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ORIGINAL RESEARCH

Impact of Socioeconomic Status on Emergency Department Visits in Patients With Atrial Fibrillation: A Nationwide Population-Based Cohort Study

Seo-Young Lee, MD*; So-Ryoung Lee, MD*; Eue-Keun Choi, MD, PhD; Kyung-Do Han, PhD; Seil Oh, MD, PhD; Gregory Y. H. Lip, MD

BACKGROUND: Socioeconomic status (SES) differences could influence management and clinical outcomes in patients with atrial fibrillation (AF), reflecting health inequalities. The authors aimed to investigate emergency department (ED) visits in patients with AF according to SES level.

METHODS AND RESULTS: The authors performed a cross-sectional analysis of ED visits in patients with nonvalvular AF using the Korean National Health Insurance Service database in 2016. The patients were divided into health premium quartiles and medical aid groups, with quartile 4 the highest SES and medical aid the lowest SES. Among patients with AF, patients who had ≥1 ED visits in 2016 were identified. The prevalence and cause of ED visits, 30- and 90-day mortality, and rehospitalization risk after ED visits were evaluated. Among the total 371 017 AF patients, 99 306 patients visited the ED in 2016. The medical aid group showed the highest ED visit rate (n=11 833, 38.0%), and patients with the highest quartile of SES (quartile 4 group) showed the lowest ED visit rate (n=38 037, 30.0%). The most common cause of ED visits was cerebral infarction in all groups. The 30- and 90-day mortality rates and rehospitalization risk after ED visits was higher in groups with lower SES.

CONCLUSIONS: Patients with AF and with lower SES had a higher risk of ED visit rate, higher 30- and 90-day mortality rates, and rehospitalization risk after ED visit. Tailored AF management according to different SES levels in patients with AF is needed to improve clinical outcomes.

Key Words: atrial fibrillation ■ emergency department ■ socioeconomic status

Atrial fibrillation (AF) is the most common sustained arrhythmia, and its prevalence has increased worldwide with the aging population.[1] AF is associated with increased mortality and morbidity, including stroke and cardiovascular disease; thus, the health care costs and economic burden associated with the treatment of AF and its complications are also increasing.[2–4] AF-related medical costs are also a major (and increasing) economic burden, particularly from hospitalizations.[4–7] Emergency department (ED) visits reflect poorly controlled symptoms or the occurrence of AF-related complications in patients with AF. Indeed, a substantial number of patients who visit the ED are subsequently hospitalized.[5,8,9]

In addition to demographic factors such as age, sex, and comorbidities, patients' socioeconomic status (SES) is regarded as an important factor for the optimal management of patients with AF. SES is associated with the risk of AF and can affect the management and prognosis of patients with AF.[10,11] Previous studies have

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CLINICAL PERSPECTIVE

What Is New?

- Among a total of 371 017 patients with atrial fibrillation (AF) stratified by socioeconomic status (SES), patients with lower SES had a higher risk of emergency department visits.
- Emergency department visits due to ischemic stroke, myocardial infarction, AF, and heart failure were higher in patients with lower SES than in patients with high SES.
- Patients with lower SES also had a higher subsequent hospitalization rate, higher 30- and 90-day mortality rate, and rehospitalization risk after emergency department visits.

What Are the Clinical Implications?

- These data clearly show the impact of SES on AF-related outcomes, including emergency department visits and rehospitalization.
- Tailored and integrated AF management according to different SES levels in patients with AF is needed to improve clinical outcomes and address health inequalities.

Nonstandard Abbreviations and Acronyms

NHI	National Health Insurance
NHIS	National Health Insurance Service
OAC	oral anticoagulant

suggested that SES affects the prevalence of AF, oral anticoagulant (OAC) prescription rates and patterns, and clinical outcomes in patients with AF,[12,13] reflecting health inequalities in AF care. Furthermore, several studies have reported that patients with AF with low SES experience higher mortality than those with middle or high SES.[13,14] However, there are limited data regarding ED visits and subsequent clinical outcomes in patients with AF according to SES.

To understand the actual burden of AF-related ED visits, especially in line with SES, we aimed to analyze ED visit patterns, reasons for ED visits, subsequent hospitalization, readmission, and mortality after ED visits in patients with AF using a nationwide population-based cohort.

METHODS

Data Source

The data that support the findings of the current study are available from the corresponding author upon reasonable request. The present study was analyzed based on the National Health Claims Database established by the Korean National Health Insurance Service (NHIS).[15] Korea has a universal and mandatory health coverage system that covers the entire Korean population. The NHIS is the single insurer managed by the Korean government, and the majority (97.1%) of the Korean population are mandatory subscribers, whereas the remaining 3% are medical aid patients. The NHIS database integrates the information of medical aid patients and, thus, contains the sociodemographic and medical claim information of the Korean population. It includes patient sociodemographic, diagnoses, prescriptions, examinations and procedures for inpatient and outpatient services, and mortality data. Diagnoses were coded using the *International Classification of Disease, Tenth Revision, Clinical Modification* (*ICD-10-CM*), codes.[8,15] The study was approved by the institutional review board of Seoul National University Hospital (E-2108-004-1240). Informed consent was waived because of the retrospective nature of the study and anonymized data.

Study Population and Definition of the SES Group

A cross-sectional retrospective analysis of adult patients with nonvalvular AF who visited the ED was performed in 2016. AF was defined as patients with diagnostic codes I48.0-I48.4 and I48.9, and patients who had mitral stenosis or underwent heart valve surgeries were excluded.[15]

The public medical insurance system in Korea has 2 components (ie, National Health Insurance [NHI] and Medical Aid Program). The NHI program includes copayments and a contributory program covering ≈97% of the Korean population, and those insured are in 2 groups: employee's health insurance and the local health insured. The NHI premium for employee's health insurance is calculated based on wages, unearned income over a certain amount, and occupational position. For the local health insured, the premium is calculated based on the income, property of eligible household, and age of household members.[16,17] The Medical Aid Program is a public medical assistance program for poor people who are recipients of the National Basic Livelihood Security System in Korea because they live under the national poverty line. Individuals are eligible for medical aid when the household income is <$600 per month and who are socially deprived and incapable of working (eg, people aged <18 or >65 years, people with disabilities, people with severe or rare diseases, and other special cases).[18] Most medical aid beneficiaries are elderly and have limited education status: in general, this is a disadvantaged group in terms of socioeconomic

level.[19] In other words, NHI premiums and the Medical Aid Program in Korea are reflective of social and economic levels. Therefore, NHI premiums and medical aid can be regarded as a surrogate variable for SES levels, as used in previous studies.[16,17,20]

In the current study, patients were divided into 5 groups according to SES as follows: quartiles distribution of NHI premiums (from quartile 1 [Q1] to quartile 4 [Q4] groups) and the medical aid group. Through the NHI premium information imposed on a household basis, each employee and local health insured are classified into 20th quartiles, and we restructured the 20th quartiles into 4 quartiles (Q1–Q4). The Q4 group had the highest quartile of the NHI premiums level and represents the highest SES group. The medical aid group represents the lowest SES group.

Covariates

The following related cardiovascular diseases and comorbidities were used as covariates. Detailed definitions of comorbidities are presented in Table S1–S6. Comorbidities included hypertension, diabetes, heart failure, prior stroke/transient ischemic attack/thromboembolism, prior myocardial infarction (MI), peripheral artery disease, chronic kidney disease, and end-stage renal disease with hemodialysis or peritoneal dialysis. The CHA2DS2-VASc scores were calculated by giving 1 point each for heart failure, hypertension, history of cardiovascular disease, diabetes, age ≥65 years, or female sex and giving 2 points for prior stroke, transient ischemic attack, or thromboembolism and age ≥75 years.[21] Patients' prescriptions of antiplatelet medications and OACs during 2016 were also evaluated.

ED Visits and Clinical Outcomes After ED Visits

Among the total AF population, patients who visited the ED at least once in 2016 were identified. An ED visit was defined as the primary diagnosis of the index ED visit. To evaluate trends in the common causes of ED visits, the 10 most common primary diagnosis codes among the total ED visits were assessed. The number of ED visits in 2016 was also recorded for patients with ED visits. Subsequent hospitalization after ED visits was analyzed, and the proportion of subsequent hospitalization after ED visits among the total ED visits was evaluated. After the index ED visits (the first ED visits in 2016), 30- and 90-day all-cause mortality and rehospitalization, where AF was the primary diagnosis code of the readmission, were evaluated in all patients with ED visits. Rehospitalization was identified as the admission where AF was the primary diagnosis code. In the overall outcome analysis, only the first ED visit of patients with AF was included.

ED Visits Due to AF-Related Complications

ED visits due to AF-related complications were defined as ED visits from ischemic stroke, AF, heart failure, gastrointestinal bleeding, MI, intracranial hemorrhage, or other major bleeding as a primary diagnosis of the index ED visits (Table S1–S6). To evaluate ED visits as a result of AF-related complications according to SES, the incidence of ED visit from AF-related complications were assessed through the number of patients with ED visits from AF-related complications per 100 patients with AF in the index year (2016), demonstrated as a percentage.

Statistical Analysis

Data are presented as mean±SD for continuous variables and as numbers and percentages for categorical variables. The prevalence of ED visits was evaluated using the number of patients with ED visits divided by the total AF population in the index year (2016), presented as a percentage. Multiple logistic regression models were used to evaluate the risk of all-cause mortality and rehospitalizations during 30 and 90 days after ED visits in patients with AF. Odds ratios (ORs) and 95% CIs were calculated after adjusting for age, sex, and multiple comorbidities according to SES. In all analyses, the highest SES (Q4 group) was set as the reference category. A further subanalysis of study groups stratified by sex was conducted to study the effect of SES on clinical outcomes. For all statistical analyses, P values <0.05 were considered statistically significant. All statistical analyses and data management were performed using the SAS software version 9.3 (SAS Institute Inc.).

Patient and Public Involvement

No patient or public were directly involved throughout the research process, such as formulation of the study design, outcome measure development, recruitment, conduct of the study, and reporting of the results. There are no plans to disseminate the results of the research directly to the study participants.

RESULTS

Prevalence of ED Visits According to SES and Patients' Baseline Characteristics

Figure 1 shows the total number of patients with AF (blue bar graph) and the number of patients with AF who visited the ED according to SES in 2016 (yellow bar graph), along with the prevalence of ED visits among the entire AF population in each SES group. Among the 5 groups stratified by SES, the medical aid group had the highest ED visit rate (n=11 833, 38.3%), and the Q4 group had the lowest ED visit rate (n=38 037,

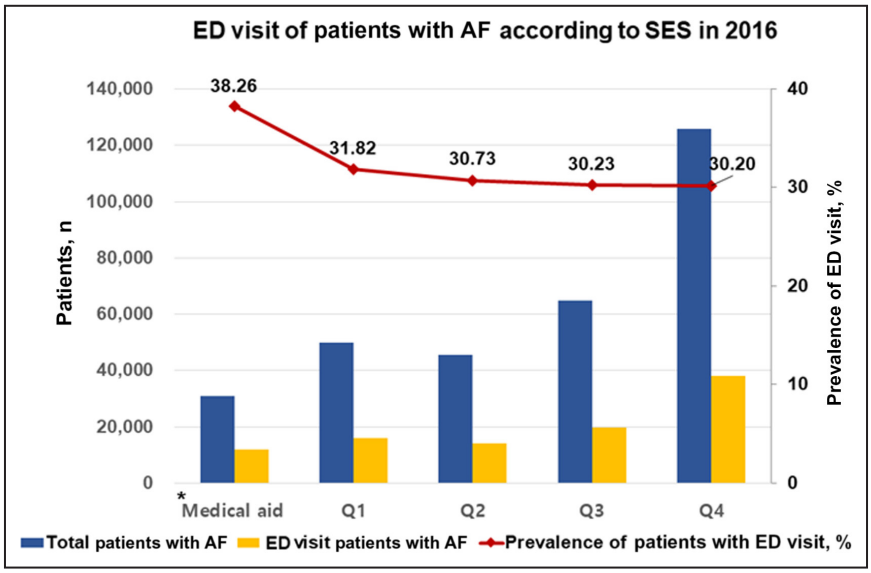

Figure 1. Number of patients with AF who visited the ED and prevalence of ED visits by SES.
*Groups divided into medical aid quartile 1 (Q1), quartile 2 (Q2), quartile 3 (Q3), and quartile 4 (Q4) in the order of low income: Q4 the highest SES and medical aid the lowest SES. AF indicates atrial fibrillation; ED, emergency department; and SES, socioeconomic status.

30.2%). Approximately 37% of patients visited the ED more than twice a year in the Q4 group, whereas in the medical aid group, ≈43% of patients visited the ED more than twice a year. The medical aid group had a higher revisit rate in the year (Figure 2).

The baseline characteristics of patients with AF who visited the ED based on SES are presented in Table 1. Among the 371 017 patients with AF, 99 306 patients (26.8%) visited the ED at least once in 2016. The Q4 group was the oldest group (mean age, 74.3±11.6 years), followed by the medical aid group (mean age, 73.3±12.5 years). Among the comorbidities, diabetes, heart failure, prior MI, peripheral artery disease, chronic obstructive pulmonary disease, and chronic kidney disease were more frequent in the medical aid group. The CHA2DS2-VASc score was not significantly different among the 5 groups, with a mean score of ≈3.5 to 4. The number of patients receiving anticoagulation therapy was highest in the Q4 group (56.6%) and lowest in the medical aid group (50.7%). Overall, the rate of patients receiving warfarin was insignificantly different (*P* for trend=0.9), whereas the rate of receiving nonvitamin K antagonist OACs was increased in the higher-income groups (38.0% in the medical aid group and 43.6% in the Q4 group, *P* for trend <0.001).

Common Causes of ED Visits According to SES

Across all 5 groups stratified by SES, the most common cause of ED visits was cerebral infarction (*ICD-10-CM* code I63), followed by AF (I48), heart failure (I50), and pneumonia (J18) (Figure 3 and Table S2). In addition to the previous 4 causes, gastroenteritis (A09) and angina (I20) were also included in the 7 major causes. In contrast to other groups, in the medical aid group, chronic kidney disease (N18) was ranked among the 7 major causes of ED visits. The quartile groups presented dizziness (R42) as the major cause of ED visits rather than chronic kidney disease.

AF-Related Complication According to SES

The number of patients with ED visits due to AF-related complications is presented in Table S3. Figure 4 shows the trends in the incidence of ED visits from AF-related complications according to SES, and the graph below shows the OAC prescription rates in different SES groups.

The incidence of ED visits due to ischemic stroke was significantly lower in the Q4 group (3.5%) than that in the medical aid group (3.8%, *P* for trend for stroke, 0.01). The incidence of ED visits due to heart failure was significantly different between the medical aid and Q4 groups (3.0% and 1.8%, respectively; *P* for trend <0.001).

The incidence of ED visits due to AF and MI was also lower in the Q4 group than that in the medical aid group (the *P* for trend for AF and MI were 0.044 and 0.004, respectively). ED visits due to major bleeding, including intracranial hemorrhage and gastrointestinal

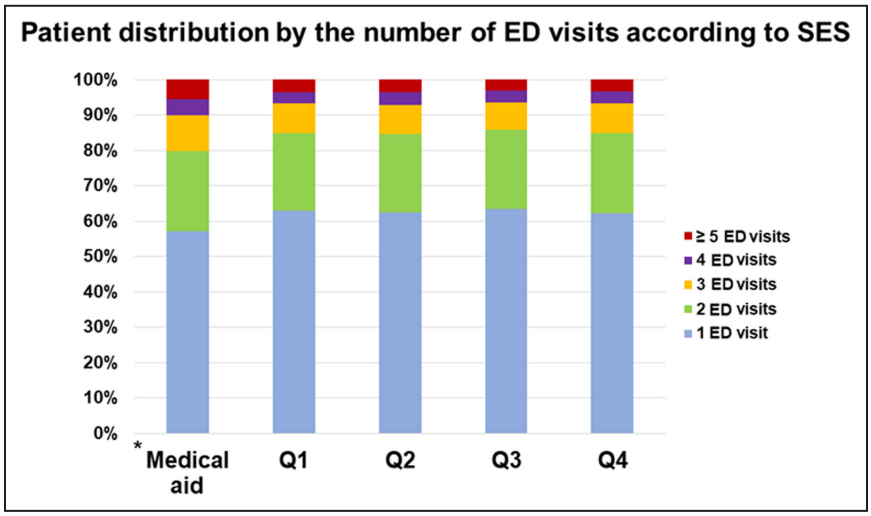

Figure 2. Patient distribution by the number of ED visits according to SES.
*Groups divided into medical aid quartile 1 (Q1), quartile 2 (Q2), quartile 3 (Q3), and quartile 4 (Q4) in the order of low income: Q4 the highest SES and medical aid the lowest SES. ED indicates emergency department; and SES, socioeconomic status.

bleeding, did not show significant differences across SES groups.

Clinical Outcomes After ED Visits

Among the total ED visits of patients with AF, ≈83.5% to 86.0% of patients had subsequent hospitalizations (Table S4). The medical aid group had a higher rate of subsequent hospitalization (n=10 202, 86.2%) than that in the other groups.

Figure 5 and Table S4 show the OR after adjusting for sex, age, and multiple comorbidities from the multiple logistic regression analyses for the risk of mortality and rehospitalization among patients with AF who had ED visits during the 30- and 90-day follow-up. Compared with the Q4 group, the medical aid group was associated with a 1.3-fold higher odds of 30- and 90-day rehospitalizations after the first ED visit. In addition, compared with the Q4 group, the medical aid and Q1 groups showed significantly higher 30- and 90-day mortality rates after the first ED visit.

Subgroup Analysis

A subgroup analysis was performed according to sex. In the analysis of common causes of ED visits, the 4 major causes of cerebral infarction (I63), AF (I48), heart failure (I50), and pneumonia (J18) were the same in both men and women (Figure S1–S6). Among the men in all SES groups, acute MI (I21) was usually ranked as the major cause of ED visit, whereas femur neck fracture (S72) was ranked as the major cause in women. When each subgroup according to sex was analyzed for the adjusted OR for the risk of mortality and rehospitalization, the same trends as the total study group were found (Tables S5 and S6).

The risks of mortality and rehospitalization were relatively higher in the male medical aid group than that in the female medical aid group. In the male medical aid group, the odds of rehospitalization and mortality were ≈1.4- and 1.3-fold higher, respectively, than that in the male Q4 group (Table S5). In contrast, the female medical aid groups showed ≈1.15-fold higher odds of rehospitalization and mortality than that in the female Q4 group (Table S6).

DISCUSSION

The current study investigated the ED visits of patients with AF according to their SES and the potential effects of SES on subsequent clinical outcomes after ED visits. The main findings of this study are as follows: (1) patients with AF in the medical aid group had a higher chance of visiting and revisiting the ED than those in the Q4 group (high-income group); (2) the most common cause of ED visits was ischemic stroke in all SES groups; (3) the incidence of ED due to ischemic stroke and heart failure was significantly higher in the medical aid group than that in the Q4 group; and (4) the risk of 30- and 90-day rehospitalization and all-cause mortality after ED visits was higher in the medical aid group than that in the Q4 group.

Thus far, the association between SES and ED utilization in patients with AF has remained unclear, especially since data on the effects of SES on ED visits in patients with AF are limited. Furthermore, most studies have focused on Western countries. To the best of our knowledge, the present study is the first investigation on the association between SES and ED visits of patients with AF in Asian populations.

Table 1. Baseline Characteristics of Patients With AF Who Visited the ED in 2016

	Medical aid	Quartile 1*	Quartile 2*	Quartile 3*	Quartile 4*	*P* for trend
Total patients with AF, n	30924	49800	45480	64875	125938	
Patients with ED visit, n	11833	15847	13976	19613	38037	
Age, y						
Mean±SD	73.3±12.5	71.6±13.4	69.5±13.9	70.7±13.0	74.3±11.6	<0.001
20–29	38 (0.3)	113 (0.71)	142 (1.0)	112 (0.6)	156 (0.4)	0.015
30–39	91 (0.8)	239 (1.5)	308 (2.2)	448 (2.3)	326 (0.9)	0.025
40–49	423 (3.6)	653 (4.1)	720 (5.2)	823 (4.2)	1102 (2.9)	<0.001
50–59	1287 (10.9)	1903 (12.0)	2072 (14.8)	2119 (10.8)	2755 (7.2)	<0.001
60–69	2008 (17.0)	3313 (20.9)	3138 (22.5)	4472 (22.8)	5579 (14.7)	<0.001
70–79	3743 (31.6)	4597 (29.0)	3883 (27.8)	6418 (32.7)	14249 (37.5)	<0.001
80-	4243 (35.9)	5029 (31.7)	3713 (26.6)	5221 (26.6)	13870 (36.5)	<0.001
Men	5514 (46.6)	8089 (51.0)	7955 (56.9)	11374 (58.0)	21223 (55.8)	<0.001
Baseline comorbidities						
Hypertension	10041 (84.9)	13096 (82.6)	11283 (80.7)	16128 (82.2)	31616 (83.1)	0.083
Diabetes	4145 (35.0)	4969 (31.4)	4218 (30.2)	6067 (30.9)	11870 (31.2)	<0.001
Heart failure	4411 (37.3)	4918 (31.0)	4160 (29.8)	5905 (30.1)	11734 (30.9)	<0.001
Stroke/TIA/ thromboembolism	3065 (25.9)	3365 (21.2)	2840 (20.3)	4226 (21.6)	9182 (24.1)	0.159
MI	806 (6.8)	831 (5.2)	730 (5.2)	928 (4.7)	1817 (4.8)	<0.001
PAD	3224 (27.3)	3367 (21.3)	2865 (20.5)	4095 (20.9)	8099 (21.3)	<0.001
COPD	3395 (28.7)	3549 (22.4)	2906 (20.8)	4364 (22.3)	8877 (23.3)	<0.001
CKD	1552 (13.1)	1363 (8.6)	1124 (8.0)	1616 (8.2)	3486 (9.2)	<0.001
Hemodialysis	647 (5.5)	431 (2.7)	357 (2.6)	469 (2.4)	863 (2.3)	<0.001
PD	58 (0.5)	45 (0.3)	47 (0.3)	59 (0.3)	102 (0.3)	0.003
CHA2DS2-VASc score						
Mean±SD	4.0±1.6	3.6±1.7	3.4±1.8	3.5±1.7	3.8±1.6	0.945
<2	912 (7.7)	2044 (12.9)	2349 (16.8)	2829 (14.4)	3759 (9.9)	0.090
≥2	10921 (92.3)	13803 (87.1)	11627 (83.2)	16784 (85.6)	34278 (90.1)	
Medications						
Nonmedication	1769 (15.0)	2438 (15.4)	2249 (16.1)	2976 (15.2)	4986 (13.1)	<0.001
Antiplatelet	4065 (34.4)	5163 (32.6)	4391 (31.4)	6111 (31.2)	11511 (30.3)	<0.001
Oral anticoagulants	5999 (50.7)	8246 (52.0)	7336 (52.5)	10526 (53.7)	21540 (56.6)	
Wafarin	1502 (12.7)	2149 (13.6)	1889 (13.5)	2698 (13.8)	4972 (13.1)	0.914
NOAC	4497 (38.0)	6097 (38.5)	5447 (39.0)	7828 (39.9)	16568 (43.6)	<0.001
AF duration, mo	95.0 ± 119.1	89.6 ± 122.3	89.2 ± 122.3	93.7 ± 124.1	106.5 ± 131.5	<0.001

Values are expressed as number (percentage). AF indicates atrial fibrillation; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; ED, emergency department; MI, myocardial infarction; NOAC, nonvitamin K antagonist oral anticoagulant; PAD, peripheral artery disease; PD, peritoneal dialysis; and TIA, transient ischemic attack.

*Groups were divided into medical aid quartile 1, quartile 2, quartile 3, and quartile 4 in the order of low income: quartile 4 the highest socioeconomic status (SES) and medical aid the lowest SES.

These data clearly show the impact of SES on AF-related outcomes, including ED visits and rehospitalization. This is important given that the AF-related health care burden has increased worldwide, even in Asian populations.[4,5,7,22,23] As the prevalence of AF increases in the population, more of such patients visit the ED.[8,24] Generally, AF-related complications or poorly controlled AF symptoms result in acute medical conditions requiring ED visits or subsequent hospitalizations.[8] Given the extent and complexity of the problems in patients with AF, it is essential to identify associated factors that lead to ED visits to apply appropriate management for patients with AF who visit the ED.

In previous studies, SES has been shown to affect health and has an independent impact on the increased risk of mortality and morbidity, as well as lengthened hospital stay.[25,26] Low SES has been identified as an important determinant of health status and is associated with adverse clinical outcomes.[27,28] Moreover, patients with a low SES use the ED more frequently

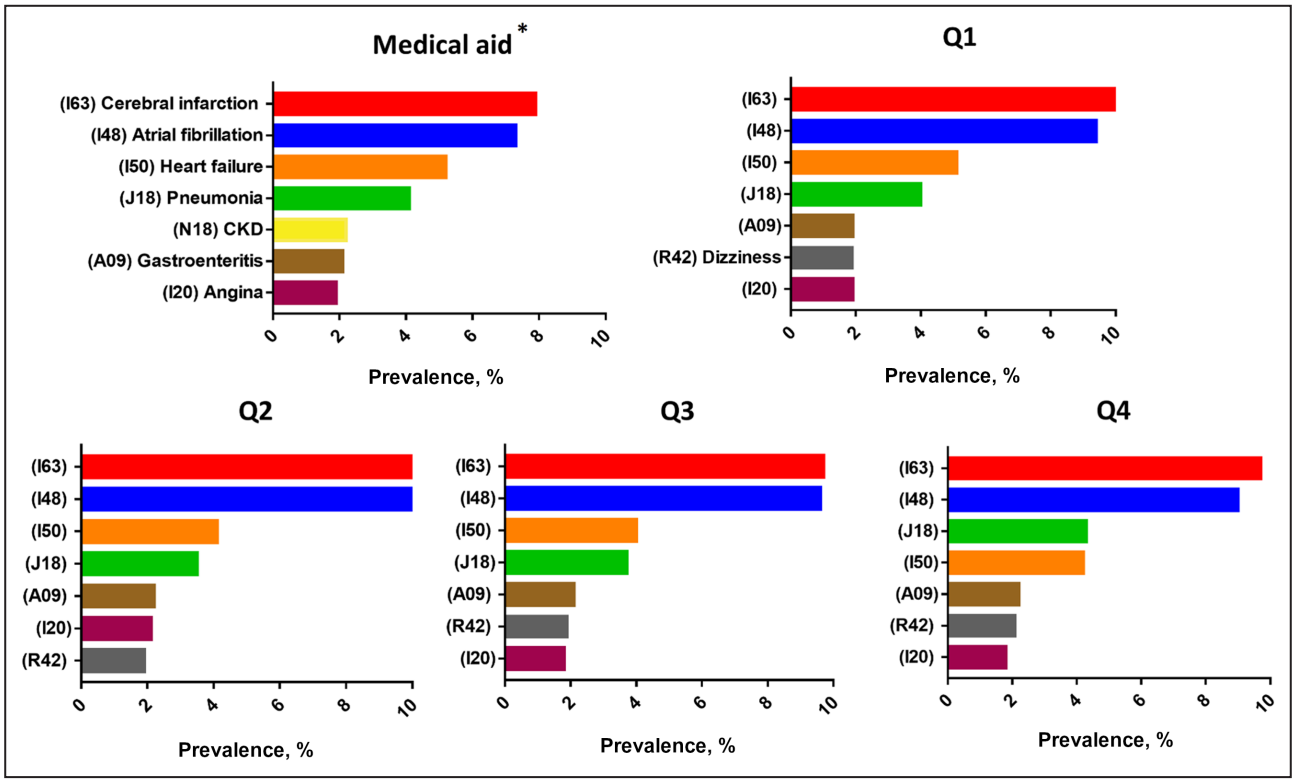

Figure 3. Common causes of ED visits in patients with AF.
*Groups divided into medical aid quartile 1 (Q1), quartile 2 (Q2), quartile 3 (Q3), and quartile 4 (Q4) in the order of low income: Q4 the highest SES and medical aid the lowest SES. AF indicates atrial fibrillation; AMI, acute myocardial infarction; CKD, chronic kidney disease; ED, emergency department; and SES, socioeconomic status.

and are admitted to the hospital more often than those with a high SES.[29] These previous studies suggest that SES has an important impact on the health care system and ED utilization, reflecting health inequalities.

In the current study, patients with lower SES had a higher chance of visiting and revisiting the ED than those with higher SES. This result was consistent with previous studies showing that low SES is independently associated with increased ED visits[28,29] and hospitalization.[27] Low SES is also associated with comorbidities such as hypertension, heart failure, and diabetes.[14,30,31] Furthermore, lower SES is also associated with an earlier onset of multimorbidities.[32] Indeed, the present study also showed that the prevalence of these comorbidities was higher in the lower SES groups (Table 1). Thus, a lower SES could be a precursor for the lack of preventive care, leading to uncontrolled risk factors for the prevention of AF-related complications. The higher prevalence of comorbidities probably also leads to deterioration of the health status, which predictably leads to increased health care burden, such as a higher rate of ED visits in lower SES groups.[29]

Several previous studies have documented the association between patients with AF with low SES and poor clinical outcomes, including higher risks of all-cause mortality and rehospitalization.[13,14,33] The present study extends the findings of previous studies showing that lower SES was associated with worse clinical outcomes in patients with AF. In the current study, the medical aid group with the lowest SES level showed higher risk for all clinical outcomes during the 30- and 90-day follow-up periods. Furthermore, the lower SES groups had a higher risk of clinical outcomes from the Q1 to Q4 groups, other than the medical aid group. However, across all SES groups, the main cause of ED visits was similar for the first to fourth SES subgroups, ie, cerebral infarction, AF, heart failure, and pneumonia. These results suggest that a lower SES in patients with AF might be related to worse clinical outcomes, even though they experience similar complications as those patients with AF of higher SES, because of the more advanced status of the underlying disease and suboptimal management.[34] In addition, the effect of low SES on poor clinical outcomes could be associated with difficult accessibility or availability of medical resources, a lack of healthy lifestyle behaviors, or a combination of both.[13]

Another possible explanation is the low use of recommended pharmacotherapies, such as OAC. OAC prescribing rates in the current study were ≈50%, comparable with other studies for Asian patients.[11]

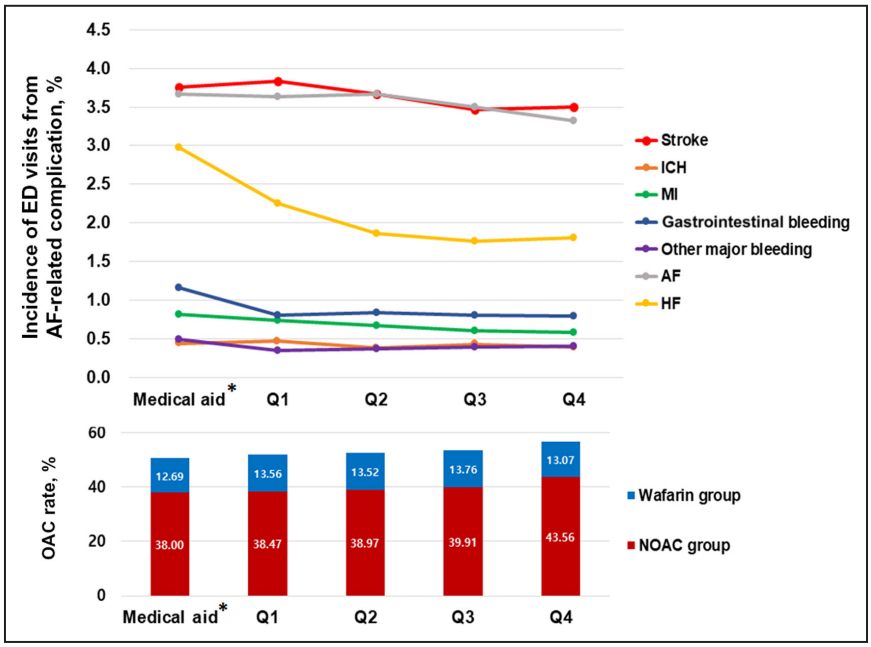

Figure 4. Trends of incidence of ED visit from AF-related complication.
*Groups divided into medical aid quartile 1 (Q1), quartile 2 (Q2), quartile 3 (Q3), and quartile 4 (Q4) in the order of low income: Q4 the highest SES and medical aid the lowest SES. AF indicates atrial fibrillation; ED, emergency department; GI, gastrointestinal; HF, heart failure; ICH, intracranial hemorrhage; MI, myocardial infarction; NOAC, nonvitamin K antagonist oral anticoagulants; OAC, oral anticoagulant; and SES, socioeconomic status.

Many patients with high stroke risk (eg CHA2DS2-VASc scores ≥2) were not prescribed OACs, especially the medical aid group, which had higher average CHA2DS2-VASc scores but a lower nonvitamin K antagonist OAC prescription rate than the high SES group. These findings are consistent with recent reports of lower OAC prescription rates and lower patient adherence being associated with patients with AF of low SES.[12,35,36] Underutilization of OACs in patients with AF has been reported in previous studies and this has been associated with an increased risk of stroke.[37] This inequality in OAC rates contrasts with a higher incidence of ischemic stroke and MI complications in the low SES groups, suggesting that these groups may be undertreated. The low OAC rate may be attributable to practice variations being present in OAC and nonvitamin K antagonist OAC usage among hospital physicians, the cost of nonvitamin K antagonist OACs

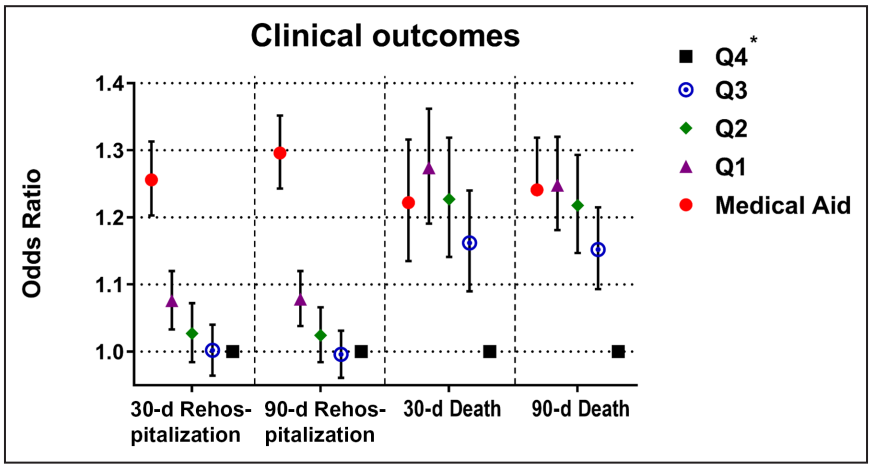

Figure 5. Thirty-day and 90-day mortality and hospitalization after ED visit by SES.
*Groups divided into medical aid, quartile 1, quartile 2, quartile 3, and quartile 4 (Q4) in the order of low income: Q4 the highest SES and medical aid the lowest SES. ED indicates emergency department; and SES, socioeconomic status.

still being high for patients with low SES, and suboptimal education of the importance of stroke prevention in AF.[37,38] Optimization of pharmacotherapies, including OACs and antiarrhythmic agents, are important for ensuring better efforts for preventing and reducing stroke and to achieve better symptom management in patients with AF.[39]

In various aspects, the current study supports the view that lower SES might be one of the predictive factors of poor clinical outcomes in patients with AF. Lower SES could be closely associated with a higher medical burden of AF-related morbidities and mortality, and the clinical outcomes of this vulnerable group could be improved by better characterization and evaluation of the patient,[40] as well as a more integrated or holistic approach to AF care and management.[41,42]

Study Limitations

The present study has several limitations. First, in this claim-based database, AF and other comorbidities were defined using operational definitions based on *ICD-10-CM* codes. Therefore, the possibility of misdiagnosis and overestimation cannot be excluded. To alleviate this bias, we used the validated definition that is widely used in previous studies.[3,8,11,15] Second, although we adjusted important covariates affecting the clinical outcome through analysis as much as possible, there might be a possibility of residual confounding factors caused by the limitations of our retrospective, cross-sectional study. In addition, because of the nature of this cross-sectional study design, associations were described rather than implying causality. Third, this cohort included the citizens of South Korea; therefore, findings from this study may not be representative of the other countries or other ethnicities. Fourth, as a variety of analyses were performed in the current study, the effect of multiple comparisons that increased the change of false-positive results should be considered, even if it is not a major problem in our investigation of the clinical association. Another limitation is that patients' hospitalization due to AF, which was not related to ED visits before 2016, were not excluded. However, the present study was conducted only in patients who visited the ED for the first time, minimizing the effect of the previous hospitalization on the results. Finally, because of the limitation of the NHIS database, we are unable to provide a quantified amount of the NHI premium in each quartile and medical aid group. Additionally, we were unable to include all plausible predictors of AF, such as smoking status, alcohol consumption, and other lifestyle components, because of the inherent limitations of the database. The impact of the residential environment is also a variable that needs to be evaluated, but there was still a limitation in approaching relevant data. Further studies are needed to evaluate these variables not included in the risk of AF.

CONCLUSIONS

Patients with lower SES had a higher risk of ED visit rate, higher 30- and 90-day mortality, and rehospitalization risk after ED visits. Tailored and integrated AF management according to different SES levels in patients with AF are needed to improve clinical outcomes and address health inequalities.

ARTICLE INFORMATION

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Supplemental Material

Tables S1–S6
Figure S1

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SUPPLEMENTAL MATERIAL

Table S1. Definitions of covariates and AF-related complications

Diagnosis	ICD-10-CM codes
Atrial fibrillation	I48.0-I48.4, I48.9
Valvular atrial fibrillation	I05.0, I05.2, I05.9, Z95.2-Z95.4
Hypertension	I10-I13, I15; and minimum 1 prescription of anti-hypertensive drug (thiazide, loop diuretics, aldosterone antagonist, alpha-/beta-blocker, calcium-channel blocker, angiotensin-converting enzyme inhibitor, angiotensin II receptor blocker).
Diabetes mellitus	E11-E14; and minimum 1 prescription of anti-diabetic drugs (sulfonylureas, metformin, meglitinides, thiazolidinediones, dipeptidyl peptidase-4 inhibitors, α-glucosidase inhibitors, and insulin).
Dyslipidemia	E78
Heart Failure	I50
Stroke/TIA/TE	I63, I64, G458, G459, I74
Myocardial infarction	I21, I22
Peripheral artery disease	I70, I73
Chronic obstructive pulmonary disease	J41-J44
Chronic kidney disease	N18, N19
Hemodialysis	Procedure code: O7011-O7020
Peritoneal dialysis	Procedure code: O7017, O7075
Percutaneous coronary intervention	Procedure code: M6561, M6562, M6563, M6564
CHA_2DS_2-VASc score	Heart failure (1 point), hypertension (1 point), age ≥75 years (2 points), diabetes mellitus (1 point), previous stroke/TIA/TE (2 points), vascular disease (prior myocardial infarction or peripheral artery disease, 1 point), age ≥65 years (1 point) and female sex (1 point)
AF-related complications (as a primary diagnosis of ED visit)	
Ischemic stroke	I63, I64
Atrial fibrillation	I48.0-I48.4, I48.9
Heart failure	I50
Myocardial infarction	I21, I22
Intracranial hemorrhage	I60-62

Gastrointestinal bleeding	I85, K22.1, K22.8, K25.0, K25.2, K25.4, K25.6, K26.0, K26.2, K26.4, K26.6, K27.0, K27.2, K27.4, K27.6, K28.0, K28.2, K28.4, K28.6, K29.0, K31.8, K55.2, K57.0, K57.1, K57.2, K57.3, K57.4, K57.5, K57.8, K57.9, K62.5, K66.1, K92.0, K92.1, K92.2
Other major bleeding	D62 (posthemorrhagic anemia), H05.2 (hemorrhage of orbit), H35.6 (retinal hemorrhage), H43.1 (vitreous hemorrhage), J94.2 (hemothorax), M25.0 (hemarthrosis), R04 (hemorrhage from respiratory passages; epistaxis, hemorrhage from throat, hemoptysis, or other sites/unspecified sites from respiratory passages)

Abbreviations: AF, atrial fibrillation; ED, emergency department.

Table S2. Common causes of ED visits in patients with AF

	Medical aid	Q1*	Q2*	Q3*	Q4*
ER visit AF patients	11,833	15,847	13,976	19,613	38,037
Stroke	939 (7.9)	1,637 (10.3)	1,427 (10.2)	1,910 (9.7)	3,707 (9.7)
AF	867 (7.3)	1,491 (9.4)	1,409 (10.1)	1,882 (9.6)	3,441 (9.0)
HF	621 (5.2)	804 (5.1)	579 (4.1)	789 (4.0)	1602 (4.2)
Pneumonia	488 (4.1)	640 (4.0)	485 (3.5)	735 (3.7)	1648 (4.3)
Gastroenteritis	251 (2.1)	298 (1.9)	306 (2.2)	418 (2.1)	819 (2.2)
Angina	227 (1.9)	298 (1.9)	291 (2.1)	356 (1.8)	690 (1.8)
Dizziness	-	296 (1.9)	261 (1.9)	366 (1.9)	798 (2.1)

Number (%)

The incidence was defined as ED visits from AF-related complications per 100 patients with AF (%).

*Groups divided into medical aid, Q1, Q2, Q3, and Q4 in the order of low income: Q4 the highest SES and medical aid the lowest SES.

Abbreviations: AF, atrial fibrillation; HF, heart failure.

Table S3. The number of patients with ED visits from AF-related complications

	Medical aid	Q1*	Q2*	Q3*	Q4*	P for trend
Total AF patients	30,924	49,800	45,480	64,875	125,938	
ER visit AF patients	11,833 (38.3)	15,847 (31.8)	13,976 (30.7)	19,613 (30.2)	38,037 (30.2)	<0.001
Stroke	1160 (3.8)	1910 (3.8)	1668 (3.7)	2248 (3.5)	4409 (3.5)	0.011
ICH	138 (0.5)	234 (0.5)	174 (0.4)	281 (0.4)	493 (0.4)	0.843
MI	255 (0.8)	370 (0.7)	307 (0.7)	398 (0.6)	731 (0.6)	0.004
GI bleeding	359 (1.2)	400 (0.8)	382 (0.8)	523 (0.8)	1006 (0.8)	0.207
Other major bleeding	152 (0.5)	177 (0.4)	171 (0.4)	254 (0.4)	509 (0.4)	0.132
AF	1133 (3.7)	1808 (3.6)	1666 (3.7)	2269 (3.5)	4181 (3.3)	0.044
HF	920 (3.0)	1124 (2.3)	847 (1.9)	1143 (1.8)	2276 (1.8)	<0.001

Number (%)

The incidence was defined as ED visits from AF-related complications per 100 patients with AF (%).

*Groups divided into medical aid, Q1, Q2, Q3, and Q4 in the order of low income: Q4 the highest SES and medical aid the lowest SES.

Abbreviations: AF, atrial fibrillation; GI, gastrointestinal; HF, heart failure; ICH, intracranial hemorrhage; MI, myocardial infarction.

Table S4. The risk of mortality and re-hospitalization among AF patients with ED visit during 30-day and 90-day follow-up

	Medical Aid	Q1*	Q2*	Q3*	Total Q4*
ED visit Patients (n)	11833	15847	13976	19613	38037
Subsequent hospitalization after ED visit	10202 (86.2)	13444 (84.8)	11672 (83.5)	16383 (83.5)	31930 (83.9)
In ED mortality	839 (7.1)	1077 (6.8)	862 (6.2)	1195 (6.1)	2342 (6.2)
30 day morality after ED visit	1064 (9.0)	1403 (8.9)	1117 (8.0)	1547 (7.9)	3029 (8.0)
Adjusted OR†	1.22 (1.14, 1.32)	1.27 (1.19, 1.36)	1.23 (1.14, 1.32)	1.16 (1.09, 1.24)	1 (ref.)
30 day re-hospitalization after ED visit	4511 (38.12)	5304 (33.47)	4374 (31.3)	6154 (31.38)	12480 (32.81)
Adjusted OR	1.26 (1.20, 1.31)	1.08 (1.03, 1.12)	1.03 (0.98, 1.07)	1.00 (0.96, 1.04)	1 (ref.)
90 day morality after ED visit	1750 (14.79)	2209 (13.94)	1765 (12.63)	2473 (12.61)	4938 (12.98)
Adjusted OR	1.24 (1.17, 1.32)	1.25 (1.18, 1.32)	1.22 (1.15, 1.29)	1.15 (1.09, 1.22)	1 (ref.)
90 day re-hospitalization after ED visit	6096 (51.52)	7199 (45.43)	5985 (42.82)	8411 (42.88)	17008 (44.71)
Adjusted OR	1.30 (1.24, 1.35)	1.09 (1.04, 1.12)	1.02 (0.98, 1.07)	1.00 (0.96, 1.03)	1 (ref.)

*Groups divided into medical aid, Q1, Q2, Q3, and Q4 in the order of low income: Q4 the highest SES and medical aid the lowest SES.

†Adjusted for age, sex, diabetes mellitus, heart failure, myocardial infarction, peripheral artery disease, chronic kidney disease.

Abbreviations: ED, emergency department; OR, odds ratio.

Table S5. The risk of mortality and re-hospitalization among AF male patients with ED visit during 30-day and 90-day follow-up

	Male				
	Medical Aid	Q1*	Q2*	Q3*	Q4*
ED visit Patients (n)	5514	8089	7955	11374	21223
Subsequent hospitalization after ED visit	4635 (84.06)	6713 (82.99)	6565 (82.53)	9331 (82.04)	17533 (82.61)
In ED mortality	384 (6.96)	504 (6.23)	506 (6.36)	713 (6.27)	1328 (6.26)
30 day morality after ED visit	501 (9.09)	646 (7.99)	641 (8.06)	918 (8.07)	1738 (8.19)
Adjusted OR†	1.28 (1.15, 1.42)	1.19 (1.08, 1.31)	1.26 (1.15, 1.39)	1.20 (1.10, 1.30)	1 (ref.)
30 day re-hospitalization after ED visit	2082 (37.76)	2521 (31.17)	2327 (29.25)	3367 (29.6)	6545 (30.84)
Adjusted OR	1.41 (1.32, 1.50)	1.09 (1.03, 1.16)	1.03 (0.97, 1.09)	1.02 (0.97, 1.07)	1 (ref.)
90 day morality after ED visit	818 (14.83)	1024 (12.66)	1015 (12.76)	1460 (12.84)	2822 (13.3)
Adjusted OR	1.33 (1.21, 1.45)	1.19 (1.10, 1.29)	1.27 (1.17, 1.38)	1.19 (1.11, 1.28)	1 (ref.)
90 day re-hospitalization after ED visit	2826 (51.25)	3480 (43.02)	3254 (40.91)	4638 (40.78)	9068 (42.73)
Adjusted OR	1.44 (1.36, 1.53)	1.11 (1.05, 1.17)	1.05 (0.99, 1.11)	1.00 (0.96, 1.05)	1 (ref.)

*Groups divided into medical aid, Q1, Q2, Q3, and Q4 in the order of low income: Q4 the highest SES and medical aid the lowest SES.

†Adjusted for age, sex, diabetes mellitus, heart failure, myocardial infarction, peripheral artery disease, chronic kidney disease.

Abbreviations: ED, emergency department; OR, odds ratio.

Table S6. The risk of mortality and re-hospitalization among AF female patients with ED visit during 30-day and 90-day follow-up

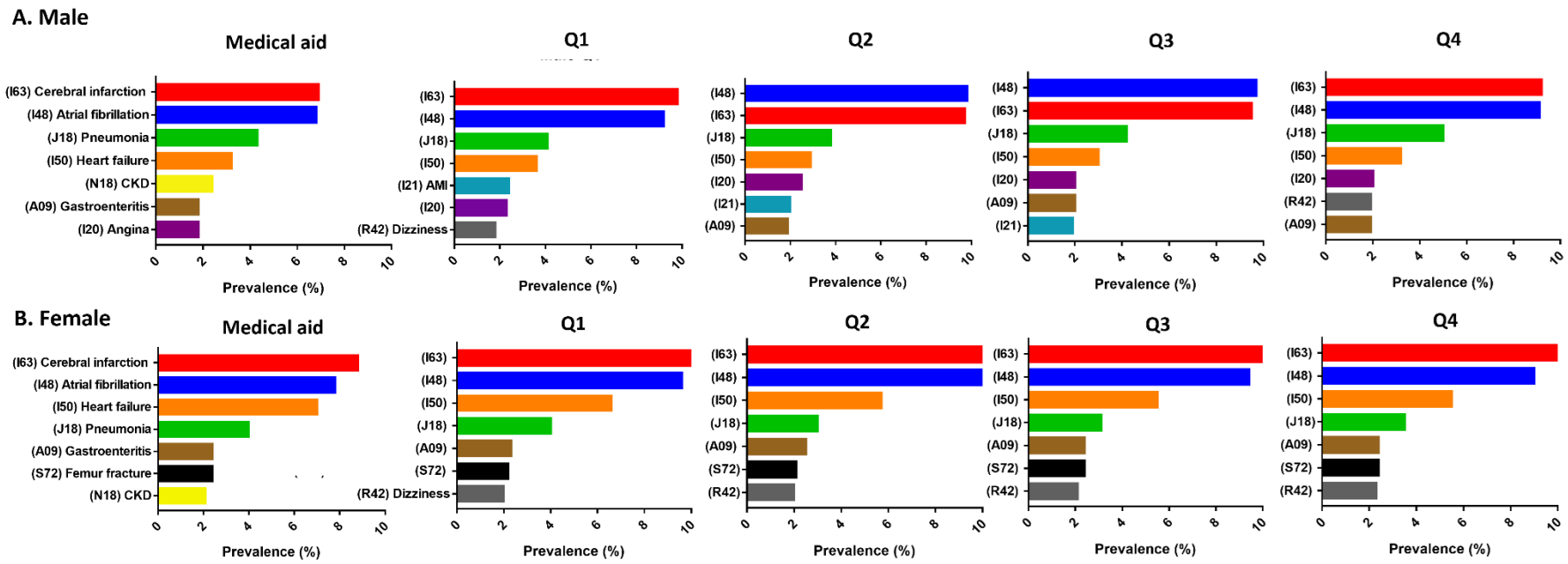
		Female			
	Medical Aid	Q1*	Q2*	Q3*	Q4*
ED visit Patients (n)	6319	7758	6021	8239	16814
Subsequent hospitalization after ED visit	5567 (88.1)	6731 (86.76)	5107 (84.82)	7052 (85.59)	14397 (85.63)
In ED mortality	455 (7.2)	573 (7.39)	356 (5.91)	482 (5.85)	1014 (6.03)
30 day morality after ED visit	563 (8.91)	757 (9.76)	476 (7.91)	629 (7.63)	1291 (7.68)
Adjusted OR†	1.15 (1.04, 1.28)	1.34 (1.22, 1.47)	1.17 (1.04, 1.30)	1.10 (1.00, 1.22)	1 (ref.)
30 day re-hospitalization after ED visit	2429 (38.44)	2783 (35.87)	2047 (34)	2787 (33.83)	5935 (35.3)
Adjusted OR	1.13 (1.06, 1.20)	1.05 (0.99, 1.11)	1.02 (0.96, 1.09)	0.99 (0.93, 1.04)	1 (ref.)
90 day morality after ED visit	932 (14.75)	1185 (15.27)	750 (12.46)	1013 (12.3)	2116 (12.58)
Adjusted OR	1.15 (1.06, 1.25)	1.28 (1.18, 1.39)	1.14 (1.04, 1.24)	1.09 (1.01, 1.18)	1 (ref.)
90 day re-hospitalization after ED visit	3270 (51.75)	3719 (47.94)	2731 (45.36)	3773 (45.79)	7940 (47.22)
Adjusted OR	1.17 (1.11, 1.24)	1.05 (0.99, 1.11)	1.00 (0.94, 1.06)	0.99 (0.94, 1.05)	1 (ref.)

*Groups divided into medical aid, Q1, Q2, Q3, and Q4 in the order of low income: Q4 the highest SES and medical aid the lowest SES.

†Adjusted for age, sex, diabetes mellitus, heart failure, myocardial infarction, peripheral artery disease, chronic kidney disease.

Abbreviations: ED, emergency department; OR, odds ratio.

Figure S1. Common causes of ED visits in patients with AF by sex



*Groups divided into medical aid, Q1, Q2, Q3 and Q4 in the order of low income: Q4 the highest SES and medical aid the lowest SES.

Abbreviations: AMI, acute myocardial infarction; CKD, chronic kidney disease.