

Prevalence of Cardiovascular Risk Factors and Global Cardiovascular Risk Among Patients in General Practice: A Cross-Sectional Study

Tatiana Wrba

Comenius University Bratislava

Marek Kucera²

Comenius University Bratislava

Diana Vondrova¹

Comenius University Bratislava

Jana Babjakova¹

Comenius University Bratislava

Jana Jurkovicova¹

Comenius University Bratislava

Lubica Argalasova¹

`lubica.argalasova@fmed.uniba.sk`

Comenius University Bratislava

Research Article

Keywords: Cardiovascular diseases, risk factors, cardiovascular risk, SCORE2, general practice, primary prevention, lifestyle

Posted Date: July 9th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10253135/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: No competing interests reported.

Title page

Prevalence of Cardiovascular Risk Factors and Global Cardiovascular Risk Among Patients
in General Practice: A Cross-Sectional Study

**Tatiana Wrba¹, Marek Kucera², Diana Vondrova¹, Jana Babjakova¹, Jana Jurkovicova¹,
Lubica Argalasova¹,**

- 1) Institute of Hygiene, Faculty of Medicine, Comenius University in Bratislava, Slovak Republic
- 2) Institute of General Medicine, Faculty of Medicine, Comenius University in Bratislava, Slovak Republic

Corresponding author

Name: Lubica Argalášová, Prof. MUDr.PhD., MPH
Address: Comenius University in Bratislava
Faculty of Medicine, Institute of Hygiene
Moskovska 3, Bratislava, 813 72, Slovak Republic
E-mail address: lubica.argalasova@fmed.uniba.sk

ORCID

Tatiana Wrba: tatiana.wrba@fmed.uniba.sk 0009-0001-6594-8607
Marek Kučera: yseobecne.sekretariat@fmed.uniba.sk 0009-0004-1538-0971
Diana Vondrová: diana.vondrova@fmed.uniba.sk 0000-0001-7840-8063
Jana Babjakova: jana.babjakova@fmed.uniba.sk 0000-0003-1491-0067
Jana Jurkovičová: jana.jurkovicova@fmed.uniba.sk 0000-0002-0892-5572
Lubica Argalášová: lubica.argalasova@fmed.uniba.sk 0000-0002-8908-3441

Statements and Declarations

The authors declare that they have no potential conflicts of interest.

Acknowledgments: Not applicable

Funding: Not applicable

Authors' contributions: The article is the authors' original work, has not received prior publication, and is not under consideration for publication elsewhere. Tatiana Wrba designed the study, collected, analysed and interpreted the data, writing manuscript. Marek Kucera: data resources. Lubica Argalasova: writing review, editing, supervision. Diana Vondrova: data curation and analysis. Jana Babjakova: writing review. Jana Jurkovicova: writing review, editing and supervision.

Ethics declaration: The study was approved by the Ethical Committee of the Bratislava Self-Governing Region. under the reference number 11347/2025/HF in September 2025.

Data availability statement: Anonymized data will be provided based on a valid request by a corresponding author.

Declaration of generative AI and AI-assisted technologies in the writing process: During the preparation of this article, the authors used the Writefull tools, which were used to linguistically proofread the manuscript.

ABSTRACT

Introduction:

Cardiovascular diseases (CVDs) remain the leading cause of mortality, morbidity, and healthcare expenditure worldwide, including Slovakia. The prevention of CVD is a cornerstone of modern preventive medicine. Recent epidemiological data highlight the ongoing need for comprehensive strategies focused on early diagnosis, effective treatment, and sustained preventive efforts.

Sample and Methods:

We conducted a cross-sectional study of 426 patients in a general practitioner's outpatient clinic in the small town, located in the Bratislava region of Slovakia. The study included patients who underwent preventive health check-ups in 2024. The sample consisted of 426 patients aged 40–69 years (57.7% women, mean age 55.16 ± 8.83 years; 42.3% men, mean age 54.91 ± 8.68 years). The study focused on the prevalence of CVD risk factors and the assessment of cardiovascular risk using the SCORE2 model.

Results:

A high prevalence of biological and lifestyle-related risk factors (smoking, alcohol consumption, overweight, obesity, hypertension, and dyslipidemia) was observed. Using SCORE2 algorithms, 70% of individuals were classified as having high or very high cardiovascular risk. The prevalence of additional CVD risk factors not included in SCORE2 increased with higher global cardiovascular risk. A statistically significant association was found between cardiovascular risk and waist-to-height ratio (WHtR), diabetes mellitus, and excessive alcohol consumption.

Conclusion:

A high proportion of individuals in this study elevated cardiovascular risk, based on both individual risk factors assessment and the SCORE2 model. Regular reassessment of cardiovascular risk is essential, as it may change over time due to the influence of modifiable risk factors. Such monitoring enables long-term tracking of both positive and negative trends in an individual's cardiovascular health.

Keywords:

Cardiovascular diseases; risk factors; cardiovascular risk; SCORE2; general practice; primary prevention; lifestyle

1 INTRODUCTION

Cardiovascular diseases (CVD) are the leading cause of death among chronic non-communicable diseases worldwide and were responsible for approximately 19.4 to 20.5 million deaths in 2021 [1]. According to the Global Burden of Cardiovascular Diseases and Risks Report, the number of deaths due to CVD increased from 12.4 million in 1990 to 19.8 million in 2022, reflecting the growth, ageing of the global population and the impact of the presence of preventable risk factors [2]. In 2019, more than 1.8 million people died from CVD in the European Union (EU) and 3.9 million in Europe in general [2]. More than 6 million new CVD cases occur in the EU each year, and the economic burden is estimated at approximately EUR 210 billion annually [3].

Before 2004, the proportion of deaths attributable to CVD in EU countries was 34.4%. Following the enlargement of the EU in 2004, when 10 new countries joined, this proportion increased to 51.9% [2]. Significant regional disparities in CVD mortality persist across EU countries, with the highest mortality observed in Eastern and Baltic countries compared to Western and Southern Europe, where rates are 4- to 7-fold higher in high-burden countries [2]. According to Eurostat, the standardised CVD death rate in Slovakia was approximately 600 per 100,000 population in 2023. Mortality trends declined between 1980 and 2010 by 25.7% in men and 30.5% in women [4,5]. According to the National Health Information Centre of Slovakia, CVDs accounted for 45.0% of all deaths in 2024 [6].

In 2003, the European Society of Cardiology (ESC) developed the SCORE (Systematic COronary Risk Evaluation) model, based on 12 European cohort studies involving approximately 250,000 apparently healthy individuals, to estimate the 10-year risk of fatal cardiovascular events [5]. In 2021, the ESC introduced recalibrated models—SCORE2 and SCORE2-OP (Systematic COronary Risk Evaluation 2 for Older People)—to estimate the 10-year risk of fatal and non-fatal cardiovascular events in individuals without prior CVD or diabetes, 40-69 years of age and 70-89 years, respectively [7,8].

The SCORE2 model provides a clinical estimate of the combined effect of multiple risk factors, including sex, age, smoking, systolic blood pressure, and non-HDL cholesterol, and is widely used in clinical practice. Based on country-specific CVD mortality rates published by the WHO, SCORE2 and SCORE2-OP are calibrated for four European risk regions (low, moderate, high and very high risk). Slovakia belongs to the high-risk category and applies SCORE2 charts to estimate both fatal and non-fatal cardiovascular risk in the population [8].

Reducing CVD mortality and morbidity requires regular screening for risk factors, early identification of high-risk individuals, and timely preventive interventions. These measures, implemented within routine preventive examinations, are particularly important given the current epidemiological situation. Identifying individuals at elevated risk enables early intervention and personalised care to prevent future cardiovascular complications before clinical manifestation. Because behavioural risk factors play a crucial role in the development of CVD, their effective management can substantially reduce the incidence of the disease.

In Slovakia, the majority residents are registered with a general practitioner (GP), who typically maintains a long-term relationship with patients and has a comprehensive knowledge of their medical history. Therefore, general practitioners play a key role in initiating, coordinating, and providing long-term follow-up on CVD prevention [8]. Preventive health check-ups are widely available; however, only 46% of adults attended such examinations in 2024, with the lowest participation observed among individuals aged 25–44 years [6].

Health check-ups aim to evaluate an individual's overall health status, identify risk factors, estimate cardiovascular risk, and enable early detection of chronic diseases, while guiding appropriate interventions related to nutrition, lifestyle, and disease prevention. The objective of this study was to examine the impact of risk factors that contribute to the development of CVD in people undergoing preventive health cheques at an outpatient general practitioner's clinic and to estimate cardiovascular risk using the SCORE2 model. In addition, the study aimed to evaluate the potential to reduce the incidence of disease through systematic screening and preventive strategies.

2 SAMPLE AND METHODS

Study Design and Setting

We conducted a cross-sectional study in a general practitioner's outpatient clinic in the town of Modra, located in the Bratislava region in the western part of Slovakia. The study included patients who underwent preventive health check-ups.

Inclusion and Exclusion Criteria

The inclusion criteria comprised male and female patients aged 40–69 years who attended a preventive health check-ups in 2024. The exclusion criteria included pregnancy, previously established cardiovascular disease, and active cancer treatment.

Data Collection

Data were collected from patients' medical records, including family history of CVD and personal medical history (hypertension and diabetes). Anthropometric (body height, body weight, waist circumference, body mass index [BMI], and waist-to-height ratio [WHtR]), clinical, and laboratory measurements were obtained.

Blood pressure was measured using two consecutive readings with a validated automatic device (Omron HBP-1120) under standardized conditions [9]. A lipid profile (total cholesterol, HDL cholesterol, non-HDL cholesterol, LDL cholesterol, and triglycerides) was assessed from venous blood samples and analysed in a certified laboratory (BPB MED).

Hypertension and type 2 diabetes mellitus (T2DM) were identified based on documented medical history. Lifestyle risk factors included smoking and alcohol consumption. Smoking status was categorized as current or former smoking. Alcohol consumption was classified as follows: non-drinkers (no alcohol use in the past year and no history of regular drinking), occasional drinkers (alcohol use in the past year but not on a weekly basis), ex-drinkers (no or occasional alcohol use in the past year but previously consumed alcohol regularly), and current drinkers (alcohol consumption on most weeks during the past year) [10].

The prevalence of individual risk factors was analysed separately for men and women. Based on the identified risk factors, the individual 10-year cardiovascular risk was estimated using the SCORE2 system calibrated for high-risk European countries [8].

Ethical Approval

This study was approved by the Ethics Committee of the Bratislava Self-Governing Region (reference number 0247/25) on September 16, 2025.

Statistical analysis

Statistical analyses were performed using Microsoft Excel 2024 and IBM SPSS Statistics for Windows, version 29.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize the anthropometric, clinical, and laboratory characteristics of the study population. Continuous variables are presented as means $\pm$ standard deviations (SDs), whereas categorical variables are presented as frequencies and percentages. Group comparisons were performed using the chi-square test for categorical variables and the Mann–Whitney U test or Kruskal–Wallis test for continuous variables, as appropriate. The normality of data distribution was assessed using the Shapiro–Wilk test. Binary logistic regression analysis was performed to evaluate the associations between cardiovascular disease (CVD) risk category (dependent variable) and individual CVD risk factors (independent variables). The results are presented as odds ratios (ORs) with 95% confidence intervals (CIs). A two-sided p value < 0.05 was considered statistically significant.

3 RESULTS

Anthropometric, clinical and behavioural characteristics

A total of 426 patients were included in the study, comprising 246 (57.7%) women (mean age 55.2 ± 8.8 years) and 180 (42.3%) men (mean age 54.9 ± 8.7 years). The mean waist circumference was 91.73 ± 14.78 cm in women and 101.58 ± 12.70 cm in men. The overall mean body mass index (BMI) was 27.01 ± 4.97 kg/m², and the mean waist-to-height ratio (WHtR) was 0.56 ± 0.09 . The average systolic blood pressure was 135.30 ± 16.57 mmHg and diastolic blood pressure was 81.99 ± 9.54 mmHg.

In the total sample, the mean total cholesterol level was 5.26 ± 1.23 mmol/L, mean LDL cholesterol was 3.58 ± 1.20 mmol/L, mean HDL cholesterol was 1.39 ± 0.40 mmol/L, and mean triglyceride level was 1.52 ± 1.00 mmol/L. The mean non-HDL cholesterol level was 3.87 ± 1.21 mmol/L.

A family history of CVD was reported by 62% of participants. Hypertension was diagnosed in 42.7% of individuals, and 8% had type 2 diabetes mellitus. Smoking was reported by 26.1% of participants, with a slightly higher prevalence among men (27.8%). The prevalence of high alcohol consumption (≥ 100 g/week) was 9.4% among men.

Baseline characteristics of studied group are summarized in Table 1.

Prevalence of CVD risk factors

Among the study participants, more than one-third (39.2%) were overweight (31.1% of women and 50.0% of men). While clinical obesity was observed nearly in one-quarter (24.6%), with a higher occurrence observed in men, 23.6% of women and 26.1% of men were obese. Central (abdominal) obesity was identified in more than two-thirds (76.0%) of participants, affecting 78.5% of women and 72.6% of men. Nearly 80% of participants had a waist-to-height ratio (WHtR) above 0.5.

Elevated systolic blood pressure ($SBP \geq 140$ mmHg) was recorded in 35.4% of participants, and elevated diastolic blood pressure ($DBP \geq 90$ mmHg) in 23.2%, with both being more prevalent in men than in women.

Table 1 Anthropometric, clinical and behavioural characteristics of the sample (mean $\pm$ SD, categorical data as %)

	Total (n = 426)	Women (n = 246)	Men (n = 180)	p-value
	mean $\pm$ SD	mean $\pm$ SD	mean $\pm$ SD	
Sex (%)	-	57.7	42.3	
Age (years)	55.05 $\pm$ 8.76	55.16 $\pm$ 8.83	54.91 $\pm$ 8.68	n.s.
Height (cm)	170.79 $\pm$ 9.25	165.49 $\pm$ 6.09	178.03 $\pm$ 7.80	<0.001
Weight (kg)	79.47 $\pm$ 17.40	72.67 $\pm$ 15.52	88.76 $\pm$ 15.45	<0.001
Waist circumference (cm)	95.88 $\pm$ 14.76	91.73 $\pm$ 14.78	101.58 $\pm$ 12.70	<0.001
WHtR (cm/cm)	0.56 $\pm$ 0.09	0.55 $\pm$ 0.09	0.56 $\pm$ 0.08	n.s.
BMI (kg/m ²)	27.01 $\pm$ 4.97	26.41 $\pm$ 5.30	27.84 $\pm$ 4.36	<0.01
Office systolic BP (mmHg)	135.30 $\pm$ 16.57	133.76 $\pm$ 17.17	137.40 $\pm$ 15.52	<0.05
Office diastolic BP (mmHg)	81.99 $\pm$ 9.54	80.91 $\pm$ 9.24	83.46 $\pm$ 9.76	<0.01
LDL-cholesterol (mmol/L)	3.58 $\pm$ 1.20	3.69 $\pm$ 1.22	3.43 $\pm$ 1,15	<0.05
HDL-cholesterol (mmol/L)	1.39 $\pm$ 0.40	1.50 $\pm$ 0.40	1.24 $\pm$ 0.36	<0.001
NonHDL-cholesterol (mmol/L)	3.87 $\pm$ 1.21	3.94 $\pm$ 1.23	3.79 $\pm$ 1.19	n.s.
Total cholesterol (mmol/L)	5.26 $\pm$ 1.23	5.44 $\pm$ 1.22	5.01 $\pm$ 1.19	<0.01
Triglycerides (mmol/L)	1.52 $\pm$ 1.00	1.45 $\pm$ 0.95	1.63 $\pm$ 1.06	<0.05

SD standard deviation, *CVD* Cardiovascular Disease, *WHtR* Waist to Height Ratio *BMI* Body Mass Index, *BP* Blood Pressure, *LDL* -Cholesterol Low-Density-Lipoprotein Cholesterol, *HDL* Cholesterol High - Density - Lipoprotein Cholesterol, *Non-HDL-Cholesterol* Non-High-Density-Lipoprotein Cholesterol, *P* Value *n.s.* Not Significant

Mean lipid levels exceeded reference values in both sexes, with the exception of triglycerides. Elevated LDL cholesterol levels were detected in 65.3% of participants, while increased non-HDL cholesterol levels were present in 49.8% of the total cohort (Table 2).

Table 2 Prevalence of CVD risk factors between genders

Risk factors		Total (n = 426)	Women (n = 246)	Men (n = 180)	p-value
		n (%)	n (%)	n (%)	
Smoking	No	315 (73.9%)	185 (75.2%)	130 (72.2%)	n.s.
	Yes	111 (26.1%)	61 (24.8%)	50 (27.8%)	
BMI	< 18.5 kg/m ²	7 (1.6%)	5 (2.0%)	2 (1.1%)	<0.001
	< 18.5 - 24.9 kg/m ²	147 (34.5%)	106 (43.1%)	41 (22.8%)	
	≥ 25 kg/m ²	167 (39.2%)	77 (31.3%)	90 (50.0%)	
	≥ 30 kg/m ²	105 (24.6%)	58 (23.6%)	47 (26.1%)	
Waist circumference	< 94 cm men; < 80 cm women	102 (24%)	53 (21.5%)	49 (27.4%)	n.s.
	> 94 cm men; > 80 cm women	323 (76%)	193 (78.5%)	130 (72.6%)	
WHtR	< 0.5	88 (20.7%)	64 (26%)	24 (13.3%)	<0.01
	≥ 0.5	338 (79.3%)	182 (74%)	156 (86.7%)	
Office systolic BP	< 140 mmHg	275 (64.6%)	168 (68.3%)	107 (59.4%)	0.059
	≥ 140 mmHg	151 (35.4%)	78 (31.7%)	73 (40.6%)	
Office diastolic BP	< 90 mmHg	327 (76.8%)	201 (81.7%)	126 (70.0%)	<0.01
	≥ 90 mmHg	99 (23.2%)	45 (18.3%)	54 (30%)	
Total-cholesterol	< 5 mmol/l	181 (42.5%)	84 (34.1%)	97 (53.9%)	<0.001
	≥ 5 mmol/L	245 (57.5%)	162 (65.9%)	83 (46.1%)	
HDL- cholesterol	> 1 mmol/L	106 (24.9%)	61 (24.8%)	45 (25.1%)	n.s.
	≤ 1 mmo/L	319 (75.1%)	185 (75.2%)	134 (74.9%)	
LDL-cholesterol	optimal	148 (34.7%)	77 (31.3%)	71 (39.4%)	n.s.

	>3 mmol/L	278 (65.3%)	169 (68.7%)	109 (60.6%)	
nonHDL-cholesterol	optimal	214 (50.2%)	116 (47.2%)	98 (54.4%)	n.s.
	> 3.8 mmol/L	212 (49.8%)	130 (52.8%)	82 (45.6%)	
Triglycerides	optimal	302 (70.9%)	178 (72.4%)	124 (68.9%)	n.s.
	> 1.7 mmol/L	124 (29.1%)	68 (27.6%)	56 (31.1%)	
Hypertension	no	246 (57.7%)	150 (61%)	96 (53.3%)	n.s.
	yes	180 (42.3%)	96 (39%)	84 (46.7%)	
Type 2 Diabetes Mellitus	no	392 (92%)	228 (92.7%)	164 (91.1%)	n.s.
	yes	34 (8%)	18 (7.3%)	16 (8.9%)	
Family history of CVD	no	162 (38%)	83 (33.7%)	79 (43.9%)	<0.05
	yes	264 (62%)	163 (66.3%)	101 (56.1%)	
Alcohol consumption	no/abstainer	83 (19.5%)	45 (18.3%)	38 (21.1%)	<0.001
	Occasional	322 (75.6%)	197 (80.1%)	125 (69.4%)	
	Daily	21 (4.9%)	4 (1.6%)	17 (9.4%)	

CVD Cardiovascular Disease, *P* Value, *BMI* Body Mass Index, *WHtR* Waist to Height Ratio
BP Blood Pressure, *LDL -C* Low-Density-Lipoprotein Cholesterol, *Non-HDL-C* Non-High-Density-Lipoprotein Cholesterol, *n.s.* Not Significant

Comparison of CVD Risk Factors by Sex

Differences in CVD risk factors between women and men are presented in Table 2. Statistically significant differences were observed for BMI ($p < 0.001$), WHtR ($p < 0.01$), systolic blood pressure ($p = 0.059$), diastolic blood pressure ($p < 0.01$), family history of CVD ($p < 0.05$), and alcohol consumption ($p < 0.001$).

Cardiovascular Risk Assessment and SCORE2 Analysis

According to the SCORE2 assessment, 70.0% ($n = 298$) of participants were classified as having high and very high risk, to developing fatal or non-fatal CVD within 10 years [86.6% ($n = 156$) of men and 57.8% ($n = 142$) of women]. The prevalence was higher in men [high risk of 54.4% ($n = 98$) and very high risk of 32.2% ($n = 58$) ($p < 0.001$] (Table 3).

Table 3 Classification of patients into cardiovascular risk categories based on SCORE2 system

SCORE2	Total (n = 426)	Women (n = 246)	Men (n = 180)	p-value
	n (%)	n (%)	n (%)	
Low-to-moderate CVD risk	128 (30%)	104 (42.2%)	24 (13.4%)	<0.01
High CVD risk	183 (43%)	85 (34.6%)	98 (54.4%)	
Very high CVD risk	115 (27%)	57 (23.2%)	58 (32.2%)	

CVD Atherosclerotic Cardiovascular Disease, SCORE2 Systematic COronary Risk Evaluation 2, P Value

To evaluate CVD risk factors not included in SCORE2 (overweight, obesity, abdominal adiposity, evaluated WHtR, diastolic blood pressure ≥ 90 mmHg, LDL cholesterol > 3 mmol/L, triglycerides > 1.7 mmol/L, type 2 diabetes mellitus, alcohol consumption, and family history of CVD), chi-square tests were performed. The prevalence of several risk factors increased with higher cardiovascular risk. Overweight, obesity, abdominal obesity (waist circumference and WHtR), elevated triglycerides, and diabetes mellitus showed significant associations with higher CVD risk. Occasional alcohol consumption demonstrated a statistically significant inverse (potentially protective) association (Table 4).

Table 4 Prevalence of CVD risk factors not included in the SCORE2 assessment in various cardiovascular risk categories according to the SCORE2

Risk factors		SCORE2			p-value
		Low-to-moderate CVD risk (n = 128)	High CVD risk (n = 183)	Very high CVD risk (n = 115)	
		n (%)	n (%)	n (%)	
BMI	< 18.5 kg/m ²	5 (3.9%)	1 (0.5%)	1 (0.9)	<0.01
	$< 18.5 - 24.9$ kg/m ²	55 (43%)	58 (31.7%)	34 (29.6)	
	≥ 25 kg/m ²	45 (35.2%)	81 (44.3%)	41 (35.7)	

	$\geq 30 \text{ kg/m}^2$	23 (18%)	43 (23.5%)	39 (33.9)	
Waist circumference	< 94 cm men; < 80 cm women	45 (35.2%)	40 (22%)	17 (14.8)	<0.01
	> 94 cm men; > 80 cm women	83 (64.8%)	142 (78%)	98 (85.2%)	
WHtR	< 0.49	45 (35.2%)	32 (17.5%)	11 (9.6%)	<0.01
	> 0.5	83 (64.8%)	151 (82.5%)	104 (90.4%)	
Office diastolic BP	< 90 mmHg	107 (83.6%)	137 (74.9%)	83 (72.2%)	n.s.
	$\geq 90 \text{ mmHg}$	21 (16.4%)	46 (25.1%)	32 (27.8%)	
LDL-cholesterol	optimal	42 (32.8%)	62 (33.9%)	44 (38.3%)	n.s.
	>3 mmol/L	86 (67.2%)	121 (66.1%)	71 (61.7%)	
Triglycerides	optimal	103 (80.5%)	126 (68.9%)	73 (63.5%)	<0.05
	> 1.7 mmol/L	25 (19.5%)	57 (31.1%)	42 (36.5%)	
Type 2 Diabetes Mellitus	no	127 (99.2%)	170 (92.9%)	95 (82.6%)	<0.01
	yes	1 (0.8%)	13 (7.1%)	20 (17.4%)	
Family history of CVD	no	54 (42.2%)	65 (35.5%)	43 (37.4%)	n.s.
	yes	74 (57.8%)	118 (64.5%)	72 (62.6%)	
Alcohol consumption	no/abstainer	22 (17.2%)	34 (18.6%)	27 (23.5%)	<0.05
	occasional	105 (82.0%)	139 (76%)	78 (67.8%)	
	daily	1 (0.8%)	10 (5.5%)	10 (8.7%)	

SCORE2 Systematic COronary Risk Evaluation 2 *CVD* Cardiovascular Disease *P* Value *BMI* Body Mass Index, *WHtR* Waist to Height Ratio *BP* Blood Pressure, *LDL -C* Low-Density-Lipoprotein Cholesterol, *n.s.* Not Significant

Binary logistic regression analysis confirmed that waist-to-height ratio (OR = 3.06; 95% CI: 1.42–6.59; $p < 0.01$), diabetes mellitus (OR = 10.53; 95% CI: 1.40–79.48; $p < 0.05$), and excessive alcohol consumption (OR = 9.12; 95% CI: 1.10–75.74; $p < 0.05$) were significantly associated with increased cardiovascular risk (Table 5).

Table 5 Impact of risk factors associated in high or very high CVD risk according to the SCORE2 system

Risk factors	OR	p-value	95 % CI
BMI ≥ 25 kg/m ² / ≥ 30 kg/m ²	0.90	n.s	0.50 – 1.62
Waist circumference > 94cm men/ > 80cm women	1.00	n.s	0.50 – 1.97
WHtR $\geq 0,5$	3.06	<0.01	1.42 – 6.59
Office diastolic BP ≥ 90 mmHg	1.38	n.s	0.78 – 2.44
LDL-cholesterol > 3 mmol/L	0.92	n.s	0.57 – 1.48
Triglycerides > 1.7 mmol/L	1.39	n.s	0.80 – 2.41
Type 2 Diabetes Mellitus	10.53	<0.05	1.40 – 79.48
Family history of CVD	1.14	n.s	0.73 – 1.79
Occasional alcohol consumption	0.83	n.s	0.47 – 1.48
Excessive alcohol consumption	9.12	<0.05	1.10 – 75.74

CVD Cardiovascular Disease, *B* β Regression Coefficient, *P* Value, *CI* Confidence Intervals, *BMI* Body Mass Index, *WHtR* Waist to Height Ratio, *BP* Blood Pressure, *LDL* -C Low-Density-Lipoprotein Cholesterol

4 DISCUSSION

Cardiovascular diseases (CVD) remain the leading cause of death worldwide, including in the European Union and Slovakia. In Slovakia, a gradual slight decline in CVD mortality has been observed, with the standardized death rate decreasing by nearly 16% during the years 2015-2019. Despite this positive trend, progress was interrupted during the COVID-19 pandemic [6]. The World Health Organization (WHO) has identified several key CVD risk factors, indicating that a substantial proportion of CVD can be prevented by addressing behavioural and environmental risk factors such as tobacco use, unhealthy diet (particularly excessive intake of salt, sugar, and fats), obesity, physical inactivity, harmful alcohol consumption, and air pollution [11].

It is well established that many individuals adopt unhealthy behaviours early in life and tend to maintain them into adulthood, including poor dietary habits, physical inactivity, smoking, and

excessive alcohol consumption. Numerous studies have demonstrated that in individuals with an unhealthy lifestyle, risk factors tend to accumulate and are strongly associated with an increased risk of CVD [12–20].

In the present study of 426 patients aged 40–69 years who underwent preventive health check-ups at a general practitioner's clinic, a high prevalence of CVD risk factors was observed. These included family history of CVD, smoking, overweight and obesity (predominantly of the abdominal type), elevated blood pressure, and increased levels of total cholesterol, LDL cholesterol, and non-HDL cholesterol. The study population represents a specific group of adults who might be expected to have a higher level of awareness regarding prevention, healthy lifestyle behaviours, and proper nutrition.

In this sample, the prevalence of current smoking was 26.1%, with a higher proportion observed among men (27.8%). The prevalence of regular alcohol consumption was 9.4% among men. The epidemiological study of behavioural cardiovascular risk factors conducted in France reported that, despite substantial preventive efforts targeting smoking, the prevalence of behavioural risk factors remains high in the French population and continues to be a public health concern [21].

The effects of low and regular alcohol consumption remain controversial in the scientific literature [22]. In France, guidelines for lower risk alcohol consumption were introduced in 2017 by a panel of experts and are regularly communicated to the public in order to promote reduction of alcohol consumption and mitigate its adverse health effects [23].

In the present study, the mean waist circumference in the sample was 95.88 ± 14.76 cm, which represents a considerable concern, as it indicates an elevated risk of developing CVD. When evaluating the impact of CVD risk factors not included in the SCORE2 assessment, we found that these factors further increased overall cardiovascular risk and the likelihood of individuals being classified into higher SCORE2 risk categories.

Waist circumference, in particular, emerged as a significant predictor of increased cardiovascular risk. Each 1 cm increase in waist circumference was associated with a statistically significant increase in the probability of belonging to a higher SCORE2 risk category. Similarly, a study by Suwala and Junik identified both BMI and waist circumference as predictors of CVD, with larger waist circumference in both men and women increasing the risk of a cardiovascular event by 3.8- to 4.8-fold over a 10-year period [24].

Another study by Gryglewska-Wawrzak et al. examined factors associated with the SCORE2 model and found that individuals in high-risk categories more frequently presented with obesity

[25]. The association between obesity and an increased risk of coronary artery disease has been consistently demonstrated across multiple epidemiological studies [26–29].

Large prospective analyses suggest that this relationship is largely mediated by comorbidity such as hypertension, dyslipidemia, and diabetes mellitus [30]. Interestingly, a study by Shao Chuan et al. described the so-called “obesity paradox” in stroke, where a higher BMI at the time of diagnosis was associated with better functional outcomes and improved survival among stroke patients [31].

When assessing CVD risk, we found that the majority of patients were classified in the high CVD risk category and did not achieve target LDL cholesterol levels [32]. Among individuals at high CVD risk, 66.1% had elevated LDL cholesterol levels.

In Slovakia, the SlovakLipid retrospective study by Toth et al. reported that more than 90% of patients with very high cardiovascular risk fail to achieve target LDL cholesterol levels [33]. Similarly, in the study by Pereira Santos et al. [34], which assessed cardiovascular risk using the SCORE2 system, 62.39% of participants had elevated LDL cholesterol levels, while only 7% of individuals in the high-risk category and 3% in the very high-risk category achieved recommended LDL cholesterol targets.

Comparable findings were reported by Campos et al. [35], who found that 94.7% of patients had elevated LDL cholesterol levels and did not reach target values, despite 35.9% of them receiving lipid-lowering treatment.

In our sample, the prevalence of high (54.4%) and very high (32.2%) cardiovascular risk among men may be partially explained by the cardioprotective effect of oestrogen in premenopausal women [36].

The EPIC-Norfolk prospective population cohort study, which included 22,673 apparently healthy individuals aged 40–69 years (SCORE2) and 70–79 years (SCORE2-OP), demonstrated that the SCORE2 low-risk model performs well in middle-aged populations and can support healthcare providers in identifying individuals who may benefit from preventive interventions [37].

In a study by Csentéri et al., who compared cardiovascular risk levels in more than 85,000 individuals aged 40–65 years using SCORE and SCORE2, 44% of participants were reclassified into higher risk categories when using SCORE2. The authors also highlighted significant challenges in achieving lipid target values in primary healthcare settings [38].

Similarly, a large retrospective cohort study by Voorbrood et al., including 205,548 adults aged 40–69 years undergoing their first cardiovascular assessment in general practice, found that

SCORE2 predicted a 6.2% risk of cardiovascular events, whereas the observed risk was higher (10.1%), suggesting that SCORE2 may underestimate cardiovascular risk in primary care [39]. In our study, occasional alcohol consumption (≤ 2.8 g/day) appeared to demonstrate a cardioprotective association. However, binary logistic regression analysis did not confirm this effect; on the contrary, excessive alcohol consumption was significantly associated with increased cardiovascular risk. Given that the study was conducted in a small town located in a traditional wine-producing region of Slovakia, we further contextualized these findings within the current evidence on alcohol consumption.

According to the 2021 ESC Guidelines for cardiovascular disease prevention, the upper recommended limit for alcohol consumption is approximately 100 g of pure alcohol per week, corresponding to roughly 8–14 g per standard drink, with similar limits for men and women. Importantly, randomized studies do not support a protective effect of moderate alcohol consumption on cardiovascular outcomes [8]. Excessive alcohol intake or binge drinking is associated with a linear increase in the risk of stroke, coronary artery disease, and heart failure [8].

The relationship between alcohol consumption and cardiovascular disease is complex and often described as biphasic. While some epidemiological studies suggest that low-to-moderate alcohol intake may be associated with reduced cardiovascular risk, these findings remain controversial due to potential confounding factors.

Recent guidance emphasized by Gupta et al. in the American Journal of Cardiology highlights that such recommendations are not intended to encourage alcohol consumption but rather to reduce risk among current drinkers. The American Heart Association recommends limiting alcohol intake to no more than one standard drink per day for women and two for men [40].

Evidence from Piano et al. suggests that reducing or abstaining from alcohol may lower the risk of certain cardiovascular conditions, such as hypertension, although uncertainty remains regarding the effects of light drinking (1–2 drinks per day) [41]. A large analysis by Krittanawong et al., based on 56 cohorts, found that moderate wine consumption (1–4 drinks per week) was associated with lower cardiovascular mortality compared with beer or spirits; however, observational studies may overestimate these benefits, and further prospective research is needed [42].

Findings from the PREDIMED trial led by Inés Domínguez-López indicated that light-to-moderate wine consumption (approximately half to one glass per day) was associated with a reduced risk of cardiovascular events among high-risk individuals adhering to a Mediterranean diet. However, this protective effect disappeared at higher levels of consumption [43].

Socioeconomic determinants of cardiovascular risk have also been reported, with studies by Santos et al. and Dienhart et al. demonstrating associations between CVD risk, educational level, and health literacy [44,45]. Additionally, Dieterle et al. reported that 71.7% of patients with arterial hypertension in a general practice population in Switzerland were classified as high-risk, with a high prevalence of CVD risk factors and target organ damage [46].

Limitations

Several limitations of this study should be acknowledged. First, the lack of a significant association between LDL cholesterol and cardiovascular risk may be related to the small sample size and the absence of detailed data on lipid-lowering therapy. Second, the observed inverse association between alcohol consumption and cardiovascular risk suggests a potential J-shaped relationship; however, this finding may be influenced by residual confounding and should be interpreted with caution. Current evidence does not support recommending alcohol consumption as a preventive strategy. The selection of participants was not random and the data cannot be generalized.

Finally, data on socioeconomic status were not collected, which limits the ability to identify and target high-risk populations more effectively in future prevention strategies.

5 CONCLUSIONS

Our study focuses on individuals at high and very high risk of CVD, with the aim of preventing the development and progression of risk factors. A substantial proportion of participants were identified as having elevated cardiovascular risk, based on both individual risk factors and the SCORE2 model.

Preventive examinations play an essential role in the routine assessment of cardiovascular risk in both primary and secondary prevention. Primary prevention specifically targets individuals at increased risk of developing CVD. Once a risk factor is identified, it is crucial to inform and educate patients about strategies to reduce or eliminate this risk. This includes promoting healthy lifestyle behaviours, maintaining optimal body weight, supporting adherence to lipid-lowering and antihypertensive treatment, and achieving recommended target levels for LDL cholesterol and blood pressure.

Regular reassessment of cardiovascular risk is essential, as risk status may change over time due to the influence of modifiable factors.

REFERENCES

- [1] Lindstrom M, Declene N, Dorsey H, et al. Global burden of cardiovascular diseases and risks collaboration 1990 - 2021: J Am Coll Cardiol, 2022; 80: 2372 - 2425.
- [2] Helis E, Augustincic L, Steiner S, et al. Time trends in cardiovascular and all-cause mortality in the 'old' and 'new' European Union countries. Eur J Cardiovasc Prev Rehabil. 2011 Jun;18(3):347-359. <https://doi.org/10.1177/1741826710389361>.
- [3] European Society of Cardiology. ESC Cardiovascular Disease Statistics. Available at: <https://www.escardio.org/The-ESC/Press-office/Fact-sheets> (Accessed October 17, 2024).
- [4] Eurostat. Age-standardised death rates by cause. Available at: https://ec.europa.eu/eurostat/databrowser/view/hlth_cd_asdr2__custom_20220651 (Accessed October 17, 2024).
- [5] Svihrova V, Barakova A, Szaboova V, et al Trends in standardized mortality rates for select groups of cardiovascular diseases in Slovakia between 1980 and 2010, Public Health, 2016;130:43–50
- [6] National Health Information Centre. Health Statistics Yearbook of the Slovak Republic 2024. Bratislava: National Health Information Centre; 2024.
- [7] Graham IM, Di Angelantonio E, Visseren FLJ, et al. European Society of Cardiology Cardiovascular Risk Collaboration. Systematic Coronary Risk Evaluation (SCORE): JACC Focus Seminar 4/8. J Am Coll Cardiol 2021;77(24):3046–3057. <https://doi.org/10.1016/j.jacc.2021.04.052>.
- [8] Visseren FLJ, Mach F, Smulders YM, et al. 2021 ESC Guidelines on cardiovascular disease prevention in clinical practice. Eur Heart J 2021;42:3227–3337.
- [9] McEvoy JW, McCarthy CP, Bruno RM, et al. 2024 ESC Guidelines for the management of elevated blood pressure and hypertension. Eur Heart J 2024;45(38):3912–4018. <https://doi.org/10.1093/eurheartj/ehae178>.
- [10] Im PK, Millwood IY, Kartsonaki C, et al. Alcohol drinking and risks of liver cancer and non-neoplastic chronic liver diseases in China: a 10-year prospective study of 0.5 million adults. BMC Med 2021;19:216. <https://doi.org/10.1186/s12916-021-02079>.
- [11] World Health Organization. Cardiovascular diseases (CVDs). Available at: [https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-\(cvds\)](https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds)) (Accessed October 17, 2024).
- [12] SCORE2 Working Group, ESC Cardiovascular Risk Collaboration. SCORE2 risk prediction algorithms: new models to estimate 10-year risk of cardiovascular disease in Europe. Eur Heart J 2021;42:2439–2454.

- [13] Giulietti F, Filipponi A, Rosettani G, et al. Pharmacological approach to smoking cessation: an updated review for daily clinical practice. *High Blood Press Cardiovasc Prev* 2020;27(5):349–362. <https://doi.org/10.1007/s40292-020-00396-9>.
- [14] Millwood IY, Walters RG, Mei XW, et al. Conventional and genetic evidence on alcohol and vascular disease aetiology: a prospective study of 500,000 men and women in China. *Lancet* 2019;393:1831–1842. [https://doi.org/10.1016/S0140-6736\(18\)31772-0](https://doi.org/10.1016/S0140-6736(18)31772-0).
- [15] Rippe JM. Lifestyle strategies for risk factor reduction, prevention, and treatment of cardiovascular disease. *Am J Lifestyle Med* 2019;13(2):204–212. <https://doi.org/10.1177/1559827618812395>.
- [16] Thayssa H, Marcos LS de M. Impact of lifestyle on the incidence of heart disease: a systematic literature review. *Int Healthc Rev*. <https://doi.org/10.56226/110>.
- [17] Almutairi M, Almutairi AA, Alodhialah AM. The influence of lifestyle modifications on cardiovascular outcomes in older adults: findings from a cross-sectional study. *Life*. 2025;15:87. doi:10.3390/life15010087.
- [18] Jafari N, Alivand S, Molaee H, et al. How lifestyle factors can contribute to cardiovascular disease incidence: a review study. *J Prev Epidemiol*. 2024;9(1):e35232. doi:10.34172/jpe.2023.35232.
- [19] Lu L, Jing W, Qian W, et al. Association between dietary patterns and cardiovascular diseases: a review. *Curr Probl Cardiol*. 2024;49(3):102412. doi:10.1016/j.cpcardiol.2024.102412.
- [20] Masoudkabar F, Mohammadidard N, Mani A, et al. Lifestyle-related risk factors of cardiovascular disease and cancer: evidence for joint prevention. *ScientificWorldJournal*. 2023;2023:2404806. doi:10.1155/2023/2404806.
- [21] Olié V, Grave C, Helft G, et al. Epidemiology of cardiovascular risk factors: behavioural risk factors. *Arch Cardiovasc Dis*. 2024;117(12):770–784. doi:10.1016/j.acvd.2024.10.328.
- [22] Wood AM, Kaptoge S, Butterworth AS, et al. Risk thresholds for alcohol consumption: combined analysis of individual-participant data for 599,912 current drinkers in 83 prospective studies. *Lancet*. 2018;391(10129):1513–1523. doi:10.1016/S0140-6736(18)30134-X.
- [23] Santé Publique France. Avis d'experts relatif à l'évolution du discours public en matière de consommation d'alcool en France. Available at: <https://www.santepubliquefrance.fr/les-actualites/2017/avis-d-experts-relatif-a-l-evolution-du-discours-public-en-matiere-de-consommation-d-alcool-en-france-organise-par-sante-publique-france-et-l-insti>. Accessed October 17, 2024.
- [24] Suwala S, Junik R. Body mass index and waist circumference as predictors of above-average increased cardiovascular risk assessed by the SCORE2 and SCORE2-OP calculators and the

- proposition of new optimal cut-off values: cross-sectional single-center study. *J Clin Med*. 2024;13:1931.
- [25] Gryglewska-Wawrzak K, Banach M, Sakowicz A, et al. Factors influencing Systemic Coronary Risk Estimation 2 (SCORE2). *Cardiol J*. 2025;32(2):153–163. doi:10.5603/CJ.95922.
 - [26] Calle EE, Thun MJ, Petrelli JM, et al. Body-mass index and mortality in a prospective cohort of U.S. adults. *N Engl J Med*. 1999;341(15):1097–1105. doi:10.1056/NEJM199910073411501.
 - [27] Manson JE, Willett WC, Stampfer MJ, et al. Body weight and mortality among women. *N Engl J Med*. 1995;333(11):677–685. doi:10.1056/NEJM199509143331101.
 - [28] Folsom AR, Stevens J, Schreiner PJ, et al. Body mass index, waist/hip ratio, and coronary heart disease incidence in African Americans and whites. *Am J Epidemiol*. 1998;148(12):1187–1194. doi:10.1093/oxfordjournals.aje.a009608.
 - [29] Hubert HB, Feinleib M, McNamara PM, et al. Obesity as an independent risk factor for cardiovascular disease: a 26-year follow-up of participants in the Framingham Heart Study. *Circulation*. 1983;67(5):968–977. doi:10.1161/01.CIR.67.5.968.
 - [30] Ndumele CE, Matsushita K, Lazo M, et al. Obesity and subtypes of incident cardiovascular disease. *J Am Heart Assoc*. 2016;5(8):e003921. doi:10.1161/JAHA.116.003921.
 - [31] Shao C, Zou D, Xu C, et al. Post-stroke body mass index and mortality in stroke survivors. *Bratisl Med J*. 2025;126:3064–3072. doi:10.1007/s44411-025-00321-3.
 - [32] Mach F, Baigent C, Catapano AL, et al. ESC/EAS guidelines for the management of dyslipidaemias: lipid modification to reduce cardiovascular risk. *Atherosclerosis*. 2019;290:140–205.
 - [33] Toth S, Turek M, Pella D. Success in achieving LDL-C target values in a high-risk population in Slovakia: the SlovakLipid retrospective study. *Arch Med Sci*. 2023;21(3):738–746. doi:10.5114/aoms/170961.
 - [34] Pereira Santos S, Guedes S, Pesqueira R, et al. Cardiovascular risk assessment using SCORE2 in a population with hypertension: the reality at primary health care. *Rev Port Cardiol*. 2024;43:601–610.
 - [35] Campos J, Figueiredo A, Silva J, et al. Use of SCORE2 in the assessment and control of cardiovascular risk in an apparently healthy individual cohort. *Rev Clin Esp (Barc)*. 2025;225(6):502302. doi:10.1016/j.rceng.2025.502302.
 - [36] Iorga A, Cunningham CM, Moazeni S, et al. The protective role of oestrogen and oestrogen receptors in cardiovascular disease and the controversial use of oestrogen therapy. *Biol Sex Differ*. 2017;8:33.

- [37] Van Trier TJ, Snarterse M, Boekholdt SM, et al. Validation of Systematic Coronary Risk Evaluation 2 (SCORE2) and SCORE2-Older Persons in the EPIC-Norfolk prospective population cohort. *Eur J Prev Cardiol.* 2024;31(2):182–189. doi:10.1093/eurjpc/zwad318.
- [38] Csenteri O, Jancsó Z, Szöllösi GJ, et al. Differences of cardiovascular risk assessment in clinical practice using SCORE and SCORE2. *Open Heart.* 2022;9(2):e002087. doi:10.1136/openhrt-2022-002087.
- [39] Voorbrood VMI, Bohnen AM, Bosman AP, et al. Underestimation of cardiovascular risk by the SCORE2 model in primary care: a call for recalibration. *Eur J Prev Cardiol.* 2025;32:zwaf253. doi:10.1093/eurjpc/zwaf253.
- [40] Shyla G, Nilah A, Kavi D, et al. Alcohol and cardiovascular disease. *Am J Cardiol.* 2026;259:132–138.
- [41] Piano MR, Marcus GM, Aycock DM, et al. Alcohol use and cardiovascular disease: a scientific statement from the American Heart Association. *Circulation.* 2025;152(1):e7–e21. doi:10.1161/CIR.0000000000001341.
- [42] Krittanawong C, Isath A, Rosenson RS, et al. Alcohol consumption and cardiovascular health. *Am J Med.* 2022;135(10):1213–1230.e3.
- [43] Domínguez-López I, Lamuela-Raventós RM, Razquin C, et al. Urinary tartaric acid as a biomarker of wine consumption and cardiovascular risk: the PREDIMED trial. *Eur Heart J.* 2025;46(2):161–172. doi:10.1093/eurheartj/ehae804.
- [44] Dienhart C, Gostner I, Frey V, et al. Including educational status may improve cardiovascular risk calculations such as SCORE2. *Front Cardiovasc Med.* 2024;11:1345277. doi:10.3389/fcvm.2024.1345277.
- [45] Santos M, Sousa-Uva M, Namorado S, et al. Estimation of 10-year cardiovascular disease risk in the Portuguese population using Systematic Coronary Risk Evaluation 2 (SCORE2). *Acta Med Port.* 2024;37(10):720–724.
- [46] Dieterle T, Sigle JP, Bengel G, et al. Cardiovascular risk stratification in unselected primary care patients with newly detected arterial hypertension. *Hypertens Res.* 2010;33(6):607–615. doi:10.1038/hr.2010.40