**SUPPLEMENTARY MATERIAL**

**Health inequalities in heart failure; national trends in outcomes by place of diagnosis, gender and socioeconomic status: 1998-2017**

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# Supplementary Figures

## S1 Flow chart of the patient selection process

CPRD acceptable incident HF population aged ≥30 years

**142,682**

**252,584**

HES HF patients ≥ 30 years with a primary ICD code for HF

**60,279**

Incident HF cohort (CPRD and HES combined) ≥30 years

**202,961**

CPRD patients not eligible for linkage to HES

**65,772 (32%)**

CPRD HF acceptable patients linked to HES

**137,189**

Exclude if first HF code (HES or CPRD) prior to 1/1/98 or after 31/7/17

**12,240 (8.9%)**

Incident HF cohort between 1/1/98 and 31/7/17

**124,949**

Exclude if clinical data not plausible in relation to date of death or death not recorded in ONS

**709 (0.6%)**

Plausible data

**124,240**

Exclude if less than 1 year of UTS registration before the HF index date

**35,824 (29%)**

At least 1 year up-to-standard records before HF index date **88,416**

**Location of Care: 88,416**

* Community 52,001
* Hospital 36,415

**Patients with socioeconomic data:** **88,262**

* IMD 1: 16,481
* IMD 2: 20,468
* IMD 3: 18,910
* IMD 4:17,542
* IMD 5: 14,861

**Gender: 88,416**

* Male 44,955
* Female 43,461

S2 Proportion of HF patients diagnosed in the community or hospital by calendar year



## S3 Predicted overall survival by population group

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## Age-standardised survival curves plotted against time in years following HF diagnosi

## S4 Cumulative incidence of death by cause and population group



Cumulative incidence curves predicted at mean population age (78 years).

# Supplementary Tables

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| S1 Heart failure selection CPRD code set |
| Medcode | Read code | Read term |
| 2062 | G58..00 | Heart failure |
| 1223 | G58..11 | Cardiac failure |
| 398 | G580.00 | Congestive heart failure |
| 2906 | G580.11 | Congestive cardiac failure |
| 10079 | G580.12 | Right heart failure |
| 10154 | G580.13 | Right ventricular failure |
| 9524 | G580.14 | Biventricular failure |
| 23707 | G580000 | Acute congestive heart failure |
| 32671 | G580100 | Chronic congestive heart failure |
| 27884 | G580200 | Decompensated cardiac failure |
| 11424 | G580300 | Compensated cardiac failure |
| 94870 | G580400 | Congestive heart failure due to valvular disease |
| 884 | G581.00 | Left ventricular failure |
| 23481 | G581.11 | Asthma - cardiac |
| 43618 | G581.12 | Pulmonary oedema - acute |
| 5942 | G581.13 | Impaired left ventricular function |
| 5255 | G581000 | Acute left ventricular failure |
| 27964 | G582.00 | Acute heart failure |
| 101138 | G583.00 | Heart failure with normal ejection fraction |
| 101137 | G583.11 | HFNEF - heart failure with normal ejection fraction |
| 106897 | G583.12 | Heart failure with preserved ejection fraction |
| 104275 | G584.00 | Right ventricular failure |
| 4024 | G58z.00 | Heart failure NOS |
| 12590 | G58z.11 | Weak heart |
| 17278 | G58z.12 | Cardiac failure NOS |
| 9913 | 1O1..00 | Heart failure confirmed |
| 22262 | G1yz100 | Rheumatic left ventricular failure |
| 21837 | G232.00 | Hypertensive heart&renal dis wth (congestive) heart failure |

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| S2 Heart failure selection ICD code set |
| ICD-10 Code | ICD-10 term |
| I50        | Heart failure |
| 150.0 | Congestive heart failure |
| I50.1     | Left ventricular failure |
| I50.9     | Heart failure, unspecified |
| I11.0  | Hypertensive heart disease with (congestive) heart failure |
| I13.2 | Hypertensive heart and renal disease with both (congestive) heart failure and renal failure |
| I13.0 | Hypertensive heart and renal disease with (congestive) heart failure |

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| S3 Missing data |
| Characteristics | Missing (%) |
| Age  | - |
| Gender | - |
| Socioeconomic status | 0.2 |
| Prescribed drugs | 17.5 |
| Comorbidities | - |
| Smoking | 5.9 |
| Alcohol | 14.1 |
| BMI (kg/m2) | 14.7 |
| Systolic BP (mm/Hg) | 2.6 |
| Cholesterol (mmol/L) | 32.9 |
| Haemoglobin (g/dL) | 24.7 |
| eGFR (ml/min/m2) | 23.3 |
| BMI, body mass index; BP, blood pressure; eGFR, estimated glomerular filtration rate |

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| S4 Predicted rates of admissions during the second and subsequent years following HF diagnosis by population groups and calendar year  |
|  | Predicted rateper 100 person-years (95% CI) | Relative diff. (%)a | PInteractionb | Average annual percent change per year (95% CI)c | Slope change: annual percent change before and after trend change (95% CI)d |
|  | 1998-2001 | 2012-2015 |  |  |  | Before | Break | After |
| All | 81.6 (79.7, 83.5) | 82.9 (80.8, 85.0) | 2 |  | 0.2 (-0.6, 0.9) | 0.2 (-0.6, 0.9) | N/A | 0.2 (-0.6, 0.9) |
| <70 years | 69.2 (65.9, 72.5) | 53.3 (50.7, 56.0) | -23 |  | -1.5 (-2.8, -0.1) |  |  |  |
| 70 to 79 years | 77.8 (74.9, 80.8) | 76.4 (72.9, 79.9) | -2 | <0·0001 | -0.3 (-1.2, 0.5) | 2.1 (0.9, 3.3) | 2007 | -3.0 (-4.4, -1.5) |
| 80 to 89 years | 85.7 (82.1, 89.3) | 99.4 (95.3, 103.5) | 16 | <0·0001 | 1.1 (0.1, 2.1) | 3.8 (2.3, 5.3) | 2007 | -1.9 (-3.3, -0.4) |
| 90 years and over | 82.1 (74.3, 89.9) | 121.7 (111.8, 131.6) | 48 | <0·0001 | 3.2 (1.6, 4.7) | 6.3 (3.3, 9.4) | 2006 | 0.4 (-1.3, 2.3) |
| Men  | 88.3 (85.3, 91.3) | 81.0 (78.2, 83.7) | -8 |  | -0.4 (-1.1, 0.3 | -0.4 (-1.1, 0.3 | N/A | -0.4 (-1.1, 0.3 |
| Women | 75.8 (73.4, 78.3) | 85.3 (82.2, 88.4) | 13 | <0·0001 | 0.7 (-0.8, 2.1) | 0.7 (-0.8, 2.1) | N/A | 0.7 (-0.8, 2.1) |
| Most affluent (Q1) | 69.0 (65.0, 73.0) | 69.6 (65.6, 73.5) | 1 |  | 0.2 (-1.3, 1.7) | 3.3 (-0.5, 7.4) | 2004 | -1.5 (-2.9, 0.0) |
| Most deprived (Q2) | 99.0 (93.6, 104.3) | 101.9 (95.6, 108.1) | 3 | 0·113 | 0.4 (-1.1, 1.8) | 0.4 (-1.1, 1.8) | N/A | 0.4 (-1.1, 1.8) |
| Community diagnosis | 72.7 (70.7, 74.6) | 65.9 (63.7, 68.1) | -9 |  | -1.1 (-2.0, -0.2) | 0.5 (-0.3, 1.4) | 2009 | -4.0 (-6.2, -1.8) |
| Hospital diagnosis | 112.0 (106.7, 117.3) | 106.5 (102.6, 110.4) | -5 | 0·262 | -0.1 (-0.9, 0.8) | 3.2 (1.7, 4.8) | 2006 | -2.9 (-4.1, -1.8) |
| **HF admissions** |
| All | 8.8 (8.3, 9.3) | 9.7 (9.1, 10.3) | 10 |  | 0.6 (-0.1, 1.4) | 0.6 (-0.1, 1.4) | N/A | 0.6 (-0.1, 1.4) |
| <70  | 7.7 (6.9, 8.6) | 5.6 (4.9, 6.3) | -27 |  | -2.7 (-3.9, -1.5) | -2.7 (-3.9, -1.5) | N/A | -2.7 (-3.9, -1.5) |
| 70 to 79 | 8.0 (7.3, 8.7) | 9.5 (8.4, 10.5) | 19 | <0·0001 | 0.8 (-0.2, 1.7) | 0.8 (-0.2, 1.7) | N/A | 0.8 (-0.2, 1.7) |
| 80 to 89 | 9.1 (8.2, 10.0) | 12.0 (10.8, 13.1) | 32 | <0·0001 | 1.9 (0.2, 3.5) | 1.9 (0.2, 3.5) | N/A | 1.9 (0.2, 3.5) |
| >90 | 7.2 (5.4, 9.0) | 12.3 (9.8, 14.9) | 71 | <0·0001 | 1.7 (-2.6, 6.1) | 6.0 (3.2, 8.9) | 2012 | -16.3 (-33.8, 5.7) |
| Men  | 10.4 (9.5, 11.2) | 9.9 (9.1, 10.7) | -5 |  | -0.5 (-1.3, 0.3) | -0.5 (-1.3, 0.3) | N/A | -0.5 (-1.3, 0.3) |
| Women | 7.4 (6.9, 8.0) | 9.5 (8.6, 10.3) | 28 | <0·0001 | 1.5 (0.3, 2.7) | 1.5 (0.3, 2.7) | N/A | 1.5 (0.3, 2.7) |
| Most affluent | 6.9 (6.0, 7.9) | 8.8 (7.7, 10.0) | 28 |  | 1.2 (-0.1, 2.5) | 1.2 (-0.1, 2.5) | N/A | 1.2 (-0.1, 2.5) |
| Most deprived | 10.2 (9.0, 11.5) | 11.9 (10.2, 13.6) | 17 | 0·582 | 0.7 (-0.4, 1.7) | 0.7 (-0.4, 1.7) | N/A | 0.7 (-0.4, 1.7) |
| Community diagnosis | 6.4 (6.0, 6.8) | 6.5 (6.0, 7.1) | 2 |  | 0.0 (-1.8, 1.9) | 3.4 (-0.3, 7.3) | 2005 | -2.3 (-4.4, -0.1) |
| Hospital diagnosis | 17.4 (15.6, 19.2) | 14.2 (13.0, 15.4) | -18 | 0·040 | -1.7 (-3.0, -0.4) | -1.7 (-3.0, -0.4) | N/A | -1.7 (-3.0, -0.4) |
| **Other CVD admissions** |
| All | 14.1 (13.6, 14.7) | 11.7 (11.1, 12.2) | -17 |  | -1.3 (-2.2, -0.4) | 0.9 (-0.3, 2.1) | 2007 | -3.8 (-5.4, -2.2) |
| <70  | 12.8 (11.8, 13.7) | 9.6 (8.8, 10.5) | -25 |  | -1.9 (-2.7, -1.0) | -1.9 (-2.7, -1.0) | N/A | -1.9 (-2.7, -1.0) |
| 70 to 79 | 13.8 (13.0, 14.7) | 10.9 (10.0, 11.9) | -21 | 0.150 | -1.2 (-2.7, 0.2) | -1.2 (-2.7, 0.2) | N/A | -1.2 (-2.7, 0.2) |
| 80 to 89 | 14.2 (13.2, 15.2) | 12.4 (11.4, 13.4) | -13 | 0.011 | -1.1 (-2.7, 0.6) | 2.9 (0.6, 5.2) | 2007 | -5.3 (-8.1, -2.5) |
| >90 | 13.6 (11.3, 15.9) | 14.9 (12.5, 17.2) | 10 | <0.0001 | 1.4 (-0.5, 3.2) | 1.4 (-0.5, 3.2) | N/A | 1.4 (-0.5, 3.2) |
| Men  | 15.8 (14.9, 16.7) | 12.0 (11.2, 12.7) | -24 |  | -1.6 (-2.5, -0.8) |  | N/A |  |
| Women | 12.8 (12.1, 13.4) | 11.3 (10.6, 12.1) | -12 | 0.003 | -0.7 (-1.4, 0.0) | 2.3 (1.1, 3.6) | 2006 | -3.3 (-4.4, -2.3) |
| Most affluent | 12.3 (11.2, 13.4) | 9.3 (8.3, 10.3) | -24 |  | -1.8 (-3.3, -0.4) | -1.8 (-3.3, -0.4) | N/A | -1.8 (-3.3, -0.4) |
| Most deprived | 15.7 (14.4, 17.1) | 13.3 (11.7, 14.8) | -15 | 0·151 | -0.8 (-2.1, 0.5) | -0.8 (-2.1, 0.5) | N/A | -0.8 (-2.1, 0.5) |
| Community diagnosis | 12.5 (12.0, 13.1) | 10.4 (9.8, 11.1) | -17 |  | -1.6 (-2.7, -0.4) | -0.2 (-1.1, 0.7) | 2010 | -4.7 (-8.4, -0.8) |
| Hospital diagnosis | 20.0 (18.5, 21.5) | 13.4 (12.5, 14.3) | -33 | <0.0001 | -2.8 (-4.2, -1.3) | 0.0 (-1.7, 1.8) | 2007 | -5.8 (-8.4, -3.1) |
| **Non CVD admissions** |
| All | 58.5 (57.0, 60.0) | 64.0 (62.3, 65.8) | 9 |  | 0.8 (0.1, 1.5) | 3.6 ((2.4, 4.8) | 2006 | -1.6 (-2.5, -0.7) |
| <70  | 48.4 (45.9, 50.9) | 39.7 (37.5, 41.8) | -18 |  | -0.9 (-2.7, 0.9) | -0.9 (-2.7, 0.9) | N/A | -0.9 (-2.7, 0.9) |
| 70 to 79 | 55.6 (53.4, 57.9) | 58.3 (55.4, 61.2) | 5 | <0·0001 | 0.1 (-0.9, 1.2) | 2.8 (1.3, 4.4) | 2007 | -2.8 (-4.6, -1.0) |
| 80 to 89 | 62.3 (59.5, 65.1) | 78.5 (75.0, 82.0) | 26 | <0·0001 | 1.7 (0.7, 2.8) | 4.0 (2.2, 5.7) | 2007 | -0.7, -2.3, 0.9) |
| >90 | 60.7 (54.4, 67.0) | 96.1 (87.7, 104.5) | 58 | <0·0001 | 3.0 (2.0, 4.0) | 3.0 (2.0, 4.0) | N/A | 3.0 (2.0, 4.0) |
| Men  | 62.1 (59.9, 64.4) | 61.7 (59.5, 64.0) | -1 |  | 0.2 (-0.6, 1.0) | 0.2 (-0.6, 1.0) | N/A | 0.2 (-0.6, 1.0) |
| Women | 55.3 (53.4, 57.2) | 66.8 (64.1, 69.4) | 21 | <0·0001 | 1.0 (-0.7, 2.8) | 1.0 (0.7, 2.8) | N/A | 1.0 (0.7, 2.8) |
| Most affluent (Q1) | 49.2 (46.1, 52.2) | 53.8 (50.5, 57.1) | 9 |  | 0.4 (-0.5, 1.3) | 0.4 (-0.5, 1.3) | N/A | 0.4 (-0.5, 1.3) |
| Most deprived (Q5) | 73.5 (69.3, 77.8) | 80.3 (75.0, 85.6) | 9 | 0·200 | 0.8 (-0.9, 2.5) | 0.8 (-0.9, 2.5) | N/A | 0.8 (-0.9, 2.5) |
| Community diagnosis | 53.8 (52.3, 55.4) | 50.8 (49.0, 52.6) | -6 |  | -0.8 (-1.7, 0.1) | 0.7 (-0.2, 1.6) | 2009 | -3.5 (-5.7, -1.2) |
| Hospital diagnosis | 74.2 (70.4, 78.0) | 82.6 (79.3, 85.8) | 11 | <0·0001 | 1.1 (0.2, 2.0) | 5.8 (4.2, 7.5) | 2006 | -2.9 (-4.0, -1.8) |
| Rates were conducted in survivors of the first year. With the exception of age groups, all predictions are at the mean population age (78 years). Follow up was until death or study end. Relative diff., relative difference; py, person-years; CI, confidence interval. a relative percentage difference in admission rates (per 100 person-years) between the first and second diagnosis time periods, calculated by 100\*([time-period 2 – time period 1] / time-period 1].b P value for the difference in trend lines between groups. Estimated by fitting an interaction term between calendar year and group in the negative binomial models also containing age.c Average annual percentage change in rates (per 100 person-years) for each increasing year of diagnosisd Change in slope estimated using Joinpoint regression.  |

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| S5 Age standardised mortality risk by diagnosis time-period and population group at 1, 3 and 5 years following HF diagnosis |
|  | 1-year | 3-year | 5-year |
| Calendar year of diagnosis | 1998-2001 | 2012-2015 | 1998-2001 | 2012-2015 | 1998-2001 | 2012-2015 |
| All | 32 (31,32) | 29 (28,29) | 50 (50,51) | 46 (46,47) | 63 (62,63) | 59 (58,59) |
| <70 years | 14 (14,15) | 12 (12,13) | 25 (24,26) | 22 (22,23) | 35 (34,36) | 31 (30,32) |
| 70 to 79 years | 25 (24,25) | 22 (21,22) | 42 (41,42) | 37 (37,38) | 55 (54,56) | 50 (49,51) |
| 80 to 89 years | 39 (39,40) | 35 (35,36) | 61 (60,62) | 56 (55,57) | 75 (75,76) | 70 (70,71) |
| 90 years and over | 58 (57,58) | 53 (52,53) | 80 (79,81) | 76 (75,76) | 91 (90,91) | 88 (87,88) |
| Men  | 34 (33,34) | 30 (30,31) | 52 (52,53) | 48 (47,49) | 65 (64,66) | 61 (60,61) |
| Women | 30 (30,31) | 27 (27,28) | 48 (48,49) | 44 (43,45) | 61 (60,61) | 56 (56,57) |
| Q1 Most affluent  | 29 (29,30) | 27 (26,27) | 47 (46,48) | 43 (43,44) | 59 (59,60) | 56 (55,57) |
| Q2 | 31 (30,31) | 28 (27,29) | 49 (48,49) | 45 (44,46) | 61 (61,62) | 57 (57,58) |
| Q3 | 32 (31,32) | 29 (28,30) | 50 (49,51) | 46 (45,47) | 63 (62,63) | 59 (58,60) |
| Q4 | 33 (32,33) | 30 (29,31) | 51 (51,52) | 48 (47,48) | 64 (63,65) | 60 (59,61) |
| Q5 Most deprived | 35 (34,36) | 32 (31,33) | 54 (53,55) | 50 (49,51) | 66 (66,67) | 63 (62,64) |
| Community diagnosis | 29 (28,29) | 24 (23,24) | 46 (46,47) | 40 (39,40) | 59 (59,60) | 52 (51,53) |
| Hospital diagnosis | 39 (39,40) | 34 (33,34) | 60 (59,60) | 53 (52,53) | 72 (72,73) | 66 (65,66) |
| Risk is reported as percentages with 95% Confidence intervals. Q; quintile |

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| S6 Complete case analysis: Associations between population groups  |
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|  | **All**  | **CVD** | **Non-CVD** |
| Group | Adjusteda | Adjusteda | Adjusteda |
| **Hospital Admissions (IRR with 95% CI)** |  |  |  |
| <70 years | 1.0 | 1.0 | 1.0 |
| 70 to 79 years | 1.19 (1.15, 1.24) | 1.11 (1.06, 1.17) | 1.23 (1.19, 1.28) |
| 80 to 89 years | 1.48 (1.42, 1.54) | 1.41 (1.34, 1.50) | 1.52 (1.45, 1.58) |
| 90 years and above | 1.79 (1.70, 1.90) | 1.70 (1.57, 1.85) | 1.83 (1.72, 1.94) |
| Male (ref) | 1.0 | 1·0 | 1·0 |
| Female | 0·90 (0·87, 0·92) | 0·86 (0·83, 0·90) | 0·90 (0·88,0·93) |
| Socioeconomic status |  |  |  |
| Q1 Most affluent (ref) | 1·0 | 1·0 | 1·0 |
| Q2 | 1.06 (1.02, 1.10) | 1.08 (1.02, 1.14) | 1.04 (1.00, 1.08) |
| Q3 | 1.06 (1.02, 1.10) | 1.08 (1.02, 1.14) | 1.05 (1.00, 1.09) |
| Q4 | 1.15 (1.10, 1.19) | 1.14 (1.07, 1.21) | 1.15 (1.10, 1.19) |
| Q5 Most deprived | 1·17 (1·12,1·21) | 1·16 (1·10,1·24) | 1·17 (1·11,1·22) |
| Community (ref) | 1·0 | 1.0 | 1.0 |
| Hospital  | 1·54 (1·50, 1·58)  | 1·73 (1·66, 1·80) | 1·45 (1·41, 1·49) |
| **Death (HR with 95% CI)** |
| <70 years |  |  |  |
| 70 to 79 years | 1.56 (1.50, 1.63) | 1.43 (1.36, 1.51) | 1.68 (1.57, 1.79) |
| 80 to 89 years | 2.55 (2.44, 2.66) | 2.37 (2.24, 2.50) | 2.64 (2.46, 2.83) |
| 90 years and above | 4.08 (3.87, 4.30) | 3.72 (3.46, 3.99) | 4.37 (3.98, 4.78) |
| Male (ref) | 1·0 | 1·0 | 1·0 |
| Female | 0·84 (0·82, 0·87) | 0·85 (0·82, 0·88) | 0·84 (0·80,0·88) |
| Socioeconomic status |  |  |  |
| Q1 Most affluent (ref) | 1·0 | 1·0 | 1·0 |
| Q2 | 1.05 (1.02, 1.09) | 1.09 (1.04, 1.14) | 1.01 (0.95, 1.08) |
| Q3 | 1.05 (1.02, 1.09) | 1.11 (1.05, 1.16) | 1.00 (0.94, 1.07) |
| Q4 | 1.11 (1.07, 1.15) | 1.11 (1.06, 1.17) | 1.11 (1.04, 1.18) |
| Q5 Most deprived | 1·13 (1·09, 1·17) | 1·14 (1·08, 1·20) | 1·13 (1·05, 1·20) |
| Community (ref) | 1.0 | 1.0 | 1.0 |
| Hospital  | 1·51 (1·47, 1·55) | 1·61 (1·56, 1·67) | 1·32 (1·26, 1·37) |
| IRR; Incidence rate ratio, CI; Confidence interval, Q; quintilea adjusted for age gender socioeconomic status, ethnicity, place of diagnosis, calendar year, beta-blocker, angiotensin converting enzyme inhibitor, angiotensin receptor blocker; aldosterone antagonist, aspirin, loop diuretic, number of comorbidities, ischaemic heart disease, myocardial infarction, atrial fibrillation, hypertension, diabetes, stroke, anaemia, obesity, chronic kidney disease, chronic obstructive pulmonary disease, asthma, depression, osteoarthritis, cancer and dementia, smoking, alcohol, body mass index, systolic blood pressure, cholesterol, haemoglobin and estimated glomerular filtration rate.  |