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Social efficiency of introduction of atherosclerosis screening program in Kazakhstan. Systematic review

Bekbossynova, M., Duysekova, S., Zeinoldina, A., Akzholova, K.

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Research supervisor: PhD, associate professor-researcher of the Department of Public Health and Management Duysekova Samal Baibolatovna

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Бекбоссынова, М., Дуйсекова, С., Зейнолдина, А., Ақжолова, К.

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Социальная эффективность внедрения программы скрининга атеросклероза в Казахстане

Бекбоссынова, М., Дуйсекова, С., Зейнолдина, А., Акжолова, К.

7М10103- «Здравоохранение»

литературный обзор диссертации, подготовленной для получения степени магистра медицинских наук (научно-педагогическое направление)

Научный руководитель: к.м.н., доцент-исследователь кафедры общественного здравоохранения и управления Дуйсекова Самал Байболатовна

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**Abstract**

**Background.** Atherosclerosis, a primary cause of cardiovascular diseases, significantly impacts morbidity and mortality in Kazakhstan. The rising burden of this disease, combined with a high prevalence of dyslipidemia, underscores the importance of effective screening to reduce associated health risks.

**Purpose.** This study aims to evaluate the social efficiency of implementing a nationwide atherosclerosis screening program in Kazakhstan, assessing its potential to improve public health outcomes and reduce cardiovascular disease mortality.

**Methods.** A literature review was conducted, analyzing global screening approaches and protocols for atherosclerosis and cardiovascular diseases in countries such as the United States, UK, and Canada. Additionally, Kazakhstan’s recent guidelines, including the “Clinical Diagnosis and Treatment Protocol for Atherogenic Disorders of Lipid Metabolism,” were examined for their applicability in the local context.

**Results.** Findings suggest that targeted and cascade screening programs, particularly those focused on high-risk individuals and familial hypercholesterolemia, are effective in reducing disease incidence and mortality. Introducing similar protocols in Kazakhstan could enhance early detection, allowing for preventive interventions and treatment. The study concludes that a structured, government-supported screening program would not only save lives but also offer substantial economic benefits by mitigating long-term healthcare costs associated with cardiovascular complications.

**Key words**: atherosclerosis, dyslipidemia, cardiovascular diseases, lipid profile, screening

**Introduction**

According to gerontologists, a person can live up to 120 years. However, under the influence of many factors, this indicator decreases. For example, according to the National Bureau of Statistics in 2022, the expected average life expectancy of residents of the Republic of Kazakhstan was 74.44 years [1]. According to UN data, in the early 1950s, the share of people living in countries with a life expectancy of more than 70 years was only 1% of the total world population. In the early 2000s, it exceeded 50% [2]. The only reason for the increase of this indicator is the early detection of various diseases, that is, the development of screening. Today, the World Health Organization (WHO) recognizes that one of the primary operational functions of public health is disease prevention, including screening.

In general, the wide distribution of screening in the world begins in the 20th century. That is, mass fluorography was started after the Second World War to identify people with tuberculosis [3]. According to the WHO, the United States was one of the first to introduce the concept of screening for the prevention of various diseases [4].

As a result, this study aims to evaluate the social efficiency of implementing a nationwide atherosclerosis screening program in Kazakhstan, assessing its potential to improve public health outcomes and reduce cardiovascular disease mortality.

According to the National Bureau of Statistics, the main causes of death in Kazakhstan in 2023, which forced the introduction of this screening, were disorders of the circulatory system - 22.7%, tumors - 10.4%, diseases of the lung-respiratory system - 9.8%, accidents, poisoning and injuries - 8.4% and diseases of the digestive system - 8.0% [5].

Atherosclerosis is the main cause of cardiovascular diseases here. It kills more people every year than the most common diseases, such as cancer, pneumonia, and diabetes. According to the definition of the World Health Organization, atherosclerosis is a variable combination of changes in the inner lining (intima) of arteries, including the accumulation of lipids, complex carbohydrates, fibrous tissue, blood components, calcification, and accompanying changes in the middle layer (media) [6]. And the main reason for the development of ischemic diseases of the cardiovascular system is atherosclerosis. Therefore, atherosclerosis can be said to be the main indicator of total mortality. When conducting research on the problem of atherosclerosis in Kazakhstan, the incidence is considered to be relatively young.

Atherosclerotic cardiovascular disease affects more than 135 million people worldwide. More than 2 billion people are at high risk of atherosclerosis. They cause more than 85% of all deaths from cardiovascular diseases. Deaths from atherosclerotic cardiovascular diseases account for 31% (17.9 million) of all deaths worldwide [7], including 45% (3.9 million) of all deaths in Europe [8], 23 of all deaths in the US % (0.65 million) is due to this disease [9]. Atherosclerotic cardiovascular disease is also a leading cause of sudden death (6.2 million sudden deaths worldwide among people aged 30–70 years) [10].

Dyslipidemia , characterized by high levels of blood lipids, is an important global health problem associated with cardiovascular disease. As a preventive measure, screening for dyslipidemia plays a crucial role in identifying individuals at risk.According to WHO experts, 85% of cardiovascular complications are caused by a healthy lifestyle, timely examination and identification of risk factors, early prevention and treatment, including lowering the level of "bad" cholesterol in the blood [11].

Blood pressure measures the force of circulating blood against artery walls. High blood pressure can damage arteries supplying blood to vital organs like the brain, heart, and kidneys. Cholesterol plays a central role in atherosclerosis—the buildup of fatty deposits in the arteries of the heart and brain. High cholesterol is responsible for an estimated 4.4 million deaths globally, or 7.9% of the total, primarily due to its impact on high blood pressure. It accounts for 18% of strokes and 56% of coronary artery disease worldwide. According to WHO, 40% of global deaths are due to just 10 major risk factors, with the remaining factors contributing less than 10%. Addressing these key risks could add 10 years to healthy life expectancy [12].













Figure 1. An representation of genetic types and damage types of dyslipidemia

**Methods**

This systematic review was conducted to assess the social efficiency of implementing a nationwide atherosclerosis screening program in Kazakhstan. A comprehensive literature search was performed across multiple databases to ensure a broad and relevant selection of studies. The databases included PubMed, MEDLINE, Scopus, Web of Science, and the Cochrane Library. Search terms encompassed combinations of keywords such as "atherosclerosis screening," "cardiovascular disease," "dyslipidemia," "public health," "screening programs," and "Kazakhstan." Studies were included based on their relevance to atherosclerosis screening programs, particularly in the context of public health outcomes and economic efficiency. To avoid bias, studies from various geographical regions were considered, focusing on screening models and their effectiveness in countries similar in healthcare infrastructure and demographics to Kazakhstan. Inclusion criteria emphasized studies from the past 15 years, systematic reviews, meta-analyses, and original research articles. All retrieved articles were screened by title and abstract, with relevant studies reviewed in full text. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were adhered to throughout the review process, ensuring a structured and transparent approach.

**Results**

The results of the study selection process: at the initial stage of study selection 1187 studies were identified. After the removal of duplicate studies, titles and abstracts of 974 studies were screened for relevance. After title and abstract screening, 54 studies were selected for full-text review. Finally, 20 papers that met inclusion criteria were included into the final systematic review as presented in Figure 2.

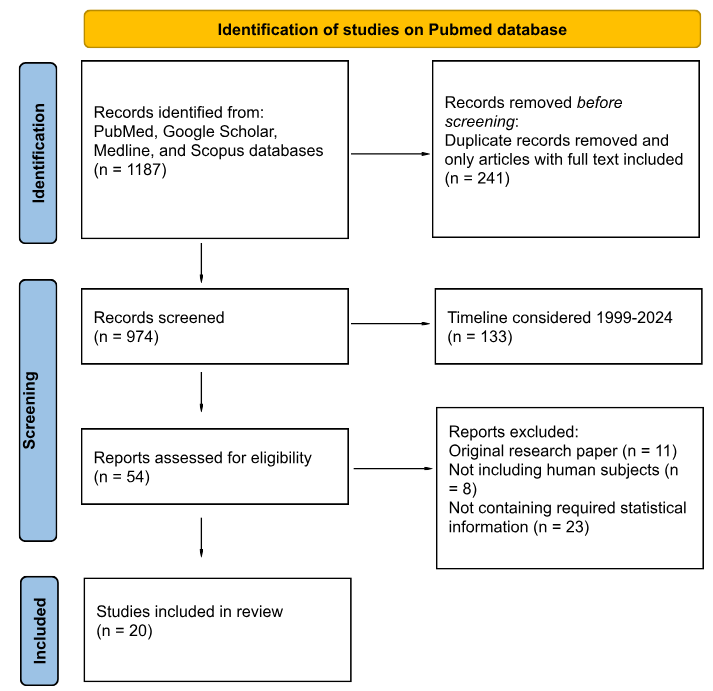


Figure 2. Flow chart showing selection of studies for review

**1. Screening programs for atherosclerosis and cardiovascular diseases**

Atherosclerosis and cardiovascular disease screening programs are implemented in various countries, with significant differences in their development. For example:

USA: The U.S. tracks atherosclerosis statistics through the CDC database, which is the leading data-driven public health service. The "National Survey of Ambulatory Care: 2019 Summary Tables by Country" reports the annual number of outpatient visits by diagnostic group, with over 12,000 visits for coronary atherosclerosis and other chronic ischemic heart diseases [13]. The overall comparison of screening programs are illustrated in Table 1.

Table 1. Screening Programs for Atherosclerosis and Cardiovascular Diseases

| **Country/Region** | **Program/Organization** | **Screening Methods/Key Features** | **Notable Outcomes and Comments** |
| --- | --- | --- | --- |
| **USA** | CDC Database | Tracks outpatient visits for conditions like coronary atherosclerosis | Over 12,000 outpatient visits for coronary atherosclerosis annually |
| **UK** | NHS | Cardiovascular screening includes cholesterol and blood pressure checks | Provides lifestyle recommendations alongside screenings |
| **Canada** | Provincial Programs | CVD screenings at the provincial and territorial levels | Screening recommendations vary by province/territory |
| **France** | National/Regional Levels | Screening programs vary by inclusion criteria and age groups | Implements a combination of national, regional, and local-level screenings |
| **Russia** | National Cardiology Center | Led by Marat Vladislavovich Yezhov; focuses on FHC | Highlights that 20% of myocardial infarction cases involve undiagnosed FHC |
| **Switzerland** | Novartis | Uses innovative medicines for treatment and management | Focuses on improving patient outcomes and extending life expectancy |
| **Europe (General)** | European Atherosclerosis Society (EAS) | Provides guidelines, consensus documents, and public education resources | Established lipid modification guidelines and consensus documents since 2007 |
| **Uzbekistan** | Tashkent Cardiology Center | Cascade screening for FHC | Approximately 1 in 200 people are affected by FHC, with cascade screening aiding diagnosis. |

In the UK, the NHS runs cardiovascular screening programs, including cholesterol and blood pressure measurements, with lifestyle recommendations. Canada has provincial and territorial-level CVD screening programs and recommendations. France has introduced screening programs for atherosclerosis and other cardiovascular diseases, varying by scope, inclusion criteria, and age groups, and implemented at national, regional, and local levels. In Russia, Marat Vladislavovich Yezhov, a leading researcher and professor at the National Medical Cardiology Research Center, is a key figure in the field of atherosclerosis. In Switzerland, Novartis, an international company, focuses on improving and extending lives through innovative medicines like Zolgensma, Cosentyx, and Incliziran [15].

In Europe, the European Atherosclerosis Society (European Atherosclerosis Society) works actively. The EAS was founded in 1964 as a forum for the exchange of ideas among researchers on the study of atherosclerosis, and scientific meetings have been held throughout Europe for many years [16] . Since 2007, the Society has produced Atherosclerosis Guidelines, and since 2010, consensus documents, and in 2012, a public resource Academy as a collection of online lectures, presentations, and talks recorded at congresses, courses, and webinars.

In 2019, the ESC/EAS guidelines for lipid modification to reduce cardiovascular risk for the treatment of dyslipidemia were established: The authors are the Dyslipidemia Treatment Working Group of the European Society of Heart (ESC) and the European Society for the Study of Atherosclerosis (EAS) [17].

In Uzbekistan, Professor Alexander Borisovich Shek, a prominent Russian scientist and the deputy director of the Tashkent Republican Specialized Scientific and Practical Cardiology Medical Center, highlights the global challenge of familial hypercholesterolemia (FHC). He notes that the prevalence of FHC is about 1 in 200 people, which translates to an estimated 165,000 individuals affected in Uzbekistan, with a population of 33 million. Shek points out that annually, 20% of myocardial infarction patients are undiagnosed FHC cases. His center plays a key role in the management of cardiology services in the country. [18].

**2. Activities aimed at the prevention of atherosclerosis in Kazakhstan.**

The "Clinical Diagnosis and Treatment Protocol for Atherogenic Disorders of Lipid Metabolism (Dyslipidemia)" was approved by the National Scientific Center for Healthcare Development (Salidat Kairbekov) and published on its website. Approved by the Joint Commission on Medical Services Quality (Ministry of Health, Kazakhstan) under protocol No. 196 (Dec 7, 2023), the protocol recommends targeted screening for familial hypercholesterolemia (FH) and cascade screening for first- and second-degree relatives of diagnosed FH patients [19, 20, 21].

According to statistics, over 36,000 people die from atherosclerosis annually in the Republic, and this number continues to rise. WHO experts state that 85% of cardiovascular disease complications can be prevented through a healthy lifestyle, timely screening, early prevention, and treatment, as well as reducing "bad" cholesterol. Individuals over 40 should undergo cardiovascular screenings every two years, free of charge, as part of a national program. These screenings help assess the 10-year risk of developing cardiovascular disease. If cholesterol levels are high, preventive treatment is prescribed, as stated by Saule Abseyitova, chairwoman of the Cardiology Society of Kazakhstan, during a press conference in Astana on June 14, 2022 [22].

3. **Review of clinical scientific works on the study of atherosclerosis and its screening**

As a result of the research conducted by Mamedov M.N., every second person among men and women aged 30-69 who took part in the research in the Vladimir region of Russia had hypercholesterolemia, and hyperglycemia was found in every fourth man and fifth woman [23].

In Tenyukov's study, "Screening Studies of Lipid Metabolism for Timely Diagnosis and Prevention of Atherosclerosis," cardiovascular diseases, primarily caused by atherosclerosis, were identified as the leading cause of death globally. The study followed 2,000 individuals over 18, monitoring blood cholesterol, lipoproteins, triglycerides, and other factors. It was found that cholesterol levels decrease in those aged 60-69. Only 28% had normal high-density lipoproteins, 54% were at risk, and 18% had pathology. Atherosclerotic changes were seen in one-third of patients over 40 during angiological screening. The study concluded that apolipoprotein disorders begin at age 18-29, emphasizing the importance of early screening to prevent disease [24]. The comparison of general findings on lipid metabolism and screening are presented in Table 2.

Table 2. General Findings on Lipid Metabolism and Screening

| **Study** | **Population/Setting** | **Key Findings** | **Implications** |
| --- | --- | --- | --- |
| Mamedov et al. | Men and women aged 30-69 in Vladimir region, Russia | 50% had hypercholesterolemia; hyperglycemia in 25% of men and 20% of women | Highlights the importance of early lipid screening and prevention |
| Tenyukova and Markov | 2,000 participants aged 18+ | Cholesterol levels decrease in ages 60-69; 28% had normal HDL, while 54% were at risk | Early detection of apolipoprotein disorders is critical |
| Kuharchuk | Men aged 40+ and women aged 50+ | SCORE scale categorizes cardiovascular risk; lipid profile and clinical signs are essential screening tools | Emphasizes lipid profiling for accurate cardiovascular risk stratification |
| Sadykova et al. | 95 volunteers aged 20-65 | Risk factors in 55.6%; lower age limit for risk is 30 years | Social importance of preventive lipoprotein testing demonstration |

In his work "Diagnosis and Correction of Lipid Metabolism Disorders for the Prevention and Treatment of Atherosclerosis," Kuharchuk highlights the importance of detecting tendon and skin xanthomas, xanthelasma, or lipoid corneas in individuals under 45, as these symptoms suggest lipid metabolism disorders like familial hypercholesterolemia, a common cause of early dyslipidemia. The screening algorithm involves identifying risk factors and clinical signs of atherosclerosis, determining lipid profiles via blood tests, assessing cardiovascular risk using the SCORE scale, and confirming atherosclerosis with instrumental methods. Screening is recommended for men over 40 and women over 50. The SCORE scale, used in Europe, categorizes cardiovascular risk into very high, high, moderate, and low. Countries with high cardiovascular risk (death rates from CVD >350 per 100,000) include Azerbaijan, Belarus, Bulgaria, Egypt, Georgia, Kazakhstan, Kyrgyzstan, North Macedonia, Moldova, Russia, Syria, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan. [25].

According to the research conducted by SN Sadykova, blood lipid spectrum was taken from 95 volunteers aged 20 to 65 years. Risk factors were found in 55.6% of people. The lower limit of the risk factor is considered to be 30 years. In conclusion, the authors showed the social importance of preventive measures, especially the effectiveness of lipoprotein testing [26].

In Vienna, Austria, a pilot project combined selective screening with cascade testing for children aged 5-7, using standardized questionnaires and cholesterol measurements. Cascade screening is implemented in several countries, including Bulgaria, Denmark, Ireland, Kosovo, Latvia, Malta, Norway, Poland, Portugal, Spain, Sweden, Switzerland, and Ukraine, with some programs being institution-based and others national. The Czech Republic introduced universal newborn screening, and Estonia offers universal screening for all ages. Germany combines universal and cascade screening through the Fridolin Program (ages 2-6) and the Vroni study (ages 5-14), while Greece implemented this approach at institutions. Cascade screening is also used in Ireland, Luxembourg, the Netherlands, Norway, and Sweden [27, 28, 39]. The cascade and screening programs overview are presented in Table 3.

### Table 3. Cascade and Familial Screening Programs

| **Country/Program** | **Target Population/Method** | **Results** | **Significance** |
| --- | --- | --- | --- |
| Vienna, Austria | Children aged 5-7; cascade screening | Cascade screening detected familial hypercholesterolemia cases effectively | Demonstrates the success of selective screening in early childhood |
| Germany: Fridolin and Vroni Programs | Fridolin (ages 2-6); Vroni (ages 5-14) | Combined universal and cascade screening approach. | Integration of genetic testing improves familial screening efficiency |
| Czech Republic: MedPed Project | Universal newborn screening | Significant contribution to identifying FHC | Establishes universal screening as a model for effective detection |
| Slovenia | Universal FH screening for 5-year-olds | Covers 91% of pediatric population; integrated genetic testing | Reduction in cardiovascular mortality through systematic screening |

Grosel U.'s work in the \*European Journal of Cardiology\* discusses successful familial hypercholesterolemia (FH) screening models in Europe. In 1994, the Netherlands began a program identifying genetically confirmed FH patients (index cases) and conducting cascade screening for their relatives, which reduced mortality over 20 years. However, funding ended in 2014, halting the program. Slovenia introduced universal FH screening in 1995, measuring cholesterol in 5-year-olds during primary care visits. The program now covers 91% of the pediatric population and integrates genetic testing. Cascade screening has also been implemented in Norway, the Czech Republic, Spain, and the UK, with the Czech Republic’s MedPed project significantly contributing to FH identification. [29].

An epidemiological, cross-sectional study was conducted to assess the prevalence of dyslipidemia in adolescents from Montes Claros, Minas Gerais, and compare the results with a study of the Brazilian population. A total of 77,833 students from 63 schools across four geographical areas participated, and data from 635 adolescents aged 10 to 16 years were evaluated. Blood samples were collected to measure total cholesterol, triglycerides, LDL cholesterol, and HDL cholesterol. The study found that 26.8% of adolescents had high total cholesterol, 15.7% had high triglycerides, 6.5% had high LDL cholesterol, and 40.8% had low HDL levels. The authors concluded that the prevalence and mean values of dyslipidemia, except for HDL cholesterol, were higher in adolescents from Montes Claros compared to the Brazilian population study used for comparison. [30].

G.S. Pushkarev's article, titled "Creation of an Algorithm for the Absolute Summary Assessment of the 10-Year Risk of Death from Cardiovascular Diseases in Women in the City of Tyumen," presents a method for estimating the cumulative cardiovascular death risk in women aged 25-64 in Tyumen. The study aimed to create an algorithm incorporating both traditional and socio-economic risk factors. The research included 1,000 women from Tyumen in an epidemiological study and concluded that the developed algorithm, which considers economic risk factors, provides an effective means to assess individual cardiovascular death risk at the local level. [31]. This and other regional studies are summarized in Table 4.

Table 4. Regional Studies on Atherosclerosis Risk and Screening

| **Study/Region** | **Methodology** | **Findings** | **Recommendations** |
| --- | --- | --- | --- |
| Pushkarev et al. (Tyumen, Russia) | SCORE-based risk algorithm for women aged 25-64 | Developed an algorithm incorporating socioeconomic risk factors | Provides a localized tool for assessing 10-year cardiovascular death risk |
| Gulov et al. (Tajikistan) | Risk factor assessment in Vankal’a village | 44.5% overweight, 37.6% hypertensive, 25.8% hyperglycemic | Highlights need for community-focused health promotion |
| Serebryakova et al. (Tomsk, Russia) | Screening among 483 female teachers | High prevalence of lipid and carbohydrate metabolism disorders | Workplace screening is effective for identifying metabolic risk factors |
| Magomedov et al. | Survey of young people and patients with atherosclerosis | 66.7% unaware of atherosclerosis; 80% frequently consumed alcohol | Increased public awareness and preventive education are required |

The introduction of X-ray contrast angiography in 1958 marked a significant innovation in diagnosing atherosclerosis, allowing for the quantification of vessel narrowing and precise localization of stenosis [52]. This method remains the "gold" diagnostic standard for cardiac surgeons planning vascular surgeries. The next advancement was the use of intravascular ultrasound, an invasive technique, which revolutionized our understanding of atherosclerosis and enabled early detection of pathological changes in vessel walls. Today, comprehensive diagnostic information for identifying atherosclerosis includes blood serum lipid levels, HS CRP, coronary risk factors, ultrasound of brachiocephalic vessels, and CT angiography. In cases with clinical manifestations of atherosclerosis, invasive methods like intravascular ultrasound should also be used for specific arterial regions [14, 32].

D. I. Sadykova describes familial hypercholesterolemia as a leading cause of early cardiovascular diseases and a frequent disorder of lipid metabolism in children. Cascade screening on the "child-parent" path for the diagnosis of OGHS was carried out from December 2018 to August 2021 on the basis of several medical institutions. Inclusion and exclusion criteria were defined for the selection of study participants. As a result, 34 children diagnosed with "heterozygous OGHS" with an average age of 8.7 years were identified during the indicated period. After screening relatives, 33 parents, 15 siblings , and 56 second relatives were diagnosed with SGHS. Most of the parents diagnosed with SGHS also had cardiovascular disease. In conclusion: "child-parent" cascade screening led to the detection of three new cases of SGHS per child-proband, which highlights the importance of early diagnosis and control of this disease in a family context [33].

A.K. Tuleuova's work, "Use of ECG Dispersion Mapping Method for Screening the Risk of Cardiovascular Diseases," addresses the growing relevance of determining early cardiovascular disease (CVD) risk in both children and adults. Screening methods are vital in this process, but issues with accessibility and efficiency remain. The study explores the use of ECG dispersion mapping for cardiac screening to identify individuals at high risk of CVD. The study involved 500 adults and 300 children in Almaty, with informed consent and ethics committee approval. Results demonstrated the effectiveness of ECG dispersion mapping in identifying at-risk patients, highlighting its potential to improve early detection, prognosis, and prevention of cardiovascular diseases when integrated into medical practice [34]. The advances in diagnostic methods are thoroughly described in Table 5.

### Table 5.Advances in Diagnostic Methods

| **Study/Author** | **Method** | **Key Outcomes** | **Clinical Implications** |
| --- | --- | --- | --- |
| Smolenskaya et al. | X-ray contrast angiography | Precise quantification of vessel narrowing | Gold standard for vascular surgical planning |
| Tuleuova et al. | ECG dispersion mapping | Effective in identifying high-risk patients for CVD | Promotes early detection and prognosis improvement |
| Shaw LJ | Subclinical atherosclerosis imaging | Plaque prevalence often exceeds traditional risk factors | Calls for more intensive assessment to improve risk stratification |
| Abbott AL | Routine imaging for subclinical atherosclerosis | Raised concerns over complications and incidental findings | Routine imaging not yet recommended due to insufficient data |

E.V. Khokhlyuk's research aimed to assess how atherosclerosis impacts functional activity in elderly patients. The study involved 99 patients aged 65 and older with atherosclerosis, treated at a hospital in Belgorod. Functional activity was evaluated using the Barthel index, and atherosclerotic lesions were identified through clinical examination and history. The study found that the severity of functional impairment depended on which arteries were affected, with lower extremity atherosclerosis causing the most significant limitations in activities such as dressing, moving, and climbing stairs. Factors like previous myocardial infarction or coronary artery bypass surgery also influenced functional activity. These findings are valuable for optimizing treatment and rehabilitation strategies for elderly patients with atherosclerosis. [35].

I.A. Skripnikova's study aimed to investigate the relationship between total cardiovascular risk (CHD) and fracture risk in women without clinical signs of atherosclerosis. The study included 200 women aged 45-69, with cardiovascular risk assessed using the SCORE scale and fracture risk evaluated through the FRAX calculator. Bone mineral density (BMD) was measured by X-ray absorptiometry. Results showed that 36% of women had low, 62% had average, and 2% had high cardiovascular risk. Among 128 women with a SCORE ≥1, 26% had osteoporosis and 34% had osteopenia. An inverse relationship between BMD and cardiovascular risk and a positive relationship between BMD and fracture risk were found. The study suggests that assessing both CVD and fracture risk together can aid in early prevention and improve patient care. [36].

RA Magomedov conducted a survey of young people who did not visit a cardiologist and patients diagnosed with vascular atherosclerosis. The questionnaire contained 16 questions about the risk factors, symptoms and prevention of atherosclerosis, including the lifestyle of the respondents. The results showed that women (53.3%) predominated among the respondents, most of them ( 60%) were overweight. Only 20% of respondents smoked, but 80% drank alcohol frequently. All respondents had a blood relative who had a stroke or heart attack. Most of them (73.3%) had high blood pressure, only 33.3% knew what atherosclerosis is. The vast majority (66.7%) did not visit a neurologist, only 33.3% monitored their blood sugar level. Despite this, only 33.3% were aware of atherosclerosis. The results of the study indicate the need to increase public awareness of the risk factors and prevention of atherosclerosis through educational materials and a more intensive medical dialogue with patients [37].

I.V. Kiseleva's study evaluated the effectiveness of screening for lipid metabolism disorders and obesity in health centers, analyzing data from 3,049 working-age individuals between 2015 and 2016. Screening methods included questionnaires and the use of express-analyzers to measure cholesterol, blood glucose, and lipid profiles. The study found that 50.9% had health risk factors, and 49.1% were healthy. Additionally, 65.2% had body parameter abnormalities, and 34.8% had hypercholesterolemia. After attending health school, 48% of participants saw a reduction in cholesterol, and 5.5% lost weight, particularly among those aged 18-30. This underscores the importance of screening in preventing cardiovascular diseases [38].

Karpov's article addresses unresolved issues in diagnosing and treating familial hypercholesterolemia (FH) in Russia. FH significantly raises the risk of atherosclerosis, with an estimated 287,000 patients with heterozygous FH and 150-300 with homozygous FH. FH patients aged 20-39 have a 100-fold higher risk of cardiovascular disease death. The article calls for the creation of lipid centers to improve FH diagnosis, treatment, and screening, similar to those in the UK, USA, Canada, and Germany. These centers would focus on diagnosing lipid disorders, enhancing screening, developing educational materials, and collaborating with patient organizations and government bodies [40].

M.V. Ezhov's article entitled "Organization of work of lipid centers in the Russian Federation - new opportunities" shows the following data: in 2016, in Russia, "methodological recommendations on the organization of medical care for patients with hereditary atherogenic disorders of lipid metabolism" were made. In 2018, the Ministry of Health of Russia approved clinical recommendations for the diagnosis and treatment of familial hypercholesterolemia. Russian standards for the treatment of lipid disorders have been updated according to European standards, specifying low levels of cholesterol. Hypercholesterolemia is widespread in Russia, therefore it is important to ensure timely diagnosis and treatment of patients in specialized lipid centers to prevent cardiovascular complications [41].

The study "Screening of Risk Factors for Chronic Non-Communicable Diseases among Inhabitants of the Mountainous Region of Tajikistan" by MK Gulov assessed risk factors in Vankal'a village, with 497 participants. The findings revealed that 44.5% were overweight, with 12.6% having first-degree obesity and 7.2% second-degree obesity. Smoking affected 27.4%, and 24.9% were alcoholics. Hypertension was present in 37.6%, hyperglycemia in 25.8%, and lipid metabolism disorders in 14.7%. The results highlight the need for health promotion and lifestyle interventions in the community [42].

As previously mentioned, the study was conducted among 483 female teachers of general secondary schools in Tomsk (from 35 to 64 years old). The answer to the research made by VN Serebryakova was 84%. The average age of the participants is 49.3±7.8 years. Workplace screening revealed a high prevalence of lipid and carbohydrate metabolism disorders. 20.1% also have a low level of HDL CC, 24.9% - high HDL. The level of hyperglycemia was 38.1% and 24.1% at glucose levels ≥5.6 and ≥6.1 mmol/L, respectively. According to glycated hemoglobin (HbA1c), 6 cases of diabetes were identified. Unfavorable epidemiological situations are characteristic of women aged 55-64 years. Such various surveys and other works show that lipid metabolism disorder does not select factors such as age, profession [43].

The conference focused on the development of lipid centers in Russia, their integration into the EAS's EAS-fhsc network, and updating national guidelines for lipid metabolism disorders. Experts discussed organizing lipid center operations, modern lipid-lowering therapies, and experiences with their use. The 2018 National Atherosclerosis Society guidelines for familial hypercholesterolemia (FH) were reviewed, alongside new clinical guidelines on chronic coronary artery disease and acute coronary syndrome. The RENAISSANCE registry, launched by NOA, collects data on severe lipid metabolism disorders, including over 1,700 patients. Key challenges include timely diagnosis, inadequate therapy, and failure to reach LDL cholesterol targets, increasing cardiovascular risk [44].

A.V. Starshinin's work "Scientific Basis of Referral of Patients with Atherosclerosis of Brachiocephalic Arteries" focuses on the importance of early detection and management of brachiocephalic artery disease within the "Healthy Moscow" project. Modern stroke prevention and treatment require coordinated care, and many countries have established systems for stroke screening and treatment. Due to limited specialized centers, it's essential to implement referral protocols for patients at risk of stroke, especially those with brachiocephalic artery issues. Early detection and proper management improve survival rates. The "Healthy Moscow" project’s screening initiative helps prevent serious stroke consequences and disease progression, addressing the global gap in access to endovascular care. This initiative holds significant value for the healthcare system in Moscow and Russia [45].

The article by Andrew H. Tran and Elaine M. Urbina, "Is There a Role for Imaging Youth at Risk for Atherosclerosis?", emphasizes the importance of assessing vascular health in children with cardiovascular risk factors. It reviews recent research showing that these children exhibit adverse changes in vascular health indicators, such as pulse wave velocity, arterial distensibility, and carotid intima-media thickness, which may signal an increased risk for cardiovascular disease. Despite challenges in measuring vascular condition due to children's physiological differences and insufficient normative data, the authors suggest that such assessments could be valuable for risk stratification and early intervention. The article calls for future research to expand normative data, improve measurement standardization, and conduct longitudinal studies linking childhood risk factors to adult cardiovascular outcomes [46].

In the article "Childhood Lipid Screening for Multifactorial Dyslipidemia: A Systematic Review of Data for the US Preventive Services Task Force," Paulo Loza reviewed evidence on childhood and adolescent lipid screening to update USPSTF recommendations. The review found no direct evidence linking screening to adult health, intermediate outcomes, harms, or treatment effects, as no randomized controlled trials were conducted. A total cholesterol level of 200 mg/dL is a strong predictor of dyslipidemia. Screening was most effective in overweight children (9-11 years) and adolescents (16-19 years), with successful results in Appalachian communities. Dietary changes showed no negative impact on growth. However, studies did not find a clear association between cholesterol levels in youth and early death, though high cholesterol in women, especially with familial hypercholesterolemia, may be linked to early death. The article concludes that while some effectiveness was found (5.8%), long-term studies are needed to assess health risks and revise cholesterol standards [47].

In "Discovering the Significance of Subclinical Atherosclerosis: Time to Start Population Screening?", Leslie J. Shaw, PhD, emphasizes the need to study atherosclerotic plaques and their link to cardiovascular risk. Research shows plaque prevalence often exceeds traditional risk factors, suggesting more intensive assessment is needed. Myheart results show even low-risk patients can have atherosclerosis, indicating the need for further evaluation. Data from SCOTT-HEART2 and ROBINSYA will help clarify the role of CTO in screening asymptomatic patients and reducing cardiovascular events [48].

AL Abbott's article "Are we ready for routine 'subclinical' screening of atherosclerosis? Not yet..." concludes that while imaging of "subclinical" atherosclerosis could be an independent risk factor for future complications, routine screening of asymptomatic individuals is not yet advisable. The article highlights concerns, such as potential complications from screening (e.g., cerebral ischemic events, radiation side effects in 12% of cases) and incidental findings in 36% of cases. Abbott calls for further research to assess the ability of imaging to improve risk stratification, personalize care, and determine optimal screening methods to predict complications [49].

Zihan Chen's article, "Predicting Atherosclerosis Using Machine Learning Based on Operation Research," aims to enhance atherosclerosis diagnosis by combining statistical analysis and machine learning to reduce information overload. Using data from a retrospective study at Nanjing University of Chinese Medicine, the study applied machine learning to select predictive features and models. The optimal correlation distance model outperformed the basic model in prediction accuracy, with further improvement through ensemble training. The study concludes that this model improves prediction efficiency, AUC accuracy, and performance, with the code and models available on GitHub [50].

According to the work "Effectiveness of targeted screening of familial hypercholesterolemia in children and adults under 44 years of age: a retrospective control study" by Emelyanchik E. Authors concluded that early diagnosis and treatment of familial hypercholesterolemia (GCS) is very important for the prevention of cardiovascular diseases. The study evaluates the effectiveness of targeted screening among relatives of patients with atherosclerosis to justify its widespread use in clinical practice. 42 (24.14%) of the total number of examined persons were diagnosed with SGHS. 18 of them are under 17 years old. Of those observed, 16 (9.1%) had confirmed SGHS, another 16 (9.01%) - probable and 9 (5.2%) - probable. The results show that targeted screening allows effective detection of SGHS and hyperlipoproteinemia, which is its early diagnosis and shows its value in prevention [51]. The screening methodology for FH and pediatrics are described in Table 6.

### Table 6. Familial Hypercholesterolemia and Pediatric Screening

| **Study/Program** | **Methodology** | **Key Findings** | **Importance** |
| --- | --- | --- | --- |
| Sadykova et al. | "Child-parent" cascade screening | Diagnosed 34 children and 104 relatives with hypercholesterolemia | Cascade screening significantly increases detection rates in families |
| Emelyanchik et al. | Targeted screening for FH among relatives | 24.1% diagnosed with FH | Early diagnosis aids prevention of cardiovascular diseases |
| Grossel et al. (Netherlands) | Genetic testing and cascade screening | Reduced mortality over 20 years but discontinued due to funding | Demonstrates the long-term success of national FH screening programs |

Kim Zulfia Faritovna's dissertation emphasizes the widespread issue of dyslipidemia, a significant risk factor for cardiovascular diseases. The prevalence of dyslipidemia ranges from 61.38% to 84.1% in various populations, with cholesterol levels exceeding 5.2 mmol/l in 90% of cases in some regions. This underscores the need for focused prevention and treatment strategies to reduce the risk of cardiovascular complications. [53].

"Lipid-lowering therapy recommendations 2023 - what's new?" The author of the scientific article on clinical medicine – Andriyashkina.D, Klimenko.A, Ogarkova.K, Chernyaeva.A, Doronina. S concludes as follows. Disruption of lipid metabolism is an important risk factor for cardiovascular diseases due to atherosclerosis. Early and accurate diagnosis of dyslipidemia is essential for effective prevention and treatment of atherosclerosis. Current guidelines help physicians develop sound preventive and therapeutic strategies aimed at reducing morbidity and mortality from atherosclerosis and its complications [54].

**Discussion**

The findings from this systematic review underscore the potential value of introducing a structured atherosclerosis screening program in Kazakhstan. Evidence from other countries demonstrates that systematic screening, especially for high-risk populations, can significantly reduce the prevalence and mortality of cardiovascular diseases. Countries with established screening programs, such as the United States and UK, report lower incidence rates of late-stage atherosclerosis and associated complications, attributed to early identification and preventive care. The review highlights that, for Kazakhstan, implementing targeted screening could help address the growing burden of cardiovascular disease and alleviate associated healthcare costs in the long term. Despite the potential benefits, challenges exist, including the need for substantial government funding and healthcare infrastructure to support routine screenings. Furthermore, cultural attitudes and public awareness may influence participation rates, making public health education a crucial component of any successful program. Addressing these challenges will be essential to realize the full social and economic benefits of a screening program, positioning Kazakhstan to improve public health outcomes sustainably.

**Conclusion**

The general literature review emphasizes that screening is the most effective method to combat atherosclerosis, with its success evident in global practices and the history of early disease prevention. Demonstrating the social value and effectiveness of screening, and subsequently integrating it into medical practice, remains crucial. Just as early detection through screening is standard for diseases like breast cancer, cervical cancer, and tuberculosis, atherosclerosis should be similarly detected early in cardiovascular diseases. Widespread population screening, if made routine, could significantly reduce the global statistics of cardiovascular diseases as a leading cause of death. The economic efficiency of screening has also been proven.

**Conflict of interest**

Authors declare no conflict of interest

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