

ANNOTATION

of the dissertation by Yerdan Maidurov on the topic:

“Clinical and angiographic features of coronary artery involvement in coronary artery disease”, submitted for the degree of Doctor of Philosophy (PhD) in the specialty **6D110100 – “Medicine”**

Relevance of the study

Cardiovascular diseases remain the leading cause of mortality worldwide, with more than 17 million deaths annually, of which approximately 7 million are attributable to coronary artery disease (CAD) [1, 2].

In the Republic of Kazakhstan, CAD also occupies a leading position in the structure of adult mortality. According to official statistics and data from the Ministry of Health, approximately 40–45% of all cardiovascular deaths are due to CAD [3, 4]. In addition to high mortality, CAD leads to significant loss of working capacity, deterioration in quality of life, and increased disability, particularly among the working-age population. A steady trend toward the “rejuvenation” of CAD has been observed, with an increasing number of patients experiencing myocardial infarction or angina symptoms before the age of 50 [5].

CAD is a multifactorial disease resulting from the interaction of both modifiable and non-modifiable risk factors. Modifiable factors include arterial hypertension, hyperlipidemia, diabetes mellitus, overweight, smoking, physical inactivity, and psycho-emotional stress [6–8]. Non-modifiable factors include age and sex [9, 10]. However, even with a similar profile of traditional risk factors, the severity of atherosclerotic coronary artery involvement may vary significantly, indicating the influence of additional modifying conditions.

Over recent decades, numerous large-scale international epidemiological studies have been conducted to determine the role of risk factors in the development of CAD. The INTERHEART study demonstrated that a combination of nine risk factors accounts for more than 90% of myocardial infarction cases worldwide, although the relative contribution of each factor varies by region and ethnicity [11]. The Multi-Ethnic Study of Atherosclerosis (MESA) revealed differences in the prevalence and severity of atherosclerotic lesions among different ethnic groups [12]. The SCORE system and guidelines of the European Society of Cardiology also emphasize the importance of an individualized risk assessment approach that takes into account regional and population differences [13].

Analysis of the literature indicates that, in most domestic studies, risk factors, angiographic characteristics of the coronary arteries, and myocardial functional parameters are assessed separately, which limits the possibility of a comprehensive evaluation of the disease [14–16]. Therefore, an integrative approach is required, involving a sequential analysis of clinical risk factors, angiographically confirmed coronary artery status, and myocardial functional parameters.

In a polyethnic population such as Kazakhstan, where the largest ethnic groups are Kazakhs and Russians, this approach can be implemented by considering ethnicity as one of the factors potentially modifying the contribution of traditional risk factors and the pattern of coronary artery involvement. Coronary angiography, as the gold

standard for diagnosing obstructive coronary artery disease, allows objective assessment of the severity, localization, and extent of atherosclerosis, enabling comparative clinical and angiographic analysis.

Considering ethnicity in the analysis of clinical and angiographic manifestations of CAD is important, as differences in genetic, metabolic, and behavioral characteristics may influence the severity of coronary artery involvement and the clinical course of the disease. A comprehensive comparative analysis—from risk factors to angiographic findings and further to myocardial function assessed by left ventricular contractility parameters—among the major ethnic groups of Kazakhstan living under similar climatic and geographic conditions allows for a more accurate identification of clinical and angiographic features of CAD.

Research Objectives

1. To study the prevalence of coronary artery disease (CAD) risk factors depending on gender and ethnic characteristics.
2. To characterize the clinical forms of CAD and angiographic findings with consideration of ethnic affiliation.
3. To determine the impact of risk factors on coronary artery involvement with consideration of patients' ethnic characteristics.
4. To assess myocardial contractile function depending on the condition of the coronary arteries.
5. To develop practical recommendations for the early detection of cardiovascular risk factors and optimization of the management of patients with CAD, taking into account ethnic characteristics.

Materials and Methods

The study had a cross-sectional design and was conducted using a continuous sampling method. A total of 640 patients with coronary artery disease were included in the study; all were examined at the cardiology center of JSC “Central Clinical Hospital” (Almaty, currently the “National Hospital” of the Medical Center of the Administrative Office of the President of the Republic of Kazakhstan) during the period from 2017 to 2019.

Patients were divided into two groups according to ethnic affiliation: Kazakhs (n=338) and Russians (n=302). The groups were comparable in terms of age, sex, and clinical diagnosis.

Clinical and anamnestic data were assessed, including major cardiovascular risk factors (arterial hypertension, diabetes mellitus, dyslipidemia, obesity, and smoking), as well as biochemical parameters of lipid and carbohydrate metabolism.

Instrumental examination included echocardiography with assessment of myocardial contractile function and selective coronary angiography with determination of the severity and extent of coronary artery lesions.

Statistical analysis was performed using the IBM SPSS Statistics software package. Logistic regression analysis was used to assess the impact of risk factors, with calculation of odds ratios, 95% confidence intervals, and p-values.

Object of the study: Patients with ischemic heart disease who underwent coronary angiography.

Subject of the study: Clinical and angiographic characteristics of coronary artery involvement, cardiovascular risk factors, and indicators of the structural and functional state of the myocardium in patients with ischemic heart disease, taking ethnic background into account.

Provisions submitted for defense

1. The structure of cardiovascular risk factors in patients with coronary artery disease demonstrates pronounced gender and ethnic characteristics, as confirmed by statistical analysis of clinical data.
2. Comparative analysis between gender and ethnic groups revealed differences in the frequency and severity of obstructive coronary artery lesions; however, ethnicity should be considered a modifying factor (influencing the contribution of traditional risk factors), rather than an independent predictor in the clinical assessment of CAD.
3. The contribution of traditional risk factors (age, diabetes mellitus, smoking, dyslipidemia) to the development of obstructive coronary artery disease differs between Kazakh and Russian ethnic groups: among Kazakhs, age, diabetes, and smoking predominate, whereas among Russians, age, hypertension, smoking, and dyslipidemia are more prominent. Ethnic affiliation modifies the risk structure but is not an independent factor.
4. The degree of impairment of myocardial contractile function is statistically significantly associated with the severity of coronary artery involvement, regardless of patients' ethnic affiliation, highlighting the universal nature of this clinical and functional relationship.

Results

1. Interethnic differences in the structure of cardiovascular risk factors were identified. In the Russian group, obesity (62.6% vs 52.1%; $p=0.03$), arterial hypertension (56.0% vs 36.4%; $p=0.001$), and dyslipidemia (76.4% vs 63.2%; $p=0.034$) were more frequently observed, as well as lower HDL cholesterol levels (0.9 ± 0.2 vs 1.3 ± 0.2 mmol/L; $p<0.001$). In the Kazakh group, disorders of carbohydrate metabolism were significantly more frequent, including higher glucose levels (6.3 ± 1.2 vs 5.7 ± 1.0 mmol/L; $p=0.003$) and diabetes mellitus (62.7% vs 37.4%; $p<0.001$).
2. Unstable angina was significantly more frequently detected in patients of the Russian group (47% vs 38.8%; $p=0.042$), with comparable frequencies of stable angina and myocardial infarction ($p>0.05$). Hemodynamically significant obstructive coronary artery lesions were identified in 55% of patients (359/640) and were significantly more common among individuals of Russian ethnicity. In the age groups of 50–69 years, the prevalence of obstructive lesions was higher among Russian patients (in men up to 72% vs 51%; $p=0.002$, in women up to 69% vs 52%; $p=0.012$).

No differences were found between the groups in the prevalence of one-, two-, and three-vessel disease ($p>0.05$).

3. According to logistic regression analysis in the overall cohort, independent predictors of obstructive coronary artery disease were age (OR=1.053; 95% CI 1.030–1.076; $p<0.001$), diabetes mellitus (OR=1.968; 95% CI 1.253–3.093; $p=0.003$), smoking (OR=3.939; 95% CI 2.439–6.369; $p<0.001$), and dyslipidemia (OR=3.662; 95% CI 1.577–8.458; $p=0.003$). Ethnic affiliation, as an independent factor, did not show a statistically significant association.

Kazakh subgroup. Independent predictors of obstructive coronary lesions were: age — each additional year increased the probability of coronary stenosis; odds ratio (OR) ≈ 1.07 (95% confidence interval (CI) 1.04–1.10; $p<0.001$); diabetes mellitus — the presence of diabetes increased the risk of coronary artery involvement by more than 2.5 times (OR ≈ 2.7 ; 95% CI 1.4–5.0; $p\approx 0.002$); smoking — smokers had approximately 1.8 times higher risk compared to non-smokers (OR ≈ 1.8 ; 95% CI 1.1–3.3; $p\approx 0.02$).

Russian subgroup. Significant risk factors included: arterial hypertension — elevated blood pressure approximately doubled the risk of coronary stenosis (OR ≈ 2.2 ; 95% CI 1.3–3.7; $p\approx 0.003$); dyslipidemia — the probability of coronary involvement increased by more than 2.5 times (OR ≈ 2.6 ; 95% CI 1.5–4.8; $p\approx 0.001$); lipid profile parameters: total cholesterol — each increase of 1 mmol/L was associated with increased risk (OR ≈ 1.7 ; 95% CI 1.1–2.6; $p\approx 0.01$); triglycerides — OR ≈ 1.6 (95% CI 1.0–2.5; $p\approx 0.04$); high-density lipoprotein cholesterol — demonstrated a protective effect (OR ≈ 0.3 ; 95% CI 0.2–0.5; $p<0.001$); smoking — increased the risk of obstructive lesions by approximately 1.6 times (OR ≈ 1.6 ; 95% CI 1.0–2.4; $p\approx 0.03$).

From the perspective of predictors of multivessel coronary artery disease: sex — $\beta = -0.266$; OR = 0.766; $p = 0.097$. Men tended to have a lower number of affected arteries compared to women; however, the differences did not reach statistical significance ($p\approx 0.097$). Age — $\beta = 0.016$; OR = 1.016 (an increase in risk by 1.6% per year); $p = 0.027$. Age was a significant predictor: with each year, the risk of multivessel disease increased by approximately 1.6%. Diabetes mellitus — $\beta = 0.120$; OR = 1.128; $p = 0.494$. Diabetes as an independent factor did not have a statistically significant effect on the number of affected arteries. Arterial hypertension — $\beta = 0.027$; OR = 1.027; $p = 0.855$. The presence of hypertension was not associated with a statistically significant increase in the risk of multivessel disease. Smoking — $\beta = 0.537$; OR = 1.711; $p = 0.005$. Smokers had nearly 1.7 times higher risk of having multiple affected arteries compared to non-smokers; this predictor was highly significant. Dyslipidemia — $\beta = 0.749$; OR = 2.115; $p = 0.001$. Patients with lipid metabolism disorders had approximately a twofold increased risk of multivessel disease. Ethnic affiliation — $\beta = 0.153$; OR = 1.165; $p = 0.303$. The variable “asian” encoded belonging to the Kazakh group. The obtained values indicate the absence of statistically significant differences in the number of affected arteries between Kazakh and Russian patients.

4. Reduction of myocardial contractile function was associated with the presence of obstructive coronary artery disease. In patients of the Kazakh ethnic group, left

ventricular ejection fraction (LVEF) was lower in the presence of obstructive lesions compared to their absence ($52\pm 8\%$ vs $56\pm 10\%$; $p=0.02$). A similar trend was observed in patients of the Russian ethnic group ($50\pm 9\%$ vs $55\pm 8\%$; $p=0.04$). No statistically significant differences between ethnic groups were found ($p>0.05$). LVEF was significantly lower in the presence of multivessel disease: in patients without obstructive lesions, it was $56.5\pm 6.8\%$, in single-vessel disease $54.2\pm 7.1\%$, and in multivessel disease $50.8\pm 7.5\%$ ($p<0.001$). No differences between ethnic groups were observed for this parameter.

Scientific novelty

For the first time, a study of coronary artery status in relation to cardiovascular risk factors was conducted in patients with coronary artery disease, taking into account ethnic affiliation, using the example of residents of Almaty (Republic of Kazakhstan).

For the first time, a predictive model for coronary artery obstruction in patients with coronary artery disease was developed, in which the main criteria include age, sex, smoking status, dyslipidemia, arterial hypertension, diabetes mellitus, and ethnic affiliation (Russian and Kazakh), with calculation of an integral threshold index.

The selection of the threshold value reflected a clinically significant combination of risk factors and ensured reproducibility of the method in both outpatient and inpatient clinical practice.

The developed prognostic model was registered as a copyrighted intellectual property object (Certificate No. 69681: “Program for Assessing the Probability of Obstructive Coronary Artery Disease in Patients with Ischemic Heart Disease”). The author has been granted Patent of the Republic of Kazakhstan for Utility Model No. №12831 dated 28.08.2026, entitled “Device for Assessing the Probability of Obstructive Coronary Artery Disease in Patients with Ischemic Heart Disease.

Practical significance

The results of this study can be used in the development of personalized approaches to the primary and secondary prevention of coronary artery disease.

For outpatient and inpatient clinical practice, a predictive model for coronary artery obstruction in patients with coronary artery disease has been proposed. This model is based on the assessment of traditional risk factors, including age, arterial hypertension, and ethnic affiliation (Russian and Kazakh), as clinically significant and stratifying variables, with calculation of an integral threshold index.

Patients with a value >2.0 are classified as having a high probability of obstructive coronary artery disease and should be prioritized for referral to coronary angiography. For patients with a value <2.0 , non-invasive examination and dynamic follow-up are recommended.

The practical application of the developed model was confirmed by an implementation certificate in the activities of the National Hospital of the Medical Center of the Administration of the President of the Republic of Kazakhstan (Implementation Certificate No. 43).

Author's contribution

All results presented in the dissertation that possess scientific novelty were obtained personally by the author. The author performed coronary angiography in all patients (n=640), as well as transthoracic echocardiography, and conducted the statistical analysis of the study results.

The program for assessing the probability of obstructive coronary artery disease in patients with CAD has been implemented at the “National Hospital” of the Medical Center of the Administration of the President of the Republic of Kazakhstan in both outpatient and inpatient settings (implementation act No. 43).

The author has obtained a copyright certificate No. 69681: “Program for assessing the probability of obstructive coronary artery disease in patients with coronary artery disease.”

The author has been granted Patent of the Republic of Kazakhstan for Utility Model No. №12831 dated 20.04.2026, entitled “Device for Assessing the Probability of Obstructive Coronary Artery Disease in Patients with Ischemic Heart Disease.

Conclusions

1. The prevalence of cardiovascular risk factors among patients with coronary artery disease in the population of Almaty demonstrates gender- and ethnicity-related characteristics. In the age groups of 50–69 years, individuals of Russian ethnicity more frequently exhibited dyslipidemia ($p<0.05$), obesity ($p<0.05$), and arterial hypertension ($p<0.05$), whereas individuals of Kazakh ethnicity in the same age groups more frequently had diabetes mellitus ($p<0.05$). In younger and older age groups, the differences were not statistically significant ($p>0.05$).
2. Hemodynamically significant obstructive coronary artery lesions were significantly more frequently detected in individuals of Russian ethnicity in the middle age groups (men aged 50–59 and 60–69 years ($p<0.05$); women aged 50–59 and 60–69 years ($p<0.05$)).
3. According to logistic regression analysis in the overall cohort, independent predictors of obstructive coronary artery disease were age, diabetes mellitus, smoking, and dyslipidemia ($p<0.05$). Ethnic affiliation, as an independent factor, did not show a statistically significant association ($p>0.05$). In the Kazakh subgroup, the leading predictors of obstructive lesions were age, diabetes mellitus, and smoking ($p<0.05$). In the Russian subgroup, significant factors included arterial hypertension, smoking, and dyslipidemia ($p<0.05$). An increase in the number of affected coronary arteries was associated with age, smoking, and dyslipidemia ($p<0.05$). Sex, diabetes mellitus, arterial hypertension, and ethnic affiliation did not have a statistically significant effect ($p>0.05$). The obtained results indicate the absence of statistically significant differences in the number of affected coronary arteries between Kazakh and Russian patients ($p>0.05$).
4. Myocardial contractile function (LVEF and GLS) was significantly reduced in patients with hemodynamically significant obstructive coronary artery disease, regardless of ethnic affiliation ($p<0.05$). This confirms the clinical significance of

stenosis severity and the necessity of mandatory assessment of left ventricular function in the management of patients with CAD.

Practical recommendations

1. In primary prevention of coronary artery disease in patients of both ethnic groups, assessment and correction of all traditional cardiovascular risk factors are mandatory. At the same time, the study results indicate differences in the contribution of individual risk factors to the development of obstructive coronary artery disease: in patients of Russian ethnicity, a stronger association was observed for dyslipidemia, smoking, and obesity, whereas in patients of Kazakh ethnicity, it was for diabetes mellitus and disorders of carbohydrate metabolism. These features should be taken into account when determining priority directions for prevention and risk factor modification.
2. When planning diagnostic and therapeutic strategies in patients with coronary artery disease, a higher probability of detecting hemodynamically significant obstructive coronary artery lesions should be considered in patients of Russian ethnicity compared to those of Kazakh ethnicity, especially in the presence of multiple cardiovascular risk factors.
3. In patients with reduced myocardial contractile and pump function of the left ventricle, coronary angiography should be considered to assess the presence of hemodynamically significant obstructive coronary artery disease in order to determine appropriate treatment strategy in a timely manner.
4. To optimize patient routing in both outpatient and inpatient settings, it is recommended to use an integral assessment of combined clinical risk factors with application of the developed predictive model. This approach allows stratification into low/moderate and high probability groups of obstructive coronary artery disease and enables differentiation of diagnostic strategies without increasing the number of unnecessary invasive procedures.

Approbation of dissertation results

Publications

1. “Clinical and angiographic features of coronary artery involvement in coronary artery disease” E.S. Maidurov, S.F. Berkinbayev, K.R. Karibayev. International professional journal “Healthcare of Kazakhstan”, Almaty, Republic of Kazakhstan, 2019, No. 2 (200), pp. 36–41.
2. “Clinical and angiographic features of coronary artery involvement in coronary artery disease” E.S. Maidurov, S.F. Berkinbayev, K.R. Karibayev. Abstracts of the XI Congress of Cardiologists of the Republic of Kazakhstan, Almaty, June 5–7, 2019, p. 41.
3. “Methods for assessing cardiovascular risk factors in different population groups” E.S. Maidurov, S.F. Berkinbayev, K.R. Karibayev, V.R. Weber. Bulletin of KazNMU, Almaty, 2019, No. 4, pp. 64–68.
4. “Population features of the course of coronary artery disease” E.S. Maidurov, S.F. Berkinbayev, K.R. Karibayev. Bulletin of KazNMU, Almaty, 2019, No. 4, pp. 69–71.

5. “Differences in the course of coronary artery disease considering additional factors” E.S. Maidurov, K.R. Karibayev, D.I. Makhanov, S.T. Erzhanov, A.Zh. Tolemisov. Bulletin of the Medical Center of the Administration of the President of the Republic of Kazakhstan, Almaty, 2019, No. 4 (77), pp. 128–131.
6. “Clinical and angiographic features of coronary artery involvement in coronary artery disease” Report presented at the Young Scientists Competition during the XII Congress of Cardiologists of the Republic of Kazakhstan, Almaty, November 19–20, 2020. Awarded 1st place.
7. Maidurov Y., Berkinbayev S., Karibayev K., Tanabayeva S., Fakhradiyev I., Tulepbergenov G., Aimakhanova A., Alimbayeva A. (2023). The Relationship Between the Incidence of Coronary Heart Disease and Ethnic Minorities. Experimental and Applied Biomedical Research (EABR), 24(2), 125–134. <https://doi.org/10.2478/sjecr-2022-0027>
8. Certificate No. 51510 dated November 15, 2024 — scientific work: “Clinical and angiographic features of coronary artery involvement in coronary artery disease in patients of Kazakh and Russian ethnicity.” Date of creation: October 17, 2019.
9. Copyright certificate No. 45181 dated April 26, 2024 — scientific work: Results of the research “Assessment of risk factors for coronary artery disease depending on ethnic differences” for the development of differentiated screening and treatment-preventive programs for different ethnic population groups. Date of creation: April 17, 2024.
10. Copyright certificate No. 69681 dated April 7, 2026 — computer software: “Program for assessing the probability of obstructive coronary artery disease in patients with coronary artery disease.” Date of creation: March 23, 2026.
11. Patent of the Republic of Kazakhstan for a Utility Model No. №12831 dated 20.04.2026: “Device for Assessing the Probability of Obstructive Coronary Artery Disease in Patients with Ischemic Heart Disease.”

Structure and scope of the dissertation

The dissertation is presented on 114 pages of typed text. The study includes an introduction, literature review, materials and methods, results, discussion, conclusions with practical recommendations, and a list of references. The work is illustrated with 10 figures and 20 tables. The bibliography includes 167 sources.