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Differences of cardiovascular risk assessment in clinical practice using SCORE and SCORE2

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ABSTRACT

Objective Cardiovascular risk estimation is an essential step to reduce the onset of adverse cardiovascular events. For this purpose, the Systematic Coronary Risk Evaluation (SCORE) risk chart method was used in Europe. In 2021, the SCORE2 algorithm was released, bringing changes in the calculation methodology. This study assessed and compared the level of cardiovascular risk in a population aged 40–65 years using the SCORE and SCORE2 methodologies.

Methods This cross-sectional study included a total of 85 802 patients in Hungary. Cardiovascular risk levels were determined using the SCORE and SCORE2 risk estimation methods.

Results Using SCORE, 97.7% of men aged 40–50 years were classified as low–moderate risk, which decreased to 32.4% using SCORE2. Using SCORE, 100% of women aged 40–50 years were classified as low–moderate risk, compared with 75.6% using SCORE2. Using SCORE, 36.8% of men aged 50–65 years were classified as high risk and 14.8% as very high risk, and 5.4% of women aged 50–65 years were classified as high risk and 0.5% as very high risk. In this age group, using SCORE2, 50% of men were classified as high risk and 25.8% as very high risk, and 38.8% of women were classified as high risk and 11.9% as very high risk.

Conclusions When the SCORE2 method was used instead of SCORE 43.91% of the whole population were classified with a higher level of risk, which represents a radical increase in the number of patients with high or very high cardiovascular risk.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Since 2003 Systematic Coronary Risk Evaluation (SCORE), risk chart based on European epidemiological database measures the probability of a fatal cardiovascular event using age, sex, smoking, systolic blood pressure, total cholesterol level and the presence of diabetes. In 2021, the European Society of Cardiology introduced substantial changes compared with the previous recommendation. A new risk estimation chart called SCORE2 has been introduced, the parameters required for risk estimation (non-high density lipoprotein (HDL) cholesterol instead of the previous total or low density lipoprotein (LDL) cholesterol) has been changed and also extended the age range from 65 years to 69 years and created an estimation chart for people aged 70 years and over (SCORE2-OP). In addition, it considers the occurrence of fatal and non-fatal cardiovascular events, thereby changing the percentage classification of risk categories, which means different ranges for different age groups.

WHAT THIS STUDY ADDS

⇒ This study compared the cardiovascular risk levels with real-life data of more than 85 000 subjects in 40–65 years age group by using SCORE and SCORE2 in a high-risk country in order to estimate the distribution of risk groups. With the application of SCORE2, a significant proportion of this population will be assigned to the high or very high-risk category instead of the previous low–moderate risk category. A significant additional burden on the healthcare system, particularly on primary care could be expected regarding target values (especially the lipid targets) achievement.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Our findings suggest an increase in the number of patients needing care for higher cardiovascular risk in primary care practices, as well as in the time, human resources and therapeutic costs needed to achieve the more strict therapeutic targets for these patients.

INTRODUCTION

Cardiovascular disease (CVD) is the leading cause of adult morbidity and mortality in developed countries, and Hungary has greater morbidity and mortality than the European Union average.[1 2] Prevention of these diseases is considered a public health priority since early identification of relevant risk factors could be an important step in the assessment of cardiovascular risk and its management in continuous care.

The first scientific model for cardiovascular risk assessment was developed in the Framingham Study in the USA.[3 4] It considers the

patient's age, sex, blood pressure, smoking status, and total cholesterol or LDL and HDL cholesterol levels, as well as the presence of diabetes mellitus.

In Europe, the first guideline related to cardiovascular risk assessment was published in 1994 as a recommendation of the Joint European Task Force, based on the results of the Framingham Study.[5] This provided an easy-to-use risk estimation model for physicians and contained principles and practical options for risk reduction. It was revised in 1998 with the Second Joint European Task Force Recommendation, which uses age, sex, smoking, systolic blood pressure, total cholesterol level and the presence of diabetes to estimate risk.[6] The third edition of the Joint European Task Force Recommendation was published in 2003.[7] Unlike the first two recommendations, this one is based on a European epidemiological database, distinguishing between low-isk and high-risk countries, and does not measure the probability of developing CVD but the probability of a fatal cardiovascular event using the Systematic Coronary Risk Evaluation (SCORE) risk chart. Accordingly, the values for risk categories of mortality have changed to low risk: <2%; moderate risk: 2–4.9%; high risk: 5–9.9%; very high risk: ≥10%. The Joint Task Force guideline of 2003 also defines areas, targets and instruments for intervention, similar to but going beyond the previous recommendations.

In 2016, the sixth Joint European Task Force Recommendation was published.[8] It was based on the principles set out in 2003 and the SCORE database, using the SCORE chart for risk assessment. An updated risk assessment methodology was employed. The current targets for intervention focus on risk factors and the description of the intervention tools.

The latest guideline on this topic was published in 2021 by the European Society of Cardiology, which introduced substantial changes compared with the 2016 recommendation[8 9] It introduced a new risk estimation chart called SCORE2, which not only introduces changes in the parameters required for risk estimation (non-HDL cholesterol instead of the previous total or LDL cholesterol) but also extends the age range from 65 years to 69 years and creates an estimation chart for people aged 70 years and over (SCORE2-OP). In addition, it considers the occurrence of fatal and non-fatal cardiovascular events, thereby changing the percentage classification of risk categories, which means different ranges for different age groups.

One of the most recent and comprehensive initiatives for cardiovascular risk assessment in Hungary is the Three Generations for Health programme, which was launched in 2019 as a government initiative. The main aim of the programme is to assess the risk factors and risk levels of CVD in the general population through general practitioner (GP) practices. Currently, 806 GP practices in Hungary are participating in the programme, which is supervised by the Gottsegen National Cardiovascular Center. Data collection used an online IT system, which allowed central evaluation and analysis and the implementation of research objectives.

The focus of this study was to determine the cardiovascular risk level of the population aged 40–65 years in Hungary using the European guidelines. At the beginning of the study, the 2016 Joint Task Force guideline on the assessment and management of cardiovascular risk was still in force, and the 2021 European Society of Cardiology guideline on this topic had already been published at the data processing stage.[8 9] Therefore, we considered it worthwhile to determine the cardiovascular risk of the participants in the appropriate age group of the study population by applying both and to compare the risk scores obtained.

This study aimed to determine the cardiovascular risk levels of the 40–65 years who participated in the programme using the algorithms of the 2016 European Guidelines on CVD prevention in clinical practice (SCORE) and the 2021 ESC Guidelines on CVD prevention in clinical practice (SCORE2) and to compare these results.

METHODS

Patients

Our study sample consisted of patients aged 40–65 years from GP practices participating in the Three Generations for Health programme, for whom data were gathered online. We collected data from the beginning of January 2019 until the beginning of December 2021. Patients were recruited consecutively: all patients in the 40–65 age group who attended a GP consultation for any reason in person or by telecommunications were enrolled if they consented. Participants' anamnestic data, parameters obtained during the physical examination performed on site and results of relevant laboratory tests were recorded in the GPs' offices. The laboratory measurements were performed in accredited laboratories (clinic, hospital or university), in the facility serving each GP practice in daily clinical practice.

The data were provided via an online interface (Icardio) set up as part of the programme, from where they were transferred to the analysts in a way not personally identifiable. Each patient was given a unique identifier in the system, which their own GP could use to retrieve their data if necessary.

SCORE and SCORE2 estimation

(1) The 2016 European Guidelines on CVD prevention in clinical practice (SCORE).

Provides an estimation of the probability of fatal cardiovascular (ie, not only coronary but also cerebrovascular and peripheral vascular) events in patients without atherosclerotic CVD over the next 10 years.

- The SCORE risk assessment chart can be used between the ages of 40 and 65.
- Uses low, moderate, high and very high-risk classifications.
- Using this method, patients with a fatal cardiovascular risk of 5% or more are considered high risk.

- The parameters needed to calculate it are age, sex, smoking, total cholesterol (or LDL cholesterol) level and systolic blood pressure value.
- Relative risk can be determined individually based on the same age and parameters. It can be used to show which more favourable category an individual of the same age may fall into when corrected for a risk factor (smoking, total cholesterol, blood pressure).

(2) The 2021 ESC Guidelines on CVD prevention in clinical practice (SCORE2)

Estimates the probability of fatal or non-fatal cardiovascular events over the next 10 years among apparently healthy patients (free of atherosclerotic disease, diabetes, chronic kidney disease and extremely high cholesterol).

- The SCORE2 risk estimation chart can be used between the ages of 40 and 69 years. (The SCORE2-OP, not used in this study, estimates a similar risk for apparently healthy people aged over 70 years.)
- It uses low–moderate, high and very high-risk categories.
- These risk classifications vary according to age (low–moderate risk: SCORE2 <2.5% under age 50, SCORE2 <5% ages 50–69; high risk: SCORE2 2.5–7.5% under age 50, SCORE2 5–10% ages 50–69; very high risk: SCORE2 >7.5% under age 50; SCORE2 >10% ages 50–69).
- Parameters for calculation are gender, age, smoking, systolic blood pressure value and non-HDL cholesterol level.
- The absolute risk reduction is measured by the improvement or elimination of a single modifiable risk factor. It can be used to show the increase in life expectancy for patients who appear healthy.

The classification of cardiovascular risk level is based not only the SCORE and SCORE2 charts but on the risk of, for example, preexisting atherosclerotic vascular disease, chronic kidney disease, diabetes mellitus. However, in this paper, we focus only on the differences in categorisation based on the percentage risk scores calculated by the two risk estimation methods of SCORE and SCORE2.

Statistical analysis

In our cross-sectional study, we used the SCORE and SCORE2 algorithms to describe the distribution of calculated cardiovascular risk levels by sex and age group. Our data are presented primarily in raw case numbers and proportions.

Patient and public involvement

No patients were involved in developing the research question or the outcome measures, and no patients were involved in planning the design or implementation of the study. Furthermore, no patients were asked to advise on the interpretation or write-up of the results. Three Generations for Health programme will be continued in a new form in primary care in Hungary and all relevant results will be used to draw people's attention to participate in cardiovascular risk screening activities.

RESULTS

After using each SCORE and SCORE2 algorithm, the calculated risk percentages were grouped into clusters according to the SCORE and SCORE2 categories. For comparability, the SCORE low and moderate categories were then merged into a low–moderate category to match the categories used in SCORE2. Thus, in both cases, low–moderate, high and very high-risk groups were created. In the application of SCORE2, the risk categories are different for each age group, so they are presented in a separate table for ease of interpretation.

Sex and age

Our study included 85 802 patients aged 40–65 years: 35 172 (40.99%) men and 50 630 (59.01%) women. The mean age was 53.5 (±6.75) years for men and 53.4 (±6.81) years for women, with no significant difference in mean age between sexes (p=0.283).

SCORE and SCORE2 comparison

The 40–50 years age group included 27 453 people: 11 112 men (40.48%) and 16 341 women (59.52%). Based on the SCORE calculation, the vast majority of men under 50 years of age, 97.7%, were in the low–moderate risk group, 2.1% were in the high-risk group and 0.2% were in the very high-risk group. Using the SCORE2 estimation, 32.4% of men belonged to the low–moderate risk group, 58.3% to the high-risk group and 9.3% to the very high-risk group. Of women under 50 years, 100% were classified as low–moderate risk using the SCORE calculation. Using the SCORE2 algorithm, 75.6% of women under 50 had a low–moderate risk, 23.2% had a high risk and 1.3% had a very high risk (table 1).

In our study, 58 349 people were in the 50–65 years age group: 24 060 men (41.23%) and 34 289 women (58.77%). Using the SCORE estimation method, 48.5% of men were classified as low–moderate risk, 36.8% as high risk and 14.8% as very high risk. Using the SCORE2 risk assessment, 24.2% of men aged 50–65 years were classified in the low–moderate risk group, 50% in the high-risk group and 25.8% in the very high-risk group. Using SCORE for women aged 50–65, 94.1% were placed in the low–moderate risk category, 5.4% in the high-risk category and 0.5% in the very high-risk category. Using SCORE2, 49.3% of the same patients were classified as low–moderate risk, 38.9% as high risk and 11.9% as very high risk (table 2).

The differences in the distribution of cardiovascular risk levels using the SCORE and SCORE2 methods are shown in tables 3 and 4.

For men aged 40–50 years (11 112 patients in total), 97.67% (10,853 patients) were classified as low–moderate risk by SCORE, compared with 32.36% (3596 patients) using SCORE2. Of the remaining patients with a low–moderate risk according to SCORE, 58.14% of men under 50 years of age were classified as high risk and 7.16% as very high risk using SCORE2. Both

Table 1 Distribution of cardiovascular risk categories by gender under 50 years of age using score and SCORE2 estimation

	Men		Women		Total	
<50 age	**SCORE**	**SCORE2**	**SCORE**	**SCORE2**	**SCORE**	**SCORE2**
Low-to-moderate risk	**97.67%** (n=10 853)	**32.39%** (n=3599)	**100%** (n=16 341)	**75.55%** (n=12 345)	**99.06%** (n=27 194)	**58.08%** (n=15 944)
High risk	**2.16%** (n=240)	**58.31%** (n=6479)	**0%** (n=0)	**23.16%** (n=3784)	**0.87%** (n=240)	**37.38%** (n=10 263)
Very high risk	**0.17%** (n=19)	**9.31%** (n=1034)	**0%** (n=0)	**1.30%** (n=212)	**0.07%** (n=19)	**4.54%** (n=1246)
Total	**100%** (n=11 112)	**100%** (n=11 112)	**100%** (n=16 341)	**100%** (n=16 341)	**100%** (n=27 453)	**100%** (n=27 453)

SCORE, Systematic Coronary Risk Evaluation.

SCORE and SCORE2 classified 0.16% (18) of men under 50 years of age as equally high risk and 0.17% (19) as equally very high risk. Of men under 50 years, 0.03% (3 people) were classified as high risk by SCORE and low–moderate risk by the SCORE2 formula.

In total, 3633 people were identified as in the same risk category by the two methods, representing 32.69% of the men aged 40–50 years in the study. At the same time, using SCORE2, 7257 persons (65.3% of men 40–50 years of age) were reclassified from the low–moderate risk category to the high or very high-risk category.

Among women 40–50 years of age, 75.55% (12,345 people) were classified in the same low–moderate risk category by both SCORE and SCORE2. No patients were placed in the high or very high-risk categories using the SCORE methodology. However, 23.16% of women 40–50 years of age were placed in the high-risk category and 1.3% in the very high-risk category when the SCORE2 algorithm was applied, representing a total of 3996 patients (24.45%) moved to a higher risk category.

Among men aged 50–65 years, 22.66% of patients (5 452) were classified in the low–moderate risk group, 22.96% (5523) in the high-risk group and 13.15% (3165) in the very high-risk group using either of the two risk assessment methods. In total, 58.77% of the men aged 50–65 years in the study (14 140) were identified equally by the two methods.

Based on SCORE, 328 male patients aged 50–65 years (1.36% of the total male population) who were classified as high risk were reclassified as low–moderate risk according to the SCORE2 formula. Of the men classified as very high cardiovascular risk by SCORE, 51 (0.21%) were reclassified as low–moderate risk and 333 (1.38%) as high risk using the SCORE2 chart. Of the male patients aged 50–65 years classified as low–moderate risk by SCORE, 6168 (25.64% of all men aged 50–65 years) were reclassified as high cardiovascular risk and 48 (0.2%) as very high cardiovascular risk using the SCORE2 estimation. Of the 2992 people (12.44%) in the high-risk category according to SCORE, 2992 (12.44%) belonged to the very high-risk category according to SCORE2. Thus, 38.27% (9,208) of male patients aged 50–65 years were placed in a higher risk category using SCORE2.

Among women aged 50–65, SCORE and SCORE2 rated the risk equally for 16 876 in the low–moderate risk group (49.22% of women aged 50–65), 242 (0.71%) in the high-risk group and 155 (0.45%) in the very high cardiovascular risk group. For 0.05% of women in this age group (16 individuals), the high-risk category calculated based on SCORE was changed to a low–moderate risk category using SCORE2. Of the group classified as very high risk according to SCORE, 0.02% (7 people) of the female patients aged 50–65 years were reclassified to the high-risk group using SCORE2.

According to SCORE, 38.11% of all women aged 50–65 years in the low–moderate risk group were reclassified to high risk and 6.75% to very high risk using SCORE2. Of the women classified as high risk by SCORE, 1609 (4.69% of all women aged 50–65 years) were reclassified to the very high risk group using

Table 2 Distribution of cardiovascular risk categories by gender between 50 and 65 years of age using SCORE and SCORE2 estimation

	Men		Women		Total	
50–65 age	**SCORE**	**SCORE2**	**SCORE**	**SCORE2**	**SCORE**	**SCORE2**
Low-to-moderate risk	**48.50%** (n=11 668)	**24.24%** (n=5831)	**94.08%** (n=32 260)	**49.26%** (n=16 892)	75.28% (n=43 928)	**38.94%** (n=22 723)
High risk	**36.75%** (n=8843)	**49.98%** (n=12 024)	**5.44%** (n=1867)	**38.84%** (n=13 318)	**18.36%** (n=10 710)	**43.43%** (n=25 342)
Very high risk	**14.75%** (n=3549)	**25.79%** (n=6205)	**0.47%** (n=162)	**11.90%** (n=4079)	**6.36%** (n=3711)	**17.62%** (n=10 284)
Total	**100%** (n=24 060)	**100%** (n=24 060)	**100%** (n=34 289)	**100%** (n=34 289)	**100%** (n=58 349)	**100%** (n=58 349)

SCORE, Systematic Coronary Risk Evaluation.

Table 3 Distribution of cardiovascular risk categories comparing SCORE and SCORE2 by gender under 50 years of age

		Men				Women			
		SCORE2				SCORE2			
<50 age		Low-to-moderate risk	High risk	Very high risk	Total	Low-to-moderate risk	High risk	Very high risk	Total
SCORE	Low-to-moderate risk	**32.36%** (n=3596)	**58.14%** (n=6461)	**7.16%** (n=796)	**97.67%** (n=10 853)	**75.55%** (n=12 345)	**23.16%** (n=3784)	**1.30%** (n=212)	**100%** (n=16 341)
	High risk	**0.03%** (n=3)	**0.16%** (n=18)	**1.97%** (n=219)	**2.16%** (n=240)	**0%** (n=0)	**0%** (n=0)	**0%** (n=0)	**0%** (n=0)
	Very high risk	**0%** (n=0)	**0%** (n=0)	**0.17%** (n=19)	**0.17%** (n=19)	**0%** (n=0)	**0%** (n=0)	**0%** (n=0)	**0%** (n=0)
	Total	**32.39%** (n=3599)	**58.31%** (n=6479)	**9.31%** (n=1034)	**100%** (n=11 112)	**100%** (n=12 345)	**100%** (n=3784)	**100%** (n=212)	**100%** (n=16 341)

SCORE, Systematic Coronary Risk Evaluation.

SCORE2. Thus, overall, 49.56% of women aged 50–65 (16 993) fell into a higher risk category (high or very high risk) if SCORE2 was used instead of SCORE.

Overall, 43.91% (37,673) of male and female patients aged 40–65 years in the study were placed in a higher risk category when using SCORE2 instead of SCORE.

DISCUSSION

Among men aged 40–50 years, the use of the SCORE2 method reduced the proportion of those in the low–moderate risk category from over 97% (as determined by SCORE) to 33%. This means that more than 67% of this male population was classified as high or very high risk using SCORE2, while the proportion of these patients using SCORE was just over 2%. The 2021 ESC guideline, which introduces SCORE2, does not specify a 'mitigation' for meeting the blood pressure, lipid or HgA1c target values for high-risk and very high-risk patients, or even specify a 1.4 mmol/L LDL cholesterol target value for those at very high risk. Therefore, almost two-thirds of the male population aged 40–50 have a high-risk and very high-risk target when using the SCORE2 method compared with before, when this was required in just over 2% of patients (using the SCORE method). This means a radical increase in the number of patients needing care due to the higher level of calculated risk. It also increases the time and human resources required for care, which might imply increasing therapeutic costs.

For women between the ages of 40 and 50, a not so radical but significant change in the distribution of risk groups was detected. Of the female participants aged 40–50 years, 100% were in the low–moderate risk category using SCORE, and more than 24% of these patients were classified as high or very high risk according to SCORE2, together with its implications for therapeutic targets and need for care.

A significant shift also occurred with the use of SCORE2 to higher risk categories among men aged 50–65 years, with 51% of this population classified as high or very high risk according to SCORE, whereas according to SCORE2, this proportion exceeded 75%.

The change was much more drastic for women between the ages of 50 and 65 than for men. Barely 6% of this female population was at high or very high risk using SCORE, whereas using SCORE2, this proportion was over 50%.

All this means in daily clinical practice that with the application of SCORE2, more than 44% of the population aged 40–50 years (men and women combined) will be assigned to the high or very high-risk category instead of the previous low–moderate risk category. The same is true for more than 41% of all patients in the 50–65 years age group. This represents a significant

Table 4 Distribution of cardiovascular risk categories comparing SCORE and SCORE2 by gender between 50 and 65 years of age

		Men				Women			
		SCORE2				SCORE2			
50–65 age		Low-to-moderate risk	High risk	Very high risk	Total	Low-to-moderate risk	High risk	Very high risk	Total
SCORE	Low-to-moderate risk	**22.66%** (n=5452)	**25.64%** (n=6168)	**0.20%** (n=48)	**48.50%** (n=11 668)	**49.22%** (n=16 876)	**38.11%** (n=13 069)	**6.75%** (n=2315)	**94.08%** (n=32 260)
	High risk	**1.36%** (n=328)	**22.96%** (n=5523)	**12.44%** (n=2992)	**36.75%** (n=8843)	**0.05%** (n=16)	**0.71%** (n=242)	**4.69%** (n=1609)	**5.44%** (n=1867)
	Very high risk	**0.21%** (n=51)	**1.38%** (n=333)	**13.15%** (n=3165)	**14.75%** (n=3549)	**0%** (n=0)	**0.02%** (n=7)	**0.45%** (n=155)	**0.47%** (n=162)
	Total	**24.24%** (n=5831)	**49.98%** (n=12 024)	**25.79%** (n=6205)	**100%** (n=24 060)	**49.26%** (n=16 892)	**38.84%** (n=13 318)	**11.90%** (n=4079)	**100%** (n=34 289)

SCORE, Systematic Coronary Risk Evaluation.

additional burden on the healthcare system, particularly on primary care, for achieving the target values, especially the lipid targets. Considering that the success of reaching LDL cholesterol target values and statin adherence has already faced very serious challenges in the developed world efficacy rates will likely only deteriorate with the introduction of widespread use of SCORE2.[10–14] Such a load seems unmanageable in the current primary healthcare system therefore a change to the organisation of care delivery is needed. A wider use of case management, shared decision-making and enhanced multidisciplinary team work such as a comprehensive model of care led by non-physician health workers, involving primary care physicians, pharmacists, dieticians, care managers, etc and family that is informed by local context could substantially improve knowledge on the disease and treatment options, and on awareness of risk.[15–17]

CONCLUSIONS

Based on our results, 43.91% (37 673 patients) of the population in the study were classified as higher risk when the SCORE2 method was used instead of SCORE to estimate cardiovascular risk. This represents a radical increase in the number of patients with a high or very high cardiovascular risk, resulting in a significant increase in the number of patients needing care for higher cardiovascular risk in primary care practices, requiring more time, more human resources (involvement of other interdisciplinary specialists: dieticians, physiotherapists, pharmacists, etc), and increased therapeutic costs in order to achieve the more strict therapeutic targets for these patients.

Such a load seems unmanageable in the current primary healthcare system, and new ways of care delivery and operational structure are needed.

LIMITATIONS

When creating SCORE2 all European countries were grouped into four risk regions according to their most recent age-standardised and sex-standardised overall CVD mortality rates per 100 000 population. The four groupings were low risk (<100 CVD deaths per 100 000), moderate risk (100 to <150 CVD deaths per 100 000), high risk (150 to <300 CVD deaths per 100 000) and very high risk (≥300 CVD deaths per 100 000). This study analysed data from Hungary which belongs to the high-risk region.

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Contributors PV is responsible for the finished work and the conduct of the study, had access to the data, and controlled the decision to publish. Data collection, data cleaning data analysis: OC and GJS; statistics: OC and GJS; drafting of the article, literature research: ZJ and PV; OC, GJS and PA; checking of the content, form, statistics and proofreading of the text: PV and PA; preparation of figures OC and GJS.; Conceptualisation, ZJ and PV; methodology, ZJ; validation, OC; formal analysis, OC and GJS; investigation, PV; resources, PV; data curation, OC; writing—original draft preparation, JZ; writing—review and editing, PV; visualisation, GJS; supervision, PA; project administration: OC. All authors have read and agreed to the published version of the manuscript.

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Competing interests None declared.

Patient consent for publication Consent obtained directly from patient(s).

Ethics approval The research was done on the database gained from 'Three Generations for Health Programme', which is a national prevention programme in Hungary based on Government Decision No.1234/2017 (IV. 28.), Gottsegen National Cardiovascular Center is responsible for providing professional, organisational and IT support for the participating GP practices/clusters and also for scientific monitoring of the programme. Gottsegen National Cardiovascular Center is the data controller in the programme, therefore, there was no need for any administrative permissions to access the raw data used in our study. Regarding the approval Medical Research Council was consulted and they deemed that ethical approval is not necessary. All methods were carried out in accordance with relevant guidelines and regulations. Informed consent was obtained from all subjects participating in the 'Three Generations for Health Programme'. Participants gave informed consent to participate in the study before taking part.

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