Circulation: Heart Failure

EMERGING INVESTIGATORS

Risk Factors for Heart Failure

20-Year Population-Based Trends by Sex, Socioeconomic Status, and Ethnicity

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BACKGROUND: There are multiple risk factors for heart failure, but contemporary temporal trends according to sex, socioeconomic status, and ethnicity are unknown.

METHODS: Using a national UK general practice database linked to hospitalizations (1998–2017), 108 638 incident heart failure patients were identified. Differences in risk factors among patient groups adjusted for sociodemographic factors and age-adjusted temporal trends were investigated using logistic and linear regression.

RESULTS: Over time, a 5.3 year (95% CI, 5.2–5.5) age difference between men and women remained. Women had higher blood pressure, body mass index, and cholesterol than men ($P<0.0001$). Ischemic heart disease prevalence increased for all to 2006 before reducing in women by 0.5% per annum, reaching 42.7% (95% CI, 41.7–43.6), but not in men, remaining at 57.7% (95% CI, 56.9–58.6; interaction $P=0.002$). Diabetes mellitus prevalence increased more in men than in women (interaction $P<0.0001$). Age between the most deprived (74.6 years [95% CI, 74.1–75.1]) and most affluent (79.9 [95% CI, 79.6–80.2]) diverged (interaction $P<0.0001$), generating a 5-year gap. The most deprived had significantly higher annual increases in comorbidity numbers (+0.14 versus +0.11), body mass index (+0.14 versus +0.11 kg/m^2), and lower smoking reductions (−1.2% versus −1.7%) than the most affluent. Ethnicity trend differences were insignificant, but South Asians were overall 6 years and the black group 9 years younger than whites. South Asians had more ischemic heart disease (+16.5% [95% CI, 14.3–18.6]), hypertension (+12.5% [95% CI, 10.5–14.3]), and diabetes mellitus (+24.3% [95% CI, 22.0–26.6]), and the black group had more hypertension (+12.3% [95% CI, 9.7–14.8]) and diabetes mellitus (+13.1% [95% CI, 10.1–16.0]) but lower ischemic heart disease (−10.6% [95% CI, −13.6 to −7.6]) than the white group.

CONCLUSIONS: Population groups show distinct risk factor trend differences, indicating the need for contemporary tailored prevention programs.

Key Words: blood pressure ■ diabetes mellitus ■ heart failure ■ hypertension ■ risk factor

Heart failure (HF) is reaching epidemic proportions in aging populations globally,[1] with increasing burden and costs projected over the next 2 decades.[2] HF is a complex clinical syndrome with sex,[3] socioeconomic,[4] and ethnic[5,6] disparities. HF results from several different etiological pathways, each influenced by wide-ranging individual, clinical, and environmental risk factors. Reasons for group disparities in the burden and outcomes of HF are multifactorial but likely include variations in genetic, environmental, and physiological susceptibility to different pathophysiological mechanisms, increased exposure to risk factors, and decreased access to health care.

To stem epidemic growth, public health approaches need to be responsive to social and population dynamics and to target the highest risk groups with tailored prevention strategies that include the most relevant and potentially modifiable risk factors. Yet, contemporary population-based trend data on known risk factors among different population groups with new HF are scarce.

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WHAT IS NEW?

- Following an initial increase in ischemic cause of HF, the figures are now falling for women, whereas remaining stable in men. Number of comorbidities is increasing faster per annum for women than men.
- Difference in age at HF diagnosis between the most affluent and most deprived is widening, with the most deprived group becoming younger at the same rate as the most affluent group are aging. Increasing differences in prevalence of comorbidities and cardiovascular risk factors are also apparent with the most deprived at significantly increasing higher risk than the most affluent.
- South Asian and black groups are younger at HF onset than whites with higher prevalence of cardiometabolic comorbidities.

WHAT ARE THE CLINICAL IMPLICATIONS?

- Decreasing prevalence of cardiovascular risk factors and increasing prevalence of comorbidities before HF onset indicates a need for earlier patient-centered multimorbidity care.
- Contemporary tailored HF prevention programs are required to address group differences and to target the worse-off groups to abate the alarming projected increase in HF burden and costs over the next 2 decades.

Nonstandard Abbreviations and Acronyms

BMI	body mass index
CPRD	Clinical Practice Research Datalink
HES	hospital episodes statistics
HF	heart failure
IHD	ischemic heart disease

Prior work has focused on overall trends in HF risk factors, which fails to delineate patterns among groups,[7] or on subgroups at single time-points,[8,9] which lack important information on changing demography. Using large linked national UK clinical databases, this study aimed to investigate differences in risk factors among groups with new-onset HF in the United Kingdom, by sex, socioeconomic status, and ethnicity and temporal changes over 2 decades.

METHODS

Study Population

We used the Clinical Practice Research Datalink (CPRD), the largest anonymized database of routinely collected primary care records globally, linked to hospital episode statistics (HES) and Index of Multiple Deprivation data. The CPRD includes ≈7% of the UK general population from general practices that have consented to contribute data. Included patients have been found to be representative of the general population in terms of the age, sex, and ethnicity.[10] Data is collected longitudinally from a patient's first registration with their general practice until they transfer out or die and includes their demographic information, clinical consultations, referrals, prescriptions, tests, and lifestyle information and has been validated for epidemiological research and coding of clinical diseases.[11] HES data contain details of all inpatient and outpatient admissions to National Health Service healthcare providers in England, including admission and discharge dates, diagnoses, and procedures taken.[12]

We included all patients aged ≥30 years who had a first HF diagnosis recorded in their CPRD or HES record between January 1, 1998 and July 31, 2017, and were eligible for data linkage (Figure I in the Data Supplement). Patients in CPRD were included if they had a Read diagnostic code for HF in their primary care record. Patients in HES were included if they had an inpatient HF *International Classification of Diseases, Tenth Revision* discharge code in the primary position. Where patients had HF codes in both datasets, the first was used as the HF index date. Patients identified in CPRD or HES were excluded if they were from a general practice that had not contributed a minimum of 12-months of CPRD assessed up to standard data, before study entry. We used an updated, clinically validated HF CPRD code set,[13] and *International Classification of Diseases, Tenth Revision* codes (Tables I and II in the Data Supplement). All patients were deemed acceptable by CPRD quality control.

Ethical Review

The study protocol was approved by the Independent Scientific Advisory Committee for data access (Protocol 18_037R). Ethics approval for the use of CPRD data following approval from Independent Scientific Advisory Committee is granted by a national research ethics committee (05/MRE04/87/AM06). Although individual patient consent is not required, all data is deidentified, and patients can opt-out of data contribution.

Data and Materials Access

Dr Lawson had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. This study is based in part on data from the Clinical Practice Research Datalink obtained under license from the UK Medicines and Healthcare products Regulatory Agency. However, the interpretation and conclusions contained in this report are those of the authors alone. Data access is through permissions from CPRD only.

Socioeconomic Status

The patient-level Index of Multiple Deprivation was used as a measure of socioeconomic status. The English Indices of Deprivation 2010 are measures of deprivation linked to small housing areas in England and covering 7 domains.[14] When domain scores are combined using appropriate weights, a single overall Index of Multiple Deprivation is produced, which is a useful proxy of individual-level deprivation for use in health research. The score was ranked into quintiles, ranging from most affluent (quintile 1) to most deprived (quintile 5).

Ethnicity

Ethnicity classification was based on CPRD and HES recording using an algorithm, validated against the national UK census for ethnicity distribution[15] (Figure II in the Data Supplement). Ethnicity was categorized into 3 distinct groups for the analyses, reflecting the most prevalent ethnic groups in the 2011 census in England and Wales,[16] as follows white, South Asian, or black. Those coded as mixed, other, or unknown had their ethnicity status counted as missing. South Asian included Pakistani, Indian, Bangladeshi, and other Asian ethnic groups, such as Asian British, whereas black includes African, Caribbean, and other black groups, such as black British.

Baseline Characteristics

We collected information on ischemic heart disease (IHD) and myocardial infarction as well as other common comorbidities. We used Read and *International Classification of Diseases, Tenth Revision* codes in CPRD and HES respectively, to ascertain comorbidities recorded up to and including the HF index date. We also collected information on other risk factors using the most recent measure before study entry, including current smoking and alcohol status, body mass index (BMI), systolic blood pressure, cholesterol, hemoglobin, and estimated glomerular filtration rate.

Statistical Analysis

Baseline characteristics are reported as numbers (%) for categorical variables, mean (SD) for continuous variables, and median (25th and 75th centiles) for skewed data. Overall differences in baseline risk factors between groups were estimated using logistic (binary variables) and linear (continuous variables) models adjusting for age, sex, socioeconomic status, ethnicity, and HF diagnosis year. Absolute differences in risk factors between the group categories were calculated comparing female with male, the most deprived with most affluent and the South Asian and black groups with the white group. A sensitivity analysis was performed to estimate overall differences between groups, restricted to patients with a hospital diagnosis of HF only.

To summarize any temporal changes in risk factors, age-adjusted logistic (binary variables) or linear (continuous variables) regression models were used. Estimates were calculated by sex, socioeconomic status, and ethnicity for 2 time-windows at the beginning (1998–2002) and end (2013–2017) of the study time period. To investigate trends more closely, the models were then fitted with a 3-way interaction term between a population group, HF diagnosis year, and age. For each group category, risk factors were estimated for each calendar year using the mean population age. As some of the continuous variables were slightly skewed, 1000 bootstrap samples were used for the linear regression models. Absolute difference and percentage change in each risk factor between 1998 and 2017 were calculated, as well as mean change per year (trend slope). Piecewise linear or logistic regressions were performed using "nl hockey" or "loghockey" commands in Stata-MP 14, respectively, to identify whether there was a significant change in a trend slope. Any difference in the rate of change between group categories was examined visually, by plotting graphs of predicted risk factors by HF diagnosis year and analytically, by the significance level of the coefficient for an interaction term between the group and HF index year (as a continuous variable) included in the models also containing age.

To estimate proportions following logistic regression and mean values following linear regression, the "Margins" command in Stata-MP 14 was used. Margins are statistics calculated from predictions of a previously fit model. With the exception of age, all estimations were performed at the mean population aged 78 years. Stata-MP 14 was used for all analyses, and the significance level was set at $P<0.05$.

RESULTS

Study Population

There were 108 638 patients with a new HF diagnosis during the study time period, 56 294 (51.8) diagnosed in the community and 52 344 (48.2%) in the hospital, mean age 77.8 (11.7) years, 50.0% female, 18.7% in the most affluent group, and 17.0% in the most deprived (Table 1). Of the 106 374 patients with ethnicity data (Figure I in the Data Supplement), 97 273 (91%) were white, 1842 (1.7%) South Asian, and 1021 (1.0%) were black. Overall, HF patients had a mean of 4 comorbidities at the time of diagnosis. Most prevalent comorbidities were hypertension (65%), IHD (50%), chronic kidney disease (43%), atrial fibrillation (41%), osteoarthritis (36%), diabetes mellitus (27%), obesity (23%), cancer (23%), and depression (22%). Between the first (1998–2002) and last time-window (2013–2017), systolic blood pressure, cholesterol, and smoking reduced, whereas BMI increased for all groups.

Overall Differences and 20-Year Trends by Sex

Women were 5 years older than men at HF diagnosis (mean, 80.4 SD 10.8 versus 75.1 SD 11.9 years; Table 1) and more likely to be diagnosed in hospital (50.5% versus 45.9%). The 5-year age difference remained following adjustment for diagnosis year, socioeconomic status, and ethnicity (5.3 years [95% CI, 5.2–5.5]; Table 2). Following the same adjustment, women had 12.6% (95% CI, 12.0–13.0) less IHD than men but 0.2 (95% CI, 0.1–0.2) more comorbidities (Table 2). For other risk factors, women were less likely to be a current smoker (19% versus 24%), but they had significantly higher systolic blood pressure (140 versus 136 mm Hg) and cholesterol (4.8 versus 4.3 mmol/L) than men (Table 1). These differences remained following adjustment with women also having higher BMI (all $P<0.001$, Table 2).

Although the mean increase in age over time was similar between men and women (interaction $P=0.863$), the increasing trend has plateaued since 2011 for women (Table 3, Figure 1A). Increasing prevalence of IHD was similar among women and men until 2006 but then began to diverge with men reaching a plateau and women experiencing a 0.5% per annum (pa) reduction

Table 1. Patient Characteristics by Sex, Socioeconomic, and Ethnicity Status

Characteristics	All (N=108 638)	Missing (%)	Men (N=54 362)	Women (N=54 276)	Most Affluent (N=20 236)	Most Deprived (N=18 403)	White (N=97 273)	South Asian (N=1842)	Black (N=1021)
Age, y	77.8 (11.7)	…	75.1 (11.9)	80.4 (10.8)	79.2 (11.1)	75.2 (12.5)	77.8 (11.6)	71.7 (12.3)	68.0 (15.2)
Female	54 276 (50%)	…	…	…	9909 (49%)	9334 (51%)	48 364 (50%)	794 (43%)	501 (49%)
Most affluent	20 236 (19%)	0.2	10 327 (19%)	9909 (18%)	…	…	18 226 (19%)	263 (14%)	57 (6%)
Most deprived	18 403 (17%)	0.2	9069 (17%)	9334 (17%)	…	…	16 339 (17%)	405 (22%)	400 (39%)
Community diagnosis	63 879 (58.8)	…	32 998 (60.7)	30 829 (56.8)	12 283 (60.7)	10 490 (57.0)	56 127 (57.7)	895 (48.6)	504 (49.4)
Hospital diagnosis	44 759 (41.2)	…	21 364 (39.3)	23 447 (43.2)	7953 (39.3)	7913 (43.0)	41 146 (42.3)	947 (51.4)	517 (50.6)
Comorbidities									
Number	4.0 (2.0)	…	3.9 (2.0)	4.1 (2.1)	3.9 (2.0)	4.2 (2.1)	4.1 (2.0)	4.4 (2.0)	4.0 (2.1)
IHD	54 673 (50%)	…	30 594 (56%)	24 079 (44%)	9894 (49%)	9746 (53%)	49 579 (51%)	1250 (68%)	413 (40%)
MI	28 849 (27%)	…	17 791 (33%)	11 058 (20%)	5271 (26%)	5134 (28%)	26 308 (27%)	746 (40%)	188 (18%)
AF	44 163 (41%)	…	22 143 (41%)	22 020 (41%)	8702 (43%)	6934 (38%)	41 140 (42%)	486 (26%)	235 (23%)
Hypertension	70 336 (65%)	…	33 794 (62%)	36 542 (67%)	13 124 (65%)	11 897 (65%)	64 085 (66%)	1464 (79%)	804 (79%)
Diabetes mellitus	28 984 (27%)	…	15 331 (28%)	13 653 (25%)	4580 (23%)	5604 (30%)	25 648 (26%)	984 (53%)	448 (44%)
Stroke	13 453 (12%)	…	6831 (13%)	6622 (12%)	2418 (12%)	2376 (13%)	12 132 (12%)	242 (13%)	127 (12%)
Anemia	13 519 (12%)	…	5291 (10%)	8228 (15%)	2365 (12%)	2449 (13%)	12 243 (13%)	442 (24%)	156 (15%)
Obesity	25 491 (23%)	…	12 930 (24%)	12 561 (23%)	3919 (19%)	5090 (28%)	23 455 (24%)	422 (23%)	363 (36%)
CKD	46 478 (43%)	…	20 493 (38%)	25 985 (48%)	8001 (44%)	7251 (39%)	42 207 (43%)	708 (38%)	323 (32%)
COPD	20 156 (19%)	…	11 162 (21%)	8994 (17%)	2834 (14%)	4687 (25%)	18 640 (19%)	204 (11%)	90 (9%)
Asthma	19 822 (18%)	…	9273 (17%)	10 549 (19%)	3262 (16%)	4055 (22%)	18 109 (19%)	435 (24%)	191 (19%)
Depression	24 102 (22%)	…	9537 (18%)	14 565 (27%)	4065 (20%)	4556 (25%)	22 140 (23%)	338 (18%)	154 (15%)
Osteoarthritis	38 624 (36%)	…	15 813 (29%)	22 811 (42%)	7286 (36%)	6476 (35%)	35 528 (37%)	651 (35%)	311 (30%)
Cancer	24 484 (23%)	…	12 629 (23%)	11 855 (22%)	5081 (25%)	3466 (19%)	22 906 (24%)	172 (9%)	150 (15%)
Dementia	5861 (5%)	…	2124 (4%)	3737 (7%)	1105 (5%)	907 (5%)	5264 (5%)	62 (3%)	53 (5%)
Smoking	20 495 (22%)	12.9	11 790 (24%)	8705 (19%)	2985 (17%)	4571 (28%)	17 994 (21%)	265 (16%)	163 (19%)
BMI, kg/m^2	26.8 (23.6–30.8)	20.9	27.0 (24.1–30.6)	26.6 (23.0–31.2)	26.3 (23.4–29.9)	27.4 (23.8–31.8)	26.9 (23.7–31.0)	26.6 (23.6–30.4)	29.0 (25.2–33.7)
Systolic BP, mm Hg	138.1 (21.7)	9.5	135.9 (20.9)	140.3 (22.3)	137.6 (21.2)	138.4 (21.7)	137.7 (21.5)	135.9 (21.0)	140.2 (21.7)
Cholesterol, mmol/L	4.5 (3.8–5.4)	39.2	4.3 (3.6–5.1)	4.8 (4.1–5.7)	4.5 (3.8–5.4)	4.5 (3.8–5.4)	4.5 (3.8–5.4)	4.3 (3.5–5.1)	4.4 (3.7–5.3)
Hemoglobin, g/dL	13.0 (1.9)	31.9	13.4 (2.0)	12.5 (1.7)	13.0 (1.9)	13.0 (1.9)	13.0 (1.9)	12.5 (1.9)	12.5 (1.9)
eGFR, mL/(min·1.73 m^2)	61.7 (20.4)	25.0	64.0 (20.6)	59.3 (20.0)	60.8 (19.8)	63.4 (21.2)	61.5 (20.4)	63.8 (22.0)	68.6 (24.6)

Data are reported as number of patients (%) or mean (SD) or median (25th and 75th centile). AF indicates atrial fibrillation; BMI, body mass index; BP, blood pressure; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; eGFR, estimated glomerular filtration rate; IHD, ischemic heart disease; and MI, myocardial infarction.

thereafter (interaction *P*=0.002, Table 3; Figure 1B). The number of comorbidities at HF onset increased at a faster rate in women (+0.20; pa) compared with men (+0.16 pa) until 2007, before slowing to a similar growth rate afterward (+0.07 pa), but without convergence (Table 3, Figure 2A).

For specific comorbidities, men had higher prevalence of atrial fibrillation, stroke, chronic obstructive pulmonary disease, and cancer than women, with similar growth rates over time (Table IV in the Data Supplement). Men also had higher prevalence of diabetes mellitus, which increased at a significantly faster rate than in women (0.7% versus 0.5% pa), showing significant separation of trend lines after 2009 (Figure 2B). Women had higher levels and significantly faster increasing rates of iron deficiency anemia (Figure 2C), asthma, and osteoarthritis than men. Prevalence of depression (Figure 2D) and obesity remained constantly higher in women than men over time. Prevalence of hypertension was also higher in women than men but has since converged due to greater increasing rates in men (Table IV in the Data Supplement).

Overall Differences and 20-Year Trends by Socioeconomic Status

At HF diagnosis, the most deprived group were 4 years younger than the most affluent group (mean, 75.2 SD 12.5 versus 79.2 SD 11.1 years; Table 1), which remained following adjustment for sex, ethnicity, and diagnosis

Table 2. Adjusted Group Differences

	Age, y	Comorbidities (N)	IHD, %	Smoking, %	Systolic, mm Hg	BMI, kg/m²	Cholesterol, mmol/L	Hemoglobin, gdL	eGFR, mL/(min·1.73 m²)
Male	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Female	5.3 (5.2 to 5.5)	0.2 (0.1 to 0.2)	−12.6 (−13.0 to −12.0)	−2.1 (−2.6 to −1.6)	3.6 (3.4 to 3.8)	0.3 (0.3 to 0.4)	0.6 (0.6 to 0.6)	−0.7 (−0.8 to −0.7)	−1.1 (−1.3 to −0.9)
Most affluent	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Most deprived	−3.8 (−4.0 to −3.5)	0.4 (0.4 to 0.4)	4.9 (3.9 to 5.8)	8.0 (7.2 to 8.9)	0.4 (−0.1 to 0.9)	0.8 (0.7 to 1.0)	−0.1 (−0.1 to −0.1)	−0.1 (−0.1 to −0.0)	−0.1 (−0.6 to 0.3)
White	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
South Asian	−5.7 (−6.2 to −5.2)	0.1 (0.1 to 0.2)	16.5 (14.3 to 18.6)	−6.4 (−8.0 to −4.9)	0.9 (−0.1 to 2.0)	−1.4 (−1.7 to −1.1)	−0.3 (−0.3 to −0.2)	−0.7 (−0.8 to −0.6)	−1.7 (−2.7 to −0.8)
Black	−9.0 (−9.9 to −8.2)	−0.3 (−0.4 to −0.2)	−10.6 (−13.6 to −7.6)	−7.3 (−9.2 to −5.3)	5.3 (3.8 to 6.9)	0.02 (−0.4 to 0.4)	−0.1 (−0.2 to −0.02)	−0.8 (−0.9 to −0.7)	0.6 (−0.9 to 2.0)

All group differences adjusted for age, sex, socioeconomic status, ethnicity, and HF index year. BMI indicates body mass index; eGFR, estimated glomerular filtration rate; and IHD, ischemic heart disease.

year (Table 2). The most deprived group had an adjusted 4.9% (3.9–6.0) higher prevalence of IHD than the most affluent group and 0.4 (0.4–0.4) more comorbidities (Table 2). Prevalence of current smoking was 28% in the most deprived compared with 17% in the most affluent (Table 1) with an 8.0% (7.2–8.9) difference remaining following adjustment (Table 2). The deprived group also had a 0.8 kg/m² (0.7–1.0) higher BMI than the most affluent group (Table 2). For each lower quintile of socioeconomic status, there was a significant reduction in age at diagnosis and a significant increase in number of comorbidities, BMI, and prevalence of IHD and smoking (Table III in the Data Supplement).

Over time, age in the most affluent group increased at a similar annual rate (≈1 month pa) as it reduced in the most deprived group (Table 3). This divergence is most marked after 2006, following an accelerated age increase in the most affluent group (Figure 1A). Despite their reducing age, the most deprived group had a faster growth rate in the number of comorbidities than the most affluent, increasing from a difference of 0.2 in 1998 to 2002 (3.1; 3.1–3.2 versus 2.9; 2.9–3.0 comorbidities, respectively) to 0.6 by 2013 to 2017 (5.1; 5.1–5.2 versus 4.5; 4.4–4.5; Table 3, Figure 2A). The most deprived group also had significantly slower annual reduction rates in smoking before 2009 (−1.9% [95% CI, −2.2 to −1.7]) than the most affluent group (−2.9% [95% CI, −3.2 to −2.7] Figure 1C).

For specific comorbidities, the deprived group had significantly higher prevalence of most comorbidities with the biggest differences for obesity (28% versus 19%), diabetes mellitus (30% versus 23%; Figure 2B), chronic obstructive pulmonary disease (25% versus 14%; Table 1), which remained following adjustment (Table IV in the Data Supplement). The deprived group also had higher annual growth rates of anemia (+0.9%; 0.8–0.1 versus +0.6%; 0.5–0.7) and depression (+0.8%; 0.6–0.9 versus +0.3%; 0.2–0.4) than the affluent group (Figures 2C and 2D). Conversely, the more affluent group had a higher annual growth rate of cancer than the deprived group (+0.9%; 0.7–1.0 versus +0.6%; 0.5–0.7; Table IV in the Data Supplement).

Overall Differences and 20-Year Trends by Ethnicity

Age at HF onset differed significantly by ethnicity with younger onset in the South Asian group (72 years) and back ethnicity group (68 years) compared with the older white group (78 years; Table 1). Following adjustment, age differences compared with the white group were −5.7 (95% CI, −6.2 to −5.2) years for the South Asian group and −9.0 (95% CI, −9.9 to −8.2) years for the black group (Table 3, Figure 1A). Following same adjustment also including age, compared to the white group, the South Asian group had 16.5 % (95% CI, 14.3–18.6) more and the black group 10.6% (95% CI, 7.6–13.6) less IHD (Table 2). Despite their younger age, the South Asian group had similar number of comorbidities to the white group (difference: 0.1 [95% CI, 0.1–0.2]), whereas the black group had 0.3 (95% CI, 0.2–0.4) less.

For specific comorbidities, the South Asian and black groups had significantly less atrial fibrillation, cancer, depression, and chronic obstructive pulmonary disease but had 12% more hypertension, 24% (South Asian), and 13% (black) more diabetes mellitus (Table IV in the Data Supplement) and 11% (South Asian) and 3% (black) more anemia than the white group. For smoking, adjusted prevalence was 6.4% (95% CI, 4.9–8.0) less in the South Asian group and 7.3% (95% CI, 5.3–9.2) less in the black group than the white group (Table 2). When stratified by sex, these differences compared with the white group narrowed to 3.0% less for South Asian men and 4% less for black men, whereas differences increased to 12% less for South Asian women and 11% for black women (not shown).

Age increased at a faster annual rate in the South Asian group before 2013 (+6 months pa; Figure 1A)

Table 3. Predicted Prevalence of Cardiovascular Risk Factors, by Population Group and Calendar Year

	Calendar Period		Time Trends (1998 to 2017)			Average Annual Change in Risk Factors (95% CI) and Year of Any Significant Change in Trend Slope		
	1998–2002	2013–2017	Absolute Difference Over Time	% diff	Interaction *P* Value	Before	Change	After
Age in years (95% CI)								
Male	74.9 (74.7 to 75.1)	75.7 (75.5 to 76.0)	1.2 (0.4 to 2.0)	1.6	Ref	−0.02 (−0.08 to 0.04)	2007	0.12 (0.07 to 0.16)
Female	79.9 (79.7 to 80.1)	80.7 (80.4 to 80.9)	1.8 (0.9 to 2.6)	2.3	0.863	0.09 (0.06 to 1.12)	2011	−0.06 (−0.15 to 0.03)
Most affluent	78.7 (78.4 to 79.0)	79.9 (79.6 to 80.2)	2.3 (1.1 to 3.4)	2.9	Ref	0.03 (−0.07 to 0.12)	2007	0.14 (0.07 to 0.21)
Most deprived	75.7 (75.3 to 76.0)	74.6 (74.1 to 75.1)	−1.4 (−2.9 to 0.2)	−1.8	<0.001	−0.08 (−0.11 to −0.05)	N/A	−0.08 (−0.11 to −0.05)
White	76.9 (76.7 to 77.1)	78.5 (78.3 to 78.7)	2.5 (1.9 to 3.1)	3.3	Ref	0.19 (0.12 to 0.25)	2005	0.08 (0.05 to 0.11)
South Asian	67.9 (66.3 to 69.5)	73.8 (72.7 to 74.8)	5.4 (2.6 to 8.3)	8.0	<0.001	0.52 (0.35 to 0.69)	2013	−0.23 (−1.16 to 0.70)
Black	70.2 (67.7 to 72.7)	68.5 (66.8 to 70.2)	0.9 (−8.7 to 10.4)	1.2	0.122	−0.04 (−0.24 to 0.16)	N/A	−0.04 (−0.24 to 0.16)
Comorbidities in number								
Male	3.0 (3.0 to 3.0)	4.7 (4.7 to 4.8)	2.3 (2.2 to 2.5)	90.2	Ref	0.16 (0.16 to 0.17)	2007	0.07 (0.16 to 0.17)
Female	3.1 (3.1 to 3.2)	4.9 (4.9 to 4.9)	2.4 (2.3 to 2.5)	90.7	<0.001	0.20 (0.19 to 0.22)	2007	0.07 (0.06 to 0.08)
Most affluent	2.9 (2.9 to 3.0)	4.5 (4.4 to 4.5)	2.2 (2.0 to 2.4)	89.7	Ref	0.18 (0.17 to 0.20)	2006	0.07 (0.05 to 0.08)
Most deprived	3.1 (3.1 to 3.2)	5.1 (5.1 to 5.2)	2.6 (2.3 to 2.9)	94.9	<0.001	0.19 (0.18 to 0.21)	2007	0.07 (0.05 to 0.08)
White	3.1 (3.1 to 3.2)	4.8 (4.8 to 4.8)	2.2 (2.1 to 2.2)	86.0	Ref	0.17 (0.16 to 0.17)	2007	0.07 (0.06 to 0.07)
South Asian	3.6 (3.3 to 4.0)	5.1 (4.9 to 5.2)	2.7 (1.3 to 4.2)	127.2	0.004	0.20 (0.06 to 0.34)	2004	0.07 (0.05 to 0.09)
Black	3.2 (2.8 to 3.6)	5.0 (4.7 to 5.2)	0.7 (−0.8 to 2.2)	13.1	0.001	0.10 (0.07 to 0.13)	N/A	0.10 (0.07 to 0.13)
Ischemic heart disease in % prevalence								
Male	51.9 (51.0 to 52.8)	57.7 (56.9 to 58.6)	8.1 (4.6 to 11.7)	16.2	Ref	1.1 (0.9 to 1.4)	2006	−0.1 (−0.3 to 0.04)
Female	41.6 (40.8 to 42.4)	42.7 (41.7 to 43.6)	3.1 (−0.4 to 6.7)	7.9	0.002	0.9 (0.7 to 1.2)	2006	−0.5 (−0.7 to −0.4)
Most affluent	44.5 (43.1 to 46.0)	48.6 (47.2 to 50.0)	10.9 (5.3 to 16.4)	28.2	Ref	1.0 (0.7 to 1.3)	2008	−0.5 (−0.8 to −0.1)
Most deprived	48.3 (46.8 to 49.7)	53.8 (52.2 to 55.5)	3.8 (−0.02, to 9.9)	7.6	0.415	1.1 (0.8 to 0.1)	2008	−0.5 (−0.9 to −0.1)
White	48.0 (47.3 to 48.6)	50.4 (49.8 to 51.1)	3.6 (1.9 to 5.3)	10.1	Ref	0.8 (0.6 to 1.0)	2007	−0.4 (−0.5 to −0.2)
South Asian	67.2 (58.4 to 76.0)	71.9 (68.3 to 75.6)	3.7 (−11.2 to 18.6)	6.7	0.346	1.1 (−0.8 to 3.0)	2007	−0.2 (−1.1 to 0.7)
Black	44.9 (34.7 to 55.2)	49.1 (43.2 to 54.9)	−9.5 (−28.2 to 9.2)	−25.6	0.484	−0.4 (−3.0 to 2.2)	2007	0.3 (−1.2 to 1.9)
Smoking in % prevalence								
Male	35.1 (34.2 to 36.1)	11.2 (10.6 to 11.8)	−13.5 (−16.7 to −10.2)	−46.3	Ref	− 3.0 (−3.1 to −2.8)	2009	0.4 (0.1 to 0.6)
Female	36.4 (34.8 to 38.0)	8.5 (7.6 to 9.3)	−11.4 (−14.2 to −8.6)	−51.4	0.054	−2.4 (−2.5 to −2.2)	2009	− 0.1 (−0.2 to 0.2)
Most affluent	37.4 (35.8 to 39.1)	17.6 (16.2 to 19.0)	−14.7(−19.1 to −10.3)	−64.4	Ref	−2.9 (−3.2 to −2.7)	2009	0.1 (−0.2 to 0.4)
Most deprived	37.6 (36.9 to 38.4)	12.4 (11.9 to 12.8)	−7.6 (−13.4 to −1.9)	−29.0	<0.001	−1.9 (−2.2 to −1.7)	2009	0.1 (−0.4 to 0.6)
White	31.3 (21.4 to 41.2)	10.1 (7.5 to 12.7)	−11.1 (−13.5 to −8.8)	−45.0	Ref	−2.7 (−2.8 to −2.6)	2009	0.2 (0.1 to 0.4)
South Asian	39.2 (27.7 to 50.8)	8.5 (5.1 to 12.0)	−25.9 (−78.5 to 26.6)	−61.0	0.010	−1.7 (−2.7 to −0.7)	2011	1.2 (0.1 to 2.3)
Black	51.9 (51.0 to 52.8)	57.7 (56.9 to 58.6)	−53.1 (−98.2 to −8.0)	−82.7	0.718	−3.9 (−6.5 to −1.2)	2006	−0.5 (−0.4 to 0.8)
Body mass index in kg/m^2								
Male	26.6 (26.5 to 26.7)	28.3 (28.2 to 28.4)	2.1 (1.7 to 2.6)	8.1	Ref	0.11 (0.08 to 0.14)	2007	0.14 (0.11 to 0.16)
Female	27.0 (26.9 to 27.1)	29.0 (28.8 to 29.1)	3.0 (2.4 to 3.6)	11.2	0.259	0.12 (0.11 to 0.14)	2013	0.32 (0.15 to 0.50)
Most affluent	26.3 (26.1 to 26.5)	27.8 (27.7 to 28.0)	2.1 (1.3 to 3.0)	8.1	Ref	0.10 (0.08 to 0.12)	2014	0.20 (0.02 to 0.37)
Most deprived	27.0 (26.9 to 27.2)	29.1 (28.9 to 29.3)	2.8 (2.0 to 3.6)	10.7	0.030	0.07 (0.02 to 0.13)	2008	0.20 (0.15 to 0.25)
White	26.8 (26.8 to 26.9)	28.6 (28.5 to 28.7)	2.4 (2.0 to 2.8)	9.2	Ref	0.11 (0.10 to 0.12)	2013	0.22 (0.16 to 0.12)
South Asian	26.4 (25.4 to 27.3)	27.1 (26.6 to 27.5)	3.6 (−2.5 to 9.8)	15.3	0.179	0.29 (−0.73 to 1.31)	2002	0.04 (−0.02 to 0.11)

(*Continued*)

Table 3. Continued

	Calendar Period		Time Trends (1998 to 2017)			Average Annual Change in Risk Factors (95% CI) and Year of Any Significant Change in Trend Slope		
	1998–2002	2013–2017	Absolute Difference Over Time	% diff	Interaction *P* Value	Before	Change	After
Black	28.1 (26.7 to 29.6)	30.0 (29.0 to 30.9)	4.0 (−0.8 to 8.8)	15.4	0.211	0.14 (0.03 to 0.24)	N/A	0.14 (0.03 to 0.24)
Systolic blood pressure in mm Hg								
Male	143.6 (143.2 to 144.0)	132.6 (132.3 to 132.9)	−13.9 (−15.3 to −12.5)	−9.5	Ref	−1.43 (−1.52 to −1.34)	2007	−0.03 (−0.12 to 0.07)
Female	148.7 (148.2 to 149.1)	134.6 (134.3 to 135.0)	−16.3 (−17.9 to −14.7)	−10.8	<0.001	−1.74 (−1.84 to −1.63)	2007	−0.27 (−0.37 to −0.18)
Most affluent	145.5 (144.7 to 146.3)	133.4 (132.9 to 133.9)	−14.4(−16.7 to −12.1)	−9.7	Ref	−1.58 (−1.77 to −1.39)	2007	−0.22 (−0.36 to −0.08)
Most deprived	146.4 (145.7 to 147.1)	134.0 (133.4 to 134.5)	−15.3(−17.8 to −12.9)	−10.3	0.901	−1.42 (−1.58 to −1.27)	2008	−0.12 (−0.29 to 0.05)
White	146.4 (146.1 to 146.8)	133.5 (133.3 to 133.8)	−15.4 (−16.3 to −14.4)	−10.6	Ref	−1.61 (−1.68 to −1.53)	2007	−0.16 (−0.23 to −0.09)
South Asian	145.1 (139.7 to 150.5)	135.5 (133.9 to 137.1)	−5.5 (−32.0 to 21.0)	−2.2	0.002	−1.48 (−2.26 to −0.70)	2007	−0.01 (−0.44 to 0.43)
Black	146.4 (141.6 to 151.2)	139.8 (137.4 to 142.3)	−27.8 (−50.1,−5.5)	−18.7	0.003	−1.88 (−3.40 to −0.36)	2005	0.03 (−0.48 to 0.54)
Cholesterol in mmol/L								
Male	5.1 (5.0 to 5.1)	4.3 (4.2 to 4.3)	−1.2 (−1.4 to −1.0)	−21.7	Ref	−0.13 (−0.14 to −0.12)	2006	0.00 (−0.00 to 0.01)
Female	5.7 (5.6 to 5.7)	4.8 (4.8 to 4.9)	−1.2 (−1.4,−1.0)	−19.7	0.191	−0.14 (−0.15 to −0.13)	2007	−0.00 (−0.01 to 0.11)
Most affluent	5.2 (5.2 to 5.3)	4.5 (4.5 to 4.6)	−1.3 (−1.5 to −1.0)	−21.8	Ref	−0.12 (−0.14 to −0.10)	2006	−0.01 (−0.02 to −0.00)
Most deprived	5.3 (5.2 to 5.4)	4.5 (4.4 to 4.5)	−1.0 (−1.3 to −0.7)	−17.7	0.396	−0.13 (−0.15 to −0.11)	2007	0.01 (−0.00 to 0.02)
White	5.4 (5.3 to 5.4)	4.5 (4.5 to 4.6)	−1.2 (−1.4 to −1.0)	−20.6	Ref	−0.13 (−0.14 to −0.12)	2006	−0.00 (−0.00 to 0.00)
South Asian	5.3 (5.0 to 5.6)	4.2 (4.1 to 4.4)	−0.6 (−8.2 to 7.0)	−12.9	0.166	−0.15 (−0.22 to −0.07)	2005	−0.00 (−0.02 to 0.02)
Black	5.4 (4.8 to 6.0)	4.4 (4.3 to 4.5)	−0.0(−0.3 to 0.4)	0.1	0.239	−0.12 (−2.00 to −0.04)	2008	0.12 (−0.02 to 0.05)
Estimated glomerular filtration rate in mL/(min·1.73 m^2)								
Male	65.3 (64.9 to 65.6)	62.7 (62.4 to 63.1)	−5.2 (−6.5 to −3.9)	−7.6	Ref	−1.39 (−1.53 to −1.25)	2004	0.44 (0.39 to 0.50)
Female	64.1 (63.8 to 64.4)	61.9 (61.5 to 62.3)	−4.6 (−5.9 to −3.3)	−6.8	<0.0001	−1.64 (−1.78 to −1.5)	2005	0.48 (0.42 to 0.54)
Most affluent	64.1 (63.6 to 64.7)	63.0 (62.5 to 63.5)	−4.3 (−6.4 to −2.2)	−6.3	Ref	−1.59 (−1.82 to −1.35)	2004	0.45 (0.37 to 0.54)
Most deprived	65.1 (64.6 to 65.6)	62.0 (61.4 to 62.6)	−5.3 (−7.5 to −3.1)	−7.9	0.007	−1.53 (−1.76 to −1.31)	2005	0.48 (0.37 to 0.58)
White	64.5 (64.3 to 64.8)	62.6 (62.3 to 62.8)	−4.5 (−5.3 to −3.7)	−6.6	Ref	−1.45 (−1.55 to −1.34)	2005	0.48 (0.44 to 0.52)
South Asian	61.8 (58.3 to 65.2)	59.8 (58.2 to 61.4)	−14.8 (−31.3 to 1.6)	−20.4	0.069	−0.03 (−0.24 to 0.18)	N/A	−0.03 (−0.24 to 0.18)
Black	64.1 (60.7 to 67.5)	64.0 (61.7 to 66.4)	5.2 (−8.8 to 19.2)	8.5	0.029	−3.29 (−7.58 to 1.00)	2002	0.45 (0.09 to 0.81)

All risk factors are reported in units of measurement for continuous variables, for example, age, number of comorbidities, and in percentages for binary variables, for example, smoking. With the exception of age, all risk factors are estimated at the mean population age (78 y). *P* values for interactions were estimated by fitting an interaction term between calendar year (as a continuous variable) and group in regression models for each risk factor also containing age. Slope changes are mean change per year. N/A indicates non applicable, no change in slope.

compared with a much slower growth in the white group (+2 months pa to 2005 then +1 month pa thereafter), such that between 1998 to 2002 and 2013 to 2017, the gap between the groups narrowed from 9 years to 5 years (Table 3). The age gap between the black and white groups widened from 7 to 10 years during the

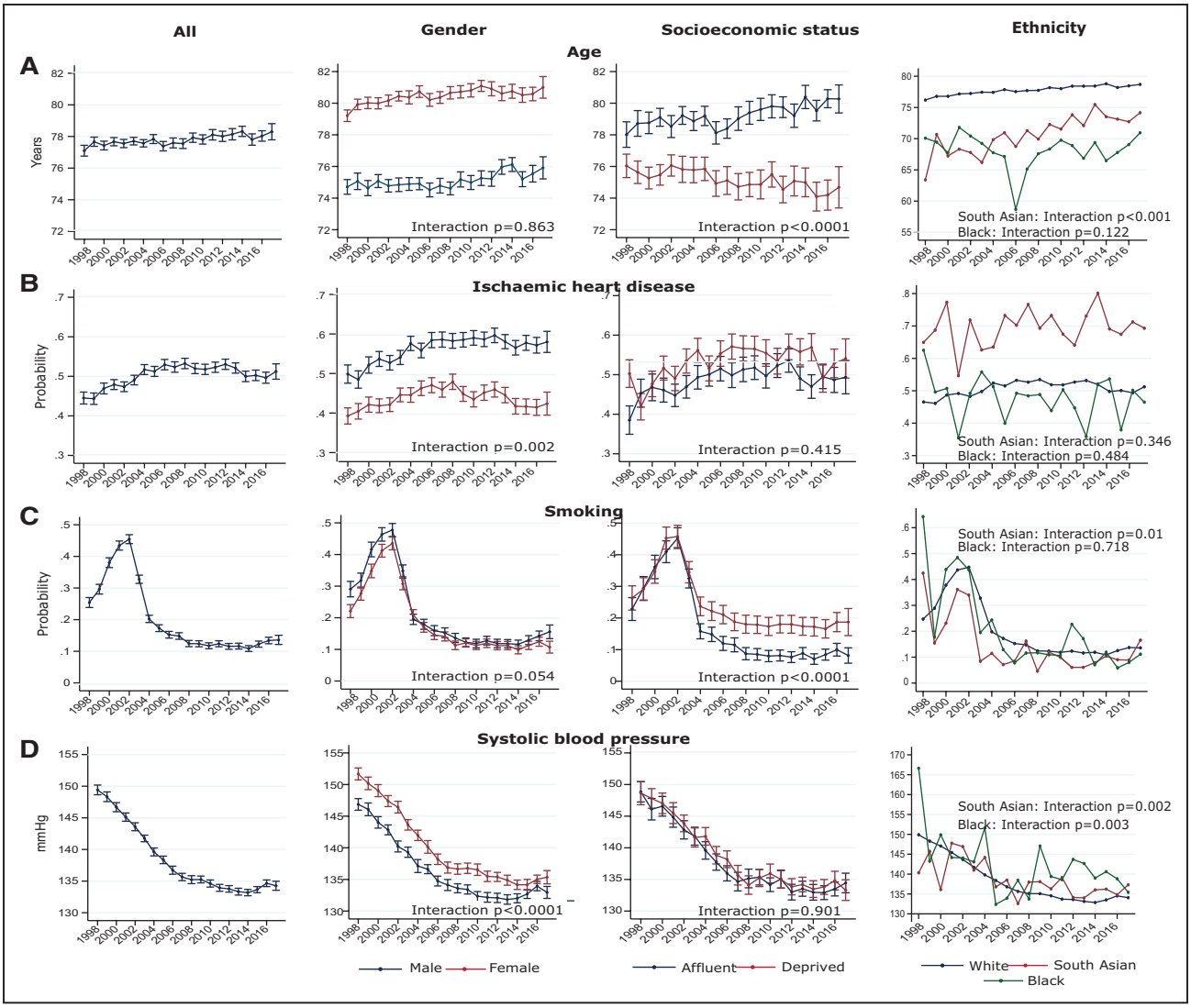

Figure 1. Known risk factors in patients with new heart failure; trends over 20 years by groups.
Estimated risk factors in people with new heart failure, by calendar year of HF diagnosis between 1998 and 2017. With the exception of age, all estimates were calculated at the mean population age (78 y). Spikes indicate 95% CI. Ethnicity graphs are on a different scale and spikes are not reported due to wide CIs. *P* values are to test the difference in trend lines between population groups (labeled interaction *P*). For the ethnicity trends, *P* values compare South Asian and black ethnicity groups with the white group. **A**, Mean age in years (*y* axis); calendar year of heart failure diagnosis (*x* axis). **B**, Proportion of new heart failure patients with ischemic heart disease (*y* axis); calendar year of heart failure diagnosis (*x* axis). **C**, Proportion of new heart failure patients who are current smokers (*y* axis); calendar year of heart failure diagnosis (*x* axis). **D**, Mean systolic blood pressure in mm Hg (*y* axis); calendar year of heart failure diagnosis (*x* axis).

same time period. All groups experienced reducing smoking rates until 2006, but rates began to increase in the white group after 2009 (0.2% [95% CI, 0.1–0.4 pa]) and in the South Asian group after 2011 (1.2% [95% CI, 0.1–2.3 pa]; Figure 1C).

Overall group differences were similar when analyses were restricted to the hospital diagnosed HF group (Table V in the Data Supplement).

DISCUSSION

This study includes a large nationally representative sample of adult patients with new HF over a 20-year time period from 1998 to 2017. The findings indicate an important change in HF demography, with HF occurring at an older age but with less traditional cardiovascular risk factors such as alcohol, smoking, blood pressure, and cholesterol and more cardiovascular and noncardiovascular comorbidities. However, there were significant differences between groups of patients with HF, and although some of these differences have reduced over time, others have persisted or increased, indicating key targets for contemporary tailored prevention programs.

Although previous studies have reported an increasing trend in ischemic cause over time,[7] detailed trend analysis in this study shows that there has been a shift to stable or decreasing proportions of HF patients with IHD over the past 10 years. The prevalence of diabetes

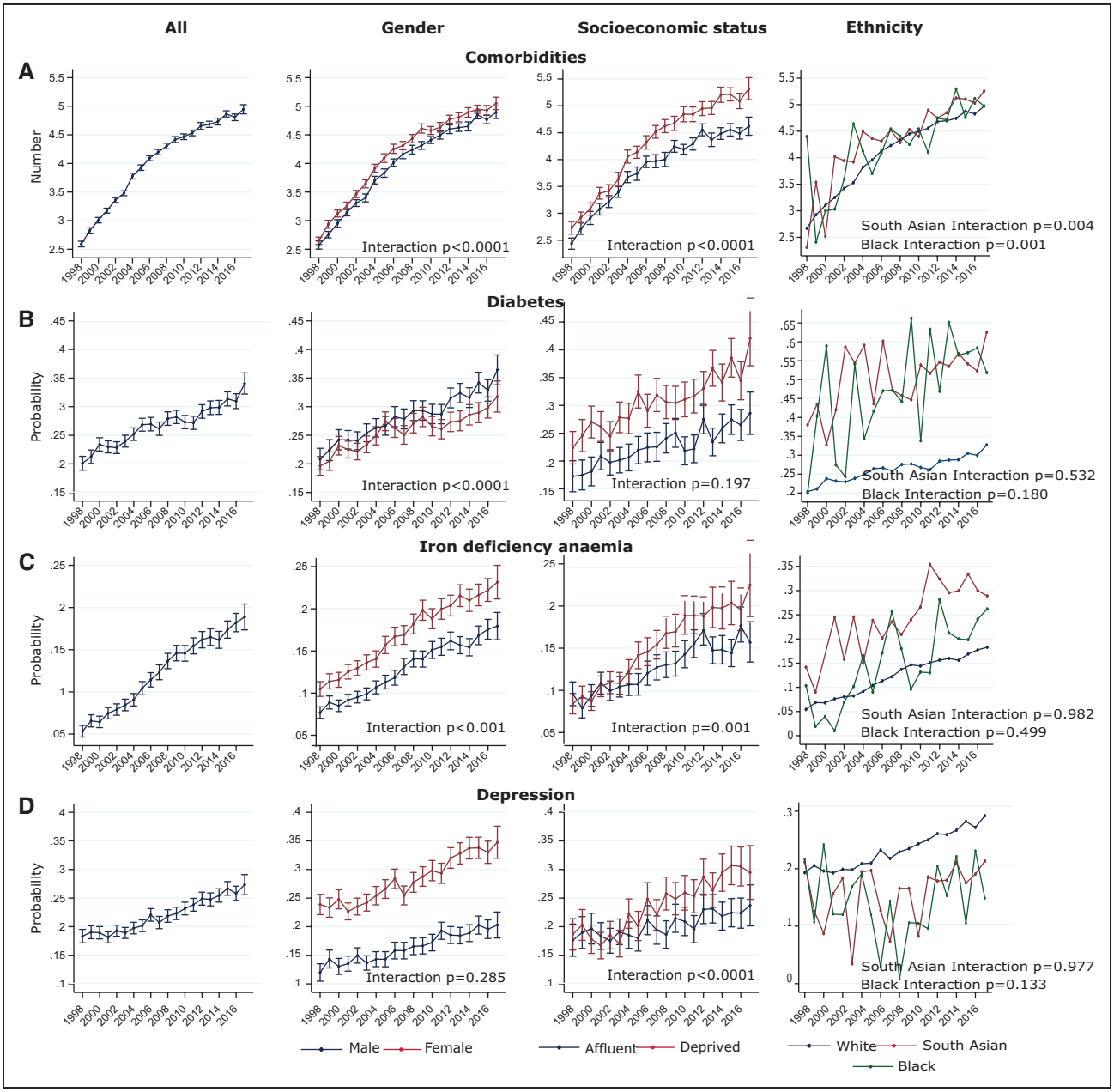

Figure 2. Comorbidities in patients with new heart failure; trends over 20 years by groups.
Estimated comorbidity prevalence in people with new heart failure, by calendar year of HF diagnosis between 1998 and 2017. Prevalence figures are estimated at the mean population age (78 y). Spikes indicate 95% CI. Ethnicity graphs are on a different scale, and spikes are not reported due to wide confidence intervals. *P* values are to test the difference in trend lines between population groups (labeled interaction *P*). For the ethnicity trends, *P* values compare South Asian and black ethnicity groups with the white group. **A**, Mean number of comorbidities present at new heart failure diagnosis (*y* axis); calendar year of heart failure diagnosis (*x* axis). **B**, Proportion of new heart failure patients with diabetes mellitus (*y* axis); calendar year of heart failure diagnosis (*x* axis). **C**, Proportion of new heart failure patients with iron deficiency anemia (*y* axis); calendar year of heart failure diagnosis (*x* axis). **D**, Proportion of new heart failure patients with depression (*y* axis); calendar year of heart failure diagnosis (*x* axis).

mellitus, obesity, hypertension, chronic kidney disease, and cancer comorbidities at HF onset are increasing, and these factors may be associated with the increasing prevalence of HF with preserved ejection fraction.[17] Diabetes mellitus and obesity are forecast to double over the next decade, and an increasing number of cancer survivors treated with cardiotoxic cancer treatments also means that HF figures, especially HF with preserved ejection fraction, may rise.[18] Also although the success of antismoking strategies has shown significant reduction in current smokers among new HF patients, our analyses indicated a worrying shift with increasing proportions in the most recent years, particularly in men and ethnic minority groups.

Although remaining stable in men, IHD has been significantly reducing in women since 2008, alongside increasing rates of hypertension, obesity, and anemia, all of which are associated with HF with preserved ejection fraction.[6,15] This sex difference is likely to increase due to the older age and faster increasing comorbidity rate in women at HF onset. This is important because the sex dimorphism in HF is not yet recognized in HF clinical guidelines.[19] The complex comorbid profile of women with HF with increasing hypertension and obesity may partly explain the higher proportion of women diagnosed first in hospital, compared with men, and highlights an emerging trend for primary prevention that will require novel approaches to improve prognosis and health.

Men were around 5 years younger than women at the time of HF diagnosis. Sex differences relating to the earlier onset of cardiovascular disease in men have been extensively debated but remain not fully understood.[20,21] Although this sex difference persisted over time, some improvements for men are evident over the past 10 years, a likely result of improved primary coronary interventions over this period.[22] Men also differed to women in having higher prevalence of diabetes mellitus, with a faster increasing trend over the past 5 years. Increased prevalence of diabetes mellitus is likely associated with the increased prevalence of ischemic-related HF in men and indicates a high-risk group. HF and diabetes mellitus combination is known to increase risk of hospital admissions and cardiovascular deaths[23,24] and may provide a target for early intervention with novel pharmacotherapies, such as SGLT2 (sodium-glucose cotransporter 2) inhibitors.[25]

It is known that higher levels of deprivation are associated with developing HF at a younger age and with more comorbidities.[26] It could be argued that the presence of prior morbidities may lead to closer monitoring and earlier diagnosis of less severe HF in this group. However, the worse outcomes and younger age at death in the most deprived group[27] suggests the contrary, that HF is more severe at onset, a likely result of the worse cardiovascular profile in this group. Worryingly, our study shows a widening socioeconomic gradient in age at onset, risk factor prevalence, and comorbidities over the past 10 years. This finding with prior evidence on increased noncardiovascular admissions and mortality in the deprived,[4] points to an urgent need for early targeted intervention for patients with HF with high levels of deprivation who require more holistic care.[28] Beyond the public health implications for preventive efforts, the disparities by socioeconomic status, and their changes over time, may importantly impact global HF trial efforts to recruit a homogeneous study population.

Overall, although the South Asian and black groups were significantly younger at HF onset than the white group, they had similar or better cardiovascular risk profiles, similar to those previously reported in a younger UK general population.[29] Risk factors generally improved over time for all groups, but we found important recent trend shifts of accelerating BMI growth in white and black groups and increasing smoking rates in the South Asian group. The earlier onset of HF in ethnic minority groups likely reflects higher coprevalence of cardiovascular premorbidities, including hypertension, diabetes mellitus and obesity, and higher levels of deprivation, compared with the white group. These ethnic differences in the United Kingdom have persisted over 2 decades and are similar to previous findings in African and white American populations.[6,30,31] In terms of cause, ischemia predominated in the South Asian group and hypertension in the black group. Although both ethnic minority groups share diabetes mellitus as a likely HF precipitator, it is postulated that the etiological differences between the groups results from differing lipid profiles.[32] Better lipid profiles in the black group means that hypertension rather than atherosclerosis is the likely mediator between diabetes mellitus and HF,[8] leading to a higher proportion of hypertension-related HF with preserved ejection fraction.[33] Despite higher levels of hypertension in both ethnic minority groups, prevalence of atrial fibrillation was lower than in the white group, a finding share with prior reports.[34] These findings are crucially important given the global challenge and epidemic of noncommunicable diseases in America, Asia, and Africa and indicate that HF prevention and treatment are going to have to be tailored to individual risk profiles.

Our national population-based study is the largest to date to report trend differences in the cause and risk factors for HF over 20 years. We included all available patients with HF presenting in primary care or hospital and used age-adjusted measures of baseline risk factors to produce comparable and representative proportions across twenty years of incident HF. Although it was beyond the scope of this study to investigate outcomes in different HF groups, this has been separately explored in the patients that were eligible for linkage to death data.[27] This is an observational study, so clinical measurements were based on routine data collection, which can be subject to misclassification and measurement error. However, clinical recording in the United Kingdom is supported by performance incentives, including the use of echocardiography for HF,[35] and accuracy of diagnosis within the CPRD has been found to be valid for a range of morbidities.[10] We also used clinically validated code sets which have high precision including for HF[11] and identified comorbidities using both primary care and hospital codes. However, we cannot rule out that changes in the completeness of coding over time may have influenced prevalence figures. That said, it is less plausible that this would preferentially impact patients of certain subgroups and so is unlikely to affect trend differences. HF phenotyping in terms of ejection fraction status or HF severity was not possible in CPRD or HES, so the study does not provide these estimates but instead provides the real-world context for the general HF population. Although recording of

ethnicity status has been a mandatory requirement since 1991, the number of South Asian and black patients were lower than expected from national UK census data.[14] This study provides the window into ethnic differences, but future HF studies are required in international settings, such as Asian-HF,[36] to investigate the HF life course and how prevention and management might differ for tailored patient or population interventions.

CONCLUSIONS

Distinct trend differences exist between HF population groups over the past 20 years, with persisting or increasing sex, socioeconomic, and ethnic differences. This study represents an epidemiological investigation in a developed country but has implications that relate to the global health agenda for developed and developing countries. Contemporary tailored HF prevention programs are required to address differences and to target the worse off groups to abate the alarming projected increase in HF burden and costs over the next 2 decades.

ARTICLE INFORMATION

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