Comparison of Framingham 10-Year Cardiovascular Event Risks in Native- and Foreign-born Primary Healthcare Populations in Sweden

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Abstract

Background

The prevalence of cardiovascular disease (CVD) around the world varies by ethnicity and region of birth. Immigrants living in Sweden may have a higher prevalence of CVD than native-born Swedes, but little is known about their actual risk of cardiovascular events (CVE). The Framingham Risk Score (FRS) uses cardiovascular risk factors to estimate the 10-year CVE risk. The aim of this study was to examine the relationship in Sweden between an elevated 10-year CVE risk and both birthplace and other risk factors.

Methods

This cross-sectional study was based on CVD risk factor data obtained from the 4D Diabetes Project, a Programme 4D subproject in Sweden. Participants were recruited from two primary healthcare centres in Stockholm, from 2013 through 2015, were between 18 and 74 years old, had no history of diabetes or pre-diabetes, and were divided into two birthplace groups (Sweden-born and foreign-born, the largest group born in the Middle East). FRS was calculated and 10-year CVE risk was determined for each participant. Logistic regression analysis was performed to generate odds ratios (OR) for the outcome, an elevated ($\geq 10\%$) risk of CVE within 10 years.

Results

Of the 830 participants in the study, 170 (20.5%) had an elevated 10-year CVE risk. A significantly higher proportion of Sweden-born (vs. foreign-born) participants had an elevated 10-year CVE risk (35.6% vs. 12.9%; $P < 0.0001$). Foreign-born participants had a significantly lower mean age (45.6 vs. 55.8 years, $P < 0.001$), but a significantly higher proportion were smokers (23.9% vs. 13.7%; $P = 0.001$). Participants born in Sweden (vs. foreign-born) were almost two times more likely to have an elevated 10-year CVE risk, even when adjustments were made for age, sex, education, waist circumference, and high-sensitivity C-reactive protein level (Adjusted OR=1.73; 95% CI, 1.10-2.77).

Conclusions

In Sweden, native-born participants were more likely to have an elevated 10-year CVE risk than those born in other countries (including the Middle East). These results contradict reports of higher rates of CVD in Middle-Eastern countries than in Sweden. A cardiovascular risk scoring system modified for region of birth or ethnicity may be needed in Sweden.

Permit

An ethical permit was granted by the Regional Ethical Review Board in Stockholm, review number 2013/2303-31/3.

Introduction

Cardiovascular disease (CVD) is the leading cause of death globally, responsible for an estimated 17.9 million deaths annually, and contributing to one-third of all deaths in the world (1, 2). An important non-modifiable risk factor for CVD is genetic preposition, which includes sex (3). Nevertheless, modifiable risk factors also play a huge role in CVD, as demonstrated by the fact that they are estimated to collectively cause more than half of all cardiovascular deaths (4). In a study of patients from 52 countries, more than 90% of all first-time myocardial infarctions were attributable to one or more of nine modifiable risk factors, including tobacco smoking, hypertension, dyslipidaemia, diabetes, obesity, psychosocial factors, inadequate physical activity, alcohol consumption, and poor diet (3, 5).

Other risk factors may also play a role in CVD. High-sensitivity C-reactive protein (hs-CRP) levels greater than 3 mg/L have been linked to a higher incidence of adverse cardiovascular events (CVE) (11). Even hs-CRP levels greater than 2.1 mg/L have been associated with increased CVE risk (10). CRP binds to LDL, is present in atherosclerotic plaques, and likely plays a role in monocyte adhesion to blood vessel walls (10, 12). Yet, there have been other animal and human studies that have found no causal link between overexpression of CRP and cardiovascular risk (13, 14). The role of hs-CRP as a risk factor for CVE remains unclear.

Various combinations of risk factors have been used to calculate CVD risk scores, including the Systematic Coronary Risk Evaluation (SCORE), Prospective Cardiovascular Münster (PROCAM), Turkish Adult Risk Factor Study (TEKHARF), and Framingham (FRS) risk scores. The scores are then used to estimate the risk of a patient having a CVE within a designated period of time. The FRS combines several well-established cardiovascular risk factors to determine an estimation of the risk of having a CVE within 10 years (22–24). It has been used in Sweden for both research (22–26) and clinical care (27). It can be used to guide whether to initiate suitable risk-reducing therapies, such as statin or anti-hypertensive medications, as part of clinical care. A particular strength of the FRS is that it considers both systolic and diastolic blood pressure (BP), as well as both LDL-C and high-density lipoprotein (HDL) levels (24), whereas, for example, SCORE considers only systolic BP and total cholesterol levels (27).

The prevalence of CVD, around the world, measured in a variety of ways, varies by ethnic background and region of birth (15–17). Within Sweden, the prevalence of CVD in different immigrant populations also varies substantially (18–21, 30, 31), but most of the studies reporting those results are now more than a decade old. One of those observed a higher prevalence of CVD in Swedish residents born in the Middle East than in those born in Sweden (20). However, another noted that immigrants living in Sweden had a lower prevalence of CVD than comparable populations in their countries of birth (21). In contrast, a 2016 publication reported that non-Western immigrants living in Sweden had a significantly lower risk of CVD-related mortality than native Swedes (18). These studies suggest that immigrant populations living in Sweden may have a higher prevalence of CVD, but a lower risk of CVD-related death, than the native-born Swedish population. With these somewhat contradictory observations in mind, there appears to be a need for an updated evaluation of CVD and 10-year CVE risk estimates in immigrant populations living in Sweden.

The primary aim of this study was to examine the relationship between having an elevated 10-year risk of CVE risk and birthplace (Sweden or foreign), in primary healthcare patients living in Sweden. The secondary aim was to determine whether there were any significant associations in these populations between an elevated 10-year CVE risk and other potential CVD risk factors that are not part of the FRS, such as age, sex, level of education, anthropometry (waist circumference), physical activity, alcohol consumption, and hs-CRP levels.

Methods

Study population

This cross-sectional study was based on data obtained from the '4D Diabetes Project: Screening and Treatment of Prediabetes and Diabetes in Primary Care – A Pilot Study', a Programme 4D sub-project conducted by the Karolinska Institutet and the Stockholm County Council. Participants were recruited for the study from two primary healthcare centres (PHCC) in Stockholm. Participants were offered inclusion in the study if they were between 18 and 74 years old and had no previous history of diabetes or pre-diabetes. The Jakobsberg and Flemingsberg PHCCs were selected because large portions of their patient populations were born outside of Sweden, and particularly outside of Europe.

Data acquisition

Data were collected from participants at the two PHCCs from 2013 through 2015. At the first visit, each participant was interviewed to obtain information about demography, country of birth, level of education, and self-reported health and lifestyle habits (physical exercise, smoking, and alcohol consumption). During that visit, BP and waist circumference were measured, and a capillary haemoglobin A1c (HbA1c) test was performed. When participants returned for a second visit, fasting blood samples were obtained, and these were analysed for serum levels of total cholesterol, HDL, calculated LDL-C, triglycerides, and hs-CRP. Also, another BP measurement was taken. For the purposes of our study, the mean values of the two BP readings were used. Also at that visit, each participant with an HbA1c ≥ 39 mmol/mol at the first visit was offered an oral glucose tolerance test (OGTT).

Participant characteristics

For participant characteristics that represented non-Framingham CVD risk factors, we converted some of the raw data into categorical variables. Level of education categories were 0 to 9 years, 10 to 12 years, and more than 12 years. Physical exercise initially had five response alternatives, which we collapsed into three categories: no physical activity at all, more than 0 minutes and up to 60 minutes per week, and more than 60 minutes per week. Alcohol consumption categories were less than 4 glasses a week and 4 glasses or more per week. Smoking initially had seven response options, which we collapsed into two categories: quit or never smoked and any active smoking. Diabetes had two categories: yes and no. The participant characteristics of waist circumference and hs-CRP level were employed as continuous variables in the regression analyses.

Framingham risk factors

We calculated a Framingham Risk Score (FRS) for each participant, based on six risk factors, including age, LDL-C, HDL, BP, diabetes, and smoking. Using the system described by Viera and Sheridan, points were either awarded or subtracted for each risk factor based on being above or below cut-offs, which included the following: (a) age of 35 to 39 years in men, 40–44 years in women; (b) LDL-C of 2.59 mmol/L to 4.13 mmol/L for both men and women; (c) HDL of 1.16 mmol/L to 1.54 mmol/L in men and 1.29 mmol/L to 1.54 mmol/L in women; (d) BP of 120/80 to 129/84 in men and 120/80 to 139/89 in women; (e) presence of diabetes; and f) smoking (23). A 10-year risk of CVE was then determined using total points and expressed as a percentage.

Outcome characteristics

For the purposes of this study, we defined an elevated risk for CVE within 10 years as 10% or higher (23, 25). Using this definition, the two primary (dependent) outcome variables for the study were 10-year CVE risk of 10% or higher and 10-year CVE risk lower than 10%.

Birthplace groups

We divided the participants in this study into two groups based on birthplace: (1) Sweden-born, comprised of those who were born in Sweden, with both parents also born in Sweden; and (2) Foreign-born, comprised of those who were born outside of Sweden or had at least one parent born outside of Sweden. This was based on the official definition of foreign-born used in Sweden (32).

Statistical methods

Descriptive statistics involving the prevalence of demographic, clinical, and outcome characteristics are presented as frequencies and proportions, and those involving Framingham risk factor characteristics are presented as means and standard deviations (SD). Comparisons were performed using Chi-square tests for categorical variables, T-tests for continuous variables following a normal distribution, and Wilcoxon-Rank sum tests for continuous variables not following a normal distribution. For continuous variables, 95% Confidence intervals (CI) were calculated when means were compared. Logistic regression analysis was performed to generate odds ratios (OR) and 95% CI for the outcome of an elevated 10-year CVE risk, and to generate adjusted odds ratios (AOR) for the outcome (adjusted for age, sex, education, waist circumference, physical activity, alcohol consumption, and hs-CRP levels).

A P value of 0.05 or less was considered as significant. Calculations were performed using STATA statistical software version 14.0 (StataCorp, College Station, Texas, USA).

Results

A total of 830 participants were included in the study. These participants were born in 69 different countries, with the largest portion born in the Middle East, including 86 in Turkey, 52 in Iran, and 48 in Iraq.

Participant and outcome characteristics

Of the 830 participants, 170 (20.5%) had an elevated 10-year CVE risk, based on having a Framingham 10-year CVE risk score of 10% or more (Table 1). When compared to foreign-born participants, the proportion of Sweden-born participants with an elevated 10-year CVE risk was significantly higher (35.6% vs. 12.9%; $P < 0.0001$), and the proportion with more than 12 years of education was significantly lower (47.8% vs. 57.3%; $P < 0.0001$). For Sweden-born and foreign-born participants, the mean total cholesterol levels were 5.2 ± 1.1 mmol/L and 4.9 ± 1.0 mmol/L, respectively ($P = 0.003$), the mean triglyceride levels were 1.3 ± 0.9 mmol/L and 1.4 ± 0.9 mmol/L, respectively ($P = 0.638$), and the mean waist circumferences were 99.7 ± 14.4 cm and 98.2 ± 13.9 cm, respectively ($P = 0.148$).

Table 1
Participant and outcome characteristics of 830 participants, by birthplace, Stockholm, Sweden, 2013–2015

<i>Characteristics</i>	Sweden-born n (%)	Foreign-born n (%)	P value
Participants	278 (33.5)	552 (66.5)	-
Sex^a			0.645
Male	122 (43.9)	233 (42.2)	
Female	156 (56.1)	319 (57.8)	
Education^a, years			< 0.0001
0 to 9	43 (15.5)	105 (19.3)	
>9 to 12	102 (36.7)	128 (23.5)	
>12	133 (47.8)	312 (57.3)	
Physical Activity, minutes per week			0.425
None	147 (53.1)	295(53.9)	
0 to 60	56 (20.2)	126 (23.0)	
> 60	74 (26.7)	126 (23.1)	
Alcohol, glasses per week			< 0.0001
< 4	199 (71.6)	511 (95.6)	
≥ 4	79 (28.4)	41 (7.4)	
hs-CRP^a, mmol/L			0.719
≤ 3	232 (83.5)	466 (84.4)	
> 3	46 (16.5)	86 (15.6)	
Framingham 10-year CVE Risk^b, %			< 0.0001
≥ 10	99 (35.6)	71 (12.9)	
< 10	179 (64.4)	481 (87.1)	

^a Chi-square test used to compare groups.

^b T-test used to compare groups.

Statistically significant P-values in **bold**

Abbreviations: hs-CRP, high-sensitivity C-reactive protein; CVE, cardiovascular event.

Framingham risk characteristics

Compared to Sweden-born participants, mean values for foreign-born participants were significantly lower for age (45.6 vs. 55.8 years, $P < 0.001$), LDL-C (3.0 vs. 3.1 mg/dL; $P = 0.034$), HDL (1.3 vs. 1.5 mg/dL; $P < 0.0001$), and systolic (117.8 vs. 128.4 mm Hg; $P < 0.0001$) and diastolic (75.8 vs. 78.2 mm Hg; $P = 0.001$) BP levels (Table 2). Conversely, a significantly higher percentage of foreign-born participants were smokers (23.9% vs. 13.7%; $P = 0.001$).

Table 2
Framingham risk factor characteristics for all 830 participants and by birthplace, Stockholm, Sweden, 2013–2015

<i>Risk factor characteristics^a</i>	Total Population (N = 830) mean ± SD	Sweden-born (n = 278) mean ± SD	Foreign- born (n = 552) mean ± SD	P-value
Age, years	49.0 ± 14.6	55.8 ± 15.0	45.6 ± 13.3	< 0.0001
LDL-C, mg/dL	3.0 ± 0.9	3.1 ± 0.9	3.0 ± 0.9	0.034
HDL, mg/dL	1.4 ± 0.4	1.5 ± 0.4	1.3 ± 0.4	< 0.0001
Systolic BP, mm Hg	121.4 ± 17.4	128.4 ± 18.3	117.8 ± 15.8	< 0.0001
Diastolic BP, mm Hg	76.6 ± 10.2	78.2 ± 10.4	75.8 ± 10.0	0.001
Smoking n (%)	170 (20.1)	38 (13.7)	132 (23.9)	0.001

^a Diabetes not listed because no participants had diabetes.

Abbreviations: LDL-C, low-density lipoprotein cholesterol; HDL, high-density lipoprotein; BP, blood pressure; SD, standard deviation.

Statistically significant P-values in **bold**

Framingham risk characteristics and C-reactive protein levels by sex

In the Sweden-born population, females had significantly higher mean levels of HDL (1.6 vs. 1.3 mg/dL; $P < 0.0001$) and lower mean levels of diastolic BP (76.4 vs. 80.6 mm Hg; $P = 0.001$) than males (Table 3).

Table 3
Framingham risk factor characteristics and hs-CRP levels for 278 Sweden-born participants, by sex, Stockholm, Sweden, 2013–2015

<i>Risk factor characteristics^a</i>	Total Sweden-born (N = 278) mean ± SD	Female (n = 156) mean ± SD	Male (n = 122) mean ± SD	P-value
Age, years	55.8 ± 15.0	54.9 ± 15.5	56.8 ± 14.3	0.307
LDL-C, mg/dL	3.1 ± 0.9	3.2 ± 0.9	3.1 ± 0.9	0.582
HDL, mg/dL	1.5 ± 0.4	1.6 ± 0.4	1.3 ± 0.3	< 0.0001
Systolic BP, mm Hg	128.4 ± 18.3	126.6 ± 19.4	130.8 ± 16.5	0.060
Diastolic BP, mm Hg	78.2 ± 10.4	76.4 ± 10.1	80.6 ± 10.4	0.001
hs-CRP, mmol/L	2.6 ± 4.2	2.6 ± 3.5	2.7 ± 5.0	0.800
Smoking n (%)	38 (13.7)	26 (16.7)	12 (9.8)	0.100

^a Diabetes not listed because no participants had diabetes.

Abbreviations: LDL-C, low-density lipoprotein cholesterol; HDL, high-density lipoprotein; BP, blood pressure; hs-CRP, high-sensitivity C-reactive protein; SD, standard deviation.

Statistically significant P-values in **bold**

In the foreign-born population, females had significantly higher mean levels of HDL (1.5 vs. 1.2 mg/dL; $P < 0.0001$) and hs-CRP (3.4 vs. 2.5 mmol/L; $P = 0.039$), and they had lower mean levels of systolic (115.8 vs. 120.6 mm Hg; $P = 0.0004$) and diastolic BP (74.3 vs. 77.9 mm Hg; $P < 0.0001$) than males (Table 4). In this population, a significantly lower percentage of females were smokers (19.8% vs. 29.6%; $P = 0.007$).

Table 4
Framingham risk factor characteristics and hs-CRP levels for 552 foreign-born participants, by sex, Stockholm, Sweden, 2013–2015

<i>Risk factor characteristics^a</i>	Total Foreign-born (N = 552) mean ± SD	Female (n = 319) mean ± SD	Male (n = 233) mean ± SD	P-value
Age, years	45.6 ± 13.3	45.5 ± 13.7	45.7 ± 12.7	0.876
LDL-C, mg/dL	3.0 ± 0.9	3.0 ± 0.8	3.0 ± 0.9	0.314
HDL, mg/dL	1.3 ± 0.4	1.5 ± 0.4	1.2 ± 0.3	< 0.0001
Systolic BP, mm Hg	117.8 ± 15.8	115.8 ± 16.7	120.6 ± 14.1	0.0004
Diastolic BP, mm Hg	75.8 ± 10.0	74.3 ± 9.5	77.9 ± 10.4	< 0.0001
hs-CRP, mmol/L	3.0 ± 4.8	3.4 ± 5.4	2.5 ± 3.9	0.039
Smoking n (%)	132 (23.9)	63 (19.8)	69 (29.6)	0.007

^a Diabetes not listed because no participants had diabetes.

Abbreviations: LDL-C, low-density lipoprotein cholesterol; HDL, high-density lipoprotein; BP, blood pressure; hs-CRP, high-sensitivity C-reactive protein; SD, standard deviation.

Statistically significant P-values in **bold**

Risk factors for elevated 10-year risk of cardiovascular events (CVE)

Compared to foreign-born participants, Sweden-born participants almost four times (Unadjusted OR = 3.75; 95% CI, 2.64–5.32; P < 0.0001) more likely to have an elevated 10-year CVE risk (Table 5). The relative likelihood of Sweden-born participants having an elevated 10-year CVE risk remained significantly higher, even when adjusted for age and sex (AOR = 1.62; 95% CI, 1.06–2.50; P = 0.029) or when adjusted for the group of risk factors that included age, sex, education, waist circumference, and hs-CRP level (AOR = 1.73; 95% CI, 1.10–2.77; P = 0.023). When we adjusted for physical activity and alcohol consumption, the odds ratios for having an elevated 10-year CVE risk were not statistically significant.

Regardless of birthplace, males were 4.5 times (AOR = 4.53; 95% CI, 2.94–7.00; P < 0.0001) more likely than females to have an elevated 10-year CVE risk (Table 5). Those with 10 to 12 years of education were significantly less likely (AOR = 0.48; 95% CI, 0.26–0.95; P = 0.013) to have an elevated 10-year CVE risk than those with less than 10 years of education. Larger waist circumference increased the odds of having an elevated 10-year CVE risk, but only by 3% (AOR = 1.03; 95% CI 1.01–1.04; P = 0.001). Finally, those with

hs-CRP levels greater than 3 mmol/L were over three times more likely (AOR = 3.40; 95% CI, 1.85–6.22; $P < 0.0001$) to have an elevated 10-year CVE risk than those with normal CRP levels (3 mmol/L or lower).

Table 5. Statistically significant odds ratios (OR)^a of risk factors for elevated 10-year risk of cardiovascular events (CVE)^b, Stockholm, Sweden, 2013-2015

	Odds Ratios (OR)	95% Confidence Intervals (CI)	P-values
Sweden-born ^c	3.75	2.64 – 5.32	< 0.0001
Foreign-born	1	-	-
Sweden -born	1.61	1.06 – 2.43	0.025
Age ^d (older)	1.13	1.10 – 1.15	< 0.0001
Sweden-born	1.62	1.06 – 2.50	0.029
Age	1.13	1.10 – 1.15	<0.0001
Sex (Male)	4.53	2.94 – 7.00	<0.0001
Sex (Female)	1	-	-
Sweden-born	1.78	1.14 – 2.78	0.011
Age	1.13	1.10 – 1.15	< 0.0001
Sex (male)	4.68	3.00 – 7.30	< 0.0001
Education (10-12 years)	0.48	0.26 – 0.85	0.013
Education (< 10 years)	1	-	-
Sweden-born	1.80	1.15 – 2.82	0.010
Age	1.13	1.10 – 1.15	< 0.0001
Sex (Male)	3.91	2.50 – 6.20	< 0.0001
Education (10-12 years)	0.53	0.29 – 0.97	0.040
Waist circumference ^d (larger)	1.03	1.01 – 1.04	0.001
Sweden-born	1.73	1.10 – 2.77	0.023
Age	1.13	1.10 – 1.16	< 0.0001
Sex (Male)	4.11	2.50 – 6.63	< 0.0001
Education (10-12 years)	0.52	0.28 – 0.97	0.040
Waist circumference (larger)	1.02	1.00 – 1.04	0.010
hs-CRP (> 3 mmol/L)	3.40	1.85 – 6.22	< 0.0001
hs-CRP (≤ 3 mmol/L)	1	-	-

Abbreviation: hs-CRP, high-sensitivity C-reactive protein.

^a Regression analyses done using stepwise adjusting for independent variables, only covariates with statistically significant odds ratios included in Table (therefore, physical activity and alcohol consumption excluded).

^b Elevated risk of a cardiovascular events (CVE) occurring within 10 years defined as $\geq 10\%$ based on Framingham risk score.

^c Unadjusted (crude) odds ratio; all other results in column are Adjusted odds ratios (AOR).

^d Continuous covariate.

Discussion

In this cross-sectional study, we examined the relationship in participants living in Sweden between elevated 10-year CVE risk and birthplace. We also studied the relationships between elevated 10-year CVE risk and specific cardiovascular risk factors, including age, sex, level of education, anthropometry (waist circumference), physical activity, alcohol consumption, and hs-CRP levels. The main finding was that, after controlling for other variables, participants born in Sweden were almost twice as likely to have an elevated 10-year CVE risk as those who were foreign-born. Additional findings were that older age, male sex, lower level of education, larger waist circumference, and abnormal hs-CRP levels were also significantly associated with an elevated 10-year CVE risk, regardless of birthplace.

The finding in our study of a higher 10-year CVE risk in the Sweden-born than in the predominately Middle-Eastern foreign-born population was unexpected. This was inconsistent with published studies that have reported higher rates of CVD in countries in the Middle-East than in countries in Western Europe, as well as Sweden (15–19, 30, 31). In our study, foreign-born participants had significantly lower systolic and diastolic BP levels than Sweden-born participants, which is similar to findings in other studies (30, 31). In addition, foreign-born participants also had significantly lower LDL-C levels, and they were on average 10 years younger than the Sweden-born participants. All of these findings likely contributed to the fact that a lower proportion of those in the foreign-born group than the Sweden-born group had an elevated 10-year CVE risk, despite the fact that the foreign-born group had a significantly lower mean HDL level and a higher prevalence of smoking.

We also observed that participants with an elevated hs-CRP level had an over three-fold higher risk of having an elevated 10-year risk of CVE, compared to those with lower hs-CRP levels. This finding was expected and has been reported by others, who have discussed the potential use of hs-CRP in assessing cardiovascular risk and have noted the lack of consensus regarding its optimal use (10). Although CRP is involved in the immunologic process that triggers vascular remodelling and plaque deposition and has been associated with increased CVE risk, definitive evidence for its role as a causative factor of CVD is still lacking (10). Nevertheless, it makes sense that high hs-CRP levels were associated with an elevated 10-year CVE risk in our study, given that the effect of hs-CRP is mediated through inflammation, a process that may also influence some of the Framingham risk factors, such as BP and cholesterol levels.

Our study included participants living in Sweden who had been born in a broad array of regions, which included the Middle East, Asia, and Africa. Previous studies in Sweden on cardiovascular health in foreign-born citizens have largely focused on single countries of birth, such as Iraq (19, 30, 31). We thought that inclusion of participants with a wider variety of ethnicities might make our results more applicable to immigrant populations throughout Sweden. However, we also acknowledge that differences in the cardiovascular health and risk profiles of individual foreign-born participants, even between those from different countries within each region, may limit the generalizability of our results to all foreign-born people in Sweden.

The issue of cardiovascular risk in immigrant populations in Sweden has received very little attention, despite a number of studies suggesting that the prevalence of CVD in these populations may be substantial (15–19, 30, 31). Studies comparing Middle Eastern and Western countries (including Sweden) have consistently found a higher prevalence of CVD in the Middle East (16, 17). Other studies have reported a higher prevalence of CVD for immigrants living in Sweden who are from the Middle East (15, 19–20, 30), though a lower prevalence of CVD when those immigrants are compared to populations in their native countries (21). However, a more recent report of Swedish residents suggested that CVD-related mortality risk was lower for non-Western-born immigrants than native Swedes (18). Our study showed that participants born in Sweden were almost twice as likely to have an elevated 10-year CVE risk as those who were foreign-born. Although these studies all looked at subtly different outcomes, these outcomes were all closely linked to cardiovascular health. As such, the contradictory results of these studies, including ours, call into question whether the cardiovascular risk scoring systems used for native populations in Western countries are applicable to immigrant populations from the Middle East.

The initial Framingham Heart Study looked at a predominantly white population of European descent when it was done in 1948, but subsequent studies in 1994 and 2003 enrolled more ethnically diverse cohorts (33). The Framingham criteria used for estimating 10-year CVE risk in our study was based on this more diverse data, but they still lack any adjustments for different countries, regions of birth, or ethnicities (23, 24). The contradiction between our study results and the known high prevalence of CVD in Middle Eastern populations suggests that there may be considerable value in conducting larger, longitudinal, and multigenerational studies, similar to the Framingham Heart Study, either in the Middle East or of Middle-Eastern immigrants in Sweden, or both, to construct new CVE risk assessment tools or criteria thresholds for this population. For example, it would be informative to conduct multi-generational studies of immigrant populations to determine whether cardiovascular risk and prevalence become more like that of native-born populations over time. Alternatively, CVE risk scores in Sweden could be followed for both Sweden-born and Middle Eastern-born populations over a period of time and then could be correlated with the actual prevalence of CVD in each of these groups during that same period. Any disparity identified between CVE risk estimates and the actual prevalence of CVD in these populations could then be addressed by calculating a coefficient to apply to standard CVE risk assessment tools, resulting in potentially more accurate CVE risk estimates, particularly for Middle Eastern-born immigrants in Sweden.

Regardless, our results suggest that a unique cardiovascular risk scoring system modified for region of birth or ethnicity may be needed in Sweden. Absent that, when using traditional cardiovascular risk estimates for patients in Sweden who are immigrants, it may be prudent for healthcare providers to either look more closely at individual risk factors or apply a different threshold when making decisions about initiating CVD prevention or treatment interventions. For example, a closer look at the Framingham risk factor results in our study suggests that smoking cessation programs and education about ways to increase HDL could potentially benefit those not born in Sweden. Taking this type of approach may help improve awareness about CVD and expand access to preventative interventions for immigrant populations in Sweden.

Limitations

The data used in our study was dependent on the population specifically recruited for the 4D Diabetes Project in Sweden. This population involved two cluster samples, comprising all willing participants from two similar primary healthcare locations. Ultimately, the Sweden-born and foreign-born study population characteristics differed significantly, particularly with regard to the mean ages of the participants. Given that age is particularly impactful on cardiovascular risk, we adjusted for age in the logistic regression analyses. However, it is still possible that two randomized and more similarly matched study populations would have rendered different results. In addition, no drop-out analysis was conducted of those who chose not to accept recruitment into the project. Without information about the characteristics of those who chose not to participate, the possibility of other selection biases cannot be excluded. It is possible, for example, that Sweden-born and foreign-born patients had different reasons and thresholds for when they sought care at a PHCC. On a related note, another potential limitation of this study was that the data used was gathered from patients who were actively seeking care at a PHCC. These patients were more likely than the general public to be sick and/or have other underlying medical conditions, and this could affect the generalizability of our results to a broader population. On the other hand, cardiovascular risk is most often assessed in those who are at higher risk, because either they are older or have other comorbidities, so it may be that this population was actually optimal to study. Lastly, as this was a cross-sectional study, we were unable to ascertain causality in any of the associations. Therefore, the results and conclusions of our study can at most be used to deepen the knowledge base and generate new hypotheses for future studies.

Conclusions

In a study of CVE risk in participants living in Sweden using the Framingham Risk Score, those born in Sweden were almost twice as likely to have an elevated 10-year CVE risk as those born in other countries, a large portion of whom had been born in the Middle East. Older age, male sex, and abnormal hs-CRP levels were associated with an elevated 10-year CVE risk. These results contradict previous reports of higher rates of CVD in residents of Middle-Eastern countries and in Middle-Eastern immigrants living in Sweden. A cardiovascular risk scoring system modified for region of birth or ethnicity may be needed in Sweden. Alternatively, healthcare providers in Sweden may need to either look more closely at individual risk factors or apply a different threshold when making decisions about initiating CVD prevention or treatment interventions in those born in the Middle East.

List Of Abbreviations

AOR: adjusted odds ratio

BP: blood pressure

CVD: cardiovascular disease

CVE: cardiovascular event

FRS: Framingham Risk Score

HbA1c: haemoglobin A1c

HDL: high-density lipoprotein

hs-CRP: high-sensitivity C-reactive protein

LDL-C: low-density lipoprotein-cholesterol

OGTT: oral glucose tolerance test

OR: odds ratio

PHCC: Primary Healthcare Center

SD: standard deviation

4D: 4 diagnoses

Declarations

Ethics approval and consent to participate

An ethical permit was granted by the Regional Ethical Review Board in Stockholm, review number 2013/2303-31/3. Data were collected after written informed consent was obtained from participants. Data were coded in order to maintain participant privacy. Both the study information sheets and the consent forms were translated from Swedish into the three most-spoken languages among the participants: Turkish, Farsi, and Arabic. Participants with abnormal blood test results were scheduled at the PHCC for further diagnosis and treatment, if indicated. Those subsequently found to have diabetes were booked at the PHCC for regular follow-up.

Consent for publication

Not applicable

Availability of data and materials

Sharing of the data with other researchers was not included in written informed consent and therefore neither data nor materials are publically available.

Competing interests

The authors declare that they have no competing interests.

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Authors' contribution

MT wrote the manuscript and performed statistical analyses; KS participated in designing the study and collecting the data, CGÖ participated in designing the study, interpreting the results, and editing the manuscript; HS participated in designing the study and editing the manuscript; VW and DY contributed to literature review, statistical analyses, and interpretation of the results. All authors read and approved the final version of the manuscript.

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