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Country of birth and risk of hospitalization due to heart failure: A Swedish population-based cohort study

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Abstract

Aims: To explore the relation between country of birth and risk of hospitalization due to heart failure (HF).

Methods and Results: All 40 to 89 year-old inhabitants in the city of Malmö, Sweden (n=114,917, of whom 15.2% were born outside Sweden) were followed from November 1st, 1990 until December 31st, 2007. During a mean follow-up of 13.5±5.3 years, a total of 7,640 individuals (47.4% men) were discharged from hospital with first-ever HF as primary diagnosis. Of them, 1,243 individuals had myocardial infarction (MI) before or concurrent with the HF hospitalization. The risk of HF was compared between immigrants from selected countries and Swedish natives. The overall analysis showed substantial differences among immigrant groups (p<0.001).

Compared to Swedish natives, significantly increased HF risk was found among immigrants from Finland (HR (hazard ratio): 1.40; 95% CI, 1.10-1.81), Former Yugoslavia (1.45: 1.23-1.72) and Hungary (1.48: 1.16-1.89), taking age, sex, marital status, annual income and housing condition into account. Analysis results were similar when cases with MI before or concurrent with the HF hospitalization were included in the analysis. In general, the risk of HF was significantly higher among immigrants from high-income and middle-income countries. Marital status, annual income and housing condition were also significant independent risk factors for HF in this population.

Conclusion: There are substantial differences in risk of hospitalization due to HF among immigrants from different countries that can not be explained by socioeconomic factors. To what extent these differences could be explained by biological risk factors remains to be explored.

Keywords: epidemiology, cohort study, heart failure, immigration

Introduction

Heart failure (HF) is one of the leading causes for morbidity and mortality, particularly in elderly (1, 2). In Europe, it is estimated that at least 15 million patients have HF (3). In Sweden, HF is the most common hospitalization diagnosis in subjects aged 65 and over, and the total annual costs for HF management are approximately 2% of the Swedish health care budget (4). HF can be the result of various cardiac diseases; however, most cases of HF are caused by hypertension or coronary heart disease (CHD) (1, 5-7).

Immigration to Sweden has increased markedly during the last decades, especially of refugees during the Balkan wars in the 1990s, from the Middle East in the first decade of this millennium and of labour immigrants from the European Community. Previously the labour immigration has been very restricted with exception from the Nordic countries, which have been without barriers, dominated by the Finns. The proportion of foreign-born people in Sweden increased from 9.2% in 1990 to 13.8% in 2008 (8). The corresponding figures in Malmö, the third largest city in Sweden, were 16% to 28% (8). It has been reported that foreign-born compared to Swedish-born people have higher risk for and higher mortality rate from cardiovascular disease (CVD) (9-11). Incidence of HF among immigrants in Sweden is however largely unknown.

Previous studies from Malmö have shown that there are substantial differences in risk of CVD between residential areas with high and low proportion of immigrants (12-15). The purpose of the present population-based study is to explore the relationship between country of birth and risk of HF hospitalizations after taking age, sex and socioeconomic indicators into account.

Methods

Study population and follow up

November 1st, 1990, a total of 118,134 subjects, aged 40 to 89 years, were registered as residents in the city of Malmö. After excluding subjects with history of myocardial infarction (MI) (n=2,133) or those who were hospitalized due to HF (n=1,714) before November 1st 1990, 114,917 (50,981 men and 63,936 women) subjects remained. All subjects were followed from November 1st, 1990 until first hospitalization attributable to HF, MI, death, emigration from Sweden, or December 31st, 2007, whichever came first. Since HF is very uncommon in young subjects, the study was restricted to individuals aged 40 to 89 years (6).

Population Registers

Information about the background characteristics was retrieved from the National Swedish Census Data ("Folk- och bostadsräkning, FoB") in 1990 (16). This survey is a total register of the Swedish population November 1st, 1990, and includes information on marital status, rented and self-owned homes, annual income and country of birth. This database consists of information from a mailed self-administered questionnaire and data from other population registers. Failure to complete and return the questionnaire was associated with a financial penalty. Information on annual income was retrieved from the Swedish income register, i.e. assessment of taxes in 1991 (i.e. for the income year 1990). Information on country of birth and marital status were retrieved from the Swedish total population register (TPR). Information on education, occupation and housing condition were based on self-reported questionnaires. The response rate of the questionnaire was 97.5%. Information about migration and deaths during the follow-up period was retrieved from the Swedish TPR and the Swedish Cause of Death Register.

HF cases were retrieved by record linkage with the Swedish Hospital Discharge Register (SHDR) (17). Subjects with a hospital discharge diagnosis of HF (International Classification of Diseases, ICD, 8th code 427.00, 427.10, 428.99; ICD, 9th code 428; and ICD, 10th code I50, I11.0, respectively) as the primary diagnosis were considered to have HF. As previously reported from this study population, cases of acute MI was retrieved by record linkage with registers of hospital discharges and deaths in accordance to diagnosis criteria used in the National MI register (18). A validation study, at the National Board of Health and Welfare in Sweden, has shown that the diagnosis of MI in the SHDR is valid in 90-95% of the cases (19). Subjects with non-fatal MI were followed until the day of infarction and censored thereafter. In addition, risk of HF was explored for all HF cases, including those with MI during the follow-up. Non-fatal MI was defined as 410 (ICD-9) or I21, I22 (ICD-10). The data from 1983-1990 prior to November 1st, 1990 were used to exclude subjects with previous hospitalization due to HF or MI. In a study that reviewed hospital records of patients with HF according to the Swedish hospital discharge register, it was shown that the validity was 95% if HF was the primary diagnosis, irrespective of clinical type (17). In that study a review board examined the validity of the diagnosis according to European Society of Cardiology definition of HF (20). No major difference in validity was found whether patients had been treated at an internal medicine or cardiology clinic (86% and 91%, respectively) (17).

Country of birth

Information about country of birth was available for 99.96% of the population (51 missing). Immigrants from countries (i.e. USA, Iraq, Ghana, etc) for which the total follow-up time was less than 2,500 person years were excluded. As in a previous study from this cohort, the Peoples Republic of China and Vietnam were grouped into one category (21). Thus, selected countries in the analysis contained 98.1% of the cohort.

In an additional analysis, country of birth was also categorized into high income countries (i.e. <= $610), middle income countries (i.e. $611-$7,620) and low income countries (i.e. > $7,620) based on 1990 GNI (Gross national income) per capita in US$(22), Table 1.

Socioeconomic status

Socioeconomic indicators used for the analysis were marital status, total annual income and housing status as previous studies have shown their association with HF (23-29).
Marital status was categorized into married, single, divorced, or widowed (21). The total annual income 1990 (in Swedish Kronor (SEK)) was categorized into 6 categories: 0 to 50,000; 50,100 to 100,000; 100,100 to 150,000; 150,100 to 200,000; 200,100 to 250,000; and >250,000 SEK per year. In November 1st, 1990, $1 corresponded to 5.62 SEK.

Annual income might not fully reflect the socioeconomic differences among people, i.e. retired people or women with low income in the high income household. Therefore, the results were also adjusted for housing status. Housing status was grouped into self-owned home (house or apartment) or rented home. Among the population, 55.6% owned their house or apartment, and 40.5% rented their apartment first or second hand. Subjects with missing data on housing status (3.9%) were in the analysis coded in a separate category.

Statistics

Hazard ratios (HR), with 95% confidence interval (CI) were calculated using Cox proportional hazards regression models. In terms of country of birth, Sweden was used as the reference group in all analysis. HRs were first adjusted for baseline age and sex, then additionally adjusted for marital status (4 categories), annual income (6 categories) and housing status (3 categories). Possible interaction between age and income, and between

country of birth and sex, respectively, on risk of HF was explored by introducing interaction terms in the multivariate models. Analysis involved the computer software SPSS (15.0). This study was approved by the Lund University Ethics review Committee (LU 78-02 and 2009/46).

Results

Baseline characteristics of study cohort

Baseline characteristics of Swedish natives and selected immigrant groups are presented in Table 1. Overall, mean (SD) age of participants at entry was 60.8 ±13.2 years and 55.6% (n=63,936) were women. A total of 99,976 subjects were born in Sweden and 15.9% outside Sweden, of whom 25% in other Nordic countries.

Incidence of MI in relation to immigration to Sweden

During the 16 year follow-up period 12,712 subjects (6,924 men and 5,788 women) had an acute MI. The incidence was 103 in men and 67 in women, respectively, per 10,000 person-years. Foreign born subjects had a higher risk for MI as compared to subjects born in Sweden (HR: 1.08; 95% CI: 1.02-1.14, p=0.008), taking age, sex and socio-economic indicators into account.

Risk of hospitalization due to HF in relation to country of birth

During a mean follow-up of 13.5±5.3 years, a total of 7,640 individuals (3,624 men and 4,016 women) were discharged from hospital with first time HF as primary diagnosis. The incidence of hospitalized HF per 10,000 person-years was 53 in men and 46 in women, respectively. Incident HF increased significantly and linearly by age, in 5-year age groups from 3 per 10,000 person-years aged 40-44 years to 267 per 10,000 person-years aged 85-89 years

(p<0.001). Of the 7,640 cases with HF, 1,243 (677 men and 566 women) had an MI before or concurrent with the hospitalization of HF. The latter group was censored at the time of the infarction in the first analysis.

The overall analysis showed substantial differences in risk in terms of hospitalization due to HF between countries of birth (p<0.001, 19df), Table 2. Adjusted for age and sex, the risk of HF was significantly higher among immigrants from Finland, Denmark, Former Yugoslavia and Hungary compared to Swedish natives. This risk increase remained among immigrants from Finland (HR: 1.40; 95% CI, 1.10-1.81), Former Yugoslavia (HR: 1.45; 1.23-1.72) and Hungary (HR: 1.48; 1.16-1.89), after taking marital status, annual income and housing conditions into account, Table 2.

The results were only marginally changed when HF cases with incident MI before or concurrent with hospitalization for HF (n=1,243) were included in the analysis, i.e. the risk increase for HF remained among immigrants from Finland (HR: 1.42; 1.13-1.78), Former Yugoslavia (HR: 1.34; 1.14-1.57) and Hungary (HR: 1.41; 1.12-1.77), Table 2.

In addition, 960 subjects died outside hospital with HF as the underlying death cause. These potential HF cases had no prior hospitalization due to HF, however including them as cases in the multivariate analysis did only marginally affect the results and immigrants from Finland, Hungary and Former Yugoslavia has significantly increased risk for HF (data not shown).

Risk of hospitalization due to HF in relation to age, sex and socioeconomic indicators

Age and male sex were, independently of marital status, housing condition and annual income, related to an increased risk of HF hospitalization, Table 3. Single, divorced and widowed compared to married subjects were also independently associated with increased risk for

hospitalization due to HF. In addition, renting house and low annual income were associated with higher risk for HF. Excluding subjects with missing information on housing conditions (i.e. 3.9%) did only marginally change the results, i.e. the significantly risk increase for HF remained among immigrants from Finland, Former Yugoslavia and Hungary.

There was a significant interaction ($p<0.001$) between annual income and age on risk of HF hospitalizations. When stratifying the cohort under and equal or above 65 years the effect of income on risk for HF was higher for younger than elderly subjects (data not shown). No significant interaction ($p=0.368$) between country of birth and sex on risk of HF hospitalization was observed.

Additional analysis

Additional analyses were performed by categorizing country of birth for immigrants into high, middle and low income countries. When the analysis was restricted to risk of HF hospitalization without previous or concurrent MI, a significant higher risk, compared to Swedish natives, was observed among immigrants from high-income countries (HR: 1.12; 1.01-1.25) and middle-income (HR: 1.14; 1.02-1.26). This risk increase was independent of age, sex, marital status and socioeconomic indicators. Including HF cases with MI (n=1,243) before or concurrent with HF during the follow-up in the analysis did only marginally change the results, Table 2, Figure 1.

Discussion

Our analysis of prospective associations between country of birth and risk of hospitalization due to HF has yielded some novel and potentially important findings. First, we have demonstrated that immigrants from Finland, Former Yugoslavia, and Hungary, compared to

Swedish-born subjects had significantly higher risk for hospitalization due to HF. These differences persisted when taking socioeconomic factors into account. Secondly, in an additional analysis we also found that the risk for HF among immigrants from high- and middle-income countries was significantly higher than their counter parts. These findings are in line with previous studies showing substantial differences in immigration, country of birth and incidence of CVD in other countries and in Sweden (2, 9-11, 30-32). In Malmö, Sweden and in other cities, residential areas with high proportion of immigrants are often characterized by high incidence of CVD (12-15). The increased cardiovascular risk among immigrants in this population is consistent with what have been reported previously from other Swedish studies (9-11).

There are several possible explanations of the findings in the present study. First, the observed increased risk of HF hospitalizations among immigrants from Finland, Former Yugoslavia and Hungary might reflect influences from their countries of origin. Most cases of HF are caused by hypertension or CHD (1, 5-7). There are substantial differences in CVD mortality between countries and regions, Eastern European countries generally have high rates of CVD or CHD mortality (33). In Hungary an increasing CVD mortality have been reported from the early 1970s, with the highest mortality rate in 1985. (34). Elevated body mass index, high intake of saturated fat and salt have been suggested as possible risk factors explaining the high risk for CVD among Hungarians (35). High incidence of CVD has also been reported in Finland and former Yugoslavia (33). Hence, we can not exclude the possibility that high CVD risk of their country of origin might explain, at least partly, the increased risk of hospitalization due to HF among immigrants from Finland, Former Yugoslavia, and Hungary in our study.

Secondly, another possible explanation could be different circumstances and reasons to migrate to Sweden. During 1965-1973 former Yugoslavians were often recruited by Swedish companies as labour immigrants with low skilled jobs, and from 1973 to 1990s, when the labour immigration was stopped, they often immigrated to Sweden for family reunion and as asylum. After the politic instability in Hungary 1956, many Hungarian immigrants came to Sweden as refugees. Finnish immigrants came to Sweden as labour migrants from 1945 to 1970s. This suggests that immigrants from the above mentioned countries to Sweden could be regarded as selected groups. To what extend this matter might influence risk of HF is unclear. In addition, before the baseline examination in 1990 the majority of all these three immigration groups have lived in Sweden at least 20 years or more. One could assume that the high risk for hospitalization due to HF in the present study might also be the result of stress from cultural and psychosocial change to acculturate and integrate into the Swedish society. However, another Swedish study has shown that Finnish labour migrants had higher risks for MI compared to Swedish natives, and that this increased risk still remained after 20 years in Sweden (36).

Third, another explanation could be associated with low socioeconomic status of immigrants compared to Swedish natives. It has been shown that Former Yugoslavians had disadvantage in labour markets compared to native Swedes (37). In addition it also matters where you live, as substantial socioeconomic differences between residential areas in cities have been demonstrated. In the city of Malmö, Sweden, residential areas with low socioeconomic circumstances and high proportion of immigrants have been characterized by high incidence of CVD (12-15). International and national studies have reported that prevalence of cardiovascular risk factors is associated with socioeconomic status (12, 38-40). In a Swedish study rented home was associated with cardiovascular mortality (40). In the present study,

risk of HF was related to socioeconomic status. However, when several socioeconomic indicators were adjusted for in the analysis, the observed difference in risk of HF among immigrants from Finland, former Yugoslavia and Hungary still remained. This suggests that the increased risk of HF in these groups is not completely mediated by the socioeconomic indicators in this study. On the other hand, the significantly increased risk of HF for Danish subjects was reduced and non-significant when adjusted for SES, which suggest that socioeconomic circumstances still play a role.

Strength and limitation

It is important to be aware of strength but also limitations in the study design, measurement procedures, and methodological issues that might influence the interpretation of the results. Rates of first hospitalizations due to HF, as presented in Table 2, were consistent with what have been reported by others (41). In that study the crude incidence for different populations ranged from 1.0-5.0 per 1000 person-years in the general population (41). Some methodological issues should also be considered. Sweden has a health care system which is financed by the community, and no insurance is needed. According to recently published Swedish studies, the Swedish health care system has achieved equality in the care and treatment of patients with HF (42, 43). In these studies symptom recognition and health care seeking were rather similar among immigrants and natives Swedes who were hospitalised due to HF (42, 43). In the city of Malmö there is only one hospital and patients from all residential areas can reach the hospital within 15 minutes, so the availability of the hospital could be regarded to be similar for all patients.

Emigration, vital status and hospitalizations at the end of the follow-up were up-dated on all individuals by data linkage with regional and national registers. The completeness and

validity of these registers have been documented in several other studies from the city (12, 21). We were unable to include cases of HF which are diagnosed and treated as out of hospital patients. Thus, we cannot draw any conclusions about less severe cases. Since all cases were treated in-hospital with a primary diagnosis of HF, we can assume that the diagnosis was valid and that the HF was quite severe in most cases (44). Furthermore, a validation study of cases retrieved from the Swedish hospital discharge register has shown that the validity of the diagnosis was 95%, irrespective of clinic type, if HF was the primary diagnosis (17). We also included those 960 subjects who died outside hospital with HF as the underlying death cause as potential HF cases, however this did only marginally affect the results. In addition, the large number of individuals and events, and the complete and reliable data about the background population are considerable study strengths. The main limitation of the present study is that we lack information on cardiovascular risk factors, e.g. blood pressure, dietary habits, smoking habits and physical activity patterns. However, to collect these data from a complete urban population is not possible.

We did not observe any risk increase for hospitalization due to HF among immigrants from low-income countries. However, only 16 events was observed in this group (n=600) limiting the statistical power due to few events.

Information on country of birth was available for almost all study subjects. Those who during the follow-up emigrated were censored at the time of emigration. However, re-migration from Sweden without reporting to the authorities could possibly exaggerate the population at risk and cause low risk estimates for some immigrant groups. A report from Sweden Statistics estimated that ~ 25000 to 50000 foreign-born individuals who officially live in Sweden have left the country (45). A previous study from the present cohort explored whether exclusion of

individuals without income, according to the assessments of taxes, had any impact on the relationships between country of birth and incidence of disease (21). No major influence on hazards ratios for incident stroke was found in that study. Therefore, we believe that a re-migrant effect is a minor problem in our study and should not explain the observed increased risk for HF related to country of birth.

Finally, it is also possible that the chosen SES indicators (i.e. housing conditions, annual income and marital status) in the present study do not fully eliminate the effect of SES on hospitalization due to HF. Information on annual income and marital status in the present study was based on data from the TPR; however, housing conditions was questionnaire-based and self-reported. Annual income might not fully reflect the socioeconomic differences for all people, e.g. retired people or women with low income in households with high income. However, we lacked information for example on household income and psychosocial stressors. The latter is known to vary by social position (46). It could also be discussed whether socio-economic circumstances are mediators, rather than confounders, in the relationship between country of birth and HF.

In conclusion, there are substantial differences in risk of hospitalization due to HF among immigrants from different countries that can not be explained by socioeconomic factors. Immigrants from Finland, Former Yugoslavia and Hungary had compared to Swedish natives significantly higher risk. To what extent these differences could be explained by biological risk factors remains to be explored.

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Conflict of interest: none declared.

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Legend to figure 1. Age- and sex-adjusted risk for hospitalization due to HF in relation to country of birth of immigrants and annual income based on 1990 GNI (Gross National Income).

Table 1. Baseline characteristics of 40-89 years old Swedish natives and selected immigrant groups by country of birth, living in Malmö, Sweden, 1990.

Country of Birth	**N**	**Men (%)**	**Mean Age (years)**	**Married (%)**	**Self-owned Home (%)**	**Mean Income (1000 SEK)**	**Mean Years in Sweden (years)**
Sweden	96674	44	62±13	54	58	136	-
Denmark (1)	2639	46	60±11	48	46	118	20
Finland (1)	1392	40	55±10	42	52	121	21
Norway (1)	513	44	60±12	43	43	113	20
Germany (1)	1484	41	61±12	52	57	125	22
Austria (1)	221	48	59±12	57	57	123	21
Italy (1)	238	70	55±10	63	52	120	21
Former Yugoslavia (2)	3372	52	53±9	63	34	111	19
Poland (2)	2221	36	55±13	45	41	94	14
Portugal (2)	236	51	53±8	72	46	116	20
Romania (2)	392	50	55±11	58	25	78	7
Hungary(2)	1128	55	56±11	52	48	115	19
Former Soviet Union (2)	475	40	62±13	47	45	107	18
Czechoslovakia (2)	447	52	55±11	46	45	107	17
Turkey (2)	213	55	53±11	59	10	93	16
Greece (2)	284	56	53±9	67	19	97	17
Iran (2)	237	57	50±10	58	10	31	3
Chile (2)	337	46	51±10	38	22	87	9
China, Vietnam (3)	284	46	57±13	69	12	51	8
Countries with p-y < 2500	2130	58	53±11	51	32	93	13
Total	114917	44	61±13	53	56	132	17
Country according to income							
Sweden	96674	44	62±13	54	58	136	-
High-income countries (1)	7439	45	59±12	48	49	118	20
Middle-income countries (2)	10153	49	54±11	55	35	100	16
Low-income countries (3)	600	61	52±12	59	17	70	10
Not applicable #	51	61	61±13	43	29	84	12
Total	114917	44	61±13	53	56	132	17

Figures are shown as mean (SD) or as proportions

SEK, Swedish Kronor

Missing data on country of birth

Number attached to each specific country belonged to country classification according to GNI (Gross National Income)

Table 2. Incidence and risk of hospitalization due to heart failure in relation to country of birth.

	HF excluding previous MI			**HF including previous MI**		
Country of Birth	**n (per 10,000 p-y)**	**HR* (95% Cl)**	**HR† (95% Cl)**	**n (per 10,000 p-y)**	**HR* (95% Cl)**	**HR† (95% Cl)**
Sweden	5589 (44)	Reference	Reference	6677 (51)	Reference	Reference
Denmark	149 (43)	1.25 (1.07-1.48)	1.16 (0.99-1.37)	177 (51)	1.23 (1.06-1.43)	1.13 (0.98-1.32)
Finland	64 (32)	1.52 (1.19-1.94)	1.40 (1.10-1.81)	78 (39)	1.52 (1.22-1.91)	1.42 (1.13-1.78)
Norway	24 (35)	0.95 (0.64-1.42)	0.90 (0.61-1.36)	28 (41)	0.92 (0.63-1.33)	0.88 (0.61-1.28)
Germany	90 (45)	1.16 (0.94-1.43)	1.13 (0.92-1.39)	109 (55)	1.17 (0.97-1.42)	1.14 (0.94-1.38)
Austria	7 (23)	0.69 (0.33-1.45)	0.66 (0.31-1.38)	7 (25)	0.57 (0.27-1.20)	0.55 (0.26-1.15)
Italy	8 (23)	0.94 (0.47-1.87)	0.85 (0.42-1.69)	11 (31)	1.04 (0.58-1.88)	0.94 (0.52-1.69)
Former Yugoslavia	144 (29)	1.72 (1.45-2.03)	1.45 (1.23-1.72)	164 (33)	1.58 (1.35-1.85)	1.34 (1.14-1.57)
Poland	100 (31)	1.20 (0.99-1.46)	1.05 (0.86-1.28)	119 (37)	1.18 (0.98-1.41)	1.03 (0.86-1.24)
Romania	17 (30)	1.36 (0.84-2.19)	1.12 (0.69-1.80)	22 (38)	1.41 (0.93-2.15)	1.17 (0.77-1.78)
Hungary	65 (41)	1.65 (1.29-2.10)	1.48 (1.16-1.89)	76 (48)	1.57 (1.25-1.97)	1.41 (1.12-1.77)
Former Soviet Union	31 (47)	1.11 (0.78-1.57)	1.04 (0.73-1.48)	35 (56)	1.04 (0.75-1.46)	0.98 (0.70-1.37)
Czechoslovakia	14 (21)	0.85 (0.51-1.44)	0.76 (0.45-1.29)	20 (30)	1.01 (0.65-1.55)	0.90 (0.58-1.40)
Turkey	6 (19)	0.86 (0.39-1.92)	0.70 (0.31-1.55)	8 (25)	0.94 (0.47-1883)	0.76 (0.38-1.53)
Greece	3 (8)	0.47 (0.15-1.45)	0.39 (0.13-1.20)	7 (17)	0.89 (0.42-1.86)	0.73 (0.35-1.54)
Iran	6 (16)	1.05 (0.47-2.34)	0.78 (0.35-1.74)	9 (24)	1.27 (0.66-2.45)	0.96 (0.50-1.85)
Chile	8 (16)	1.01 (0.50-2.01)	0.79 (0.39-1.58)	9 (18)	0.92 (0.48-1.78)	0.73 (0.38-1.40)
China, Vietnam	9 (22)	0.77 (0.40-1.48)	0.62 (0.32-1.20)	10 (24)	0.71 (0.38-1.32)	0.58 (0.31-1.07)
p value (df=19)		*p*<0.001	*p*<0.001		*p*<0.001	*p*<0.001
Country according to income						
Sweden	5589 (44)	Reference	reference	6677 (51)	reference	reference
High-income countries	377 (37)	1.19 (1.07-1.32)	1.12 (1.01-1.25)	451(44)	1.18 (1.07-1.30)	1.11 (1.01-1.22)
Middle-income countries	415 (28)	1.31 (1.19-1.45)	1.14 (1.02-1.26)	493 (33)	1.28 (1.16-1.40)	1.10 (1.01-1.21)
Low-income countries	16 (18)	0.91 (0.56-1.49)	0.74 (0.45-1.22)	19 (21)	0.89 (0.57-1.39)	0.73 (0.46-1.14)
p value (df=4)		*p*<0.001	*p*= 0.023		*p*<0.001	*p*=0.035

HF, heart failure; MI, myocardial infarction; HR, hazard ratio; CI, confidence interval; p-y; person-years

* HR adjusted for age and sex

† HR adjusted for age, sex, marital status, annual income and self-owned home

Table 3. Risk of hospitalization due to heart failure in relation to age, sex and socioeconomic status at baseline

	HF excluding previous MI HR† (95% Cl)	**HF including previous MI HR† (95% Cl)**
Age		
Per year	1.11 (1.10-1.12)	1.11 (1.10-1.11)
p value	*p*<0.001	*p*<0.001
Sex		
Woman	reference	reference
Man	1.99 (1.88-2.11)	2.08 (1.98-2.20)
p value	*p*<0.001	*p*<0.001
Marital Status		
Married	reference	reference
Single	1.16 (1.07-1.26)	1.10 (1.02-1.18)
Divorced	1.18 (1.09-1.28)	1.19 (1.10-1.27)
Widowed	1.20 (1.12-1.28)	1.19 (1.12-1.27)
p value	*p*<0.001	*p*<0.001
Housing Condition		
Self-owned	reference	reference
Rented	1.16 (1.10-1.22)	1.16 (1.11-1.21)
p value	*p*<0.001	*p*<0.001
Annual Income (SEK)		
0 to 49,000	reference	reference
50,000 - 100,000	0.99 (0.93-1.07)	1.01 (0.94-1.07)
100,100- 150,000	0.85 (0.78-0.92)	0.86 (0.80-0.93)
150,100-200,000	0.66 (0.60-0.74)	0.67 (0.61-0.74)
200,100 - 250,000	0.53 (0.45-0.61)	0.52 (0.46-0.60)
>250,000	0.56 (0.48-0.66)	0.55 (0.48-0.63)
p value	*p*<0.001	*p*<0.001

HF, heart failure; MI, myocardial infarction; HR, hazard ratio; Cl, confidence interval

† HR adjusted for age, sex, and when appropriate for marital status, annual income and self-owned home

Figure1. Age- and sex-adjusted risk for hospitalization due to HF in relation to country of birth of immigrants and annual income based on 1990 GNI (Gross National Income).