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Income and outcomes of patients with incident atrial fibrillation

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ABSTRACT

Background Socioeconomic disparities can be associated with adverse outcomes in patients with cardiovascular diseases. The impact of personal income on the outcomes of patients with atrial fibrillation (AF) is unclear.

Methods Nationwide observational registry-based study on patients with incident AF in Finland during 2007–2018.

Results 203 154 patients (mean age 73.0±13.5; females 49.0%) were diagnosed with incident AF during the study period. Overall, 16 272 (8.0%) patients experienced first-ever ischaemic stroke and 63 420 (31.2%) died (mean follow-up 4.3±3.3 years). After adjusting for confounding factors, low personal income was associated with increased risk of overall mortality in all age strata and the incidence of first-ever stroke in patients aged <65 years and 65–74 years, but not in those ≥75 years. The magnitude of this effect was greatest in patients aged <65 years. After propensity score matching of patients <65 years in the lowest and highest quintiles of maximum personal annual income, at 10 years, those in the highest income quintile (≥€54 000) had significantly lower risk of first-ever stroke (subdistribution HR 0.495, 95% CI 0.391 to 0.628) and overall mortality (HR 0.307, 95% CI 0.269 to 0.351) compared with patients in the lowest income quintile (≤€12 000).

Conclusions Personal annual income has a significant impact on the incidence of first-ever ischaemic stroke and overall mortality among patients with incident AF, particularly among patients of working age. Low-income indicate the need for intervention strategies to improve outcomes of AF.

Trial registration number NCT04645537.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Socioeconomic status may affect the outcome of cardiovascular diseases.

WHAT THIS STUDY ADDS

⇒ First-ever stroke and mortality are more frequent in low-income atrial fibrillation (AF) patients, particularly among those of working age.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE AND/OR POLICY

⇒ Low-income indicates the need for intervention strategies to improve outcomes of AF.

INTRODUCTION

Atrial fibrillation (AF) significantly increases the risk of stroke and mortality,[1 2] particularly among patients with advanced age and cardiovascular comorbidities.[3–5] Optimal oral anticoagulation therapy is the cornerstone treatment to reduce the risk of adverse events in patients at moderate to high risk of thromboembolism.[3 6] Socioeconomic disparities are considered among the contributors to death from cardiovascular causes.[7–9] Low socioeconomic status seems also to be associated with higher prevalence of AF[10–12] as well as increased risk of stroke,[13] bleeding[13 14] and mortality[14–17] among patients with AF. These findings may be driven by lack of measures or adherence to drug treatment for maintaining sinus rhythm and preventing thromboembolism after AF diagnosis.[18 19] However, previous analyses did not consider socioeconomic status as age-dependent and its definition has been heterogeneous. The present analysis evaluates the effect of maximum personal annual income as a measure of socioeconomic status on 10-year outcomes in different age strata of patients with AF from a nationwide registry.

METHODS

Study population

The Study (Finnish AntiCoagulation in Atrial Fibrillation) (ClinicalTrials Identifier: NCT04645537; ENCePP Identifier: EUPAS29845) is a retrospective nationwide registry-based cohort study, which includes all patients diagnosed with AF in Finland during 2004–2018.[20] Patients with a diagnosis of AF were identified from the following national healthcare registers: the hospitalisations and outpatient specialist visits (HILMO) registry, the primary healthcare (AvoHILMO) registry and the National Reimbursement Register upheld by the Social Insurance Institute (KELA) registry. The inclusion criterion for the cohort was the International Classification of Diseases, 10th Revision (ICD-10) diagnosis code I48 (including AF and atrial flutter, together referred as AF) recorded between 2004 and 2018. Cohort entry occurred on the date of the first recorded AF diagnosis. The exclusion criteria were the following: (1) age <18 years at AF diagnosis; (2) permanent migration abroad before 31 December 2018; (3) any stroke or transient ischaemic attack (TIA) before AF diagnosis. Follow-up

Table 1 Characteristics of patients aged <65 years according to their maximum personal annual income quintiles

	1	2	3	4	5	
Maximum personal annual income quintiles	**n=10 152**	**n=10 998**	**n=10 784**	**n=10 878**	**n=10 768**	**P value**
Mean income, €	5445±4123	20373±4110	31321±2841	43806±4838	77878±17 258	<0.0001
Mean cohort entry year	2011±3	2012±3	2013±3	2013±3	2013±3	<0.0001
Demographics						
Mean age, years	56.4±9.2	54.5±10.2	53.2±9.8	53.0±9.4	53.6±8.7	<0.0001
Female gender	3675 (36.2)	4617 (42.0)	3713 (34.4)	2512 (23.1)	1451 (13.5)	<0.0001
Highest educational level						<0.0001
Category 1	4648 (45.8)	3305 (30.1)	2255 (20.9)	1720 (15.8)	1192 (11.1)	
Category 2	4517 (44.5)	5838 (53.1)	5594 (51.9)	4566 (42.0)	2824 (26.2)	
Category 3	987 (9.7)	1855 (16.9)	2935 (27.2)	4592 (42.2)	6752 (62.7)	
Comorbidities						
Abnormal liver function	159 (1.6)	86 (0.8)	39 (0.4)	37 (0.3)	30 (0.3)	<0.0001
Abnormal renal function	373 (3.7)	243 (2.2)	164 (1.5)	139 (1.3)	125 (1.2)	<0.0001
Alcohol abuse	1901 (18.7)	846 (7.7)	496 (4.6)	442 (4.1)	300 (2.8)	<0.0001
Diabetes	2211 (21.8)	1761 (16.0)	1367 (12.7)	1283 (11.8)	1099 (10.2)	<0.0001
Dyslipidaemia	3324 (32.7)	3367 (30.6)	2913 (27.0)	2917 (26.8)	2905 (27.0)	<0.0001
Heart failure	1525 (15.0)	1055 (9.6)	718 (6.8)	688 (6.3)	544 (5.1)	<0.0001
Hypertension	6307 (62.1)	6599 (60.0)	6016 (55.8)	5868 (53.9)	5631 (52.3)	<0.0001
Prior bleeding	1051 (10.4)	646 (5.9)	544 (5.0)	507 (4.7)	445 (4.1)	<0.0001
Prior myocardial infarction	643 (6.3)	526 (4.8)	424 (3.9)	391 (3.6)	341 (3.2)	<0.0001
Vascular disease	1869 (18.4)	1519 (13.8)	1187 (11.0)	1143 (10.5)	977 (9.1)	<0.0001
Dementia	74 (0.7)	29 (0.3)	9 (0.1)	10 (0.1)	8 (0.1)	<0.0001
Psychiatric disorder	3740 (36.8)	2099 (19.1)	1403 (13.0)	1138 (10.5)	758 (7.0)	<0.0001
CHA_2DS_2-VASc score	1.5±1.1	1.4±1.0	1.2±0.9	1.0±0.9	0.9±0.9	<0.0001
OAC before stroke occurrence	6017 (59.3)	6639 (60.4)	6133 (56.9)	6118 (56.2)	5956 (55.3)	<0.0001

Values denote n (%) or mean (SD). Vascular disease: prior myocardial infarction and/or peripheral vascular disease.
CHA2DS2-VASc, congestive heart failure, hypertension, age≥75 years, diabetes, history of stroke or TIA, vascular disease, age 65–74 years, sex category (female); OAC, oral anticoagulant.

continued until death or 31 December 2018. This study focused on 203 154 patients with incident AF without history of stroke or TIA and the study was conducted within a cohort of patients diagnosed with incident AF during 2007–2018. The study flow chart summarises patients' selection (online supplemental figure 1).

Income

Patients' personal highest personal annual taxable income during 2004–2018 was gathered from the national Tax Register. The personal annual income was capped to a maximum of €100 000 to avoid identification of patients with highest incomes. Since income level was expected to inversely correlate with age, analyses were performed separately for the age strata <65 years, 65–74 years and ≥75 years.

Educational level

Data on patients' highest achieved educational level were obtained from Statistics Finland and was categorised according to the International Standard Classification of Education (ISCED) classification. Educational level was divided into three categories: category 1: ISCED 0–2 (no registered, preprimary, primary or lower secondary education); category 2: ISCED 3 (Upper secondary or vocational education); category 3: ISCED 5–8 (tertiary, bachelor-level, master-level or doctoral level education). ISCED category 4 does not exist in Finland.

Study outcomes

Study outcomes were all-cause mortality and first-ever ischaemic stroke. Ischaemic stroke was considered to occur on the first date of a recorded ICD-10 diagnosis code I63 in the hospital register or in the National Death Register upheld by Statistics Finland. Dates of death were retrieved from the National Death Register.

Statistical analysis

Analyses were performed separately for patients aged <65 years, 65–74 years and ≥75 years at cohort entry. Maximum personal annual income was entered as quintiles of income for each age stratum. The χ^2 test was used to analyse differences between categorical variables, and the Kruskall-Wallis' test to compare continuous variables. Continuous variables are reported means and standard errors, and categorical variables as counts and percentages. Unadjusted rates of adverse events were estimated using competing risk and the Kaplan-Meier's methods. Cox regression was used to estimate the HRs of all-cause mortality for income quintiles. Proportional hazard assumption was evaluated by assessing the survival curves and using a test based on Schoenfeld residuals. Since stroke may be hindered by mortality occurring during the study period, competing risk analyses using the Fine-Gray regression model with all-cause death as a competing event were performed to estimate the unadjusted and adjusted subdistribution HRs (SHRs) for incidence of ischaemic stroke in each maximum personal annual income quintile. In the Fine-Gray and Cox regression models, adjustments were made for age, gender, calendar year of AF diagnosis, hypertension, prior myocardial infarction, any coronary or peripheral vascular disease, heart failure, dyslipidaemia, liver disorder, kidney failure, bleeding events, diabetes, alcohol abuse, dementia, psychiatric disorders, education level and maximum personal annual income. The definitions of comorbidities are displayed in online supplemental table 1.

Table 2 Characteristics of patients aged 65–74 years according to their maximum personal annual income quintiles

Maximum personal annual income quintiles	1	2	3	4	5	
	n=10 663	n=10 893	n=10 943	n=11 370	n=11 098	P value
Mean income, €	1370±1500	8363±2301	17168±2890	29978±4826	65109±21 237	<0.0001
Mean cohort entry year	2012±3	2013±3	2013±3	2014±3	2014±3	<0.0001
Demographics						
Mean age, years	70.3±2.8	70.1±2.8	69.8±2.8	69.2±2.8	69.1±2.8	<0.0001
Female gender	6401 (60.0)	5730 (52.2)	5023 (45.9)	4368 (38.4)	2695 (24.3)	<0.0001
Highest educational level						<0.0001
Category 1	7119 (66.8)	6327 (57.6)	5308 (48.5)	4016 (35.3)	2434 (21.9)	
Category 2	3009 (28.2)	3626 (33.0)	3775 (34.5)	3628 (31.9)	2388 (21.5)	
Category 3	535 (5.0)	1038 (9.4)	1860 (17.0)	3726 (32.8)	6276 (56.6)	
Comorbidities						
Abnormal liver function	79 (0.7)	85 (0.8)	89 (0.8)	76 (0.7)	74 (0.7)	<0.0001
Abnormal renal function	429 (4.0)	363 (3.3)	320 (2.9)	336 (3.0)	300 (2.7)	<0.0001
Alcohol abuse	714 (6.7)	606 (5.5)	512 (4.7)	434 (3.8)	347 (3.1)	<0.0001
Diabetes	2849 (26.7)	2821 (25.7)	2588 (23.6)	2493 (21.9)	2316 (20.9)	<0.0001
Dyslipidaemia	5136 (48.2)	5577 (50.8)	5627 (51.4)	5730 (50.4)	5517 (49.7)	<0.0001
Heart failure	1977 (18.5)	1596 (14.5)	1308 (12.0)	1091 (9.6)	868 (7.8)	<0.0001
Hypertension	7820 (73.3)	8324 (75.8)	8290 (75.8)	8363 (73.6)	8021 (72.3)	<0.0001
Prior bleeding	1084 (10.2)	1005 (9.2)	983 (9.0)	998 (8.8)	942 (8.5)	<0.0001
Prior myocardial infarction	892 (8.4)	839 (7.6)	826 (7.5)	754 (6.6)	706 (6.4)	<0.0001
Vascular disease	2850 (26.7)	2864 (26.1)	2634 (24.1)	2577 (22.7)	2259 (20.4)	<0.0001
Dementia	183 (1.7)	162 (1.5)	137 (1.3)	88 (0.8)	61 (0.5)	<0.0001
Psychiatric disorder	1983 (18.6)	1604 (14.6)	1385 (12.7)	1164 (10.2)	925 (8.3)	<0.0001
CHA_2DS_2-VASc score	3.0±1.0	2.9±1.1	2.8±1.0	2.6±1.0	2.4±1.0	<0.0001
OAC before stroke occurrence	8031 (75.3)	8943 (81.4)	8993 (82.2)	9426 (82.9)	9252 (83.4)	<0.0001

Values denote n (%) or mean (SD).
Vascular disease: prior myocardial infarction and/or peripheral vascular disease.
CHA2DS2-VASc, congestive heart failure, hypertension, age≥75 years, diabetes, history of stroke or TIA, vascular disease, age 65–74 years, sex category (female); OAC, oral anticoagulant.

Since baseline characteristics differed significantly among groups of subgroups of patients identified by income quintiles, with higher prevalence of comorbidities among patients with lower income, propensity score matching analysis was performed to adjust for such imbalances between patients in the lowest and highest personal annual income quintiles. A propensity score was estimated for each age stratum using logistic regression with the lowest and highest quintiles of maximum personal annual income as the dependent variable considering the following covariates: age, gender, calendar year of AF diagnosis, hypertension, prior myocardial infarction, any coronary or peripheral vascular disease, heart failure, dyslipidaemia, liver disorder, kidney failure, bleeding events, diabetes, alcohol abuse, dementia, psychiatric disorders and education level. Propensity score matching was performed using a caliper width of 0.2 the SE of the logit, that is, 0.4. Standardised difference <0.1 was considered a non-significant imbalance between the covariates. P<0.05 was set for statistical significance. Statistical analyses were performed with the IBM SPSS Statistics software (V.27.0, SPSS) and Stata (V.15.1, StataCorp).

RESULTS

Overall series

The mean age of the patients was 73.0±13.5 years and 49.0% were female; 16 272 (8.0%) experienced first-ever ischaemic stroke and 63 420 (31.2%) died during a mean follow-up of 4.3±3.3 years. The mean personal annual income was €36 061±€31 000 among patients <65 years, €24 660±€24 570 among 65–74 years patients and €13 400±€18 544 among patients ≥75 years. The mean personal annual income compared rather well with those of the general population as estimated in 2010 only for young patients, while the personal annual income of patients with AF was markedly lower in the elderly strata (general population: 50–64 years, €32 712; 65–74 years, €26 627; ≥75 years, €21 250).

Patients in the lower income quintiles had lower educational status and higher prevalence of comorbidities in all age groups (tables 1–3). This translated into a higher CHA_2DS_2-VASc score in lower income quintiles. The income-related disparities in the prevalence of comorbidities were largest among patients <65 years (table 1). In particular, among these younger patients, those with lower income had increased prevalence of alcohol abuse, diabetes, heart failure, vascular disease and psychiatric disorders. These comorbidities were more prevalent in lower income patients also among 65–74 years patients (table 2). Among patients ≥75 years, such disparities were numerically less evident, but still statistically significant (table 3). The use of any oral anticoagulant before a stroke event was markedly lower among 65–74 years and ≥75 years with low income (tables 2–3), but not among younger patients.

Overall series

In unadjusted analyses, overall mortality and incidence of first-ever ischaemic stroke were higher in the lowest income quintile compared with higher income quintiles in all age groups table 4, online supplemental figure 1). Patients in the lowest personal annual income quintile had a remarkably high risk of adverse events as estimated with competing risk and the Kaplan-Meier's

Table 3 Characteristics of patients aged ≥75 years according to their maximum personal annual income quintiles

Maximum personal annual income quintiles	1	2	3	4	5	
	n=21 057	n=18 161	n=18 077	n=18 406	n=18 816	P value
Mean income, €	0±0	2517±1119	7209±1743	15226±3090	43063±21 882	<0.0001
Mean cohort entry year	2012±3	2013±3	2013±3	2013±3	2014±3	<0.0001
Demographics						
Mean age, years	84.9±5.7	83.6±5.4	82.6±5.2	82.0±5.2	81.8±5.3	<0.0001
Female gender	4725 (22.4)	5131 (29.3)	6382 (35.3)	8097 (44.0)	10 689 (56.8)	<0.0001
Highest educational level						<0.0001
Category 1	17 928 (85.1)	14 758 (81.3)	13 876 (76.8)	11 655 (63.3)	7032 (37.4)	
Category 2	2770 (13.2)	2958 (16.3)	3390 (18.8)	4134 (22.5)	3251 (17.3)	
Category 3	359 (1.7)	445 (2.5)	811 (4.5)	2617 (14.2)	8533 (45.3)	
Comorbidities						
Abnormal liver function	50 (0.2)	45 (0.2)	58 (0.3)	60 (0.3)	66 (0.4)	<0.0001
Abnormal renal function	1033 (4.9)	899 (5.0)	969 (5.4)	891 (4.8)	947 (5.0)	<0.0001
Alcohol abuse	235 (1.1)	233 (1.3)	291 (1.6)	285 (1.5)	308 (1.6)	<0.0001
Diabetes	4882 (23.2)	4300 (23.7)	4407 (24.4)	4284 (23.3)	3807 (20.2)	<0.0001
Dyslipidaemia	8944 (42.5)	8877 (48.9)	9569 (52.9)	10 017 (54.4)	10 218 (54.3)	<0.0001
Heart failure	6850 (32.5)	4985 (27.4)	4375 (24.2)	3931 (21.4)	3382 (18.0)	<0.0001
Hypertension	16 714 (79.4)	14 792 (81.4)	14 771 (81.7)	14 953 (81.2)	14 782 (78.6)	<0.0001
Prior bleeding	2387 (11.3)	2116 (11.7)	2169 (12.0)	2347 (12.8)	2396 (12.7)	<0.0001
Prior myocardial infarction	2628 (12.5)	2038 (11.2)	1958 (10.8)	1981 (10.8)	1815 (9.6)	<0.0001
Vascular disease	7930 (37.7)	6556 (36.1)	6401 (35.4)	6476 (35.2)	6195 (32.9)	<0.0001
Dementia	2321 (11.0)	1744 (9.6)	1475 (8.2)	1357 (7.4)	1223 (6.5)	<0.0001
Psychiatric disorder	2253 (10.7)	1923 (10.6)	2087 (11.5)	1964 (10.7)	1822 (9.7)	<0.0001
CHA_2DS_2-VASc score	4.5±1.1	4.4±1.1	4.3±1.1	4.1±1.1	3.9±1.1	<0.0001
OAC before stroke occurrence	12 698 (60.3)	12 687 (69.9)	13 587 (75.2)	14 148 (76.9)	14 614 (77.7)	<0.0001

Values denote n (%) or mean (SD).
Vascular disease: prior myocardial infarction and/or peripheral vascular disease.
CHA2DS2-VASc, congestive heart failure, hypertension, age ≥75 years, diabetes, history of stroke or TIA, vascular disease, age 65–74 years, sex category (female); OAC, oral anticoagulant.

methods, particularly among patients <65 years (online supplemental figure 1).

Multivariate analyses demonstrated that lower income quintiles were associated with higher risk of adverse events even after adjusting for other baseline covariates (table 4). Lower income was associated with increased risk of overall mortality in all age strata, while the risk of ischaemic stroke was increased among patients <65 years and 65–74 years patients, but not in those aged ≥75 years (table 4).

Among covariates of interest, adjusted analyses showed that lower educational level was an independent risk factor of overall mortality, but not of ischaemic stroke, in all age strata (online supplemental figure 3, online supplemental table 2). The results of multivariate analyses for identification of independent risk factors for adverse events are summarised in online supplemental tables 3–8.

Propensity score matched analysis

Propensity score matching of the lowest and highest income quintiles in the age group <65 years resulted in 4237 pairs of patients (online supplemental table 9). These matched cohorts had similar baseline characteristics but higher prevalence of alcohol abuse among higher income patients (online supplemental table 9). Patients in the highest personal annual income quintile (≥€54 000) had significantly lower risk of first-ever ischaemic stroke (SHR 0.495, 95% CI 0.391 to 0.628) and all-cause mortality (HR 0.307, 95% CI 0.269 to 0.351) compared with patients in the lowest income quintile (≤€12 000) (figure 1).

Propensity score matching of the lowest and highest income quintiles in the age group 65–74 years resulted in 4470 pairs of patients with similar baseline characteristics (online supplemental table 10). Patients in the highest personal annual income quintile (≥€40 000) had significantly lower risk of first-ever ischaemic stroke (SHR 0.772, 95% CI 0.651 to 0.918) and all-cause mortality (HR 0.529, 95% CI 0.482 to 0.582) compared with patients in the lowest income quintile (≤€4000).

Propensity score matching of the lowest and highest income quintiles in the age group ≥75 years resulted in 9473 pairs of patients with similar baseline characteristics (online supplemental table 11). Patients in the highest personal annual income quintile (≥€22 000) had significantly lower risk of all-cause mortality (HR 0.746, 95% CI 0.715 to 0.779) compared with patients in the lowest income quintile (<€1000 €). However, the risk of first-ever ischaemic stroke (SHR 1.065, 95% CI 0.969 to 1.170) was similar between matched pairs in the lowest and highest income quintiles.

DISCUSSION

The results of the present analysis showed that, after adjusting for multiple covariates, low personal income was associated with increased risk of overall mortality and first-ever ischaemic stroke, particularly in working age patients.

Low socioeconomic status is dependent on several factors, which may have significant impact on living conditions and access to health services. In turn, severe diseases may underlie a poor socioeconomic status and both may contribute to poor outcome of these patients. In this study, we observed that this may be true for a large proportion of patients with AF with low personal income. Still, it is difficult to discern the contribution of each of these factors either on socioeconomic status

Table 4 Impact of maximum personal annual income on 10-year first-ever ischaemic stroke and all-cause mortality among patients with atrial fibrillation in different age strata

Subgroups and outcomes	Events (%)	Patient years	Incidence/year (%)	Unadjusted risk estimates	Adjusted risk estimates
<65 years					
Stroke					
Maximum personal annual income					
≤€12 000	592 (5.8)	55 132	1.1 (1.0 to 1.2)	Reference	Reference
€13 000–€26 000	357 (3.2)	62 459	0.6 (0.5 to 0.6)	0.603, 0.529 to 0.688	0.693, 0.606 to 0.793
€27 000–€36 000	300 (2.8)	58 819	0.5 (0.5 to 0.6)	0.571, 0.498 to 0.657	0.712, 0.615 to 0.824
€37 000–€53 000	274 (2.5)	59 609	0.5 (0.4 to 0.5)	0.519, 0.449 to 0.599	0.668, 0.572 to 0.781
≥€54 000	242 (2.2)	60 063	0.4 (0.4 to 0.5)	0.456, 0.392 to 0.530	0.600, 0.504 to 0.713
All-cause mortality					
Maximum personal annual income quintiles					
≤€12 000	2663 (26.2)	55 559	4.8 (4.6 to 5.0)	Reference	Reference
€13 000–€26 000	1241 (11.3)	62 598	2.0 (1.9 to 2.1)	0.415, 0.388 to 0.444	0.600, 0.560 to 0.644
€27 000–€36 000	700 (6.4)	58 873	1.2 (1.1 to 1.3)	0.248, 0.228 to 0.269	0.428, 0.392 to 0.468
€37 000–€53 000	581 (5.3)	59 650	1.0 (0.9 to 1.1)	0.203, 0.185 to 0.222	0.359, 0.326 to 0.396
≥€54 000	483 (4.5)	60 130	0.8 (0.7 to 0.9)	0.168, 0.152 to 0.185	0.299, 0.268 to 0.334
65–74 years					
Stroke					
Maximum personal annual income					
≤€4000	832 (7.8)	49 576	1.7 (1.6 to 1.8)	Reference	Reference
€5000–€12 000	713 (6.5)	52 836	1.3 (1.3 to 1.5)	0.881, 0.798 to 0.974	0.879, 0.795 to 0.973
€13 000–€22 000	587 (5.4)	50 673	1.2 (1.1 to 1.3)	0.790, 0.710 to 0.878	0.780, 0.700 to 0.870
€23 000–€39 000	546 (4.8)	46 539	1.2 (1.1 to 1.3)	0.845, 0.758 to 0.942	0.840, 0.747 to 0.945
≥€40 000	431 (3.9)	44 915	1.0 (0.9 to 1.1)	0.710, 0.631 to 0.798	0.716, 0.625 to 0.820
All-cause mortality					
Maximum personal annual income quintiles					
≤€4000	3619 (33.9)	50 159	7.2 (7.0 to 7.5)	Reference	Reference
€5000–€12 000	2543 (23.2)	53 352	4.8 (4.6 to 5.0)	0.663, 0.630 to 0.697	0.681, 0.647 to 0.717
€13 000–€22 000	1984 (18.1)	51 091	3.9 (3.7 to 4.1)	0.539, 0.511 to 0.570	0.567, 0.536 to 0.599
€23 000–€39 000	1498 (13.2)	46 822	3.2 (3.0 to 3.4)	0.440, 0.414 to 0.468	0.488, 0.457 to 0.521
≥€40 000	1196 (10.8)	45 123	2.7 (2.5 to 2.8)	0.364, 0.341 to 0.389	0.411, 0.382 to 0.443
≥75 years					
Stroke					
Maximum personal annual income					
<€1000	2494 (11.8)	62 759	4.0 (3.8 to 4.1)	Reference	Reference
€1000–€4000	1920 (10.6)	60 526	3.2 (3.0 to 3.3)	0.921, 0.867 to 0.977	0.981, 0.924 to 1.042
€5000–€10 000	1696 (9.4)	62 727	2.7 (2.6 to 2.8)	0.850, 0.800 to 0.905	0.948, 0.890 to 1.009
€11 000–€21 000	1665 (9.0)	62 684	2.7 (2.5 to 2.8)	0.857, 0.806.0.912	0.986, 0.923 to 1.052
≥€22 000	1614 (8.6)	63 788	2.5 (2.4 to 2.7)	0.838, 0.787 to 0.897	0.991, 0.922 to 1.065
All-cause mortality					
Maximum personal annual income quintiles					
<€1000	14 078 (66.9)	64 831	21.7 (21.4 to 22.1)	Reference	Reference
€1000–€4000	9919 (54.6)	62 133	16.0 (15.7 to 16.8)	0.741, 0.722 to 0.760	0.841, 0.820 to 0.863
€5000–€10 000	7987 (44.2)	64 006	12.5 (12.2 to 12.8)	0.580, 0.564 to 0.596	0.730, 0.709 to 0.751
€11 000–€21 000	7288 (40.0)	64 041	11.3 (11.1 to 11.6)	0.529, 0.515 to 0.545	0.690, 0.670 to 0.711
≥€22 000	6683 (35.5)	64 946	10.3 (10.0 to 10.5)	0.478, 0.464 to 0.492	0.611, 0.590 to 0.632

Risk estimates are subdistributional HR or HRs with 95% CI.

or adverse events. The prognostic impact of personal income on the outcome of AF patients may be explained by non-healthy lifestyle which per se may be the underlying cause of AF. This in turn may be associated with a reduced trigger to access to health services also in countries like Finland with free access to health services. Low income patient population may be less prone to ablation therapy and the adherence to drug treatment for maintaining sinus rhythm, and preventing thromboembolism may be suboptimal. Therefore, low personal income should be considered when planning treatment strategies in AF patients, particularly among those at working age.

In this analysis, age was inversely related with maximum personal income and the magnitude of the impact of income disparities was most evident among patients with AF <65 years (table 4, online supplemental figure 2). Low

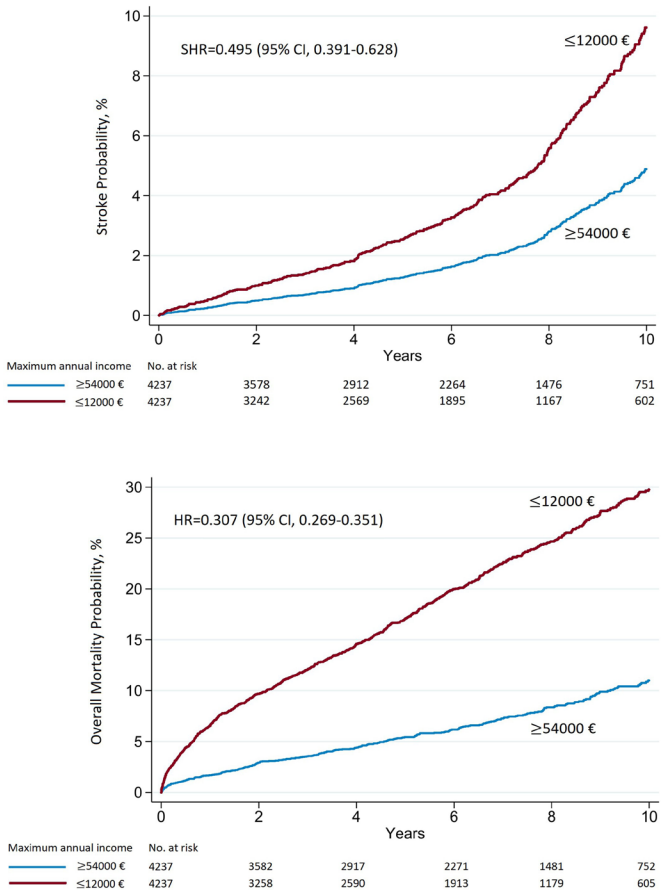

Figure 1 Competing risk and Kaplan-Meier's estimates of first-ever ischaemic stroke and all-cause mortality in the lowest and highest quintiles of maximum personal annual income among propensity score matched patients with incident atrial fibrillation aged <65 years. HR, hazard ratio; SHR, subdistribution HR; CI, confidence interval.

socioeconomic status in working age patients might have a different impact on the outcome as poor personal income is frequently related to unemployment, which itself carries a risk for poverty, individual and family distress, increased social isolation and non-healthy lifestyle as well as lack of adherence to therapies for diseases.[21] In Finland, the general retirement age for the national pension is 65 years, which means that patients aged >65 years are expected to have lower income, and therefore, its impact on adverse events is less evident. Here, we observed a difference of about 30% in 10-year mortality between the lowest and the highest income quintiles of patients with AF aged less than 65 years. Such a marked difference in overall mortality provides a clear figure of the magnitude of the effect of poor socioeconomic status on outcome of younger patients. Importantly, such differences were evident when adjusted for confounders in propensity score analysis (figure 1).

Educational level is among the main potential contributors of low income, but we observed that its negative prognostic impact may be limited in patients with AF (online supplemental figure 3, online supplemental table 2). After adjusting for other confounders, higher educational level might have contributed to lower mortality in patients aged <75 years, but it did not affect the risk of first-time ischaemic stroke. Again, AF patients with the highest educational level had significantly higher maximum personal annual income in each age stratum and its contribution to adverse events cannot be conclusively excluded. However, higher education is not always a guarantee for adequate income and healthy lifestyle. The present findings suggest income may be the ultimate barrier to optimal antiarrhythmic and anticoagulation treatment in AF.

Few studies have evaluated the effect of socioeconomic status on the incidence, treatment or outcome of AF considering several measures of social, educational and economic status at individual, family or regional levels.[10–19] Data on tax registry or self-reported personal or family income[10 16 18] or neighbourhood/regional income[11 14 17 19] have been investigated in some studies. Socioeconomic status was estimated according to a composite of individual or regional education level, housing quality, household income, employment and occupation in other studies.[12 13 15]

Despite its heterogeneous definition, socioeconomic status has been shown to univocally affect the outcome of patients with AF. This study confirmed previous findings in a large nationwide unselected cohort of patients with a long follow-up. Using patients' individual income instead of household income has significant advantages in the analysis of socioeconomic status. In fact, income includes only wages, salaries, and income from self-employment for each patient. Household income includes earnings for each household member as well as income from social security and other sources. Household income may be representative of the socioeconomic status of family members, but not necessarily of each of its members. Neighbourhood or regional socioeconomic status may introduce even a larger bias by considering the exposure within a large area, while socioeconomic conditions may be different at individual level. Furthermore, the strength of our analysis is that analyses were performed in different age strata considering individual educational level and comorbidities as potential confounders.

LIMITATIONS

The challenges inherent to the retrospective study design and use of administrative data are the main limitations of our study. Second, although the year of cohort entry was considered in all adjusted analyses, some differences in salaries during the study period might still affect the results. Third, analyses did not consider individual changes in annual income. However, we do believe that the maximum annual income may be representative of the overall socioeconomic status of these patients. Finally, even though we were able to adjust our analyses for several comorbidities obtained from nationwide registries, other unmeasured confounders might have had an impact on the socioeconomic status of the patients and their outcomes. In particular, the lack of information on lifestyle and clinical biomarkers in these patients does not allow a more in depth analysis of these relevant risk factors.

CONCLUSIONS

Personal annual income has a significant impact on 10-year rates of first-ever ischaemic stroke and overall mortality among patients with AF, particularly among patients <65 years. Low personal income should be considered when planning strategies to improve the outcome of patients with AF, particularly those at working age.

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Patient consent for publication Not applicable.

Ethics approval The study protocol was approved by the Ethics Committee of the Medical Faculty of Helsinki University, Helsinki, Finland (no. 15/2017) and granted research permission from the Helsinki University Hospital (HUS/46/2018). Respective permissions were obtained from the Finnish register holders (KELA 138/522/2018; THL 2101/5.05.00/2018; Population Register Centre VRK/1291/2019-3 and Tax Register VH/874/07.01.03/2019)). The patients' identification numbers were pseudonymised, and the research group received individualised, but unidentifiable data. Informed consent was waived due to the retrospective registry nature of the study. The study conforms to the Declaration of Helsinki as revised in 2002.

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