), and the majority of admissions to hospital for acute heart failure occurring in these regions, data on patient characteristics and post-discharge outcomes on acute heart failure from low-income and middle-income countries are scarce.[2–4]

Marked differences in prognosis among world regions have been reported from international clinical trials of interventions for both acute and chronic heart failure, but patients in trials are highly selected, managed differently, and are unlikely to be representative of those managed as part of usual clinical care.[5–10] The scarcity of data available from registries, mostly on chronic heart failure, suggest marked differences in patient characteristics and worse outcomes in low-income and middle-income countries.[4,11] Unfortunately, little comprehensive data have been collected simultaneously to quantify and compare international differences and factors associated with post-discharge outcomes

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Research in context

Evidence before this study

We searched MEDLINE and Embase from Jan 1, 1985, until May 1, 2019, for relevant articles published in English on differences in post-discharge outcomes of patients hospitalised for acute heart failure according to region, country income classification, or country income inequality, using the terms "heart failure" OR "acute heart failure" AND "outcome" OR "mortality" AND "regional" OR "international" OR "income" OR "Income inequality". Most reports on regional differences in acute heart failure-related mortality were from clinical trials that had many inclusion and exclusion criteria and might not have been epidemiologically representative of the global problem. Registry data usually focused on specific regions such as Europe, or countries such as the USA, Japan, and South Korea, which makes inter-regional comparisons difficult. Furthermore, few registries included patients from lower-income countries. Data on the effects of country income classification are limited to one post-hoc analysis of a trial of acute heart failure that included few lower-income countries. No study has investigated the association between country-level income inequality and post-discharge outcomes in acute heart failure. We found that reports varied considerably on regional differences in post-discharge outcomes for acute heart failure, probably because of differences in trial inclusion criteria. We found no study with global representation of an unselected acute heart failure population.

Added value of this study

REPORT-HF is, to our knowledge, the first large, prospective registry of acute heart failure specifically designed to study worldwide variations in clinical practice patterns and outcomes among a large number of countries at different economic levels. Our study provides new information on global differences in post-discharge mortality for acute heart failure, setting a standard for future clinical and public health interventions. Post-discharge mortality remains high globally, especially for those with heart failure with reduced ejection fraction (HFrEF) from low-income regions with high income inequality. Regional differences were observed in the proportion of eligible patients with HFrEF who were discharged on guideline-directed medical treatment (GDMT), which was strongly associated with mortality. Variations in access and implementation of GDMT might explain regional variation in mortality for HFrEF. Scarcity of effective treatments for heart failure with preserved ejection fraction (HFpEF) might explain why there is much less international variability in outcome.

Implications of all the available evidence

Differences in outcome according to national income and income inequality might reflect that component of risk that is modifiable with optimal contemporary care. After an episode of acute heart failure, patients with HFrEF from countries with lower income or greater income inequality have a substantially higher 1-year mortality, but patients with HFpEF do not. Low uptake of GDMT for HFrEF observed in lower-income countries might explain higher national mortality rates and this inequality might be eliminated by improved access to care and medications.

from a large, representative population with acute heart failure.

The international registry to assess medical practice with longitudinal observation for treatment of heart failure (REPORT-HF) was specifically designed to assess international variations in clinical practice patterns and outcomes for patients with acute heart failure.[12] The aim of this analysis was to assess differences in 1-year post-discharge mortality according to region, country income, and income inequality.

Methods

Study design and setting

The design and methods of the REPORT-HF study have previously been described.[12] In brief, REPORT-HF is an observational, prospective, global cohort study with patients prospectively enrolled across 358 sites from 44 countries on six continents. At many sites, the volume of patients in relationship to the research resource available was sufficiently high such that sites were enrolled on predetermined days of the week or weeks of the month. The original sample size of the study was proposed to be 20 000 patients to estimate comparisons of interest and taking into account potential loss to follow-up with an assumed 30% attrition. Comparisons of interest required at least 300 patients per group to detect a margin of difference of up to 10%. As part of the prespecified analysis, the target sample size was re-evaluated during the study enrolment period, resulting in a revised estimated attrition rate of approximately 25% rather than the estimated 30% loss of information. The sample size was therefore adjusted to 18 700 for the total cohort. The first patient was enrolled on July 23, 2014, and last patient March 24, 2017.

This study was done in accordance with the Declaration of Helsinki, and the protocol received approval from the institutional review board, or ethics committee, or both, at each participating centre.

Participants

Participants were adults hospitalised with a primary diagnosis of acute heart failure according to the treating physician.[12] Consecutive eligible patients (ie, patients hospitalised with a primary diagnosis of new-onset, first diagnosis heart failure or decompensation of chronic heart failure as assessed by the clinician-investigator) were asked to give consent. Written informed consent was obtained from all patients or a

legal representative, if permitted. Those unable or unwilling to provide informed consent could not be included. The only other exclusion criterion was participation in a clinical trial with any investigational treatment.

Procedures

During the index hospitalisation, data were collected on patient demographics, medical history, comorbidities, and admission and discharge medications, as well as vital signs, physical exam, laboratory values, acute therapies and procedures, and hospital course, including length of stay and mortality. Data were captured in a central electronic database using the same case report form at all sites and reviewed by central data management and clinical groups that raised queries, which were then resolved by local study monitors.

Heart failure with reduced ejection fraction (HFrEF) was defined as a left ventricular ejection fraction (LVEF) of less than 40%, heart failure with mid-range ejection fraction (HFmrEF) was defined as an LVEF 40–49%, and heart failure with preserved ejection fraction (HFpEF) was defined as a LVEF of at least 50%. Coronary artery disease was defined as having a history of coronary artery bypass grafting, percutaneous coronary intervention, acute coronary syndrome, or myocardial infarction. History of valve disease was defined as a positive history of valve disease or valvular surgery at discharge. At the 6-month follow-up visit, data on medication use was collected. Medication data were acquired through follow-up with the patient or primary care provider, or both, where medicine name, doses, and units were captured. There were programmed database edits checks and manual data review with queries if no medications were recorded and manual review with queries if doses or units were off for any of the cardiovascular medications. Additional data quality checks were done using the records provided at the analysis stage.

	Total (N=18 102)	Central and South America (n=2525)	Eastern Europe (n=2761)	Eastern Mediterranean region and Africa (n=2172)	North America (n=1565)	Southeast Asia (n=2292)	Western Europe (n=3489)	Western Pacific (n=3298)	p value*
Demographics									
Sex†									
Female	7003 (39%)	1016 (40%)	1148 (42%)	818 (38%)	644 (41%)	834 (36%)	1243 (36%)	1300 (39%)	NA
Male	11 099 (61%)	1509 (60%)	1613 (58%)	1354 (62%)	921 (59%)	1458 (64%)	2246 (64%)	1998 (61%)	<0·0001
Age, years†	67 (57–77)	67 (57–77)	68 (60–77)	64 (55–73)	63 (54–73)	61 (53–70)	75 (65–81)	67 (56–77)	<0·0001
BMI, kg/m²	26 (23–31)	25 (22–30)	27 (24–31)	27 (24–31)	29 (24–36)	23 (20–26)	27 (24–32)	24 (21–27)	<0·0001
Missing	9396 (52%)	1668 (66%)	1531 (55%)	1414 (65%)	133 (8%)	1347 (59%)	1694 (49%)	1609 (49%)	NA
Obesity	..	..	..	..	..	..	..	..	<0·0001
BMI ≤30 kg/m²	2850 (16%)	243 (10%)	524 (19%)	269 (12%)	772 (49%)	97 (4%)	690 (20%)	255 (8%)	NA
Missing	9396 (52%)	1668 (66%)	1531 (55%)	1414 (65%)	133 (8%)	1347 (59%)	1694 (49%)	1609 (49%)	NA
Race†	..	..	..	..	..	..	..	..	<0·0001
White	9409 (52%)	1019 (40%)	2738 (99%)	1382 (64%)	775 (50%)	0	3402 (98%)	93 (3%)	NA
Black	852 (5%)	90 (4%)	0	44 (2%)	701 (45%)	1 (<1%)	14 (<1%)	2 (<1%)	NA
Asian	5642 (31%)	2 (<1%)	9 (<1%)	100 (5%)	27 (2%)	2289 (100%)	23 (1%)	3192 (97%)	NA
Native American	364 (2%)	356 (14%)	0	0	6 (<1%)	0	2 (<1%)	0	NA
Pacific Islander	7 (<1%)	3 (<1%)	0	0	2 (<1%)	0	2 (<1%)	0	NA
Other	1828 (10%)	1055 (42%)	14 (1%)	646 (30%)	54 (4%)	2 (<1%)	46 (1%)	11 (<1%)	NA
Heart failure diagnosis	..	..	..	..	..	..	..	..	<0·0001
DCHF†	10 353 (57%)	1504 (60%)	1842 (67%)	1347 (62%)	1249 (80%)	487 (21%)	2177 (62%)	1747 (53%)	NA
NYHA class	..	..	..	..	..	..	..	..	<0·0001
I	837 (8%)	153 (9%)	65 (4%)	158 (9%)	15 (3%)	109 (9%)	180 (10%)	157 (7%)	NA
II	3226 (29%)	549 (33%)	479 (26%)	543 (31%)	135 (28%)	314 (25%)	582 (31%)	624 (28%)	NA
III	4959 (45%)	736 (44%)	962 (53%)	693 (39%)	263 (55%)	401 (32%)	895 (48%)	1009 (46%)	NA
IV	2050 (19%)	240 (14%)	326 (18%)	372 (21%)	68 (14%)	417 (34%)	216 (12%)	411 (19%)	NA
Missing	7030 (39%)	847 (34%)	929 (34%)	406 (19%)	1084 (69%)	1051 (46%)	1616 (46%)	1097 (33%)	NA
LVEF	..	..	..	..	..	..	..	..	<0·0001
<40%	7600 (50%)	1191 (55%)	805 (34%)	1016 (57%)	592 (49%)	1125 (58%)	1399 (52%)	1472 (50%)	NA
40–49%	3009 (20%)	367 (17%)	641 (27%)	380 (21%)	137 (11%)	411 (21%)	506 (19%)	567 (19%)	NA
≥50%	4505 (30%)	592 (28%)	955 (40%)	387 (22%)	492 (40%)	410 (21%)	775 (29%)	894 (31%)	NA
Missing	2988 (17%)	375 (15%)	360 (13%)	389 (18%)	344 (22%)	346 (15%)	809 (23%)	365 (11%)	NA

(Table 1 continues on next page)

	Total (N=18 102)	Central and South America (n=2525)	Eastern Europe (n=2761)	Eastern Mediterranean region and Africa (n=2172)	North America (n=1565)	Southeast Asia (n=2292)	Western Europe (n=3489)	Western Pacific (n=3298)	p value*
(Continued from previous page)									
Signs and symptoms									
Dyspnoea at rest	13 260 (83%)	1838 (83%)	2320 (87%)	1844 (91%)	595 (71%)	1738 (86%)	2435 (77%)	2490 (81%)	<0·0001
Missing	2088 (12%)	318 (13%)	86 (3%)	140 (6%)	723 (46%)	260 (11%)	326 (9%)	235 (7%)	NA
Paroxysmal nocturnal dyspnoea	8864 (64%)	1116 (64%)	1681 (69%)	1538 (83%)	291 (40%)	969 (53%)	1437 (59%)	1832 (65%)	<0·0001
Missing	4189 (23%)	776 (31%)	311 (11%)	323 (15%)	835 (53%)	454 (20%)	1034 (30%)	456 (14%)	NA
Peripheral oedema	11 080 (69%)	1819 (77%)	2078 (77%)	1388 (67%)	923 (73%)	900 (50%)	2280 (73%)	1692 (60%)	<0·0001
Missing	1944 (11%)	154 (6%)	45 (2%)	113 (5%)	296 (19%)	477 (21%)	370 (11%)	489 (15%)	NA
Pulmonary rales	10 011 (67%)	1585 (70%)	1954 (72%)	1747 (85%)	372 (33%)	1129 (68%)	1608 (63%)	1616 (64%)	<0·0001
Missing	3224 (18%)	268 (11%)	57 (2%)	113 (5%)	439 (28%)	627 (27%)	943 (27%)	777 (24%)	NA
JVP	6145 (58%)	1112 (64%)	899 (59%)	1035 (66%)	575 (59%)	1012 (64%)	798 (49%)	714 (48%)	<0·0001
Missing	7574 (42%)	793 (31%)	1240 (45%)	594 (27%)	590 (38%)	707 (31%)	1846 (53%)	1804 (55%)	NA
Comorbidities									
Hypertension	11 547 (64%)	1716 (68%)	2214 (80%)	1304 (60%)	1208 (77%)	1091 (47%)	2195 (63%)	1819 (55%)	<0·0001
Missing	20 (<1%)	4 (<1%)	0	1 (<1%)	1 (<1%)	3 (<1%)	9 (<1%)	2 (<1%)	NA
Atrial fibrillation or flutter	5637 (31%)	681 (27%)	1304 (47%)	459 (21%)	595 (38%)	188 (8%)	1594 (46%)	816 (25%)	<0·0001
Missing	20 (<1%)	4 (<1%)	0	1 (<1%)	1 (<1%)	3 (<1%)	9 (<1%)	2 (<1%)	NA
Type 2 diabetes	6658 (37%)	787 (31%)	911 (33%)	1019 (47%)	652 (42%)	957 (42%)	1279 (37%)	1053 (32%)	<0·0001
Missing	6 (<1%)	0	1 (<1%)	2 (<1%)	0	0	1 (<1%)	2 (<1%)	NA
Chronic kidney disease	3638 (20%)	439 (17%)	629 (23%)	382 (18%)	526 (34%)	239 (10%)	918 (26%)	505 (15%)	<0·0001
Missing	6 (<1%)	0	1 (<1%)	2 (<1%)	0	0	1 (<1%)	2 (<1%)	NA
Anaemia	8453 (47%)	998 (40%)	978 (35%)	1124 (52%)	1055 (67%)	1236 (54%)	1797 (52%)	1265 (38%)	<0·0001
Missing	5 (<1%)	0	1 (<1%)	2 (<1%)	0	0	0	2 (<1%)	NA
Valvular heart disease	3552 (20%)	517 (20%)	832 (30%)	322 (15%)	263 (17%)	178 (8%)	1006 (29%)	434 (13%)	<0·0001
Missing	20 (<1%)	4 (<1%)	0	1 (<1%)	1 (<1%)	3 (<1%)	9 (<1%)	2 (<1%)	NA
Coronary artery disease	8710 (48%)	826 (33%)	1714 (62%)	1121 (52%)	731 (47%)	1172 (51%)	1530 (44%)	1616 (49%)	<0·0001
Missing	19 (<1%)	4 (<1%)	0	1 (<1%)	1 (<1%)	2 (<1%)	9 (<1%)	2 (<1%)	NA
Cause									
Ischaemic	6034 (40%)	594 (31%)	1148 (45%)	864 (48%)	336 (27%)	715 (37%)	1101 (40%)	1276 (44%)	NA
Hypertension	2812 (19%)	428 (22%)	553 (22%)	338 (19%)	302 (25%)	468 (24%)	366 (13%)	357 (12%)	NA
Cardiomyopathy	2854 (19%)	333 (17%)	300 (12%)	261 (15%)	362 (30%)	449 (23%)	501 (18%)	648 (23%)	NA
Valvular	1930 (13%)	317 (16%)	363 (14%)	232 (13%)	90 (7%)	135 (7%)	492 (18%)	301 (11%)	NA
Other	1491 (9%)	279 (14%)	182 (7%)	96 (5%)	138 (11%)	174 (9%)	322 (11%)	300 (10%)	NA
Missing	2981 (16%)	574 (23%)	215 (8%)	381 (18%)	337 (22%)	351 (15%)	707 (20%)	416 (13%)	NA
Medication at discharge (patients with HFrEF)									
ACEI or ARB	5317 (68%)	856 (68%)	616 (75%)	739 (71%)	363 (60%)	637 (56%)	1048 (73%)	1058 (71%)	NA
Missing	238 (3%)	73 (6%)	20 (2%)	35 (3%)	17 (3%)	22 (2%)	41 (3%)	30 (2%)	NA
Diuretics (any)	6548 (84%)	951 (76%)	744 (90%)	904 (86%)	527 (87%)	945 (83%)	1299 (90%)	1178 (79%)	NA
Missing	232 (3%)	70 (6%)	19 (2%)	35 (3%)	17 (3%)	22 (2%)	39 (3%)	30 (2%)	NA
Loop diuretics	6466 (83%)	942 (75%)	731 (89%)	898 (86%)	522 (86%)	941 (82%)	1285 (89%)	1147 (77%)	NA
Missing	238 (3%)	73 (6%)	20 (2%)	35 (3%)	17 (3%)	22 (2%)	41 (3%)	30 (2%)	NA
Thiazides	235 (3%)	26 (2%)	58 (7%)	19 (2%)	4 (1%)	7 (1%)	70 (5%)	51 (3%)	<0·0001
Missing	238 (3%)	73 (6%)	20 (2%)	35 (3%)	17 (3%)	22 (2%)	41 (3%)	30 (2%)	NA
β blocker	5748 (74%)	982 (79%)	686 (83%)	755 (72%)	493 (81%)	564 (49%)	1225 (85%)	1043 (70%)	NA
Missing	238 (3%)	73 (6%)	20 (2%)	35 (3%)	17 (3%)	22 (2%)	41 (3%)	30 (2%)	NA
MRA	4585 (59%)	861 (69%)	617 (75%)	504 (48%)	255 (42%)	421 (37%)	873 (61%)	1054 (71%)	<0·0001
Missing	232 (3%)	70 (6%)	19 (2%)	35 (3%)	17 (3%)	22 (2%)	39 (3%)	30 (2%)	NA

(Table 1 continues on next page)

	Total (N=18 102)	Central and South America (n=2525)	Eastern Europe (n=2761)	Eastern Mediterranean region and Africa (n=2172)	North America (n=1565)	Southeast Asia (n=2292)	Western Europe (n=3489)	Western Pacific (n=3298)	p value*
(Continued from previous page)									
Medication at 6-month follow-up									
ACEi or ARB†	9189 (59%)	1272 (61%)	1704 (69%)	1140 (63%)	712 (53%)	876 (44%)	1923 (64%)	1562 (55%)	<0·0001
β blocker†	10 437 (67%)	1400 (67%)	1883 (76%)	1222 (68%)	1057 (78%)	925 (47%)	2330 (78%)	1620 (57%)	<0·0001
Diuretics†	11 176 (67%)	1345 (65%)	1923 (78%)	1376 (63%)	1078 (80%)	1326 (67%)	2516 (84%)	1614 (57%)	<0·0001
MRA†	6608 (43%)	9539 (45%)	1289 (52%)	573 (32%)	469 (35%)	528 (27%)	1411 (47%)	1399 (50%)	<0·0001
Length of stay, days†	8 (5–12)	8 (5–14)	9 (6–13)	6 (4–10)	6 (4–10)	6 (4–8)	9 (6–13)	9 (7–14)	<0·0001
1-year mortality	3461 (20%)	547 (23%)	439 (16%)	472 (22%)	324 (21%)	470 (21%)	668 (20%)	541 (17%)	<0·0001
Hospitalisation									
Hospitalised for any cause	6674 (38%)	799 (33%)	1062 (39%)	773 (36%)	955 (62%)	428 (19%)	1583 (47%)	1074 (34%)	<0·0001
Hospitalised for heart failure	3940 (22%)	482 (20%)	654 (24%)	478 (23%)	626 (41%)	240 (11%)	826 (24%)	634 (20%)	<0·0001
Death or heart failure hospitalisation	6928 (39%)	972 (40%)	1038 (38%)	913 (43%)	830 (54%)	673 (30%)	1395 (41%)	1107 (35%)	<0·0001

Data are n (%), unless otherwise stated. BMI=body-mass index. DCHF=decompensated chronic heart failure. NYHA=New York Heart Association. LVEF=left ventricular ejection fraction. JVP=jugular venous pressure. ACEi=angiotensin-converting enzyme inhibitor. ARB=angiotensin receptor blocker. MRA=mineralocorticoid receptor antagonist. *All comparisons p<0·001. †No data missing.

Table 1: **Differences between patients according to region**

Outcomes

Standardised follow-up calls were done at 6 months and 1 year. Follow-up information from study participants was collected via telephone interviews unless a regular follow-up visit was planned at the investigator's site for routine care. Vital status was supplemented by national reporting databases where available.[12] Cause of death was ascertained by the local investigators and classified as cardiovascular, non-cardiovascular, or unknown.

Statistical analysis

We report post-discharge mortality according to region, country income level, and country income distribution. Geographical groupings of the 44 participating countries were determined using a modification of the WHO classification into seven regions (appendix p 1). The final categories were selected to enable meaningful comparisons among geographical regions and to provide balance between the number of countries and patients in each region (appendix p 1). Countries were also grouped by income level, based on the World Bank classification (appendix p 1). We used the gross national income in 2017 as a reference.[13] The effect of income inequality was studied using the Gini coefficient, with zero (0%) representing absolute income equality and one (100%) indicating absolute income inequality. For most countries, the Gini coefficients were obtained from the UN Development Programme.[14] Data from 2003 were used to account for a potential lag effect, because current health is more likely to be related to previous rather than contemporary income inequality.[15] If the Gini coefficient for 2003 was unavailable, the value closest to 2003 was used. In secondary analyses, we regrouped countries in Asia into northeast (China, Japan, Korea, and Taiwan), southeast (Indonesia, Malaysia, Thailand, and Vietnam),

	Total (n=18 102)	Lower middle income (n=3025)	Upper middle income (n=7521)	High income (n=7556)	p value for linear trend*
Demographics					
Sex†					
Female	7003 (39%)	1083 (36%)	3042 (40%)	2878 (38%)	NA
Male	11 099 (61%)	1942 (64%)	4479 (60%)	4678 (62%)	0·374
Age, years†	67 (57–77)	61 (52–70)	67 (57–76)	71 (60–80)	<0·0001
BMI, kg/m²	27 (24–32)	24 (22–27)	27 (24–31)	28 (24–34)	<0·0001
Missing	9396 (52%)	1940 (64%)	4427 (59%)	3029 (40%)	NA
Obesity	..	..	..	..	<0·0001
BMI ≤30 kg/m²	2850 (16%)	133 (4%)	892 (12%)	1825 (24%)	NA
Missing	9396 (52%)	1940 (64%)	4427 (59%)	3029 (40%)	NA
Race†	..	..	..	..	<0·0001
White	9409 (52%)	345 (11%)	3776 (50%)	5288 (70%)	NA
Black	852 (5%)	2 (<1%)	119 (2%)	731 (10%)	NA
Asian	5642 (31%)	2497 (83%)	2111 (28%)	1034 (14%)	NA
Native American	364 (2%)	0	285 (4%)	79 (1%)	NA
Pacific Islander	7 (<1%)	0	3 (<1%)	4 (<1%)	NA
Other	1828 (10%)	181 (6%)	1227 (16%)	420 (6%)	NA
Heart failure†	..	..	..	..	<0·0001
DCHF	10 353 (57%)	973 (32%)	4634 (62%)	4746 (63%)	NA
Ischaemic aetiology	6034 (33%)	1159 (38%)	2746 (37%)	2129 (28%)	<0·0001
Missing	2981 (16%)	346 (11%)	1002 (13%)	1633 (22%)	NA
NYHA class	..	..	..	..	<0·0001
I	837 (5%)	123 (4%)	354 (5%)	360 (5%)	NA
II	3226 (18%)	479 (16%)	1537 (20%)	1210 (16%)	NA
III	4959 (27%)	682 (23%)	2536 (34%)	1741 (23%)	NA
IV	2050 (11%)	431 (14%)	1130 (15%)	489 (6%)	NA
Missing	7030 (39%)	1310 (43%)	1964 (26%)	3756 (50%)	NA

(Table 2 continues on next page)

	Total (n=18 102)	Lower middle income (n=3025)	Upper middle income (n=7521)	High income (n=7556)	p value for linear trend*
(Continued from previous page)					
LVEF	..	..	..	..	<0·0001
<40%	7600 (42%)	1343 (44%)	3140 (42%)	3117 (41%)	NA
40–49%	3009 (17%)	544 (18%)	1431 (19%)	1034 (14%)	NA
>50%	4505 (25%)	542 (18%)	2121 (28%)	1842 (24%)	NA
Missing	2988 (17%)	596 (20%)	829 (11%)	1563 (21%)	NA
Signs and symptoms					
Dyspnoea at rest	13 260 (73%)	2281 (75%)	6050 (80%)	4929 (65%)	<0·0001
Missing	2088 (12%)	311 (10%)	503 (7%)	1274 (17%)	NA
Paroxysmal nocturnal dyspnoea	8864 (49%)	1390 (46%)	4685 (62%)	2789 (37%)	<0·0001
Missing	4189 (23%)	648 (21%)	1083 (14%)	2458 (33%)	NA
Peripheral oedema	11 080 (61%)	1270 (42%)	5166 (69%)	4644 (61%)	<0·0001
Missing	1944 (11%)	536 (18%)	345 (5%)	1063 (14%)	NA
Pulmonary rales	10 011 (55%)	1674 (55%)	5037 (67%)	3300 (44%)	<0·0001
Missing	3224 (18%)	656 (22%)	519 (7%)	2049 (27%)	NA
JVP	6145 (34%)	1253 (41%)	2629 (35%)	2263 (30%)	<0·0001
Missing	7574 (42%)	1019 (34%)	2977 (40%)	3578 (47%)	NA
Comorbidities					
Hypertension	11 547 (64%)	1512 (50%)	4992 (66%)	5043 (67%)	<0·0001
Missing	20 (<1%)	4 (<1%)	3 (<1%)	13 (<1%)	NA
Atrial fibrillation or flutter	5637 (31%)	277 (9%)	2375 (32%)	2985 (40%)	<0·0001
Missing	20 (<1%)	4 (<1%)	3 (<1%)	13 (<1%)	NA
COPD or asthma	2587 (14%)	224 (7%)	1045 (14%)	1318 (17%)	<0·0001
Missing	6 (<1%)	1 (<1%)	4 (<1%)	1 (<1%)	NA
Type 2 diabetes	6658 (37%)	1187 (39%)	2585 (34%)	2886 (38%)	0·496
Missing	6 (<1%)	1 (<1%)	4 (<1%)	1 (<1%)	NA
Chronic kidney disease	3638 (20%)	325 (11%)	1332 (18%)	1981 (26%)	<0·0001
Missing	6 (<1%)	1 (<1%)	4 (<1%)	1 (<1%)	NA
Liver disease	542 (3%)	30 (1%)	245 (3%)	267 (4%)	<0·0001
Missing	6 (<1%)	1 (<1%)	4 (<1%)	1 (<1%)	NA
Anaemia	8453 (47%)	1552 (51%)	2829 (38%)	4072 (54%)	<0·0001
Missing	5 (<1%)	1 (<1%)	4 (<1%)	0	NA
Valvular heart disease	3552 (20%)	269 (9%)	1566 (21%)	1717 (23%)	<0·0001
Missing	20 (<1%)	4 (<1%)	3 (<1%)	13 (<1%)	NA
Coronary artery disease	8710 (48%)	1629 (54%)	3831 (51%)	3250 (43%)	<0·0001
Missing	19 (<1%)	3 (<1%)	3 (<1%)	13 (<1%)	NA
Cause	..	..	..	..	<0·0001
Ischaemic	6034 (40%)	594 (31%)	1148 (45%)	864 (48%)	NA
Hypertension	2812 (19%)	428 (22%)	553 (22%)	338 (19%)	NA
Cardiomyopathy	2854 (19%)	333 (17%)	300 (12%)	261 (15%)	NA
Valvular	1930 (13%)	317 (16%)	363 (14%)	232 (13%)	NA
Other	1491 (9%)	279 (14%)	182 (7%)	96 (5%)	NA
Missing	2981 (16%)	346 (11%)	1002 (13%)	1633 (22%)	NA
Medication at discharge					
ACEi or ARB	11 895 (66%)	1815 (60%)	5105 (68%)	4975 (66%)	NA
Missing	72 (<1%)	16 (1%)	42 (1%)	14 (<1%)	NA
Diuretics	15 153 (84%)	2324 (77%)	6116 (81%)	6713 (89%)	<0·0001
Missing	72 (<1%)	16 (1%)	42 (1%)	14 (<1%)	NA

(Table 2 continues on next page)

and south Asia (India), similar to an earlier publication.[2] For comparisons between groups the one-way analysis of variance, χ^2 test, or Mann-Whitney U-test was used for normally distributed continuous variables, categorical variables, and non-normally distributed continuous variables, respectively. Differences in clinical characteristics according to country income were tested using a non-parametric test for linear trend. To test for differences in survival between regions, income classes, and tertiles of Gini coefficients, the log-rank test was used. Differences were graphically depicted using Kaplan-Meier curves. Univariable and multivariable regression of factors associated with 1-year mortality was done using Cox regression analyses. Variables included for multivariable analyses were chosen based on previous reports of strong associations with mortality in studies of acute heart failure and expert clinical opinion.[16] Collinearity of independent variables was checked by assessing the variance inflation factor, where none of the variables exceeded the suggested maximum level of ten.[17] Given the large number of patients enrolled and the multiple comparisons, the investigators viewed p values considering the relative effect sizes and clinically important differences. Because missingness was non-random, but rather part of obtaining an understanding of regional differences in initial data, we did not perform multiple imputation, but transformed the variable to include missing values. In multivariable analyses, we classified countries by seven geographic regions. Because classification by region alone might not capture important differences between countries, we also classified countries using three levels of country income (low [≤US$3955 per capita], middle [$3956–12 235], and high [>$12 235]) and by tertiles of Gini index and included these in the multivariable models separately. We checked the proportionality hazards assumption for Cox models using statistical tests and graphical diagnostics on the basis of the Schoenfeld residuals. In secondary analyses, we did Cox regression while clustering the estimates around countries to obtain more robust estimates. The STROBE statement checklist is included in the appendix (p 8). All analyses were done in STATA, version 15.0, or R, version 3.4.2. A two-sided p value of less than 0·05 was considered statistically significant.

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

Over 32 months, between July 23, 2014, and March 24, 2017, at 358 sites in 44 countries, 41793 patients were screened, and 22 988 of whom were excluded because they did not fulfil the inclusion or exclusion criteria (7725,

18·4%) or did not provide informed consent (7628, 18·3%; appendix p 1). Patients screened but not enrolled were similar in age and sex compared with those enrolled. Of 18 553 patients who gave consent, 451 died during the index admission, and 18 102 were discharged. The median age was 67 years (IQR 57–77) and 11 099 (61%) of 18 102 patients in the total discharge population were men (table 1). The median age ranged from 61 years (IQR 53–70) in southeast Asia to 75 years (65–81) in western Europe. Of the total discharge population, most patients (10 353 [57%] of 18 102) were admitted with an episode of decompensated chronic heart failure (DCHF), with the highest proportion in North America (1249 [80%] of 1565) and lowest in southeast Asia (487 [21%] of 2292). Half of the total discharge population had HFrEF. HFpEF was most often reported in North America (492 [40%] of 1221) and eastern Europe (955 [40%] of 2401). The comorbidity burden showed strong regional heterogeneity, with a high prevalence of hypertension in eastern Europe (2214 [80%] of 2761) and North America (1208 [77%] of 1564), whereas atrial fibrillation was particularly common among patients from western Europe (1594 [46%] of 3480). Type 2 diabetes was most common among patients from eastern Mediterranean region and Africa (1019 (47%) of 2172, whereas chronic kidney disease (526 [34%] of 1565) and anaemia (1055 [67%] of 1550) were more common among patients from North America. Patients from eastern Europe and Central and South America were more often on angiotensin-converting enzyme inhibitors (ACEi) or angiotensin receptor blockers (ARBs), β blockers, or mineralocorticoid receptor antagonists (MRAs) at discharge and at 6-month follow-up compared with other regions. Patients from southeast Asia (median 6 days [IQR 4–8]) and North America (6 [4–10]) had the shortest length of stay, and eastern Europe (9 [6–3]), western Europe (9 [6–13]), and western Pacific (9 [7–14]) the longest. Country characteristics of Asian countries grouped into northeast, southeast, and south Asia are shown in the appendix (p 4).

Classifying countries according to income level, most patients were either from high (7556 [42%] of 18 102) or upper-middle-income (7521 [42%] of 18 102) countries (table 2). Compared with patients from higher-income countries, patients from lower-middle-income countries were almost a decade younger (61 years [IQR 52–70] *vs* 71 years [60–80]), with a lower body-mass index (BMI; 24 kg/m² [22–27] *vs* 28 [24–34]) and were more often admitted with a first episode of heart failure. Despite their relative youth, patients from lower-middle-income countries were in a worse (ie, higher) New York Heart Association class class, more often had HFrEF, and generally had worse signs and symptoms. Except for coronary artery disease and diabetes, the comorbidity burden was lower in lower-middle-income countries. Patients from lower-middle-income countries were more likely to be admitted to an intensive care unit or critical care unit during admission to hospital.

	Total (n=18 102)	Lower middle income (n=3025)	Upper middle income (n=7521)	High income (n=7556)	p value for linear trend*
(Continued from previous page)					
Loop diuretics	14 733 (81%)	2279 (75%)	5847 (78%)	6607 (87%)	<0·0001
Missing	72 (<1%)	16 (1%)	42 (1%)	14 (<1%)	NA
Thiazides	833 (5%)	71 (2%)	440 (6%)	322 (4%)	0·041
Missing	72 (<1%)	16 (1%)	42 (1%)	14 (<1%)	NA
β blocker	13 043(72%)	1498 (50%)	5583 (74%)	5962 (79%)	<0·0001
Missing	72 (<1%)	16 (1%)	42 (1%)	14 (<1%)	NA
MRA	8852 (49%)	1149 (38%)	4164 (55%)	3539 (47%)	0·001
Missing	72 (<1%)	16 (1%)	42 (1%)	14 (<1%)	NA
Medication at 6-month follow-up					
ACEi or ARB†	9189 (59%)	1332 (53%)	3937 (61%)	3920 (60%)	<0·0001
β blocker†	10 437 (67%)	1199 (47%)	4361 (68%)	4877 (75%)	<0·0001
Diuretics†	11 176 (72%)	1583 (62%)	4488 (70%)	5105 (79%)	<0·0001
MRA†	6608 (43%)	752 (30%)	3047 (47%)	2809 (43%)	<0·0001
Length of stay, days†	8 (5–12)	6 (4–9)	9 (6–13)	8 (5–12)	<0·0001
1-year mortality	3461 (20%)	619 (20%)	1457 (19%)	1385 (18%)	0·009
Hospitalisation					
Hospitalised for any cause at 1 year	6674 (37%)	534 (18%)	2674 (36%)	3466 (46%)	<0·0001
Hospitalised for heart failure	3940 (22%)	316 (10%)	1667 (22%)	1957 (26%)	<0·0001
Death or heart failure hospitalisation	6928 (38%)	894 (30%)	2955 (39%)	3079 (41%)	<0·0001

Data are n (%) or median (IQR), unless otherwise stated. BMI=body-mass index. DCHF=decompensated chronic heart failure. NYHA=New York Heart Association. LVEF=left ventricular ejection fraction. JVP=jugular venous pressure. COPD=chronic obstructive pulmonary disease. ACEi=angiotensin-converting enzyme inhibitor. ARB=angiotensin receptor blocker. MRA=mineralocorticoid receptor antagonist. *All comparisons p<0·001. †No data missing.

Table 2: **Differences between patient characteristics according to country income level**

At discharge and 6-month follow-up, prescription rates of ACEi or ARBs, β blockers, and MRAs were lower in lower-middle-income countries compared with higher-income countries.

Of the 18 102 patients discharged, vital status could not be ascertained in 470 patients (3%) at 1 year. Of 17 632 patients, 3461 (20%) died within 1 year. Patients from eastern Europe had the lowest 1-year mortality (439 [16%] of 2724) and those from eastern Mediterranean and Africa (472 [22%] of 2124) and Latin America (547 [22%] of 2419) had the highest, with large intercountry variation ranging from 10% in Bulgaria to 32% in Indonesia (figures 1, 2). Age-adjusted and heart failure diagnosis (new onset *vs* DCHF)-adjusted mortality were higher in patients from lower-income countries (26%) compared with middle-income (20%) and higher-income (17%) countries. Patients from regions with greater income inequality had worse mortality (figure 2). Most deaths were due to cardiovascular causes (2076 [60%] of 3461), with the proportion being highest in eastern Europe (310 [71%] of 439; figure 3). In North America, a large proportion of deaths were not classified. Causes of death stratified by region are listed in the appendix (p 7). The proportion of all deaths was attributable to

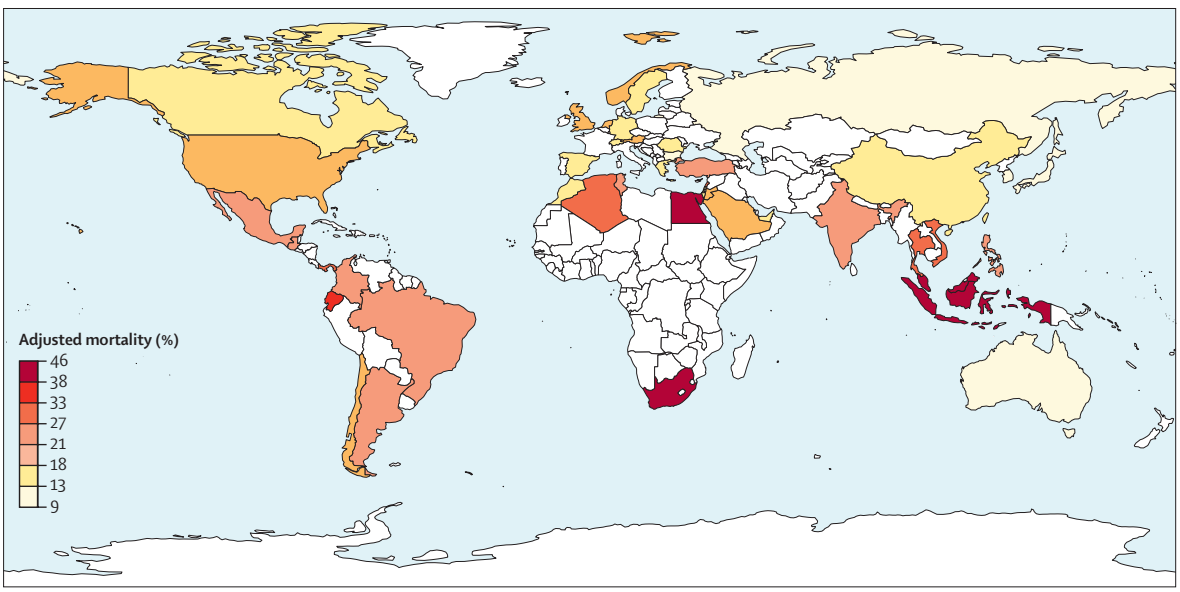


Figure 1: **World map showing age, heart failure diagnosis, and New York Heart Association class-adjusted percentage of patients who died within 1 year**

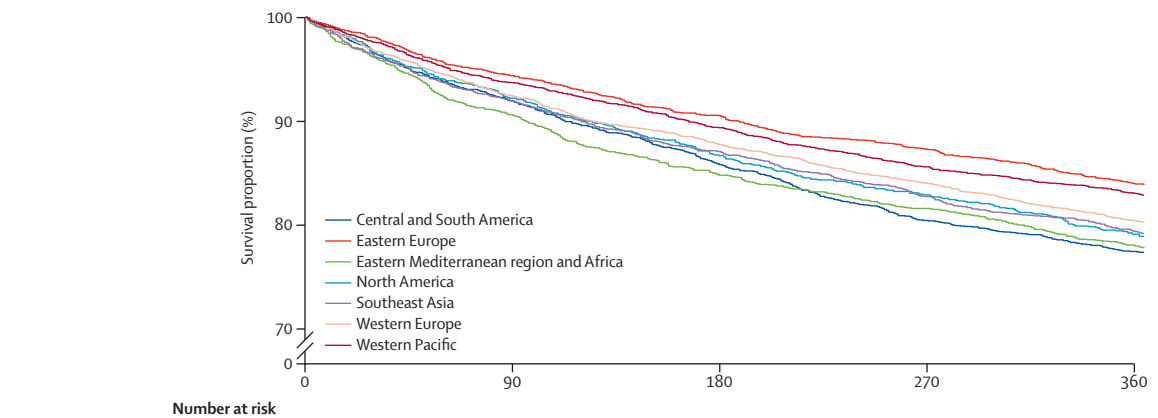
cardiovascular causes was higher in countries with lower income (65% *vs* 50%; p<0·001) and, to a lesser extent, greater income inequality (60% *vs* 58%; p<0·001).

Regional differences in 1-year mortality remained after adjusting for prognostic indicators, with patients from lower-income regions (HR 1·58, 95% CI 1·41–1·78; p<0·0001) and greater income inequality (1·25, 1·13–1·38; p<0·0001) being more likely to die (table 3). We found an interaction between regional income level and heart failure subtype ($p_{interaction}$<0·001; appendix p 7), where differences in mortality across income levels were observed for patients with HFrEF but not for those with HFpEF (figure 3). There was also an interaction between income inequality and regional income where patients from low-income countries with a low Gini index had the worst outcomes overall and patients from high-income countries with a low Gini index did better (1-year mortality 29% *vs* 17%; p<0·0001). On a continuous scale, a 10-point increase in Gini index was associated with greater post-discharge mortality (HR 1·16, 95% CI 1·11–1·21; p<0·001) in our multivariable model. Similarly, an increase of US$5000 in GDP was associated with better post-discharge mortality (0·96, 0·95–0·98; p<0·001) after multivariable adjustments. In secondary analyses, we obtained more robust variance estimates using country as the clustering variable. Compared with higher-income countries, patients from upper-middle-income (1·22, 1·12–1·33) and lower-middle-income (1·58, 1·41–1·78) countries had worse outcomes. Similarly, patients from southeast Asia had the worst outcomes (2·02, 1·73–2·37), followed by eastern Mediterranean and Africa (1·74, 1·50–2·01) and Central and South America (1·69, 1·47–1·94). Results remained similar for Gini tertiles, where patients from the highest tertile of disparity had the worst outcomes (1·32, 1·21–1·45) compared with patients from the lowest tertile. No significant interaction (p=0·347) was observed between Gini coefficient and income class for 1-year all-cause mortality.

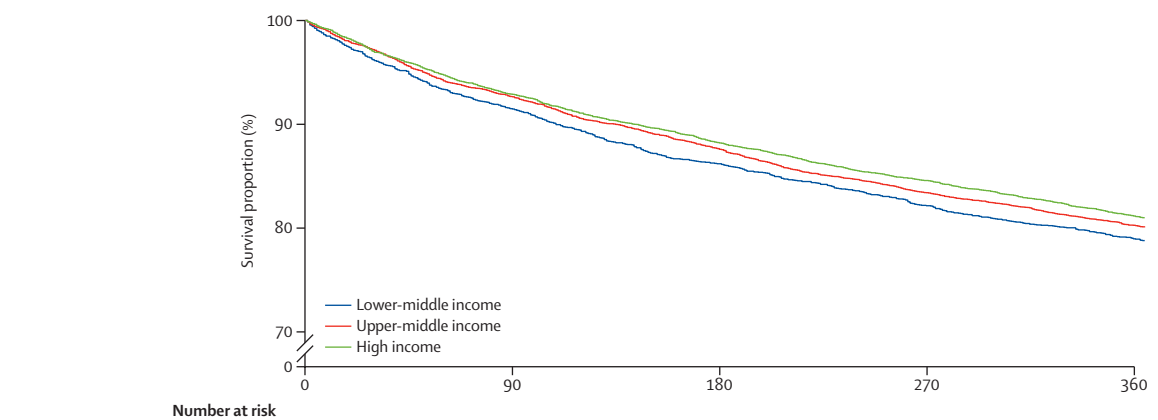
Across all regions, important predictors of worse 1-year mortality were old age, lower systolic blood pressure, anaemia, chronic kidney disease, valvular heart disease, and not receiving ACEi or β blockers at discharge (table 3). Compared with patients with HFrEF, patients with HFmrEF (HR 0·82, 95% CI 0·74–0·90), and HFpEF (0·67, 0·61–0·74) had better outcomes.

Discussion

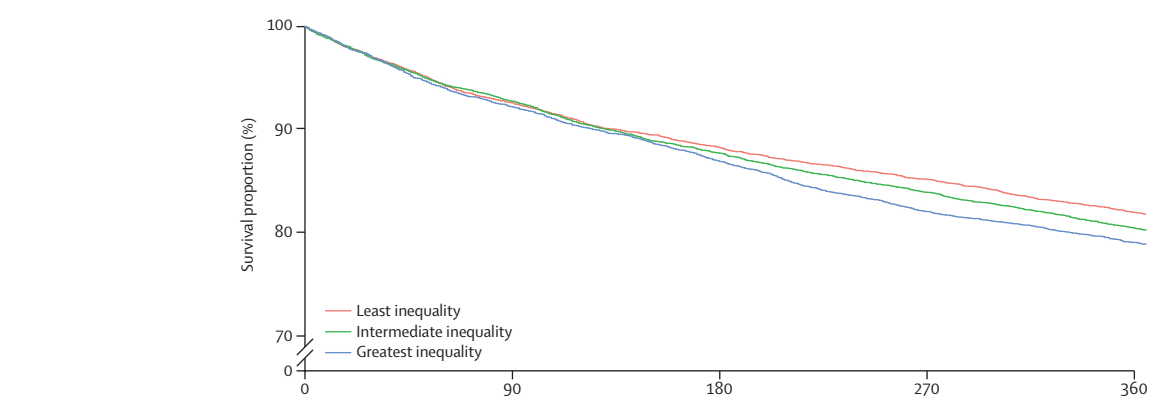
People with greater socioeconomic deprivation are at a higher risk for non-communicable disease in general, and heart failure in particular, with a younger age at onset and worse outcomes.[18] REPORT-HF is the first international registry to collect the same data on patients with acute heart failure simultaneously from all inhabited world regions, and shows substantial variation in post-discharge mortality. Patients with HFrEF from countries with lower incomes were less likely to receive GDMT, both at discharge and at 6 months and had a higher 1-year mortality despite being almost a decade younger than patients from high-income countries. Conversely, patients with HFpEF had a somewhat overall better prognosis with much less variation according to national income or income inequality. Differences in the quality of care and availability of GDMT might account for the variability in outcome for HFrEF. Scarcity of treatments known to improve prognosis for HFpEF might explain why variations in access to care have little effect on the outcome of HFpEF.



Number at risk					
Central and South America	2419	2225	2078	1940	1863
Eastern Europe	2724	2571	2466	2376	2286
Eastern Mediterranean region and Africa	2124	1925	1803	1733	1658
North America	1541	1419	1333	1270	1204
Southeast Asia	2259	2077	1967	1870	1796
Western Europe	3404	3147	2977	2834	2687
Western Pacific	3161	2963	2825	2704	2622



Number at risk					
Lower-middle income	2934	2686	2531	2413	2320
Upper-middle income	7354	6818	6450	6132	5898
High income	7344	6823	6468	6182	5898



Number at risk					
Least inequality	4447	4119	3919	3769	3605
Intermediate inequality	7336	6804	6428	6140	5873
Greatest inequality	5411	4992	4707	4434	4266

***Figure 2*: Kaplan Meier curves showing 1-year all-cause mortality rate stratified to region (A), country income level (B), and tertiles of income inequality (C)**

The 1-year mortality in REPORT-HF (20% overall, 13% in eastern Europe, and 18% in western Europe) is consistent with that observed in the European Society of Cardiology Heart Failure Pilot[19] and long-term registry[20] (ESC-HF-LT; 23·4%). In the National Audit of England and Wales, among more than 150 000 patients enrolled between 2014 and 2018, the 1-year mortality was strongly related to age at around 20% for those aged 65–74 years.[21] In North America, 1-year mortality in REPORT-HF was 21%, which is lower than observed in Get-With-The-Guidelines (GWTG; 36%) and OPTIMIZE-HF (35%) registries. However, these registries excluded people younger than age 65 years for these analyses, hence the average age of their patients was almost two decades older than patients from North America in REPORT-HF.[22,23] Further informed consent was not required in GWTG or OPTIMIZE. In Asia, data from the ASIAN-HF registry showed a 1-year all-cause mortality of 13% for patients with either HFpEF or HFrEF enrolled as in-patients.[24] Patients with acute heart failure enrolled in the Trivandrum Heart Failure Registry[25] showed a 1-year mortality of 30%. Whether these data are representative of other Indian states is uncertain. Mortality in REPORT-HF for Latin America (23%),

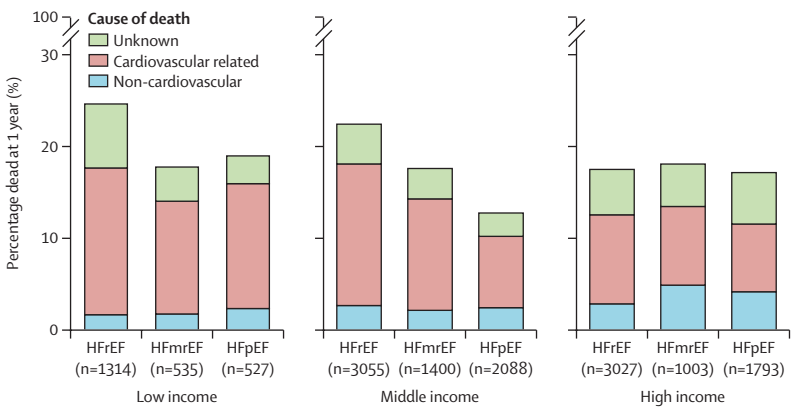


Figure 3: **Mortality rates after 1-year stratified to heart failure subtype and country income level**
HFrEF=heart failure with reduced ejection fraction. HFmrEF=heart failure with mid-range ejection fraction. HFpEF=heart failure with preserved ejection fraction.

	Univariable	Multivariable*
Demographics		
Age (per 10 years)	1·17 (1·15–1·21), <0·001	1·19 (1·15–1·22), <0·001
Sex		
Female	1 (ref)	1 (ref)
Men	1·04 (0·97–1·11), 0·291	0·99 (0·92–1·07), 0·808
Clinical characteristics		
Systolic blood pressure (above or below median)	0·60 (0·55–0·64), <0·001	0·65 (0·60–0·70), <0·001
DCHF	1·67 (1·56–1·80), <0·001	1·43 (1·32–1·55), <0·001
NYHA class		
I	1 (ref)	1 (ref)
II	1·43 (1·24–1·64), <0·001	1·36 (1·19–1·57), <0·001
III	1·91 (1·65–2·20), <0·001	1·85 (1·59–2·16), <0·001
IV	3·07 (2·56–3·69), <0·001	2·62 (2·16–3·18), <0·001
Peripheral oedema	1·41 (1·30–1·52), <0·001	1·24 (1·14–1·34), <0·001
Diabetes	1·16 (1·08–1·24), <0·001	1·03 (0·96–1·11), 0·322
Coronary artery disease	1·20 (1·12–1·28), <0·001	1·04 (0·96–1·12), 0·343
Atrial fibrillation	1·18 (1·10–1·26), <0·001	1·01 (0·93–1·08), 0·798
Anaemia	1·93 (1·79–2·09), <0·001	1·53 (1·41–1·66), <0·001
Chronic kidney disease	1·57 (1·45–1·70), <0·001	1·18 (1·09–1·28), <0·001
Valvular heart disease	1·38 (1·27–1·50), <0·001	1·17 (1·07–1·27), <0·001
LVEF type		
<40%	1 (ref)	1 (ref)
40–50%	0·83 (0·76–0·92), <0·001	0·82 (0·74–0·90), <0·001
>50%	0·71 (0·65–0·77), <0·001	0·67 (0·61–0·74), <0·001

(Table 3 continues in next column)

(Continued from previous column)

	Univariable	Multivariable*
Regional or socioeconomic factors		
Region		
Eastern Europe	1 (ref)	1 (ref)
Central and South America	1·46 (1·29–1·66), <0·001	1·69 (1·47–1·94), <0·001
Eastern Mediterranean and Africa	1·44 (1·27–1·65), <0·001	1·74 (1·50–2·01), <0·001
North America	1·35 (1·17–1·56), <0·001	1·30 (1·11–1·52), <0·001
Southeast Asia	1·33 (1·17–1·52), <0·001	2·02 (1·73–2·37), <0·001
Western Europe	1·25 (1·11–1·41), <0·001	1·17 (1·02–1·33), 0·023
Western Pacific	1·07 (0·94–1·21), 0·285	1·22 (1·07–1·40), 0·004
Country income		
High income	1 (ref)	1 (ref)
Upper-middle income	1·06 (0·98–1·14), 0·151	1·22 (1·12–1·33), <0·001
Lower-middle income	1·14 (1·03–1·25), 0·008	1·58 (1·41–1·78), <0·001
Income inequality		
Low	1 (ref)	1 (ref)
Middle	1·09 (1·01–1·19), 0·046	1·04 (0·95–1·14), 0·0378
High	1·19 (1·08–1·29), <0·001	1·25 (1·13–1·38), <0·001
Medication or quality of care		
Length of stay (above or below median)	1·45 (1·35–1·55), <0·001	1·37 (1·27–1·47), <0·001
β blocker at discharge	0·73 (0·68–0·78), <0·001	0·77 (0·71–0·83), <0·001
ACEi or ARB at discharge	0·60 (0·56–0·64), <0·001	0·73 (0·68–0·78), <0·001

Data are HR (95% CI), p value. DCHF=decompensated chronic heart failure. NYHA=New York Heart Association. LVEF=left ventricular ejection fraction. ACEi=ACE inhibitor. ARB=angiotensin receptor blocker. *Corrected for all variables in table 3 except for Gini tertiles and income class. Estimates for Gini tertiles and income class are corrected for all variables except for region; income and region; Gini, respectively.

Table 3: **Predictors of 1-year mortality**

southeast Asia (23%), and China (17%) were consistent with or exceeded those reported for patients enrolled in hospital in INTER-CHF.[4] We suggest that any differences in mortality in other registries and those in REPORT-HF might be due to differences in centres included, proportion of patients dwelling in rural areas, and the need for patients to consent to participation. Post-hoc analyses from two clinical trials[26,27] have found similar results to those of REPORT-HF with respect to socioeconomic deprivation and mortality. However, REPORT-HF not only is much larger, but it also includes a more diverse population, with few inclusion and exclusion criteria, no intervention that might influence patient participation, and many more countries and regions. Despite being a decade younger and having a more favourable risk profile, patients in low-to-middle-income countries had a 3% higher 1-year crude mortality. After correcting for age and other risk factors, the excess mortality in countries of low and middle income appeared much larger. Despite the association between country income level and post-discharge outcomes, there were a number of countries that had lower post-discharge mortality than predicted by their low GDP. This suggests other unmeasured factors beyond GDP might effect post-discharge mortality, including differences in country health-care financing and delivery systems, local standards and practices, as well as compliance with guideline-directed medical therapies and their up-titration. Our multivariable models did not fully explain differences in post-discharge mortality, suggesting that beyond the variables captured, other factors might play a role, which deserve further study.

Strong predictors of post-discharge mortality in REPORT-HF included age, systolic blood pressure, anaemia, renal function, presence of valvular heart disease, and LVEF phenotype, which generally confirms prior knowledge.[16] In REPORT-HF, patients with HFpEF had considerably better outcomes than those with HFrEF.[28] Analyses of cohorts with chronic heart failure generally show that, compared with those with HFrEF, patients with HFpEF have a better prognosis,[28] and this is true for those of either European or Asian origin.[29] The lower mortality with HFpEF in REPORT-HF might reflect patient selection incurred by the consent procedure. Older patients hospitalised with heart failure often have multiple precipitating factors and other diagnoses all contributing to the need for admission. Multimorbid patients might be less likely to be asked and less likely to consent to participation but also have the worst outcome. Yet, despite being a decade younger and having a more favourable risk profile, patients with HFpEF from low to middle-income countries had a similar mortality at 1 year compared with patients with HFpEF from high-income countries. Although all-cause mortality for patients with acute heart failure might be similar for those with HFrEF and HFpEF, causes of death might differ; patients with HFrEF might be more likely to die from cardiovascular events whereas patients with HFpEF might have a broad and complex range of problems that conspire together, leading to death.

REPORT-HF reflects real-world practice and shows variations in practice that might be determined by locally available resources, skills, and guidelines. Values for plasma natriuretic peptides were not available for almost 10 000 patients and were therefore not included in multivariable models for this analysis. For practical reasons, we did not take a random sample of countries or of clinical sites within a country. The registry required patients to give consent for the use of their data and for follow-up. Patients who could not provide consent could not participate, which explains our low index-hospitalisation mortality. Compassionate investigators might have thought it inappropriate to enrol sicker, frailer patients who would have difficulty in returning for follow-up visits. Selection bias is likely to have led to enrolment of younger patients with fewer comorbidities and a better prognosis. Despite the factors that might have excluded sicker patients, the 1-year mortality was still 20%. In North America, many of the sites chosen served predominantly African-American patients, who might develop heart failure at a younger age and have a worse prognosis than Americans of European descent. No time to event data were available for hospitalisations. Causes of death were determined according to the investigator's opinion and were not independently adjudicated. This might account for why so many deaths were reported as unknown. Patients who die at home, without much additional information, are often adjudicated as sudden deaths in clinical trials.

The REPORT-HF international prospective registry shows that mortality in the year after a hospitalisation for acute heart failure is substantial and worse in countries with lower average income or greater income inequality. Regional variations in mortality for patients with HFrEF suggests that risk is modifiable and might be improved by greater access to expert care and medicines. In contrast, there appears to be little or no regional variation in outcome for HFpEF, which might reflect the lack of treatments that substantially alter outcome.

Contributors

All authors contributed equally to drafting the Article, critical revisions and final approval. In addition, JT, SB, and WTT prepared the data, prepared the figures and performed statistical analyses. JT, SB, WTT, and WO did statistical analyses. JT wrote the first draft of the Article with input from SPC, GF, JGFC, and CSPL. The study was designed by JGFC, CEA, UD, KD, GE, MH, SVP, MG, AS, AO, CSPL, GF, and SPC. Critical revisions of the Article were provided by JGFC, CEA, UD, KD, GE, MH, SVP, MG, AS, AO, CSPL, GF, and SPC.

Declaration of interests

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