MODERN APPROACHES TO CARDIOVASCULAR RISK PREDICTION IN PATIENTS WITH PREDIABETES

Soliyeva M.I.
Muborakov H.M.
Yusupova Sh.K.
Andijan state medical institute.

Abstract. *The objective of this study was to provide an in-depth evaluation of the prognostic utility of the updated SCORE2 algorithm in cardiovascular risk stratification among patients with prediabetes. A cohort of 45 individuals aged 40–65 years was examined and compared with a control group, with risk assessment performed using both the SCORE and SCORE2 models. Stratification incorporated sex-specific and age-related factors, alongside lipid parameters such as non–HDL cholesterol. Our findings demonstrated that SCORE2 offers a more granular and individualized risk estimation, capturing a broader spectrum of adverse prognostic characteristics than the conventional SCORE model. Notably, significant disparities were observed in the Uzbek population, highlighting the potential ethnic variability in cardiovascular risk profiling. These results underline the superior predictive accuracy and clinical relevance of SCORE2, supporting its integration into routine clinical practice. Incorporating SCORE2 into preventive strategies for prediabetic patients could significantly improve early risk detection, guide timely interventions, and ultimately reduce the burden of cardiovascular morbidity and mortality.*

Key words: *prediabetes, cardiovascular risk, SCORE2, stratification, lipid profile, prevention.*

СОВРЕМЕННЫЕ ПОДХОДЫ К ПРОГНОЗИРОВАНИЮ СЕРДЕЧНО-СОСУДИСТОГО РИСКА У ПАЦИЕНТОВ С ПРЕДИАБЕТОМ

Аннотация. *Цель исследования заключалась в углублённой оценке прогностической ценности обновлённой шкалы SCORE2 для стратификации сердечно-сосудистого риска у пациентов с предиабетом. В исследование включены 45 пациентов в возрасте 40–65 лет, результаты которых сопоставлялись с данными контрольной группы. Оценка риска проводилась по системам SCORE и SCORE2 с учётом гендерных и возрастных факторов, а также показателей липидного обмена, включая холестерин, не связанный с липопротеинами высокой плотности. Согласно полученным данным, использование SCORE2 позволяет выявить более широкий спектр неблагоприятных прогностических характеристик и обеспечивает детализированное распределение пациентов по категориям риска. Особенно выраженные различия отмечены в узбекской популяции, что подчёркивает этническую специфику факторов риска. Полученные результаты подтверждают высокую клиническую значимость SCORE2 и необходимость её интеграции в практику для оптимизации профилактических мероприятий у лиц с предиабетом, что может способствовать снижению заболеваемости и смертности от сердечно-сосудистых осложнений.*

Ключевые слова: *предиабет, сердечно-сосудистый риск, SCORE2, стратификация, липидный профиль, профилактика.*

PREDIABETLI BEMORLARDA YURAK-QON TOMIR XAVFINI BASHORAT QILISHNING ZAMONAVIY YONDASHUVLARI

Annotatsiya. Ushbu tadqiqotning maqsadi — prediabet tashxisi qo'yilgan bemorlarda yurak-qon tomir xavfini stratifikatsiya qilishda yangilangan SCORE2 algoritmining prognoz qiymatini chuqur tahlil qilishdir. Tadqiqotga 40–65 yosh oralig'idagi 45 nafar ishtirokchi jalb etildi va ularning ko'rsatkichlari nazorat guruhi bilan solishtirildi. Baholash jarayonida SCORE va SCORE2 tizimlari qo'llanildi, jins va yosh omillari hamda lipid almashinuvi ko'rsatkichlari, jumladan, yuqori zichlikdagi lipoproteinlar bilan bog'liq bo'lmagan xolesterin darajasi hisobga olindi. Natijalar shuni ko'rsatdiki, SCORE2 an'anaviy SCORE modeliga qaraganda xavfni yanada aniqlik bilan baholash imkonini beradi va kengroq prognoz spektrini qamrab oladi.

Ayniqsa, o'zbek populyatsiyasida sezilarli farqlar kuzatildi, bu esa yurak-qon tomir xavfini belgilovchi etnik xususiyatlarning mavjudligini ta'kidlaydi. Tadqiqot natijalari SCORE2 tizimining yuqori klinik ahamiyatga egaligini ko'rsatib, uni amaliyotga joriy etish prediyabetli bemorlarda xavfni erta aniqlash, profilaktika choralarini optimallashtirish va yurak-qon tomir kasalliklari oqibatidagi kasallanish hamda o'lim darajasini kamaytirishga xizmat qilishi mumkinligini tasdiqlaydi.

Kalit so'zlar: prediabet, yurak-qon tomir xavfi, SCORE2, stratifikatsiya, lipid profili, profilaktika.

Relevance. Prediabetes represents a heterogeneous condition that occupies an intermediate stage between normoglycemia and overt type 2 diabetes mellitus. Its prevalence is steadily increasing, particularly among elderly individuals and patients with excess body weight. Currently, five distinct diagnostic criteria are employed, including threshold values of glycated hemoglobin (HbA1c), fasting plasma glucose, and two-hour postprandial glucose. However, the lack of consensus regarding which definition should be considered the most appropriate significantly hinders the standardization of clinical practice. Moreover, the risks of adverse outcomes in this group — ranging from progression to diabetes to cardiovascular complications, chronic kidney disease, and premature mortality — directly depend on the diagnostic criteria applied [1, 5].

Findings from large randomized clinical trials convincingly demonstrate that both lifestyle modification and pharmacological interventions are highly effective and cost-efficient for diabetes prevention and for reducing cardiovascular risk in patients with prediabetes [2, 3]. Nevertheless, the absence of a unified approach to defining this condition remains a barrier to the broad implementation of preventive programs. Therefore, the development of harmonized diagnostic criteria for prediabetes holds not only scientific importance but also substantial practical value, facilitating optimized screening and expanding insurance coverage for lifestyle interventions [6].

The updated cardiovascular risk assessment system SCORE2, presented at the European Society of Cardiology Congress in August 2021 [1], marked a major advance in preventive cardiology. It was based on contemporary epidemiological data, which prompted significant modification of the algorithm [7]. Europe was stratified into four regions according to cardiovascular risk level (low, moderate, high, and very high), while non–high-density lipoprotein cholesterol (non-HDL-C) was introduced as a key lipid marker.

In addition, a dedicated version, SCORE2-OP (Systematic COronary Risk Evaluation – Older Persons), was developed to account for competing risks and to predict the probability of both fatal and nonfatal cardiovascular events in apparently healthy individuals over 70 years of age [8].

Unlike its predecessor (SCORE), which was limited to estimating fatal cardiovascular outcomes within the subsequent decade, the SCORE2 algorithm provides prediction of both fatal and nonfatal events. This important distinction precludes direct numerical comparison between the two models without applying conversion factors [9].

The development of SCORE2 was the result of international collaboration involving more than 200 researchers who combined data from 45 cohort studies across 13 countries, with a total sample exceeding 700,000 participants. The algorithm incorporates key predictors of cardiovascular risk, including age, sex, lipid profile, blood pressure levels, and smoking status. A fundamentally new element is the use of competing-risk modeling, which allows for a more accurate prediction of adverse outcomes in relatively younger populations (40–69 years) [10].

Thus, SCORE2 is a calibrated and validated tool for estimating the 10-year risk of a first cardiovascular event in the European population, characterized by high predictive value and significant practical applicability. Its implementation enhances precision in the stratification of prediabetic patients, optimizes preventive strategies, and improves the overall effectiveness of healthcare systems [5].

All of the above factors determine the relevance of the present study.

Purpose of the study. The purpose of this investigation was to assess the predictive value and applicability of the SCORE2 system for cardiovascular risk stratification in the prediabetic population.

Materials and research methods. The study included 45 patients aged 40 to 65 years, comprising 25 men (mean age 59.3 ± 8.2 years) and 20 women (mean age 55.2 ± 7.1 years). In all participants, the risk of fatal cardiovascular events (CVE) was initially assessed using the SCORE algorithm, followed by recalculation of the combined risk of fatal and nonfatal outcomes in accordance with current clinical guidelines. In addition, the cardiovascular risk was evaluated using the SCORE2 system. The study was conducted at the Andijan State Medical Institute [3, 4].

The control group consisted of 20 apparently healthy individuals without evidence of metabolic disturbances.

Inclusion criteria: individuals over 20 years of age with overweight/obesity, dyslipidemia, or arterial hypertension.

Exclusion criteria: presence of type 1 diabetes mellitus, other endocrinopathies, ongoing metformin therapy, severe autoimmune diseases, systemic vasculitides, or malignant neoplasms.

Methods of investigation included:

General clinical examination;

Biochemical studies (fasting plasma glucose, 2-hour postprandial glucose, glycated hemoglobin [HbA1c], total, direct and indirect bilirubin, alanine aminotransferase [ALT], aspartate aminotransferase [AST], prothrombin index, coagulation profile, C-reactive protein, urea, creatinine, and complete lipid spectrum);

Hormonal assessment (when indicated: insulin and C-peptide levels);

ISSN:
2181-3906
2026

International scientific journal
«MODERN SCIENCE AND RESEARCH»
VOLUME 5 / ISSUE 2 / UIF:8.2 / MODERNSCIENCE.UZ

Instrumental methods: electrocardiography (ECG), ultrasound examination of endocrine glands and internal organs, chest radiography, and other procedures when clinically required.

For the calculation of individual risk, sex-specific models were applied with consideration of competing risks. Parameters included age, smoking status, systolic blood pressure, total cholesterol, and high-density lipoprotein cholesterol (HDL-C).

The diagnosis of type 2 diabetes mellitus (T2DM) and prediabetes was established according to the criteria of the American Diabetes Association (ADA). Patients with previously confirmed T2DM or with the following laboratory findings — fasting plasma glucose > 6.1 mmol/L, 2-hour postprandial glucose ≥ 11 mmol/L, or HbA1c ≥ 6.5% — were classified as having T2DM. Individuals with impaired fasting glucose (IFG; fasting plasma glucose > 5.6 mmol/L), impaired glucose tolerance (IGT; 2-hour postprandial glucose 7.9–11 mmol/L), or elevated HbA1c in the range of 5.7–6.4% were classified as having prediabetes.

Results of the study and their discussion. In 2016, the SCORE algorithm was incorporated into the clinical guidelines for the prevention of cardiovascular diseases, aiming at an integrated risk assessment and the estimation of 10-year cardiovascular mortality. However, for evaluating the true burden of atherosclerotic pathology, a composite indicator encompassing both mortality and morbidity (including nonfatal myocardial infarction and stroke) is considered to be more informative.

In this context, the improved algorithm SCORE2 was introduced, enabling the prediction of both fatal and nonfatal cardiovascular events within 10 years among individuals aged 40–69 years, who are generally healthy but present with untreated or stable risk factors. Importantly, the calculated risk varies across age categories (Table 1).

Table 1.

Cardiovascular risk categories by age

Age group	Low risk	Moderate risk	High risk
< 50 years	< 2.5	2.5 – 7.5	≥ 7.5
50–70 years	< 5	5 – 10	≥ 10
≥ 70 years	< 7.5	7.5 – 15	≥ 15

Among the 45 patients included in the study, the fatal cardiovascular risk was initially assessed using the SCORE system, followed by estimation of the combined risk of fatal and nonfatal events in line with current clinical recommendations.

According to the SCORE2 classification, the distribution of patients was as follows: 17 with low risk, 15 with moderate risk, 7 with high risk, and 6 with very high risk. The overall risk values ranged from 0.3% to 53.2%, with a mean of 8.8 ± 7.5%.

When recalculated using SCORE2, it was found that all patients in fact fell into the categories of high and very high risk (18 and 27 individuals, respectively). The mean risk of fatal and nonfatal events was 11.5 ± 5.7%, which was 2.7% higher than the value estimated by the traditional SCORE model (p < 0.001). Comparative characteristics of risk factors between study groups are presented in Table 2.

Table 2.

ISSN:
2181-3906
2026

International scientific journal
«MODERN SCIENCE AND RESEARCH»
VOLUME 5 / ISSUE 2 / UIF:8.2 / MODERNSCIENCE.UZ

Cardiovascular risk factor indicators in study groups

Indicators	Observation group (п=45)	Control group (п=15)	p
Age, years (Me (Q1-Q3))	45 ± 2.8	44 ± 3.2	0,17
Men, n (%)	18 (51.4%)	10 (50%)	0.18
Smokers, n (%)	9 (25.7%)	2 (10%)	0.16
SBP, mmHg (Me (Q1-Q3))	145± 8.4	118 ± 6.6	0.79
DBP, mmHg (Me (Q1-Q3))	96 ± 11.5	82 ± 8.4	0.35
Total cholesterol, mmol/L (Me (Q1-Q3))	6.5 ± 0.2	4.4 ± 0.8	<0,001
LDL cholesterol, mmol/L (Me (Q1-Q3))	4.2 ± 0.6	4.0 ± 0.5	0.004
HDL cholesterol, mmol/L (Me (Q1-Q3))	1.9 ± 0.4	1.4 ± 0.3	0.56
Non-HDL cholesterol, mmol/L [Me (Q1-Q3)]	5.5 ± 0.7	3.5 ± 0.6	<0,001

Note: Me – median; SBP – systolic blood pressure; DBP – diastolic blood pressure; TC – total cholesterol; LDL – low-density lipoproteins; HDL – high-density lipoproteins; CVD – cardiovascular diseases

The comparative assessment of mean cardiovascular risk by SCORE and SCORE2 is summarized in Table 3. The observed differences were statistically significant.

Our findings demonstrated that the use of SCORE2, unlike the conventional SCORE model, which incorporates non-HDL cholesterol (non-HDL-C) as an additional lipid parameter, allows for more detailed and personalized risk stratification. This approach revealed adverse prognostic features, particularly within the Uzbek patient cohort

Thus, the study established a close association between prediabetes and an increased risk of cardiovascular complications. These results emphasize the importance of early risk stratification and timely preventive interventions at the preclinical stage of the disease.

International professional societies, including the American Association of Clinical Endocrinologists (AACE), underscore the significance of identifying individuals with prediabetes and implementing preventive measures at the earliest possible stage. The adoption of such strategies may reduce the incidence of severe complications and alleviate the burden on healthcare systems.

Table 3.

Mean cardiovascular risk (CVR) level of patients assessed by SCORE and SCORE2 systems

Scales		SCORE (%)	SCORE2 (%)
Groups	Observation group (n = 35)	– Low risk<1%: n = 12 – Moderate risk >1–5%: n = 13 – High risk >5–10%: n = 10	– Low risk: n = 7 – Moderate risk: n = 15 – High risk: n = 7 – Very high risk: n = 6
	Control group (n = 20)	p <0,001	p <0,001

Note: p – statistical significance of intergroup differences

Conclusions. According to the SCORE2 algorithm, patients were distributed as follows: 17 individuals were classified as low risk, 15 as moderate risk, 7 as high risk, and 6 as very high risk. The probability range of fatal and nonfatal cardiovascular events varied between 0.3% and 53.2%, with a mean value of 8.8 ± 7.5%. Upon advanced stratification with SCORE2, all participants were reclassified into high (n = 18) and very high (n = 27) risk categories.

Incorporation of non–high-density lipoprotein cholesterol (non-HDL-C) into SCORE2 provided a more precise and individualized estimation of cardiovascular risk, demonstrating less favorable prognostic outcomes among the Uzbek cohort.

Application of the SCORE2 system ensures a more refined and differentiated approach to assessing individual cardiovascular risk compared with the traditional SCORE algorithm.

References

1. Chipayo-Gonzales D., Ramakrishna H., Nuñez-Gil I.J. SCORE2: новый обновлённый алгоритм прогнозирования риска сердечно-сосудистых заболеваний в Европе // Journal of Cardiothoracic and Vascular Anesthesia. – 2022. – V. 36, № 1. – P. 18–21. DOI: 10.1053/j.jvca.2021.09.033.

2. SCORE2 working group and ESC Cardiovascular Risk Collaboration. SCORE2 risk prediction algorithms: new models to estimate 10-year risk of cardiovascular disease in Europe // European Heart Journal. – 2021. – V. 42, № 25. – P. 2439–2454. DOI: 10.1093/eurheartj/ehab309.

3. Armstrong K., Berlin M., Schwartz J.S., Propert K., Ubel P.A. Barriers to influenza immunization in a low-income urban population // American Journal of Preventive Medicine. – 2001. – V. 20, № 1. – P. 21–25. DOI: 10.1016/s0749-3797(00)00263-4.

4. Huang Y., Huang W., Mai W., Cai X., An D., Liu Z., Huang H., Zeng J., Hu Y., Xu D. White-coat hypertension is a risk factor for cardiovascular diseases and total mortality // Journal of Hypertension. – 2017. – V. 35, № 4. – P. 677–688. DOI: 10.1097/HJH.0000000000001226.

5. Cai X., Zhang Y., Li M., Wu J.H., Mai L., Li J. et al. Association between prediabetes and risk of all-cause mortality and cardiovascular disease: updated meta-analysis // BMJ. – 2020. – V. 370. – Article m2297. DOI: https://doi.org/10.1136/bmj.m2297.

6. Huang Y., Cai X., Mai W., Li M., Hu Y. Association between prediabetes and risk of cardiovascular disease and all-cause mortality: systematic review and meta-analysis // BMJ. – 2016. – V. 355. – Article i5953. DOI: https://doi.org/10.1136/bmj.i5953.

7. Sinha A., Ning H., Ahmad F.S. et al. Association of fasting glucose with lifetime risk of incident heart failure: the Lifetime Risk Pooling Project // Cardiovascular Diabetology. – 2021. – V. 20, № 1. – P. 66. DOI: https://doi.org/10.1186/s12933-021-01265-y.

8. Cai X., Liu X., Sun L., He Y., Zheng S., Zhang Y. et al. Prediabetes and the risk of heart failure: a meta-analysis // Diabetes, Obesity and Metabolism. – 2021. – Online ahead of print. DOI: https://doi.org/10.1111/dom.14388.

9. Pandey A., Vaduganathan M., Patel K.V., Ayers C., Ballantyne C.M., Kosiborod M.N. et al. Biomarker-based risk prediction of incident heart failure in pre-diabetes and diabetes //

JACC: Heart Failure. – 2021. – V. 9, № 3. – P. 215–223. DOI: https://doi.org/10.1016/j.jchf.2020.10.013.

10. Gong Q., Zhang P., Wang J., Ma J., An Y., Chen Y. et al. Morbidity and mortality after lifestyle intervention for people with impaired glucose tolerance: 30-year results of the Da Qing Diabetes Prevention Outcome Study // The Lancet Diabetes & Endocrinology. – 2019. – V. 7, № 6. – P. 452–461. DOI: https://doi.org/10.1016/S2213-8587(19)30093-2.