

Risk assessment according to the SCORE risk chart — from history, through present, to the future

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INTRODUCTION

In current medical practice estimation of risk is one of the most important parts of treatment. Risk estimation is used prior, during, and after most medical treatments. It is useful in qualification for surgery, in choosing pharmacotherapy and in planning preventive strategies [1–3]. Various tools are used for risk stratification. Those used in most of the clinical settings include simple risk stratification tools and charts. These are mathematical models based on classical and non-classical risk factors, which relate their prognostic value to population epidemiological studies and allow for a careful estimation of patient risk [4]. For a score to be defined as good and clinically relevant, it must meet several requirements. The later usefulness of the risk assessment tools depends on the cohorts of patients it was developed on, the endpoints included, the statistical methods used, and the data entry formats used in them. Most risk estimation tools are based on classical risk factors such as age, sex, smoking, blood pressure, and cholesterol, and many also include risk factors such as diabetes, family history of cardiovascular disease (CVD), simplified measurements of height and body weight, or laboratory test results. Unfortunately, almost none of the risk scores includes non-classical risk factors, and certainly none of the tools is perfect.

HISTORY OF CARDIOVASCULAR RISK ASSESSMENT

The first big data on the cardiovascular risk and origins of preventive cardiology come from the Framingham Heart Study. In 1948, the Framingham Heart Study was initiated — under the direction of the National Heart Institute. It was an ambitious medical research project that changed medicine as we know it. At that time, little was known about the underlying causes of heart disease and stroke, but cardiovascular mortality had been steadily rising since the beginning of the 19th century and was slowly assuming the scale of a global epidemic [2]. The purpose of the Framingham Heart Study was to identify common findings and features that contributed to the development of CVD long before its occurrence in a large group of participants who had not had a heart attack or stroke.

The initial research included 5209 men and women aged 30–62 years from a small city called Framingham, and based on an extensive examination and lifestyle research, which was later analysed and identified common patterns of the development of diseases of the circulatory system. Continuously since 1948, patients have been undergoing follow-up and are re-examined every two years with a detailed medical history, physical examination, and laboratory testing. In 1971, a new study phase was started, involving a second generation of 5124 adult offspring of the participants of the initial cohort, who were invited to participate in a similar study. In 1994, the need for greater variation in the Framingham community was considered to better reflect the general population. At

that time, the study included the first external cohort. In April 2002 the study entered a new phase — enrolment of the third generation of participants, grandchildren of the original cohort, and in 2003, a second group of participants from an external cohort was included in the register.

Monitoring the population of the Framingham study has led to identification of major cardiovascular risk factors such as high blood pressure, high blood cholesterol, smoking, obesity, diabetes, and lack of physical activity — as well as provided valuable insights into the role of cholesterol, age, gender, and psychosocial issues. Over the past half-century, the study has resulted in the publication of over 1000 articles in leading medical journals, and therefore changed the concept of cardiovascular risk factors as an integral part of the modern medical programme, leading to the development of effective strategies for treatment and prevention.

The Framingham Heart Study continues its impact on the understanding of cardiovascular risk by increasing its diagnostic capacity on the basis of the existing research material and adding new diagnostic technologies such as echocardiography, carotid artery ultrasonography, cardiac magnetic resonance, and bone densitometry, which have been incorporated into current and future research protocols.

The Framingham Heart Study provided the basics for risk assessment, and over the years many programmes were developed in order to better describe and improve the stratification of cardiovascular risk. Probably the best known and most widely used risk score in Europe is the SCORE risk chart. The scale was developed and published by the European Society of Cardiology (ESC) in 2003 [5]. The SCORE project was aimed at developing a useful tool to facilitate and improve the clinical management of cardiovascular risk in clinical practice. The design of the project was to include datasets from 12 European cohort studies (most of them performed in the general population). The project included 205,178 persons (88,080 women and 117,098 men). Patients were followed for 10 years for the occurrence of death attributable to CVD. Basing on the obtained data, a mathematic model was developed that allowed the estimation of 10-year risk of fatal CVD, in which age was used as a measure of exposure time to risk rather than as a risk factor. The group performed separate estimations for high-risk and low-risk regions of Europe. Moreover, separate models were developed, based in one case on total cholesterol and in the other on total cholesterol/high-density lipoprotein cholesterol ratio. To facilitate the use of the SCORE model, simple graphic risk charts were proposed [5]. The first published charts included only classical cardiovascular risk factors and allowed objective risk stratification in patients aged 45–64 years.

THE CURRENT PLACE OF THE SCORE RISK CHART

The place of the SCORE risk chart is strictly specified by the guidelines of the ESC. Reference for the SCORE risk chart is

made in almost all of the guidelines on different topics, but probably the most specific comments on its utility come from the guidelines on CVD prevention [3]. The guidelines state that it is essential for clinicians to be able to assess cardiovascular risk on-site with appropriate accuracy. This led to recommending the SCORE system as a tool of choice for the European population. Currently, guidelines recommend only using SCORE as a risk calculation tool. It is recommended for total cardiovascular risk estimation in adults over 40 years of age, unless they are automatically categorised as being at high-risk or very high-risk based on documented CVD, diabetes mellitus (> 40 years of age), kidney disease, or highly elevated single risk factor (such as cholesterol or blood pressure).

The greatest advantages of the SCORE risk charts are that they are available with different values according to the nationality of the patient, they are based on a large data set tested thoroughly on European data, and they operate on cardiovascular death as an end-point. Compared to the other risk-assessment schemes, SCORE is based on one of the largest known populations, representing 2.1 million person-years of observation and 7934 cardiovascular deaths, of which 5652 were attributed to coronary heart disease. On the other hand, the Framingham and ASSIGN scores are based on smaller-sized samples, while others, like PROCAM, QRISK and QRISK2, are based on samples that are not representative of the general population [6–10]. All of them are based on a different end-point than SCORE.

The SCORE risk charts are easily accessible on the web and offer a simple and useful risk estimation model [11], which makes it accessible to many users. There is also a website that provides an interactive risk calculator HeartScore® for countries with high or low cardiovascular risk for 15 European countries in 17 languages. The first ESC recommendations specified the low-risk countries for use of the low-risk charts as: Andorra, Austria, Belgium, Cyprus, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Luxembourg, Malta, Monaco, The Netherlands, Norway, Portugal, San Marino, Slovenia, Spain, Sweden, Switzerland, and the United Kingdom. The high-risk countries were Armenia, Azerbaijan, Belarus, Bulgaria, Georgia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Macedonia FYR, Moldova, Russia, Ukraine, and Uzbekistan. However, it was thought that some countries at very high risk may be underestimated by the charts.

The availability of the types of SCORE charts allowed their better reproducibility. A study performed in a “high-risk” country aimed at calculating risk using SCORE for low-risk countries and the calibrated SCORE. It showed that the percentage of patients at high or very high risk was 4.73% with the low-risk SCORE, and 15.44% with the calibrated SCORE ($p < 0.01$). The population-calibrated SCORE chart classifies a larger number of patients at high or very high risk, and its use would imply treating more patients with lipid-lowering medication [12].

Several countries decided to introduce their separate version of SCORE risk charts. Re-calibrated charts are available for Belgium, Germany, Greece, The Netherlands, Spain, Sweden, and Poland. New calibrations are still in development, for example for Germany and Russia [13, 14]. Those calibrations are of great importance especially due to the large disparities observed in the prevalence of coronary heart disease and death attributable to this disease across Europe (Fig. 1). Polish population studies performed on hypertensive populations showed that the general ESC-developed model seemed to underestimate the burden of cardiovascular risk among hypertensive patients. The cardiovascular risk, especially in the hypertensive female population, seemed to be much higher when estimated according to other systems [15].

The Polish variant of the SCORE chart is available thanks to the availability of several major registries that extensively described the prevalence of cardiovascular risk factors in the Polish population [16]. Its new calibration was published a few years ago and showed that general cardiovascular risk in Poland is much higher than was previously estimated [17]. Currently, use of the so-called “Pol-SCORE” is encouraged for risk stratification in Polish patients (Fig. 2).

SHORTCOMINGS OF THE SCORE RISK CHARTS

All of the risk assessment scores have certain limitations. Most of the limitations of the SCORE risk chart were stressed by the ESC [5]. Its underlying risk functions are based on single risk factor measurements, not on the person’s ‘usual’ levels. For example, blood pressure values or cholesterol levels can be variable in time and alter results [5]. Applicability to non-Caucasian populations has not been examined, and therefore results cannot be extrapolated to these populations. The endpoint that was chosen for the SCORE risk chart calculation was fatal atherosclerotic CVD. It is a hard end-point, but does not include a combination of fatal and non-fatal events. This was because of limited availability of non-fatal endpoint data in several cohort studies and possible variation in endpoint definition. Consequently, SCORE will only be able to predict a small fraction of cardiovascular events actually occurring in patients.

Probably the most important drawback of the SCORE risk chart is that it considers only the principal, classical risk factors. Currently, we know that the impact of others, particularly non-classical risk factors, can modulate disease risk and needs to be considered. These factors include a strong family history of early-onset CVD, milder degrees of impaired glucose regulation, low-density lipoprotein cholesterol, triglycerides, or fibrinogen [5]. Newer studies suggest also the impact of obstructive sleep apnoea, erectile dysfunction, depression and anxiety, air pollution, and periodontal disease as potent cardiovascular risk factors (Table 1) [18–24].

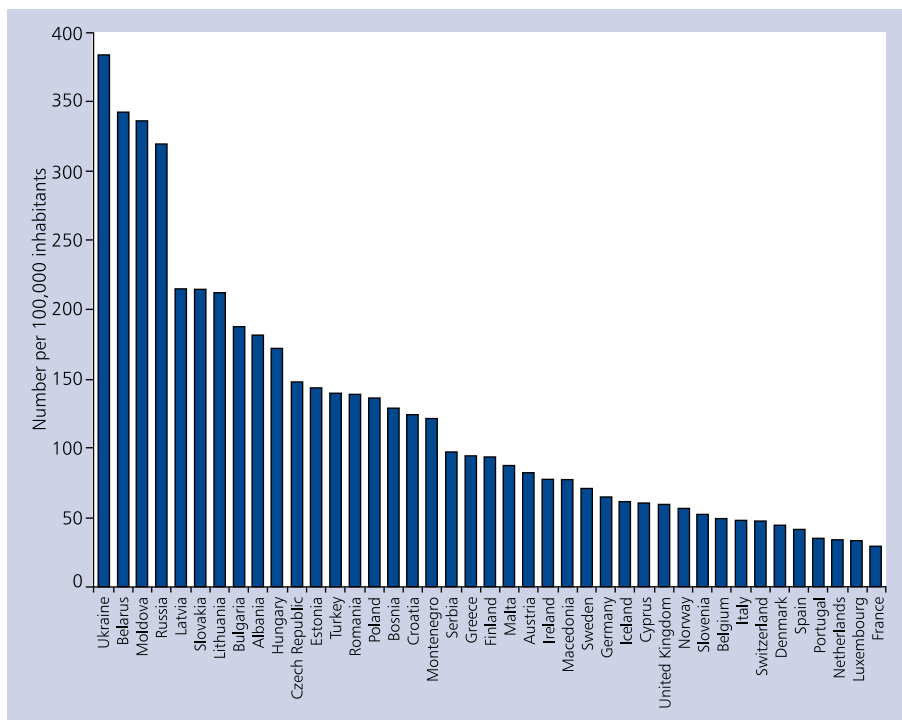


Figure 1. Age-standardised number of deaths attributable to coronary heart disease in the European countries based on the data from the World Health Organisation

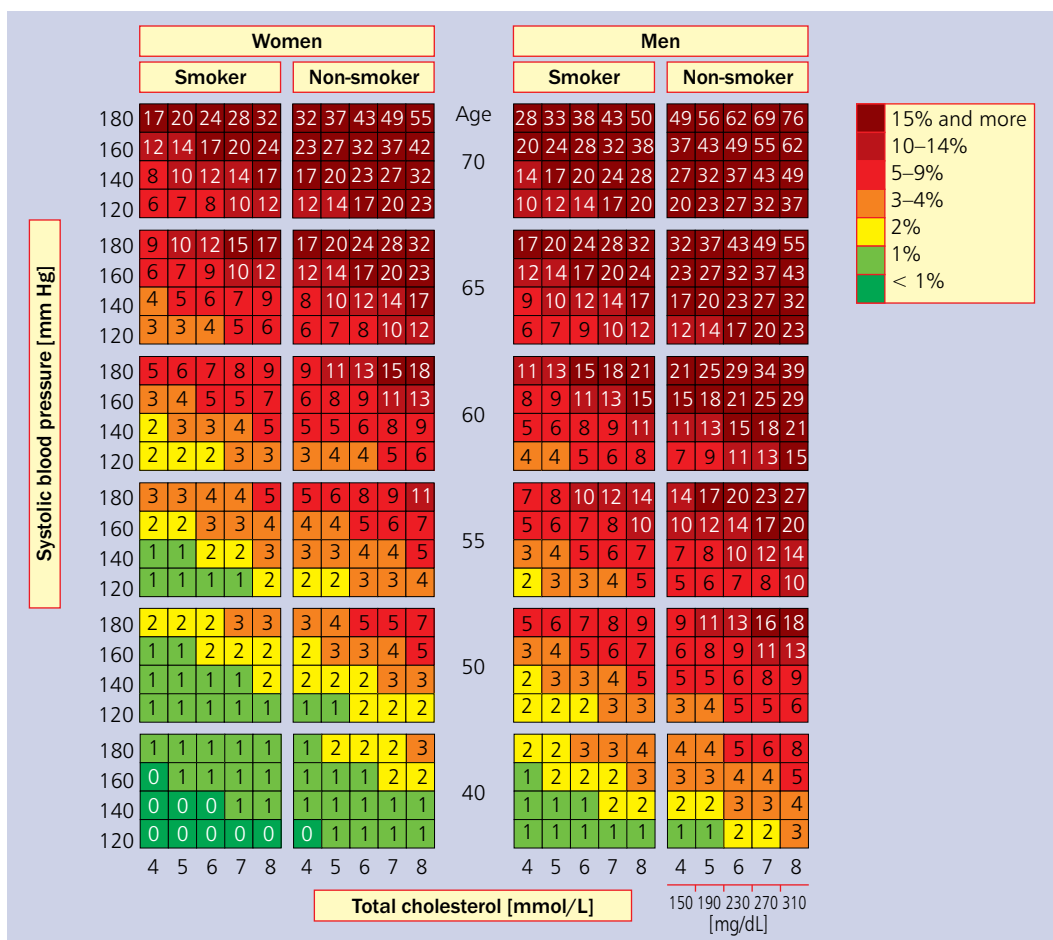


Figure 2. Polish version of the SCORE risk chart [17]

Table 1. Risk underestimation in the SCORE risk chart

Groups of patients with underestimated risk
Patients with premature cardiovascular disease in family history
Patients at the borderline values of the age category
Patients leading sedentary lifestyle
Patients with abdominal obesity
Diabetic and pre-diabetic patients
Patients with low HDL-C or apo A1, elevated hsCRP, triglycerides, fibrinogen, homocysteine, apo B and Lp (a), familial hypercholesterolaemia
Patients with preclinical atherosclerotic lesions (e.g. presence of atherosclerotic plaque or increased thickness of the carotid intima-media complex on ultrasonography)
Patients from the lower social strata,
Non-Caucasian patients
Young people (< 40 years of age) and older (> 70 years)
Patients with non-classical cardiovascular risk factors

apo A1 — apolipoprotein A1; apo B — apolipoprotein B; Lp (a) — lipoprotein (a); hsCRP — high-sensitivity C-reactive protein; HDL-C — high-density lipoprotein cholesterol

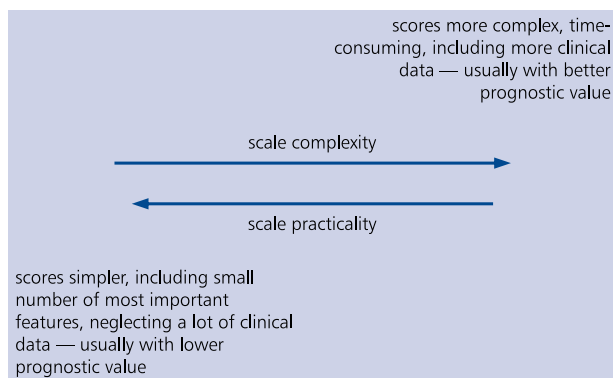


Figure 3. Graphical representation of the relationship between complexity and practicality of the stratification scales (Modified after [27])

SUMMARY — WHAT IS THE FUTURE OF RISK ASSESSMENT?

Total cardiovascular risk is not the only area of medicine in which a lot of risk assessment scores exist. Several studies were performed in order to compare different scores [25, 26]. Ideal risk score would probably incorporate all the known risk factors but it probably would be absolutely impossible to use in clinical practice because of its complexity and being time-consuming. Each scale can be judged by the prism of its “complexity” and “practicality” [27]. Complexity of a scale — defined as the inclusion of as many potentially important predictors as possible, and describing them in the

most detailed way, is, in principle, contradictory to practicality. The second feature — the practicality of the scale — is the ease of use of the scale in the clinical situation and maximum limitation of indexed information, while maintaining a satisfactory overall prognostic value. It can be assumed that the best stratification scale should be the scale with practicality localised in the centre of both axes illustrated in Figure 3. Many indicate that the SCORE scale is one of the closest now to fulfilling these qualities.

Conflict of interest: none declared

References

- Kristensen SD, Knuuti J, Saraste A, et al. 2014 ESC/ESA Guidelines on non-cardiac surgery: cardiovascular assessment and management: The Joint Task Force on non-cardiac surgery: cardiovascular assessment and management of the European Society of Cardiology (ESC) and the European Society of Anaesthesiology (ESA). *Eur Heart J.* 2014; 35(35): 2383–2431, doi: [10.1093/eurheartj/ehu282](https://doi.org/10.1093/eurheartj/ehu282), indexed in Pubmed: [25086026](https://pubmed.ncbi.nlm.nih.gov/25086026/).
- Łęgosz P, Płatek AE, Board TN, et al. Cardioorthopedics - is it necessary in clinical practice? A study of patients with hip replacement surgery. *Kardiol Pol.* 2017; 75(8): 729–735, doi: [10.5603/KP.2017.0151](https://doi.org/10.5603/KP.2017.0151), indexed in Pubmed: [28819952](https://pubmed.ncbi.nlm.nih.gov/28819952/).
- Piepoli MF, Hoes AW, Agewall S, et al. 2016 European Guidelines on cardiovascular disease prevention in clinical practice: The Sixth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of 10 societies and by invited experts) Developed with the special contribution of the European Association for Cardiovascular Prevention & Rehabilitation (EACPR). *Eur Heart J.* 2016; 37(29): 2315–2381, doi: [10.1093/eurheartj/ehw106](https://doi.org/10.1093/eurheartj/ehw106), indexed in Pubmed: [27222591](https://pubmed.ncbi.nlm.nih.gov/27222591/).
- Gorenou V, Hagen A. Overview of risk-estimation tools for primary prevention of cardiovascular diseases in European populations. *Cent Eur J Public Health.* 2015; 23(2): 91–99, doi: [10.21101/cejph.a4004](https://doi.org/10.21101/cejph.a4004), indexed in Pubmed: [26851417](https://pubmed.ncbi.nlm.nih.gov/26851417/).
- Conroy RM, Pyörälä K, Fitzgerald AP, et al. SCORE project group. Estimation of ten-year risk of fatal cardiovascular disease in Europe: the SCORE project. *Eur Heart J.* 2003; 24(11): 987–1003, doi: [10.1016/S0195-668X\(03\)00114-3](https://doi.org/10.1016/S0195-668X(03)00114-3), indexed in Pubmed: [12788299](https://pubmed.ncbi.nlm.nih.gov/12788299/).
- D’Agostino RB, Vasan RS, Pencina MJ, et al. General cardiovascular risk profile for use in primary care: the Framingham Heart Study. *Circulation.* 2008; 117(6): 743–753, doi: [10.1161/CIRCULATIONAHA.107.699579](https://doi.org/10.1161/CIRCULATIONAHA.107.699579), indexed in Pubmed: [18212285](https://pubmed.ncbi.nlm.nih.gov/18212285/).
- Woodward M, Brindle P, Tunstall-Pedoe H. Adding social deprivation and family history to cardiovascular risk assessment: the ASSIGN score from the Scottish Heart Health Extended Cohort (SHHEC). *Heart.* 2007; 93(2): 172–176, doi: [10.1136/hrt.2006.108167](https://doi.org/10.1136/hrt.2006.108167), indexed in Pubmed: [17090561](https://pubmed.ncbi.nlm.nih.gov/17090561/).
- Hippisley-Cox J, Coupland C, Vinogradova Y, et al. Predicting cardiovascular risk in England and Wales: prospective derivation and validation of QRISK2. *BMJ.* 2008; 336(7659): 1475–1482, doi: [10.1136/bmj.39609.449676.25](https://doi.org/10.1136/bmj.39609.449676.25), indexed in Pubmed: [18573856](https://pubmed.ncbi.nlm.nih.gov/18573856/).
- Assmann G, Cullen P, Schulte H. Simple scoring scheme for calculating the risk of acute coronary events based on the 10-year follow-up of the prospective cardiovascular Münster (PROCAM) study. *Circulation.* 2002; 105(3): 310–315, doi: [10.1161/hc0302.102575](https://doi.org/10.1161/hc0302.102575), indexed in Pubmed: [11804985](https://pubmed.ncbi.nlm.nih.gov/11804985/).
- Hippisley-Cox J, Coupland C, Vinogradova Y, et al. Derivation and validation of QRISK, a new cardiovascular disease risk score for the United Kingdom: prospective open cohort study.

- BMJ. 2007; 335(7611): 136, doi: [10.1136/bmj.39261.471806.55](https://doi.org/10.1136/bmj.39261.471806.55), indexed in Pubmed: [17615182](https://pubmed.ncbi.nlm.nih.gov/17615182/).
11. <http://www.heartscore.org/Pages/online.aspx>.
 12. Brotons C, Moral I, Soriano N, et al. Impact of using different SCORE tables for estimating cardiovascular risk. *Rev Esp Cardiol (Engl Ed)*. 2014; 67(2): 94–100, doi: [10.1016/j.rec.2013.06.018](https://doi.org/10.1016/j.rec.2013.06.018), indexed in Pubmed: [24795115](https://pubmed.ncbi.nlm.nih.gov/24795115/).
 13. Jdanov DA, Deev AD, Jasilionis D, et al. Recalibration of the SCORE risk chart for the Russian population. *Eur J Epidemiol*. 2014; 29(9): 621–628, doi: [10.1007/s10654-014-9947-7](https://doi.org/10.1007/s10654-014-9947-7), indexed in Pubmed: [25179794](https://pubmed.ncbi.nlm.nih.gov/25179794/).
 14. Rucker V, Keil U, Fitzgerald AP, et al. Predicting 10-Year Risk of Fatal Cardiovascular Disease in Germany: An Update Based on the SCORE-Deutschland Risk Charts. *PLoS One*. 2016; 11(9): e0162188, doi: [10.1371/journal.pone.0162188](https://doi.org/10.1371/journal.pone.0162188), indexed in Pubmed: [27612145](https://pubmed.ncbi.nlm.nih.gov/27612145/).
 15. Szyndler A, Kucharska WA, Dubiela-D Browska AE, et al. Polish Hypertension Registry. SCORE model underestimates cardiovascular risk in hypertensive patients: results of the Polish Hypertension Registry. *Blood Press*. 2011; 20(6): 342–347, doi: [10.3109/08037051.2011.587267](https://doi.org/10.3109/08037051.2011.587267), indexed in Pubmed: [21675828](https://pubmed.ncbi.nlm.nih.gov/21675828/).
 16. Piotrowski W, Waśkiewicz A, Cicha-Mikołajczyk A. MUSZ BYC AG WERSJE TYTUŁOW W NWSIE KWADRATOWYM Ryzyko globalne zgonu z powodu chorób sercowo-naczyniowych dorosłej populacji polskiej: ocena prospektywna kohort zbadanych w wielośrodkowych ogólnopolskich badaniach stanu zdrowia ludności — WOBASZ i WOBASZ Senior. *Kardiologia Pol.* 2016; 74(3): 262–273, doi: [10.5603/kp.a2015.0175](https://doi.org/10.5603/kp.a2015.0175).
 17. Zdrojewski T, Jankowski P, Bandosz P, et al. [A new version of cardiovascular risk assessment system and risk charts calibrated for Polish population]. *Kardiologia Pol.* 2015; 73(10): 958–961, doi: [10.5603/KP.2015.0182](https://doi.org/10.5603/KP.2015.0182), indexed in Pubmed: [26521843](https://pubmed.ncbi.nlm.nih.gov/26521843/).
 18. Wolf J, Dereziński T, Szyndler A, et al. Prevalence and characteristics of OSAFED syndrome in atrial fibrillation primary care patients. *Kardiologia Pol.* 2017; 75(5): 432–438, doi: [10.5603/KP.a2017.0023](https://doi.org/10.5603/KP.a2017.0023), indexed in Pubmed: [28181212](https://pubmed.ncbi.nlm.nih.gov/28181212/).
 19. Szymański FM, Puchalski B, Filipiak KJ. Obstructive sleep apnea, atrial fibrillation, and erectile dysfunction: are they only coexisting conditions or a new clinical syndrome? The concept of the OSAFED syndrome. *Pol Arch Med Wewn.* 2013; 123(12): 701–707, indexed in Pubmed: [24104459](https://pubmed.ncbi.nlm.nih.gov/24104459/).
 20. Platek AE, Szymanski FM, Filipiak KJ, et al. Stratification of cardiovascular risk in patients with atrial fibrillation and obstructive sleep apnea—validity of the 2MACE score. *Sleep Breath.* 2017; 21(3): 601–606, doi: [10.1007/s11325-017-1469-6](https://doi.org/10.1007/s11325-017-1469-6), indexed in Pubmed: [28155102](https://pubmed.ncbi.nlm.nih.gov/28155102/).
 21. Łęgosz P, Kołkowski M, Platek AE, et al. Assessment of cardiovascular risk in patients undergoing total joint arthroplasty: the CRASH-JOINT study. *Kardiologia Pol.* 2017; 75(3): 213–220, doi: [10.5603/KP.a2016.0162](https://doi.org/10.5603/KP.a2016.0162), indexed in Pubmed: [27878804](https://pubmed.ncbi.nlm.nih.gov/27878804/).
 22. Szymański FM, Filipiak KJ, Platek AE, et al. Can thromboembolic risk be associated with erectile dysfunction in atrial fibrillation patients? *Cardiol J.* 2015; 22(4): 446–452, doi: [10.5603/CJ.a2015.0010](https://doi.org/10.5603/CJ.a2015.0010), indexed in Pubmed: [25733318](https://pubmed.ncbi.nlm.nih.gov/25733318/).
 23. Shahid F, Lip GYH. Risk stratification models in atrial fibrillation. *Semin Thromb Hemost.* 2017; 43(5): 505–513, doi: [10.1055/s-0036-1597285](https://doi.org/10.1055/s-0036-1597285), indexed in Pubmed: [28129663](https://pubmed.ncbi.nlm.nih.gov/28129663/).
 24. Czerniuk MR, Eickholz P, Grötz KA. Oral cavity infections: why should cardiologists care about them? *Kardiologia Pol.* 2015; 73(10): 901–908, doi: [10.5603/KP.2015.0188](https://doi.org/10.5603/KP.2015.0188), indexed in Pubmed: [26521837](https://pubmed.ncbi.nlm.nih.gov/26521837/).
 25. Filipiak KJ, Kołkowski Ł, Grabowski M, et al. Comparison of the seven-year predictive value of six risk scores in acute coronary syndrome patients: GRACE, TIMI STEMI, TIMI NSTEMI, SIMPLE, ZWOLLE and BANACH. *Kardiologia Pol.* 2014; 72(2): 155–165, doi: [10.5603/KP.a2013.0216](https://doi.org/10.5603/KP.a2013.0216), indexed in Pubmed: [23990236](https://pubmed.ncbi.nlm.nih.gov/23990236/).
 26. Cooney MT, Dudina AL, Graham IM. Value and limitations of existing scores for the assessment of cardiovascular risk: a review for clinicians. *J Am Coll Cardiol.* 2009; 54(14): 1209–1227, doi: [10.1016/j.jacc.2009.07.020](https://doi.org/10.1016/j.jacc.2009.07.020), indexed in Pubmed: [19778661](https://pubmed.ncbi.nlm.nih.gov/19778661/).
 27. Filipiak KJ. Po co walidować skale ryzyka? *Kardiologia Pol.* 2007; 65(7): 796–797.

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