(Supplemental Materials)

Study Data Resources from National Health Insurance Research Database (NHIRD) and Validity on Main Study Outcomes

Since 1995, the Taiwanese government started to initiate a single-payer health insurance system, currently known as National Health Insurance (NHI), whichhas a contract with most healthcare facilities in Taiwan[1].(https://www.nhi.gov.tw/English/Content_List.aspx?n=8FC0974BBFEFA56D&topn=ED4A30E51A609E49). According to this health care system, it is mandatory for physicians to upload the claims data from each visit to the National Health Insurance Ministry. As a distinct primary health care system in Taiwan, referrals from general practitioners are not required to seek for specialist care. In this regard, patients have non-emergency health concerns may either visit local private clinics, public clinics or go directly to specialists at hospital outpatient departments. The implementation of NHI provides universal care health coverage, which covers all necessary medical expenditures including outpatient visits, the inpatient system, all relevant prescriptions, all laboratory or investigational studies and operations.Therefore, the National Health Insurance Research Database (NHIRD) of Taiwan therefore contains and collects detailed healthcare data from more than 23 million NHI enrollees, representing more than 99.99% of Taiwan's population[2, 3].

The positive predicted value of HF hospitalization diagnosed based on ICD-9-CM codes in Taiwan NHIRD was 97.6%[3,4]. All-cause mortality was defined as withdrawal of the patient from the NHI program, similar to the definitions of prior studies of Taiwan NHIRD[5, 6]. Since the coverage rate of NHI system was more than 99.99% in Taiwan, almost all mortality events or HF readmissions would be captured within the NHIRD.

Categorization of Income Groups in Current Study

The monthly income of patients was categorized into three groups (low: <20,000; median: 20,000–39,999; and high: ≥40,000 New Taiwan dollar [NTD]) according to income-based insurance premium as published elsewhere[7, 8]. with average minimum monthly wage around 20,000 NTD according to the rule of Taiwan government. Therefore, we defined subjects with the monthly income of < 20,000 NTD as the low-income group, and whose monthly incomes were equal to or higher than 2 folds of the minimum wage as the high-income group (≥40,000 NTD).

Propensity matching analysis

We calculated propensity scores for the likelihood of being in the low-income as compared with the high-incomeby multivariate logistic regression analyses, The areas under the receiver operating characteristic curve (AUCs) of the logistic regression models were 0.874 (95% CI 0.853 - 0.896) and 0.885 (95% CI 0.869 - 0.901) for“low income versus high income” and “median income versus high income”, respectively. Subsequently, we matched patients in the high-income group to those in the low-income group with a 1:1 ratio on the basis of the closest propensity score for being in the low income within a threshold of ±0.01 using the greedy algorithm. If more than one patient in the high-income group could be matched to the corresponding subject in the low-income group, one patient from the high-income group was selected randomly without repeat sampling. A similar matching process was performed for the comparison of median-income versus high-income based on the propensity scores for being in the median-income.

Inverse probability of treatment weighting (IPTW)

The details about the methodology of IPTW have been published[9]. The inverse probability of treatment weights of propensity scores was used tobalance covariates across the 3 income groups[10]. Inverse probability of low- and median-income groups was weighted to the high-income group. We did not weight the high-income group and the weight for all patients in the high-income group is (nominally) one. We created pseudo groups forlow- and median-income groups that had a similar distribution as high-income groups by giving weight less than one.Generalized boosted models (GBMs) based on 5,000 regression trees were used to calculate weights for optimal balance among the three groups[11]. The advantages of GBM include: (1) extension to multiple groups; and (2) giving the best performance in variedscenarios and varied weight trimming percentiles (from 50 to 100)[12]. All covariates in Table 1 were included in the GBM of thepropensity scores. The balance of potential confounders at baseline between each group was assessed by using the absolute standardized mean difference (ASMD). ASMD $\leq$0.1 indicates a nonsignificant difference in baseline covariates between two study groups[10].

Subgroup Analysis on Main HF Outcomes

Subgroups analyses showed that differential prognostic implications (HF readmission alone and composite all-cause mortality/HF readmission) among income strata, (middle- and low-income groups vs. high-income group) were more pronounced in younger patients (<65 years vs. 65–75, ≥75 years), female patients, those with less cardiac and non-cardiac comorbidities, and those not receiving HF-related medications (all $p_{interaction}$: <0.001) **(Supplemental Figure 3)**.

References

1. Liang-Yu Lin, Charlotte Warren-Gash, Liam Smeeth, Pau-Chung Chen. Data Resource Profile: The National Health Insurance Research Database (NHIRD). Epidemiol Health. 2018;40:e2018062. doi: 10.4178/epih.e2018062. Epub 2018 Dec 27.

2. Chen YC, Yeh HY, Wu JC, Haschler I, Chen TJ, Wetter T. Taiwan's National Health Insurance Research Database: administrative health care database as study object in bibliometrics. Scientometrics2011;86:365-380.

3. Hsieh CY, Su CC, Shao SC, et al. Taiwan's National Health Insurance Research Database: past and future. Clin Epidemiol 2019;11:349-358. doi: 10.2147/CLEP.S196293.

4. Yu-Sheng Lin, Tien-Hsing Chen, Ching-Chi Chi, Ming-Shyan Lin, Tao-Hsin Tung, Chi-Hung Liu, Yung-Lung Chen, Mien-Cheng Chen. Different Implications of Heart Failure, Ischemic Stroke, and Mortality Between Nonvalvular Atrial Fibrillation and Atrial Flutter-a View From a National Cohort Study. J Am Heart Assoc. 2017 Jul 21;6(7):e006406.doi: 10.1161/JAHA.117.006406.

5. Chun-Ying Wu 1, Yi-Ju Chen, Hsiu J Ho, Yao-Chun Hsu, Ken N Kuo, Ming-Shiang Wu,Jaw-Town Lin. Association Between Nucleoside Analogues and Risk of Hepatitis B virus–related Hepatocellular Carcinoma Recurrence Following Liver Resection. JAMA.2012 Nov 14;308(18):1906-14. doi: 10.1001/2012.jama.11975.

6. hien-Yi Yang, Chi-Hua Chen, Shin-Tarng Deng, Chi-Shan Huang, Yu-Jr Lin, Yi-Ju Chen, Chun-Ying Wu, Shuen-Iu Hung, Wen-Hung Chung. Allopurinol Use and Risk of Fatal Hypersensitivity Reactions:

A Nationwide Population-Based Study in Taiwan. JAMAIntern Med. 2015 Sep;175(9):1550-7. doi: 10.1001/jamainternmed.2015.3536.

7. Tze-Fan Chao, Chia-Jen Liu, Ta-Chuan Tuan, Su-Jung Chen, Kang-Ling Wang, Yenn-Jiang Lin, Shih-Lin Chang, Li-Wei Lo, Yu-Feng Hu, Tzeng-Ji Chen, Chern-En Chiang, Shih-Ann Chen. Rate-Control Treatment and Mortality in Atrial Fibrillation. Circulation.2015 Oct 27;132(17): 1604-12. doi: 10.1161/CIRCULATIONAHA.114.013709.Epub 2015 Sep 17.

8. Hsuan-Te Chu, Chih-Chieh Tseng, Chih-Sung Liang, Ta-Chuan Yeh, Li-Yu Hu, Albert C Yang, Shih-Jen Tsai, Cheng-Che Shen. Risk of Depressive Disorders Following MyastheniaGravis: A Nationwide Population-Based Retrospective Cohort Study. Front Psychiatry. 2019 Jul 9;10:481. doi: 10.3389/fpsyt.2019.00481. eCollection 2019.

9. Yi-Hsin Chan, Hsin-Fu Lee, Lai-Chu See, Hui-Tzu Tu, Tze-Fan Chao, Yung-Hsin Yeh, Lung-Sheng Wu, Chi-Tai Kuo, Shang-Hung Chang, Gregory Y H Lip. Effectiveness and Safety of Four Direct Oral Anticoagulants in Asian Patients With Nonvalvular Atrial Fibrillation. Chest. 2019 Sep;156(3):529-543. doi: 10.1016/j.chest.2019.04.108. Epub 2019 May 16.

10. Peter C Austin. The Use of Propensity Score Methods With Survival or Time-To-Event Outcomes: Reporting Measures of Effect Similar to Those Used in Randomized Experiments. Stat Med. 2014 Mar 30;33(7):1242-58. doi: 10.1002/sim.5984. Epub 2013 Sep 30.

11. Daniel F McCaffrey, Beth Ann Griffin, Daniel Almirall, Mary Ellen Slaughter, Rajeev Ramchand, Lane F Burgette. A Tutorial on Propensity Score Estimation for Multiple Treatments Using

Generalized Boosted Models. Stat Med. 2013 Aug 30;32(19):3388-414. doi: 10.1002/sim.5753. Epub 2013 Mar 18.

12. Brian K Lee, Justin Lessler, Elizabeth A Stuart. Weight Trimming and Propensity Score Weighting. PLoS One. 2011 Mar 31;6(3):e18174. doi: 10.1371/journal.pone.0018174.

Supplemental Table 1.Temporal trend of heart failure (HF) medicationsstratified by three income groups

Year (major time intervals)	1996-2001	2002-2007	2008-2013	*P (trend)*
HF medications use	**OR (95% Confidence Interval)**	**OR (95% Confidence Interval)**	**OR (95% Confidence Interval)**	
ACEi/ARB				
Low-income	*(Reference)*	*(Reference)*	*(Reference)*	
Median-income	**1.44 (1.39-1.49)**	**1.48 (1.45-1.51)**	**1.09 (1.07-1.11)**	**<0.001**
High-income	**1.63 (1.53-1.74)**	**1.56 (1.50-1.62)**	**1.23 (1.19-1.27)**	**<0.001**
BB				
Low-income	*(Reference)*	*(Reference)*	*(Reference)*	
Median-income	**1.22 (1.17-1.26)**	**1.09 (1.07-1.12)**	**0.94 (0.92-0.96)**	**<0.001**
High-income	**1.47 (1.38-1.56)**	**1.30 (1.25-1.35)**	**1.16 (1.12-1.20)**	**<0.001**
MRA				
Low-income	*(Reference)*	*(Reference)*	*(Reference)*	
Median-income	**1.13 (1.11-1.16)**	**1.03 (1.01-1.05)**	**1.00 (0.98-1.02)**	**<0.001**
High-income	**1.23 (1.18-1.28)**	**1.10 (1.05-1.15)**	**1.06 (1.02-1.11)**	**<0.001**
Amiodarone				
Low-income	*(Reference)*	*(Reference)*	*(Reference)*	
Median-income	**1.20 (1.12-1.28)**	**0.98 (0.96-1.00)**	**0.99 (0.96-1.02)**	**<0.001**
High-income	**1.52 (1.34-1.71)**	**1.13 (1.09-1.19)**	**1.08 (1.03-1.14)**	**<0.001**
DD				
Low-income	*(Reference)*	*(Reference)*	*(Reference)*	
Median-income	**0.88 (0.86-0.90)**	**0.89 (0.87-0.91)**	**0.95 (0.93-0.96)**	**<0.001**
High-income	**0.82 (0.79-0.86)**	**0.83 (0.80-0.87)**	**0.89 (0.86-0.91)**	**<0.001**
Digoxin				
Low-income	*(Reference)*	*(Reference)*	*(Reference)*	
Median-income	**0.83 (0.81-0.85)**	**0.85 (0.84-0.88)**	**1.03 (1.00-1.05)**	**<0.001**
High-income	**0.86 (0.83-0.90)**	**0.84 (0.80-0.88)**	**0.97 (0.93-1.02)**	**<0.001**

Models adjusted for age, gender, medical history and comorbidity burden in terms of Charlson comorbidity index (CCI).

Supplemental Table 2.Baseline characteristics of patients with HF after propensity matching

Variables	Low-income (n =36,924)	High-income (n =36,924)	P value	Median-income (n =40,733)	High-income (n =40,733)	P value
Age, years; mean value (SD)	59.49 (13.95)	59.87 (12.45)	< 0.001	58.85 (13.28)	58.97 (12.51)	0.205
Age ≥ 75 years, n (%)	4130 (11.2)	4405 (11.9)	0.007	4134 (10.1)	4405 (10.8)	< 0.001
Age 65–74 years, n (%)	8860 (24)	8764 (23.7)		9231 (22.7)	8793 (21.6)	
Age <65 years, n (%)	23934 (64.8)	23755 (64.3)		27368 (67.2)	27535 (67.6)	
Male gender, *n* (%)	27742 (75.1)	28041 (75.9)	0.01	31288 (76.8)	31824 (78.1)	< 0.001
Charlson Comorbidity Index (SD)	6.23 (3.02)	6.19 (3.09)	0.054	6.19 (2.98)	6.13 (3.07)	0.006
Comorbidities, *n* (%)						
Hypertension	26998 (73.1)	27214 (73.7)	0.072	30309 (74.4)	30371 (74.6)	0.618
Diabetes mellitus	16014 (43.4)	15854 (42.9)	0.235	17549 (43.1)	17430 (42.8)	0.4
Previous stroke/TIA	8261 (22.4)	8240 (22.3)	0.853	8881 (21.8)	8808 (21.6)	0.535
Vascular diseases	21146 (57.3)	21399 (58)	0.06	23867 (58.6)	23984 (58.9)	0.405
ESRD	5766 (15.6)	5679 (15.4)	0.376	6398 (15.7)	6216 (15.3)	0.078
COPD	10572 (28.6)	10588 (28.7)	0.896	11423 (28)	11255 (27.6)	0.189
Malignancy	5757 (15.6)	5669 (15.4)	0.371	6302 (15.5)	6113 (15)	0.065
Autoimmune diseases	2272 (6.2)	2287 (6.2)	0.819	2536 (6.2)	2484 (6.1)	0.449
Liver cirrhosis	1859 (5)	1815 (4.9)	0.456	1989 (4.9)	1892 (4.6)	0.111
Dyslipidemia	15064 (40.8)	15246 (41.3)	0.173	17782 (43.7)	17907 (44)	0.377
CKD	8767 (23.7)	8561 (23.2)	0.074	9684 (23.8)	9422 (23.1)	0.03
MVD	2353 (6.4)	2401 (6.5)	0.472	2690 (6.6)	2659 (6.5)	0.661
Anemia	7488 (20.3)	7210 (19.5)	0.01	7964 (19.6)	7669 (18.8)	0.009
Valvular heart surgery	545 (1.5)	565 (1.5)	0.545	690 (1.7)	696 (1.7)	0.871
CABG	1399 (3.8)	1432 (3.9)	0.527	1628 (4)	1653 (4.1)	0.656
AF	6389 (17.3)	6584 (17.8)	0.059	7329 (18)	7395 (18.2)	0.548
Degree of urbanization, n (%)			0.398			< 0.001
Urban	25801 (69.9)	24829 (67.2)		29351 (72.1)	28132 (69.1)	

Suburban	8668 (24.3)	10781 (29.2)		9648 (23.7)	11273 (27.7)	
Rural	2155 (5.8)	1314 (3.6)		1734 (4.3)	1328 (3.3)	
Medications, n (%)						
ACEIs	5466 (14.8)	5538 (15)	0.457	6123 (15)	6180 (15.2)	0.577
ARBs	8702 (23.6)	8890 (24.1)	0.104	10622 (26.1)	10700 (26.3)	0.534
Amiodarone	3796 (10.3)	3915 (10.6)	0.152	4494 (11)	4571 (11.2)	0.391
Digoxin	8694 (23.5)	8680 (23.5)	0.903	9343 (22.9)	9459 (23.2)	0.335
Beta-blockers	12599 (34.1)	12902 (34.9)	0.019	15128 (37.1)	15240 (37.4)	0.417
Diuretics*	18006 (48.8)	18006 (48.8)	1	19544 (48)	19551 (48)	0.961
MRA#	7160 (19.4)	7114 (19.3)	0.668	8234 (20.2)	8247 (20.2)	0.91
Mean propensity score (SD)	0.29 (0.20)	0.29 (0.20)	0.985	0.30 (0.14))	0.30 (0.14)	0.985
Mortality in hospital	1644 (4.5)	991 (2.7)	< 0.001	1056 (2.6)	1030 (2.5)	0.564

*MRA excluded; #including eplerenone/spironolactone

ACEIs = angiotensin-converting-enzyme inhibitors, AF = atrial fibrillation; ARBs = angiotensin receptor blockers; CABG = coronary artery bypass graft; CKD = chronic kidney disease; COPD = chronic obstructive pulmonary disease; ESRD = end-stage renal disease; HF = heart failure; MRA = mineralocorticoid receptor antagonist; SD = standard deviation; TIA = transient ischemic attack; VHD = valvular heart disease.

Supplemental Table 3.Incidence of mortality, HF readmission and composite endpoints after propensity matching

Income Groups	Number of patients	Mortality			HF readmission			Mortality / HF readmission		
		Incidence*	HR (95%CI)	P value	Incidence*	HR (95%CI)	P value	Incidence*	HR (95%CI)	P value
Low vs. High			-	-						
High-income	36,924	7.17	-	-	11.46	-	-	16.78	-	-
Low-income	36,924	15.58	2.08 (2.04 – 2.13)	< 0.001	17.58	1.36 (1.33 – 1.39)	< 0.001	30.37	1.601(1.58 – 1.63)	< 0.001
Median vs. High										
High-income	40,733	6.93	-	-	11.52	-	-	16.63	-	-
Median-income	40,733	8.54	1.23 (1.20 – 1.25)	< 0.001	13.41	1.12 (1.10 – 1.15)	< 0.001	19.73	1.15 (1.13 – 1.17)	< 0.001

*Number of events per 100 person-years of follow-up

CI = confidence interval; HF = heart failure; HR = hazard ratio

Supplemental Table 4.Baseline characteristics of patients with HF after propensity matching (inverse probability of treatment weighting)

Baseline Demographics	Low-income (n=401,639)	Median-income (n=190,167)	High-income (n=41,292)	Absolute Standardized Mean Difference (vs high income)	
				Low-income	Median-income
Age, years; mean (SD)	53.5 (18.7)	57.67 (15.42)	58.9 (12.6)	0.344	0.090
≥75, %	15.6	14.9	10.7		
65–74, %	18.1	20.4	21.3		
<65, %	62.3	66.1	68.0		
Male gender, %	79.9	79.1	78.4	0.037	0.016
Charlson comorbidity index; mean (SD)	5.87 (3.05)	6.05 (2.98)	6.11(3.06)	0.080	0.021
Comorbidities, %					
Hypertension	71.0	73.6	74.7	0.082	0.023
Diabetes mellitus	39.9	42.4	42.9	0.062	0.010
Stroke/TIA	19.0	20.9	21.6	0.065	0.017
Vascular diseases	53.7	58.0	59.2	0.111	0.025
ESRD	15.5	15.3	15.2	0.008	0.003
COPD	24.0	26.4	27.4	0.076	0.022
Malignancy	14.5	15.0	15.3	0.021	0.006
Autoimmune diseases	6.3	6.0	6.1	0.008	0.004
Liver cirrhosis	4.7	4.7	4.6	0.007	0.004
Dyslipidemia	42.8	44.1	44.6	0.036	0.010
CKD	23.1	23.3	23.1	0.002	0.003
VHD	6.2	6.5	6.6	0.015	0.002
Anemia	19.1	18.5	18.7	0.009	0.005
Valvular heart surgery	2.5	1.9	1.9	0.041	0.003
CABG	4.3	4.4	4.4	0.006	0.001
AF	16.2	17.7	18.3	0.055	0.015
Degree of urbanization, %				0.141	0.189
Urban	72.9	74.0	69.5		

Suburban	22.2	20.4	27.3		
Rural	5.0	5.6	3.2		
Medications, %					
ACEIs	15.1	15.1	15.1	0.002	0.001
ARBs	27.7	26.6	26.6	0.024	0.001
Amiodarone	11.4	11.3	11.5	0.004	0.007
Digoxin	22.5	23.3	23.2	0.016	0.002
Beta-blockers	39.6	38.3	37.9	0.036	0.009
Diuretics*	68.5	68.1	68.1	0.008	0.001
MRA†	21.8	20.5	20.3	0.038	0.005

*MRA excluded; #including eplerenone/spironolactone

ACEIs = angiotensin-converting-enzyme inhibitors, AF = atrial fibrillation; ARBs = angiotensin receptor blockers; CABG = coronary artery bypass graft; CKD = chronic kidney disease; COPD = chronic obstructive pulmonary disease; ESRD = end-stage renal disease; HF = heart failure; MRA = mineralocorticoid receptor antagonist; SD = standard deviation; TIA = transient ischemic attack; VHD = valvular heart disease.

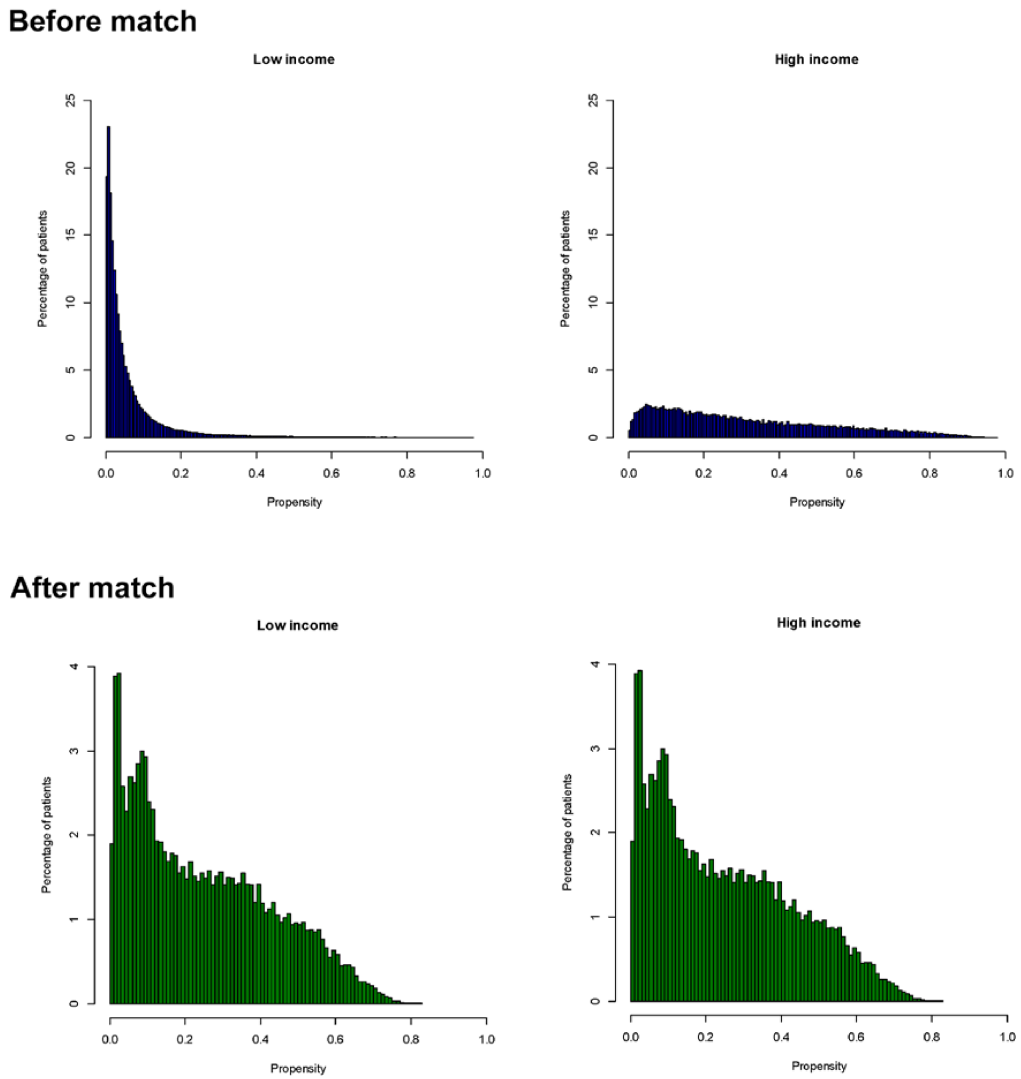
Supplemental Table 5. Incidence of mortality, HF readmission and composite endpoints after propensity matching(inverse probability of treatment weighting)

Income Groups	Number of patients	Mortality			HF readmission			Mortality / HF readmission		
		Incidence*	HR (95%CI)	P value	Incidence*	HR (95%CI)	P value	Incidence*	HR (95%CI)	P value
Low vs. High			-	-						
High-income	41,292	6.40	-	-	11.53	-	-	15.91	-	-
Low-income	401,639	21.60	2.19 (2.07 – 2.86)	< 0.001	21.61	1.16(1.08 – 1.35)	< 0.001	38.45	1.49 (1.35 – 1.58)	< 0.001
Median vs. High										
High-income	41,292	6.40	-	-	11.53	-	-	15.91	-	-
Median-income	401,639	9.55	1.53 (1.26 – 1.75)	< 0.001	14.41	1.09 (1.05 – 1.25)	< 0.001	20.91	1.11 (1.078 – 1.22)	< 0.001

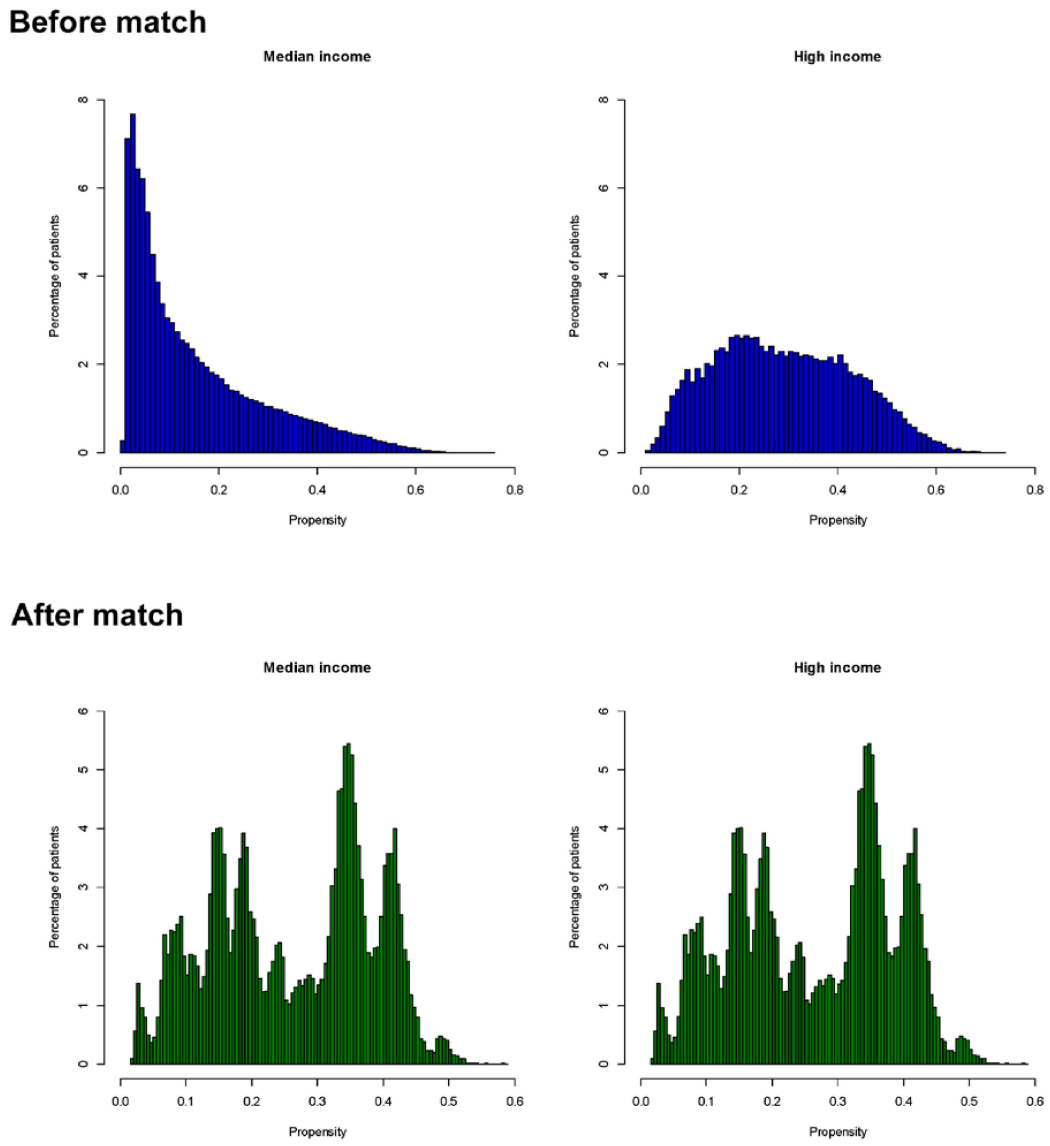
*Number of events per 100 person-years of follow-up

CI = confidence interval; HF = heart failure; HR = hazard ratio

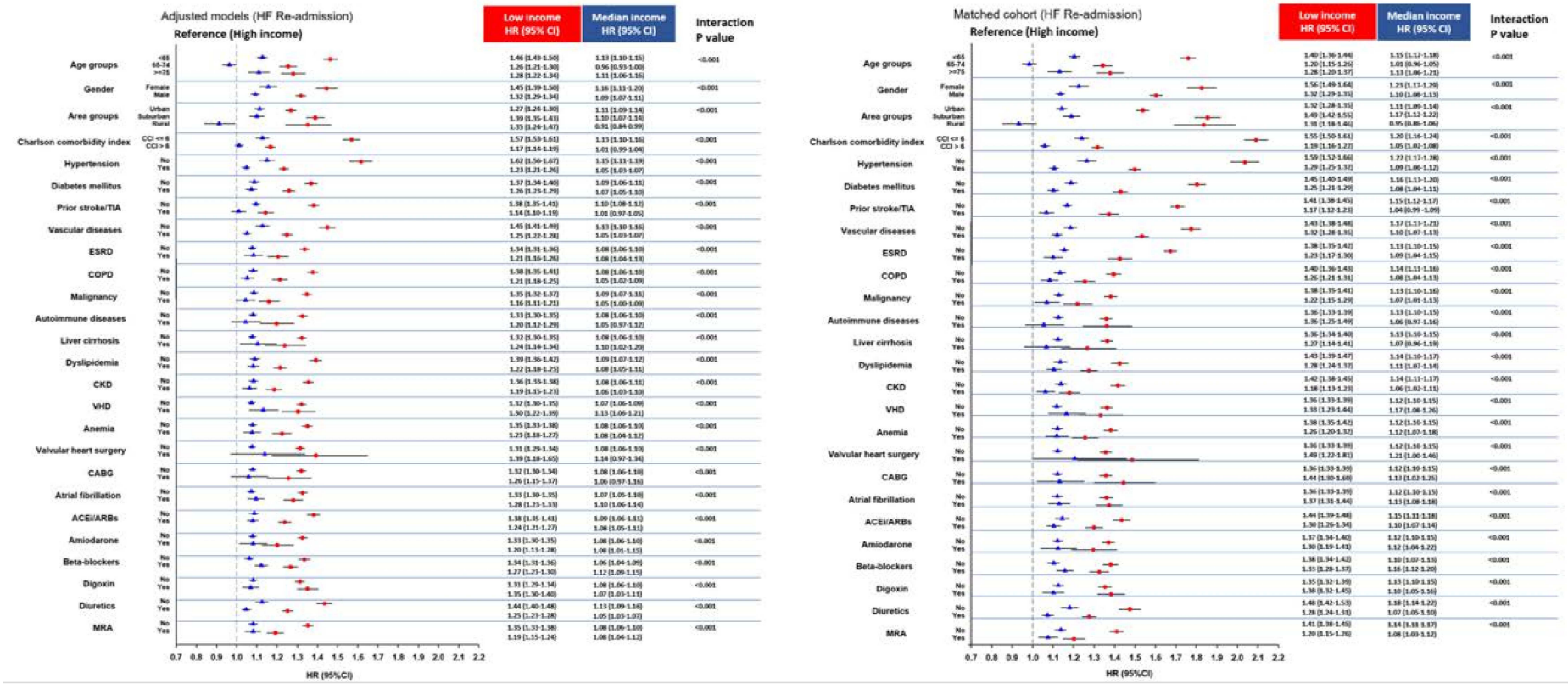
Supplemental Figure 1



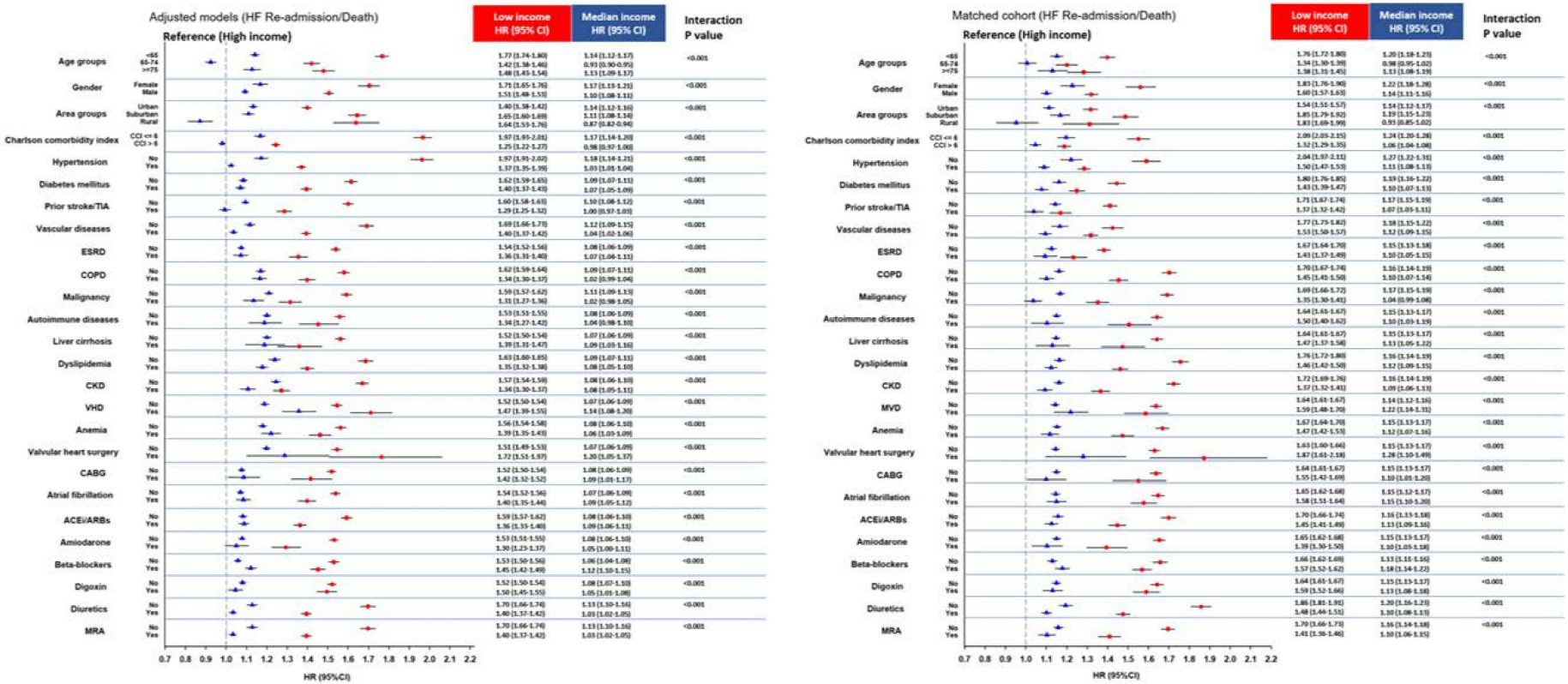
Supplemental Figure 2



Supplemental Figure 3A



Supplemental Figure 3B



Supplemental Figure 4

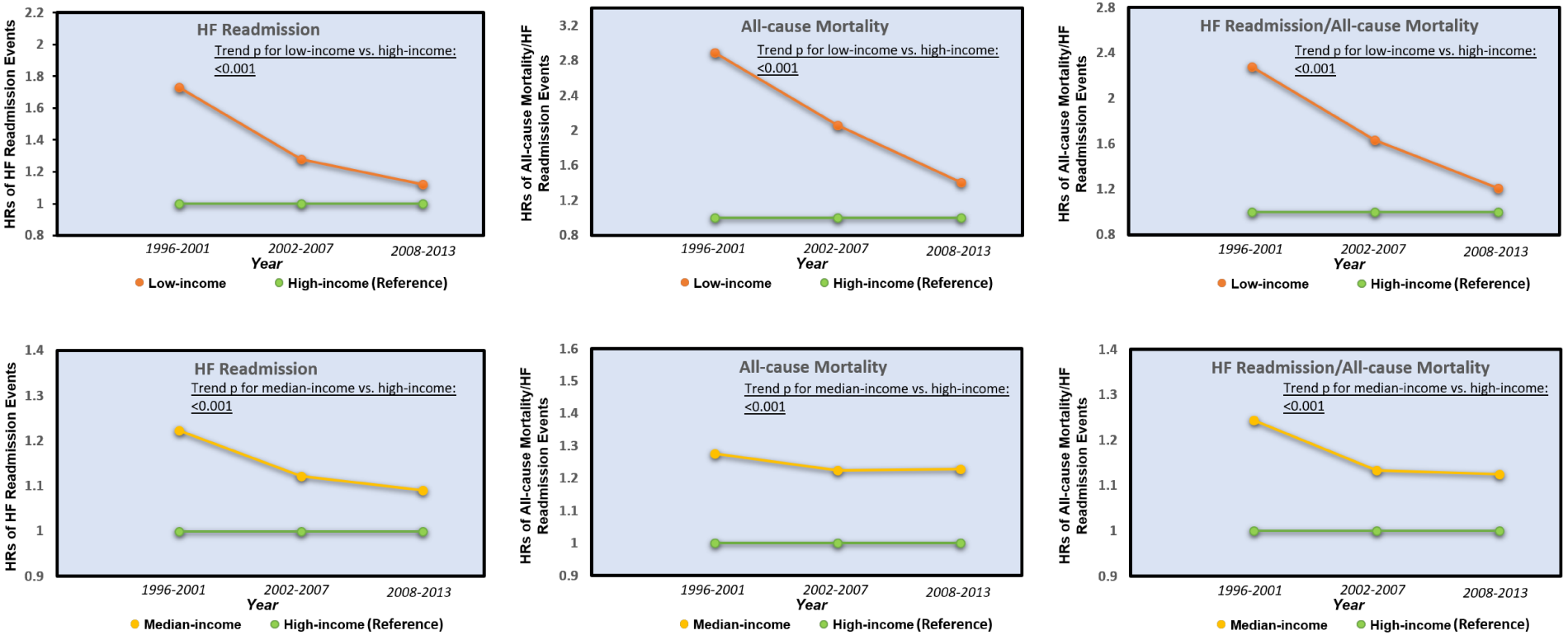


Figure legends

Supplemental Figure1.

Distributions of propensity scores of patients for being as low- versus high-income groups before and after propensity match.

Supplemental Figure 2.

Distributions of propensity scores of patients for being as median- versus high-incomegroups before and after propensity match.

Supplemental Figure 3.

Subgroup analyses of HF readmission (A) and composite endpoint of HF readmission/all-cause mortality (B) in income groups after adjustment (left) and after propensity match (right)using Cox regression models.

Red bars: low-income group; blue bars: median-income group. ACEIs=angiotensin-converting-enzyme inhibitors, ARBs=angiotensin receptor blockers; CABG=coronary artery bypass graft; CI=confidence interval; CKD=chronic kidney disease; COPD=chronic obstructive pulmonary disease; ESRD=end-stage renal disease; HF=heart failure; HR=hazard ratio; MRA=mineralocorticoid receptor antagonist; TIA=transient ischemic attack; VHD=valvular heart disease.

Supplemental Figure 4.

Temporal trends of HF readmission, all-cause mortality and composite endpoint of HF readmission/all-cause mortality by income groups over time (1996–2001, 2002-2007, 2008-2013)after propensity match.