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Comparison of social gradient in cardiometabolic health in Czechia and Venezuela: a cross-sectional study

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ABSTRACT

Objectives This study compared the relationships of social determinants with cardiometabolic risk in different socioeconomic contexts: sociopolitically unstable Venezuela (VE) and stable Czechia (CZ).

Design: cross-sectional analysis involving two population-based studies.

Setting Brno, Czechia and 23 cities of Venezuela.

Participants 25–64 years old subjects from CZ (2013–2014, n=1579, 56% females) and VE (2014–2017, n=1652, 70% females).

Main outcome measures The composite cardiometabolic risk score (CMRS) (scaled 0–8) was calculated using eight biomarkers (body mass index, waist circumference, blood glucose, systolic and diastolic blood pressure, total and high-density lipoprotein-cholesterol, triglycerides). Social characteristics included education in both countries, income in CZ and a composite measure of social position (SP) in VE. Sex stratified ordinal regression examined the social gradient in having less favourable CMRS.

Results In CZ, men and women with low education and women with low income had higher odds of higher CMRS compared with those with high education and income with OR 1.45 (95% CI 1.01 to 2.21), 2.29 (95% CI 1.62 to 3.24) and 1.69 (95% CI 1.23 to 2.35). In VE, women with low education and low SP had higher odds to have higher CMRS OR 1.47 (95% CI 1.09 to 1.97) and 1.51 (95% CI 1.16 to 1.97), while men with low education and low SP had lower odds to have higher CMRS OR 0.64 (95% CI 0.41 to 1.00) and 0.61 (95% CI 0.40 to 0.97), compared with those with high education and high SP. Independently of age, sex and socioeconomic characteristics, Venezuelans had higher odds to have higher CMRS than Czechs (OR 2.70; 95% CI 2.37 to 3.08).

Conclusions The results suggest that the associations of socioeconomic status indices and cardiometabolic risk differed between CZ and VE, likely reflecting differences in the social environment among countries. Further research is needed to confirm and quantify these differences.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The study evaluated the social gradient in cardiometabolic health in two nations with distinct sociopolitical contexts.
⇒ The assessment of cardiometabolic health was based blood biomarkers.
⇒ The techniques used for selecting and recruiting participants varied between the two studies.
⇒ Both studies included data on educational level, but other socioeconomic factors were not comparable.

INTRODUCTION

Health inequalities can be reduced by understanding and addressing the effects of social determinants of health (SDoH) on population and individual scales.[1] SDoH are a complex network of economic and social conditions such as education, income, occupation, housing, neighbourhoods, etc characterising individual socioeconomic status (SES).[2] Globally, there is a persistent social gradient in health, whereby those at the higher end of the socioeconomic spectrum generally experience better health compared with those at the lower end.[2] Past evidence suggests that subjects with lower SES are exposed to higher levels of psychosocial stressors[2] manifest more signs of physiological stress[3] and exhibit more unhealthy behaviours, such as tobacco use, excessive alcohol use, physical inactivity and poor nutrition[3] than those with higher SES. The extent of health inequalities varies between sexes, due to sex-unique biological, social and cultural factors such as sex hormones, reproductive health, social roles and expectations of men and women as well as discrimination, violence and access to healthcare.[4]

Previous studies have described the association of SDoH and cardiometabolic health.[5 6] However, these relationships have not been sufficiently explored in populations with contrasting socioeconomic contexts. The Czech population has had a stable social, political and economic environment in the last three decades.[7] In stark contrast, Latin America is the region with one of the highest health inequalities worldwide,[8] and the Venezuelan population is an exemplar of chronic stressors

resulting from the severe economic and political crisis since 2014.[9 10] In addition to differences between populations, differences in the social gradients may also be observed between genders within populations. This study compares the sex-specific relationships between markers of SES and cardiometabolic health in these two different populations using composite Cardiometabolic Risk Score (CMRS) as a marker of cardiometabolic health to assess the consistency in the social gradients in different populations and sexes.

METHODS

Design and populations

Data from 25 to 64 years old subjects from two observational studies (the Kardiovize study in Czechia and EVESCAM in Venezuela) were used for this analysis.

The Kardiovize Study

The Kardiovize study is an epidemiological study using a random sample of adult residents from the city of Brno, designed as a prospective cohort.[11] The recruitment and baseline examinations were completed in 2014. This study aimed to enrol 1% of the adult population of Brno randomly selected and stratified by sex and age. Eligibility criteria included permanent residence in Brno and registration (required by the law) with any of the five health insurance companies operating in Czechia. Survey sampling was done in January 2013. A sample of 6377 permanent residents from Brno aged 25–64 years was selected and invited by mail. The overall achieved response rate was 33.9%. No information on non-respondents was available due to confidentiality restrictions.

The EVESCAM study

The study design, sampling and implementation were described previously.[12 13] In brief, the EVESCAM is a population-based study, whose cross-sectional initial phase was designed to evaluate cardiometabolic risk factors in subjects aged ≥20 years in Venezuela, from July 2014 to January 2017.

A multistage stratified sampling method was used to select a nationally representative sample of the general population of Venezuela. Initially, 23 cities from the 8 regions—1–4 cities per region—were chosen. Each selected city was stratified by municipalities. Two municipalities in each city, then two parishes in each municipality and finally two locations in each parish were randomly selected. Then, mappings and censuses of each location delimited the streets or blocks and selected the households to visit. Actual household visits were conducted. Inclusion criteria were subjects ≥20 years living in the house selected for more than 6 months. In total, 4454 subjects were recruited (86.3% urban and 13.7% rural areas), among which 3420 were evaluated, corresponding to a net response rate of 77.3%.

Data Collection

The Kardiovize Study

Face-to-face health interviews were performed by trained nurses and physicians at the International Clinical Research Center of the St Anne's University Hospital in Brno, using the web-based research electronic data capture.[14] The questionnaire included demographics, SES, cardiovascular risk behaviours, smoking status, medical history and mental health. Blood pressure was measured with the participant alone using an automated office measurement device (BpTRU, model BPM 200; Bp TRU Medical Devices, Canada). The anthropometric assessment included height and weight measurements using a medical digital scale with a metre (SECA 799; SECA, Germany) and manual tape measurement of the waist circumference. Laboratory analyses were performed with 12-hour fasting blood samples using a Modular SWA P800 analyzer (Roche, Basel, Switzerland), total cholesterol, triglycerides, and glucose were analysed by the enzymatic colorimetric method (Roche Diagnostics, Mannheim, Germany), and high-density lipoprotein cholesterol (HDL-c) was analysed with the homogeneous method for direct measurement without precipitation (Sekisui Medical, Hachimantai, Japan).

The EVESCAM Study

Questionnaires, anthropometrics and other physical measurements were obtained by trained health personnel. A questionnaire was used to collect information on demographics, family, and personal medical history, cardiovascular risk behaviours, SES, and mental health. Blood pressure was measured twice, at 5 min intervals, with a validated oscillometric sphygmomanometer (Omron HEM-705C Pint Omron Healthcare CO., Kyoto/Japan). Weight was measured using a calibrated scale (Tanita UM-081, Japan). Height was measured using a portable stadiometer (SECA 206, SECA, Hamburg, Germany). Waist circumference was measured twice with a metric tape. Blood samples were collected according to a standardised protocol after at least 8 hours of fasting.

Variable definitions

The CMRS score was calculated using eight cardiometabolic biomarkers: body mass index (BMI); waist circumference; systolic and diastolic blood pressure; fasting blood glucose; total cholesterol, HDL-c, and triglycerides. To assess the impact of the SDoH on the CMRS score, subjects were stratified by country and sex, and each biomarker was classified by quartile. Those in the highest quartile (>75%)—except HDL-c which is the lowest quartile (<25%)—were scored as 1 point, and those in lower quartiles as 0 points. Then, the eight biomarkers were added up. The CMRS score ranged from 0 to 8 points, with higher scores representing higher cardiometabolic risk.[15] Subjects with a medical history of cardiovascular disease, or using medication for dysglycaemia, hypertension or dyslipidaemia were excluded. Additionally, to compare the CMRS between countries, a second calculation of the CMRS was performed by stratifying only by sex (but not country).

The socioeconomic variables used in this analysis were a subset of SDoH and included educational level in both

countries, household income in Czechia, and composite index of social position (SP) in Venezuela. In the Czech population, educational attainment was classified into three groups: 'low' defined as elementary or vocational education without a final graduation exam, 'middle' defined as high school education, and 'high' including subjects with higher professional or university education. Monthly household income was available only for Czech subjects and classified as 'low (<€1200)', 'middle (€1200–€1800)' and 'high (>€1800)'. In the Venezuelan population, education was classified as 'low' for illiterate subjects or elementary school education, 'middle' for high school education, and 'high' for a university degree. The composite index of SP was evaluated using the Graffar method modified by Méndez-Castellano[13] and includes four components: (1) the source of income; (2) the profession of the householder; (3) mother's education and (4) housing conditions. The resulting variable was classified as 'high/middle–high', 'middle' or 'low'.

Statistical analysis

Statistical analyses were conducted using SPSS software (V.26.0, SPSS). Both databases were harmonised and merged into one analysed dataset. Subjects from the EVESCAM study younger than 25 years or older than 65 years were excluded to match the age range of the Kardiovize study. All analyses were stratified by sex in order to assess differences in social gradients within populations.

Categorical variables were described using frequency and compared using the χ^2 test. Continuous variables were described using mean and SD and compared using the Student's t-test or one-way analysis of variance. All statistical tests were two sided, and p values <0.05 were considered statistically significant. Sex-stratified ordinal regression analysis was used to determine the association between CMRS and the socioeconomic variables using three models: model 1 represents the crude model; model 2 was adjusted by age and model 3 was adjusted by age, education or socioeconomic characteristics according to the variable evaluated.

Patient and public involvement

To conduct our study, it was not appropriate to involve patients or the public in the design, conduct, reporting or dissemination plans of our research.

RESULTS

Subjects characteristics

In total, 3231 subjects were included, 1579 from Czechia (56.4% women) and 1652 from Venezuela (70.0% women) (figure 1). In Czechia, BMI, waist circumference, systolic and diastolic blood pressure, blood glucose, and triglycerides were higher in men than in women, and total cholesterol and HDL-c were higher in women than in men (table 1). Men had a higher proportion of the high level of education and higher income than women (p=0.007). In Venezuela, waist circumference, systolic blood pressure, blood glucose and triglycerides were higher in men than in women, total cholesterol and HDL-c were higher in women than in men, BMI and diastolic blood pressure were similar between sexes (table 1). Women had a higher proportion of the high level of education level than men (p<0.001), and the SP was similar between sexes (table 1).

SES differences in cardiometabolic biomarkers by country

The proportions of the highest quartile of cardiometabolic biomarkers among categories of education, household income (in Czech population) and SP (in Venezuelan population) are reported in online supplemental table 1. Among Czech women, lower education was associated with a higher prevalence of the highest quartile of all cardiometabolic biomarkers, compared with those with middle or high education levels, and lower household income was associated with a higher prevalence of the highest quartile in all biomarkers, except low HDL cholesterol (online supplemental table 1). In Czech men,

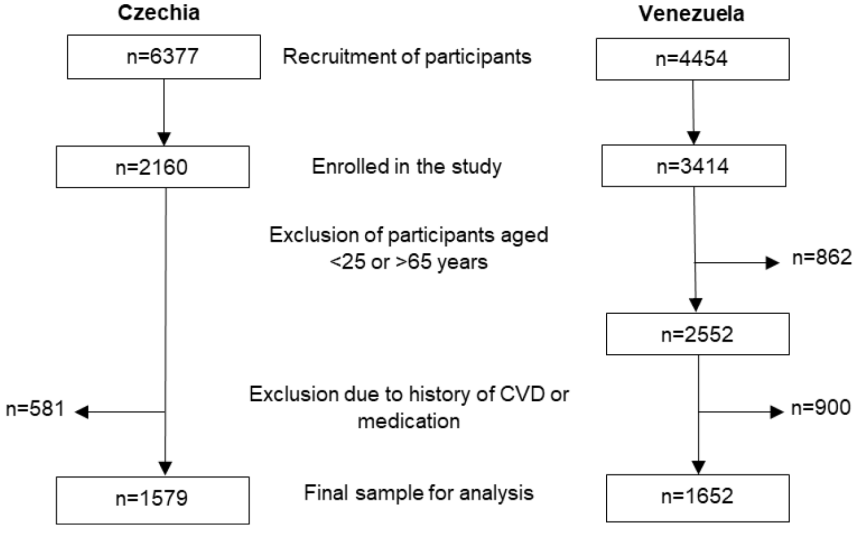

Figure 1 Flow chart for sample analysis. CVD, cardiovascular disease.

Table 1 Clinical biomarkers and socioeconomic characteristics by country and sex*

	Czechia			Venezuela		
	Men	Women	P value	Men	Women	P value
n (%)	688 (43.6)	891 (56.4)		498 (30.0)	1160 (70.0)	
Age (years)	43.47 (10.5)	44.8 (10.7)	0.010	44.3 (11.2)	43.4 (10.9)	0.148
Weight (kg)	85.4 (13.9)	68.6 (13.0)	<0.001	76.5 (16.4)	66.9 (15.7)	<0.001
Height (m)	1.81 (0.1)	1.68 (0.1)	<0.001	1.70 (0.1)	1.5 (0.1)	<0.001
BMI (kg/m^2)	25.8 (3.8)	24.3 (4.4)	<0.001	26.3 (4.9)	26.8 (6.0)	0.083
Waist circumference (cm)	93.5 (10.7)	81.1 (11.2)	<0.001	92.5 (13.1)	89.7 (12.9)	<0.001
Systolic BP (mm Hg)	120.3 (13.0)	115.6 (14.3)	<0.001	127.9 (16.7)	121.4 (18.2)	<0.001
Diastolic BP (mm Hg)	81.3 (9.0)	76.7 (8.6)	<0.001	75.8 (10.9)	74.8 (10.7)	0.109
Blood glucose (mmol/L)	4.9 (0.5)	4.7 (0.5)	<0.001	5.6 (1.4)	5.3 (1.0)	<0.001
Total cholesterol (mmol/L)	5.0 (0.9)	5.2 (1.0)	0.017	4.0 (1.0)	4.1 (1.0)	0.022
HDL-c (mmol/L)	1.3 (0.3)	1.7 (0.3)	<0.001	0.9 (0.3)	1.0 (0.2)	<0.001
Triglycerides (mmol/L)	1.3 (0.8)	0.9 (0.5)	<0.001	1.3 (0.8)	1.1 (0.5)	<0.001
Education (%)			0.007			<0.001
High	50.1	42.9		33.7	44.4	
Middle	33.2	40.4		44.8	38.3	
Low	16.6	16.6		21.6	17.3	
Household income (euro) (%)			<0.001			
High (>1800)	34.8	21.1				
Middle (1200–1800)	36.7	31.6				
Low (<1200)	28.5	47.4				
Social position (%)						0.143
High/middle–high				19.5	22.4	
Middle				29.7	32.0	
Low				50.8	45.6	

*Results are reported as mean (SD).
†Cardiometabolic biomarkers included in the CMRS. Statistical analysis using t-test. Differences in sex categories using the χ^2 test.
.BMI, body mass index; BP, blood pressure; CMRS, Cardiometabolic Risk Score; HDL-c, high-density lipoprotein cholesterol.

lower education was associated with a higher prevalence of the highest quartile of BMI, waist circumference and blood glucose, compared with those with high education levels (p<0.05), and there were no detectable differences in the highest quartiles of CMRS components in different household income categories (online supplemental table 1).

Among Venezuelan women, lower education was significantly associated with a higher prevalence of the highest quartile of waist circumference and systolic blood pressure compared with those with high education levels. Lower SP was associated with a higher prevalence of the lowest quartile of HDL cholesterol (online supplemental table 1). In Venezuelan men, lower education was associated with a lower prevalence of the highest quartile in BMI. Lower SP was associated with a higher prevalence of the highest quartile of blood glucose, but a lower prevalence of the highest quartile of waist circumference and BMI (online supplemental table 1).

Cardiometabolic risk score

In Czechia, in both sexes, the CMRS increased with age and decreased with higher education levels (p<0.05) (figure 2). In women, the CMRS decreased with higher household income, but not in men (table 2). In Venezuela, the CMRS increased with age in both sexes (p<0.05) (figure 2). In women, the CMRS decreased with higher education level and higher SP; in men, the CMRS increased with the highest education level, but not by SP (table 2). These data also exhibit divergent relationships compared with the social gradient.

Association of social determinants and cardiometabolic risk by country

In Czechia, using ordinal regression analysis, the crude model showed a significant increase in the CMRS with lower education levels in both sexes, and with lower income in women, maintained after adjustment for age in the second model. In the fully adjusted model, men

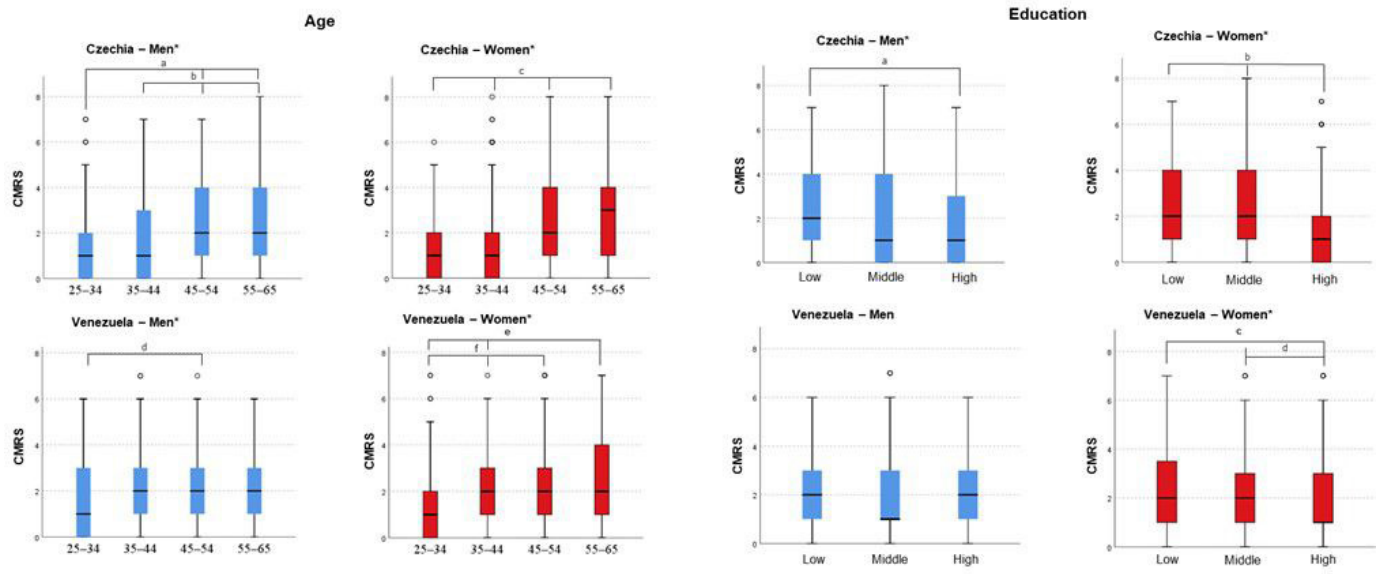

Figure 2 Cardiometabolic risk score by age and education. Differences between categories use one-way ANOVA. Post hoc analysis using Bonferroni test. *Differences between all categories p<0.05; different letters represent statistical differences (p<0.05) across groups. ANOVA, analysis of variance.

and women with a low level of education showed 57% and 95% higher odds to present higher CMRS, in comparison to those with the highest level of education. Additionally, women with low household income showed 41% higher odds to have higher CMRS in comparison to women with high household income, this association was not found in men (table 3).

In Venezuela, the crude model showed a significant increase in CMRS in women with low or middle levels of education or low SP, and a decrease in CMRS in men with middle level of education and low SP, in comparison to those with high education and high SES (table 3). In the age-adjusted model, women with low and middle education levels had 47% and 33% higher odds to have a higher CMRS compared with women with the highest level of education, and those with low or middle SP had 51% and 47% higher odds to have higher CMRS in comparison to women with high/middle-high SP. In contrast, men with low and middle education levels showed 36% and 34% higher odds to have a higher CMRS in comparison to men with the highest education level, and those with low SP had 39% lower odds to have a higher CMRS compared with men with high/middle-high SP. In the fully adjusted model, the association of CMRS and education was not

Table 2 The average CMRS in the categories of education

Czechia					
	CMRS			**CMRS**	
Education	**Men**	**Women**	**Income**	**Men**	**Women**
Low	2.40	2.63	Low	2.09	2.43
Middle	2.14	2.31	Middle	1.89	1.73
High	1.84	1.46	High	2.14	1.57
P value	**0.013**	**<0.001**		0.330	**<0.001**
Venezuela					
	CMRS			**CMRS**	
Education	**Men**	**Women**	**SES**	**Men**	**Women**
Low	1.93	2.41	Poverty	1.86	2.12
Middle	1.91	2.14	Middle	2.12	2.08
High	2.22	1.80	Middle-high/high	2.23	1.81
P value	0.168	**<0.001**		0.121	**0.046**

Results are reported as mean. Differences between categories using one-way ANOVA.
The bold values represent statistically significant (p<0.05) results.
ANOVA, analysis of variance; CMRS, Cardiometabolic Risk Score; SES, socioeconomic status.

Table 3 The association* of Cardiometabolic Risk Score and social determinants by country and by sex*

Czechia	Men OR (95% CI)	Women OR (95% CI)	Venezuela	Men OR (95% CI)	Women OR (95% CI)
Model 1: crude			Model 1: crude		
Age	**1.05** (1.04 to 1.06)	**1.07** (1.06 to 1.08)	Age	**1.02** (1.00 to 1.03)	**1.05** (1.04 to 1.06)
Education			Education		
High	1	1	University	1	1
Middle	1.23 (0.91 to 1.66)	**2.19** (1.69 to 2.84)	High school	**0.67** (0.47 to 0.98)	**1.43** (1.14 to 1.79)
Low	**1.65** (1.13 to 2.40)	**3.22** (2.29 to 4.53)	Elementary	0.72 (0.47 to 1.11)	**1.89** (1.42 to 2.53)
Household income			Social position		
High (>1800)	1	1	High/middle–high	1	1
Middle (1200–1800)	0.82 (0.59 to 1.13)	1.19 (0.85 to 1.68)	Middle	0.81 (0.52 to 1.28)	**1.35** (1.02 to 1.79)
Low (<1200)	1.07 (0.76 to 1.50)	**2.28** (1.66 to 3.15)	Low	0.64 (0.43 to 0.97)	**1.37** (1.06 to 1.79)
Model 2: adjusted by age			Model 2: adjusted by age		
Education			Education		
High	1	1	University	1	1
Middle	1.26 (0.93 to 1.69)	**1.76** (1.35 to 2.29)	High school	**0.66** (0.46 to 0.95)	**1.33** (1.06 to 1.67)
Low	**1.45** (1.01 to 2.21)	**2.29** (1.62 to 3.24)	Elementary	**0.64** (0.41 to 1.00)	**1.47** (1.09 to 1.97)
Household income			Social position		
High (>1800)	1	1	High/middle–high	1	1
Middle (1200–1800)	0.90 (0.65 to 1.24)	1.13 (0.80 to 1.60)	Middle	0.78 (0.50 to 1.23)	**1.47** (1.11 to 1.95)
Low (<1200)	0.93 (0.66 to 1.32)	**1.69** (1.23 to 2.35)	Low	**0.61** (0.40 to 0.97)	**1.51** (1.16 to 1.97)
Model 3: adjusted by age, education, household income			Model 3: adjusted by age, education, social position		
Education			Education		
High	1	1	University	1	1
Middle	1.34 (0.97 to 1.83)	**1.60** (1.21 to 2.11)	High school	0.75 (0.50 to 1.14)	1.25 (0.97 to 1.61)
Low	**1.57** (1.05 to 2.37)	**1.95** (1.34 to 2.83)	Elementary	0.76 (0.45 to 1.30)	1.38 (0.97 to 1.96)
Household income			Social position		
High (>1800)	1	1	High/middle–high	1	1
Middle (1200–1800)	0.85 (0.61 to 1.19)	1.04 (0.73 to 1.48)	Middle	0.87 (0.54 to 1.41)	**1.35** (1.01 to 1.81)
Low (<1200)	0.78 (0.54 to 1.14)	**1.41** (1.01 to 1.98)	Low	0.74 (0.45 to 1.25)	1.25 (0.91 to 1.72)

The bold values represent statistically significant (p<0.05) results.
*Ordinal regression analysis.

significant in both sexes; women with middle SP showed higher CMRS than those with high/middle SP (table 3).

CMRS differences between Czech and Venezuelan populations

To compare the CMRS between countries, the calculation of CMRS was stratified only by sex, but not by country. Not surprisingly, Venezuelans had a higher CMRS than Czechs (2.86 and 2.14, respectively; p<0.001). Using ordinal regression analysis, Venezuelans were 124% more likely to have a higher CMRS than Czechs (OR 2.24; 95% CI 1.97 to 2.53); which was independent of age and sex (OR 2.80; 95% CI 2.46 to 3.19), and socioeconomic characteristics (OR 2.70; 95% CI 2.37 to 3.08) (table 4).

DISCUSSION

The results showed some differences in the relationships between markers of SES and CMRS by country and sex. In Czechia, higher CMRS was independent of age associated with lower education levels in both sexes and with lower income in women, but not in men. In Venezuela, higher levels of CMRS were associated with lower education levels in women, but higher education levels in men. The higher CMRS was also associated with lower SP in Venezuelan women, with no association in men. Additionally, Venezuelans were more likely to have higher CMRS in comparison to Czechs, independently of age, sex and socioeconomic characteristics.

These results suggest that social disparities are differentially manifested across levels of socioeconomic stability for the world's countries.[16] In stable, high-income countries, including Czechia, subjects with higher socioeconomic

Table 4 The association* of Cardiometabolic Risk Score and affiliation to the country

	OR	95% CI
Model 1: crude		
Czechia	1	
Venezuela	**2.24**	1.97 to 2.53
Model 2: adjusted for age and sex		
Czechia	1	
Venezuela	**2.80**	2.46 to 3.19
Model 3: adjusted for age, sex and socioeconomic characteristics		
Czechia	1	
Venezuela	**2.70**	2.37 to 3.08

The bold values represent statistically significant (p<0.05) results.
*Ordinal regression analysis.

positions typically had better health, including less cardiometabolic risk factors.[1]

Previous studies from high-income countries described a similar direction of social gradient as observed in this study. The meta-analysis from 2017[6] including 39 cohorts from Europe and 19 cohorts from the USA found that higher levels of education and income were consistently associated with a lower risk of cardiometabolic outcomes. The magnitude of the association varied depending on the specific cardiometabolic outcome and the level of education or income, but overall, individuals with higher education and income had a significantly lower cardiometabolic risk compared with those with lower levels.[6] Previous studies also reported sex differences in the social gradient of cardiometabolic health, with women generally experiencing higher levels of cardiometabolic risk at lower levels of SES compared with men.[4] This may be due to a combination of biological, behavioural and social factors that disproportionately affect women with lower SES, including higher rates of tobacco and alcohol use, unhealthy diet and physical inactivity.[4] The differences between sexes can be also potentially explained by the high demand of high occupational positions of men with long working hours and considerable responsibilities, leading to a higher level of stress and related cardiometabolic risk.[17] In several low-income countries, social empowerment has been culturally associated with a certain appearance, namely the large body size associated with excessive adiposity.[18] Subjects with higher socioeconomic positions had better access to nutrition-dense food and limited physical activity leading to worse cardiometabolic health.[19] In middle-income countries, including Venezuela, previous studies described the varying influences of SDoH on cardiometabolic health, particularly among men.[18 20] In a cross-sectional population-based Brazilian study,[21] a higher level of education was associated with lower cardiometabolic risk in both sexes. Another cross-sectional study performed in 8 Latin American countries[22] (N=53 186 adults) described a direct association of education with cardiometabolic risk in men, with an inverse association in women, consistent with current results.

Cardiometabolic health is determined by a complex system of social and environmental stressors.[23] The impact of stressors on human physiology is defined by their accumulation and interactions, with new relationships emerging over time.[24] Sociopolitical contexts of the specific population can have a significant influence on cardiometabolic risk.[25] Factors such as income inequality, social policies and access to healthcare and social services can all contribute to differences in cardiometabolic health outcomes between population groups.[1] Moreover, in countries facing a humanitarian, economic or militaristic crisis, the spectrum of social stressors is even broader including loss of human rights expressed by lack of security, unavailability of health and social services, loss of social networks and families, or displacement.[26] Future studies may explore the mechanisms underlying the observed differences in social gradient and determine whether these observations are more driven by imbalances in environmental stress internalisation or behavioural and lifestyle differences related to environmental resources.

Social determinants may influence health through a variety of mechanisms, including behaviours (eg, diet, physical activity, tobacco use) but also physiological responses to stress. The cumulative effects of stress on the body can be evaluated using the allostatic load (AL)[27 28] which is a useful health outcome predictor.[29] Higher AL is associated with lower SES. A prospective Swedish study over 27 years (N=855 subjects) observed the association of lower socioeconomic levels and higher AL in both sexes,[30] and a Swiss cohort study including 803 adults found that a lower education level was associated with higher AL in both sexes, and lower occupational position associated with higher AL in women, but lower AL in men.[17] The repetitive exposure to stressors leading to AL is the potential pathway of social disparities in cardiometabolic health. Several previous studies[17 30 31] suggest that AL may be an important mediator of the relationship between social determinants and cardiometabolic health. Further research is needed to better understand the mechanisms through which social determinants influence cardiometabolic health. For a successful strategy of reducing the burden of cardiometabolic-based chronic disease (CMBCD), a deep understanding of this complex network is needed.[23] Therefore, preventive healthcare strategies must consider diverse social environments across the world, culturally adapt emergent relationships, and then translate concepts into more precise interventions.[32]

In the present study, various exceptions to the social gradient were found by analysing contrasting populations (figure 3). Explanations for these exceptions may provide valuable clues on how SDoH interact with biological factors to initiate and then impel CMBCD. Once

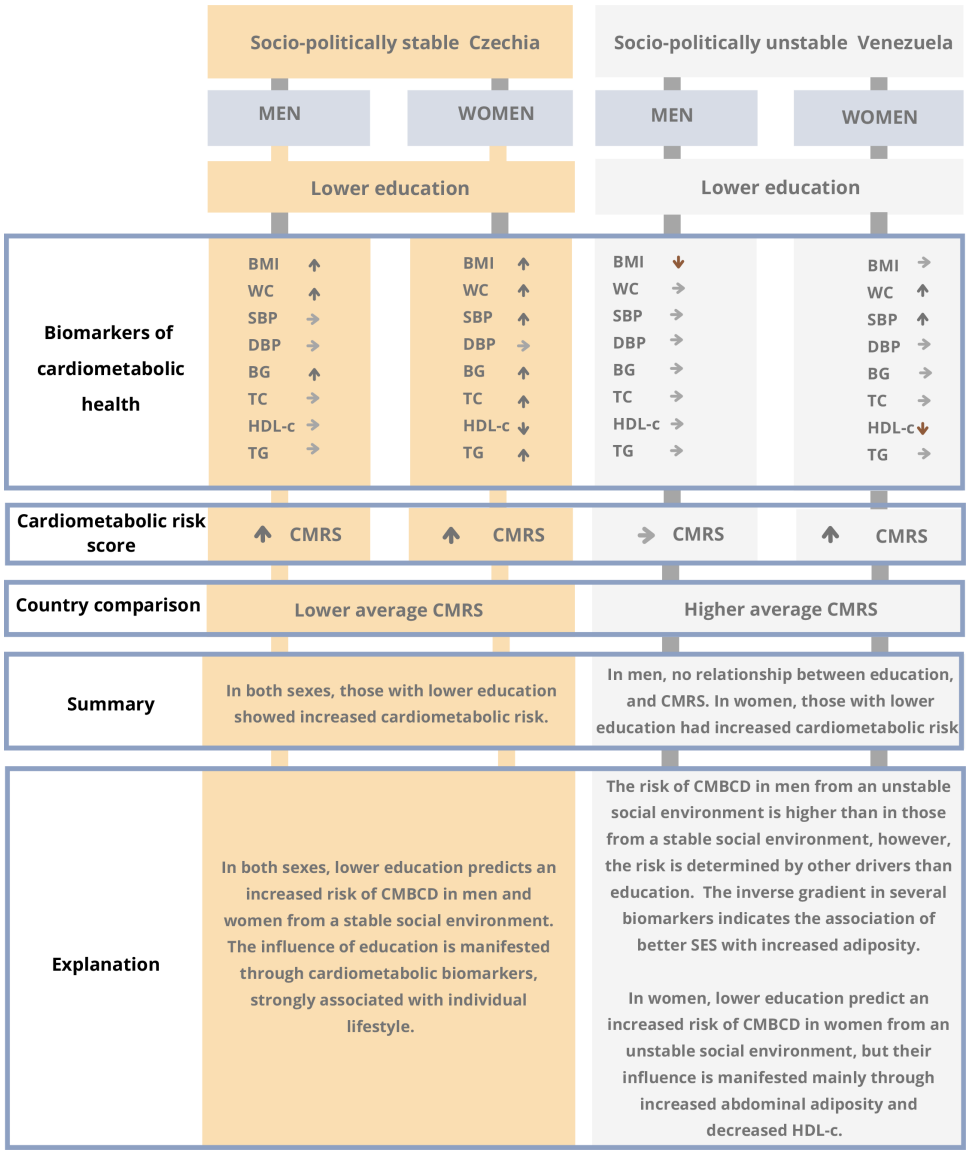

Figure 3 The summary of results. The figure shows that the complex relationships among education and cardiometabolic biomarkers are different in a socioeconomic unstable environment (Venezuela) compared with a country with stable socioeconomic environment (Czechia). BG, blood glucose; BMI, body mass index; CMBCD, cardiometabolic–based chronic disease; CMRS, Cardiometabolic Risk Score; DBP, diastolic blood pressure; HDL-c, high-density lipoprotein cholesterol; SBP, systolic blood pressure; TC, total cholesterol; TG, triglycerides; WC, waist circumference.

clarified, preventive care can then integrate these socioeconomic interventions on a population scale through policy change and structured lifestyle interventions.

Some limitations of this study should be mentioned. First, the cross-sectional design does not allow a causal relationship to be established. Second, both sampling methods were different: the EVESCAM represents a national sample, whereas the Kardiovize represents a community sample from one city (Brno) in Czechia. Thus, while EVESCAM represents both urban and rural population, the Kardiovize represents only the urban population. We also observed a significantly lower response rate in Czechia compared with Venezuela potentially caused by differences in recruitment. The Kardiovize study used a mail-based recruitment method, which may have resulted in a higher non-response rate due to factors such as incomplete or incorrect contact information, lack of interest in participating or other barriers to response. On the other hand, the EVESCAM study used household visits for recruitment, which may have resulted in a lower non-response rate compared with a study that relies on the mail or other indirect methods. There was also a difference in the inclusion criteria. The EVESCAM study included participants over the age of 20, while the Czechia study only included participants between the ages of 25 and 64. Although we excluded EVESCAM participants outside of this age range for the analysis, the limited age range may not fully capture the relationship between social determinants and cardiometabolic health. The different inclusion criteria may also have affected the overall representation of the study samples, potentially limiting the generalisability of the findings to the wider

population. Nevertheless, both studies were collected during the same time period sharing similar aims and methodologies.

In conclusion, our findings suggest that social determinants and cardiometabolic health in Czechia and Venezuela expressed different relationships when compared with the social gradient. Further research is needed to confirm and quantify these differences, ideally using standardised methods of socioeconomic factors assessment. This complex interaction of socioeconomic factors, stress response and cardiometabolic risk require further study to better understand the primary drivers of CMBCD and optimise the performance of preventive care models.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval Both studies complied with the Declaration of Helsinki and all participants signed the informed consent. The Kardiovize Study was approved by the ethics committee of St Anne's University Hospital, Brno, Czechia with a reference number2 G/2012. The EVESCAM was approved by the National Bioethics Committee (CENABI) of Venezuela. Participants gave informed consent to participate in the study before taking part.

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