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Medical and Socioeconomic Risk Factors for the Development of Cardiovascular Diseases

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Abstract

Cardiovascular diseases (CVDs) remain the leading cause of mortality worldwide. According to the World Health Organization, approximately 19.8 million deaths were attributed to CVDs in 2022, accounting for 32% of all global deaths.

Objective. To comprehensively assess the role of medical and socioeconomic factors in the development of cardiovascular diseases, determine their contribution to the prevalence of risk factors, and identify the most significant determinants influencing cardiovascular risk formation.

Methods. A narrative literature review was conducted using a structured search strategy in PubMed, Scopus, and Web of Science databases covering the period 2005–2025. The review focused on the impact of social determinants of health on cardiovascular risk. Following screening and full-text assessment, 79 publications were included in the final analysis.

Results. Cardiovascular diseases remain the leading cause of mortality and disability-adjusted life years (DALYs) globally, with substantial variation depending on countries' levels of socio-demographic development. Global evidence demonstrates a consistent social gradient: low income, limited education, unsafe urban environments, and restricted access to healthcare are associated with higher CVD risk and poorer clinical outcomes. Economic and psychosocial factors (poverty, unstable employment, financial stress, depression, and social isolation), as well as environmental exposures (air pollution, noise, and limited access to green spaces), increase cardiovascular risk through behavioral and biological mechanisms, including chronic stress and systemic inflammation. In Kazakhstan, pronounced regional and urban–rural disparities highlight the need for prevention strategies that address social determinants and barriers to healthcare access.

Conclusions. The most significant medical and socioeconomic determinants of CVDs were identified, and their mechanisms of influence on risk factor prevalence were established. The findings confirm the necessity of a comprehensive, multilevel

approach integrating social interventions, preventive strategies, and early biomedical risk stratification.

Keywords: cardiovascular diseases, medical factors, socioeconomic factors, social determinants of health (SDOH), DALYs.

1. Introduction

Cardiovascular diseases (CVD) remain the leading cause of death worldwide. According to WHO data, approximately 19.8 million people died from CVD in 2022, accounting for 32% of all global deaths [1]. In European countries, CVD is also one of the leading causes of death (Eurostat, 2023) [2].

In recent years, there has been growing interest in the role of social determinants of health (SDOH) in the development of cardiovascular risk. According to an umbrella review by Teshale et al. (2023), education, economic status, living conditions, and adverse events in early childhood are associated with an increased risk of coronary heart disease, hypertension, stroke, and mortality [3].

A review by Brandt et al. (2023) identifies five key SDOH domains: economic stability, education, social environment, housing, and access to healthcare, which influence behavioral and clinical risk factors [4].

The findings of Xia et al. (2024) confirm that socioeconomic deprivation increases the risk of atherosclerotic disease regardless of traditional biomedical indicators [5]. Environmental characteristics of the urban environment, including air pollution and a lack of recreational areas, have an additional impact, especially among socially vulnerable groups. Lu et al. (2024) also found that socioeconomic inequality significantly affects CVD (e.g., low wages, limited access to healthcare resources) [6]. Psychosocial factors such as low income, limited social support, and poor living conditions are also associated with a less favorable cardiovascular profile (Qureshi et al., 2022) [7].

In Kazakhstan, the burden of cardiovascular disease remains significant. Despite a marked downward trend in mortality, it still exceeds the European average. According to Junusbekova et al. (2023), age-standardized preventable mortality from all CVD (I00–I99) in the country decreased from 267.6 to 165.8 per 100.000 population but remains above European levels. Mortality from ischemic heart disease (I20–I25) in Kazakhstan is 86.7 per 100.000, while in European countries (e.g., the Netherlands, Luxembourg, Portugal, and Belgium) it is about 70-80 per 100.000 (Eurostat, 2021) [8].

The aim of the study: to comprehensively assess the role of medical and social factors in the development of cardiovascular diseases, determine their contribution to the prevalence of risk factors, and establish the most significant determinants influencing the formation of cardiovascular risk.

2. Materials and Methods

This review provides a narrative overview of the literature with a structured search of scientific publications devoted to studying the impact of social determinants of health on the risk of developing cardiovascular disease. The search was conducted in the international bibliographic databases PubMed, Scopus, and Web of Science for the period 2005–2025. The search identified 1,486 publications. After removing duplicates (n = 312), 1,174 papers that passed the screening of titles and abstracts were selected for further analysis. A full-text evaluation was performed for 212 publications, resulting in the exclusion of 130 of them. A total of 79 publications were included in the final literature review.

The search was conducted using combinations of keywords and relevant MeSH terms, including social determinants of health, cardiovascular disease, CVD risk factors, socioeconomic status, health inequity, urban environment, and psychosocial factors. The inclusion criteria were systematic and umbrella reviews, cohort studies, meta-analyses, and large population studies. Publications that did not reflect the relationship between social factors and cardiovascular outcomes, did not correspond to the topic of the review, or were of low methodological quality were excluded.

The literature was selected in stages: first, titles and abstracts were screened, then full-text publications were evaluated for compliance with the inclusion criteria. The most relevant and methodologically significant studies were included in the final review.

Data processing was descriptive and analytical in nature. The results of the included studies were compared with each other to identify common trends, differences, and confirmed associations between social determinants and risk factors for cardiovascular disease. Particular attention was paid to the quality of the evidence base, the representativeness of the samples, and the methods used to assess social factors. The review was prepared in accordance with international recommendations for conducting narrative literature reviews (Narrative Review Standards).

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3. Results

Global epidemiology of CVD and the role of SDOH

Analysis of data from the Global Burden of Disease (GBD) 2023 shows that cardiovascular disease remains the leading cause of global mortality and disability. According to GBD 2023, mortality and disability rates from CVD vary significantly between countries depending on their socio-demographic index (SDI) level. The report emphasizes that people in countries with low SDI die from noncommunicable diseases, including CVD, much earlier than people in countries with high SDI; the gap in average age at death can be as much as decades, clearly demonstrating the depth of global inequalities (Figure 1) [9].

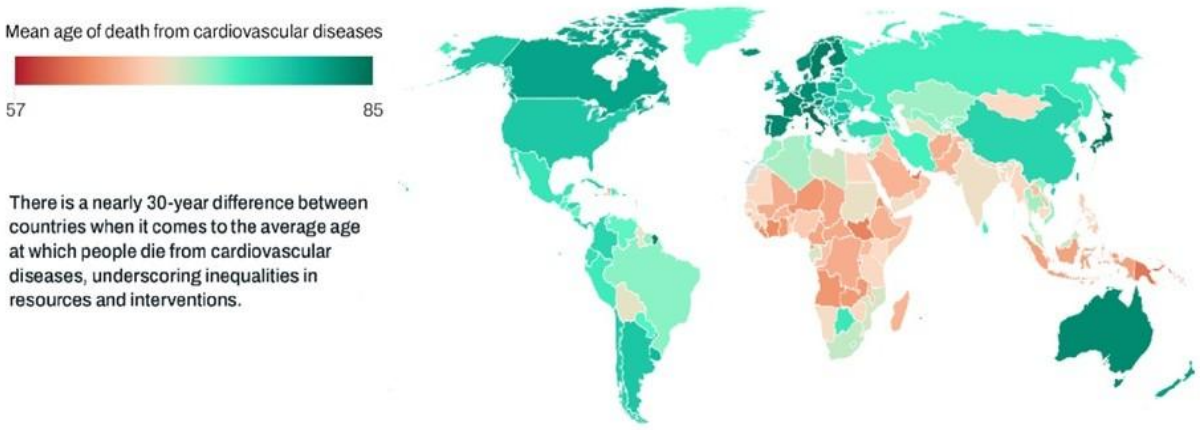

Figure 1 - Global differences in average age of death from cardiovascular disease in 2023 [9].

Global estimates of disease burden confirm that CVD remains the leading cause of DALY loss. The burden associated with CVD varies more than 16-fold between countries, with the highest rates occurring in countries with low socioeconomic development [10, 11].

According to the World Heart Federation's World Heart Report 2023, age-standardized mortality rates from CVD show a clear regional gradient:

a) the highest rates are in Central Europe, Eastern Europe, and Central Asia.

b) the lowest are in high-income regions.

These differences form a global "cardiovascular risk map" that reflects the socioeconomic and infrastructural characteristics of countries.

A combination of data from the WHO, GBD, and global epidemiological studies confirms that the burden of cardiovascular disease is not determined solely by biological mechanisms. Social determinants of health–income level, education, urban environment, employment, access to healthcare, and social support–form a consistent risk gradient. In conditions of social vulnerability, the risk of developing CVD is higher, access to treatment is poorer, and clinical outcomes are less favorable. Therefore, taking SDOH into account and eliminating them are key elements of modern CVD prevention strategies [12,13].

Economic determinants and cardiovascular disease risk

Economic determinants are among the key factors that determine differences in the prevalence and outcomes of cardiovascular disease. International studies emphasize that low income, poverty, unstable employment, financial stress, and economic crises form a consistent gradient of CVD risk, affecting both traditional biomedical factors and access to healthcare and living conditions.

Low income and socioeconomic disadvantage. Socioeconomic difficulties are consistently associated with a higher prevalence of hypertension, obesity, type 2 diabetes, and other risk factors. One of the most comprehensive confirmations of this is the study by Stringhini et al. (The Lancet, 2017), which included 48 cohort samples and more than 1.7 million participants [14]. The authors showed that low socioeconomic status reduces life expectancy and increases the risk of premature death, with HR=1.42 for men and 1.34 for women. Even after adjusting for behavioral risk factors, socioeconomic status retained an independent influence (HR 1.26). Similar results are presented in the work of Schultz et al. (2018), where low income and education are identified as independent predictors of cardiovascular mortality [15].

Precarious employment. A form of employment characterized by low job security, irregular income, and a lack of social guarantees (precarious employment) is recognized as a significant social determinant of health. A study by Matilla-Santander et al. (The Lancet Regional Health – Europe, 2022), covering 1,583,957

Swedish workers, found that men in a state of "borderline precarious employment" had a higher risk of myocardial infarction (RR = 1.13; 95% CI 1.07–1.20) compared to stable employment; in the case of "constant precarious employment," an increased risk of stroke was noted (HR = 1.24; 95% CI 1.16–1.33). The authors also report that for some trajectories, for example, former agency workers, the reduction in the probability of a collective agreement RR for stroke reached 1.32 (95% CI 1.04–1.68), and a reduction in income/prolonged low wages was associated with an increased risk of both MI and stroke. Importantly, these associations persisted after adjusting for traditional biomedical risk factors, highlighting the significant impact of employment status on cardiovascular disease incidence [16].

Data from OECD Health at a Glance 2023 also confirm that socioeconomic inequality is significant. In OECD countries, 43% of people in the lowest income quintile report diseases including cardiovascular disorders, compared to 27% of people with high incomes [17].

Economic crises. Macroeconomic shocks increase health risks for the population, especially in socially vulnerable groups. A review by Karanikolos et al. (BMJ, 2013) showed that the 2008 global financial crisis led to increased social inequality and worsened control of key CVD risk factors in several European countries [18]. Current GBD 2023 data confirm that economic shocks, including the COVID-19 pandemic, have exacerbated global socioeconomic differences in premature mortality and cardiovascular disease rates, particularly in countries with low and medium socioeconomic development (SDI) indices [9]. A study by Song S et al. (2024) found that age-standardized all-cause mortality rates from cardiovascular disease rose sharply between 2019 and 2021, for example, by 11.3% in the United States [19].

Economic factors such as low income, poverty, unstable employment, financial stress, and economic crises are closely associated with an increased risk of cardiovascular disease. They determine living conditions, access to healthcare, opportunities to maintain healthy behaviors, and vulnerability to chronic stress. Together, economic determinants form a significant social gradient of cardiovascular risk and should be considered when developing preventive programs and strategies to reduce CVD at the population level (Table 2).

Table 1 - Economic determinants and their impact on cardiovascular disease risk

Economic determinant	Indicators of impact on CVD	Conclusions
Low income, poverty (low SES)	↑ Risk of CVD (26% higher risk of CVD mortality in individuals with low SES); ↑ Mortality (HR=1.42 in men, HR=1.34 in women); Overall mortality after adjusting for risk factors (HR=1.26); ↑ Obesity (HR for mortality in men 1.04); ↑ Diabetes mellitus (loss of 3.9 years of life)	The study results indicate that socioeconomic conditions, in addition to risk factors, should be considered as targets for local and global health strategies, health risk surveillance, interventions, and policies [14]
Socioeconomic disadvantage low SDI	↓ Access to healthcare (79.6% of DALYs from CVD in 2023 are caused by controllable risk factors, indicating insufficient control and prevention); ↑Chronic diseases (the prevalence of CVD as a chronic condition has doubled: 311 million in 1990 and 626 million in 2023)	Countries with low SDI have higher mortality from CVD. Countries will need to adopt effective health and public health strategies if they are to make progress towards global targets for reducing the burden of CVD [10]
Unstable employment	↑ Risk of heart attack (men): (RR=1.13 with permanent unstable employment, RR=1.08 with marginal unstable employment); ↑ Risk of stroke (men): (RR=1.24 for permanent unstable employment, RR=1.14 for borderline unstable employment)	Having a consistently low or very low income was associated with an increased risk of heart attack and stroke in both men and women [16]

Continuation of the Table 1 - Economic determinants and their impact on cardiovascular disease risk

Economic determinant	Indicators of impact on CVD	Conclusions
Financial stress	↑ Chronic stress (associated with an increase in various CVD outcomes—stroke (OR = 1.86), IHD (OR=1.05), myocardial infarction (OR=1.03), and HF (OR=5.02)); ↑ BMI (6.20-16.10% influence); ↓ Lifestyle: smoking (3.94-6.68% influence); physical inactivity (1.59-6.68%); ↓ Immunity (4.60%-8.60%); ↓ Metabolic factors (1.70%–7.90%)	Stress caused by financial difficulties is associated with an increased risk of cardiovascular disease, which is due to factors related to body composition, lifestyle, immunity, and metabolism [21]
Economic crises	↑ Mortality (OR=1.2, 95% CI 0.87, 1.70); ↑ Myocardial infarction (OR=2.504, 95% CI 1.663, 3.773) ↑ Heart failure (16% during the crisis versus 11% during normal periods, p <0.0001)	The observed spike in mortality was striking and exceeded the mortality rates expected according to preliminary forecasts by the Ministry of Health. There was a consistent trend toward worsening treatment outcomes during hospitalization, indicating a link between the financial crisis and heart disease incidence and mortality [22]
Low education level	↑ CVD incidence (HR=0.51, i.e., a 49% reduction in CVD risk among more educated participants); ↑ Hypertension (13.9% of the association); ↑ BMI (6.9% of the association); ↑ Diabetes (5.2% of the association)	The percentage of the association between education and CVD incidence mediated by the identified mediators was 26%. Hypertension, BMI, and diabetes mediated 13.9%, 6.9%, and 5.2% of this association, respectively. Measures to reduce the prevalence of these risk factors may help reduce educational inequalities in CVD [23].
Low socio-demographic index (SDI)	↑ Mortality from CVD (approximately 19.2 million people); ↑ DALYs from CVD (437 million disability-adjusted life years)	A nonlinear but negative association was found between SDI and age-standardized prevalence of CHD [24]. CVD remains the leading cause of disease burden and mortality worldwide, with the greatest burden in regions with low, medium, and medium SDI. Countries will need to adopt effective health system and public health strategies if they are to make progress toward global targets for reducing the burden of cardiovascular disease [10]

Compiled by the authors

Education and health

Education is considered one of the most powerful social determinants of health (SDOH), directly affecting the risk of developing cardiovascular disease. The level of education shapes the cognitive and behavioral resources necessary for making medical decisions, following recommendations, and leading a healthy lifestyle.

Educational attainment and CVD risk. A systematic review and meta-analysis of 72 cohort studies demonstrated that individuals with low educational attainment had a significantly higher risk of coronary heart disease, stroke, and cardiovascular mortality compared to those with high educational attainment: the risk ratio (RR) for low vs. high education was approximately 1.36 (95% CI 1.11-1.66) for coronary heart disease [25].

Another large cohort analysis (Dégano et al., 2017) showed that among participants with a university education, the risk of CVD was approximately half (HR≈0.51; 95% CI 0.30-0.85) compared to those with only basic or lower education [23].

These data confirm that low educational attainment is an independent risk factor for CVD.

Health literacy. Health literacy, the ability of an individual to understand, evaluate, and apply health

information, is an important mediator between educational attainment and CVD outcomes. A systematic review by Ghisi et al. (2018) showed that in a group of patients with ischemic heart disease, the average prevalence of low health literacy was about 30%, and it was associated with a higher number of hospitalizations, less social support, and poorer quality of life [26].

A subsequent review by Beasant et al. (2022) on the prevention of CVD found that low health literacy is associated with less favorable behavioral indicators (e.g., smoking, inactivity) and poorer control of risk factors [27].

Thus, increasing educational attainment and developing health literacy may serve as an important strategy for reducing the risk of CVD.

Education as a key social determinant of health. A study by Ololade et al. (2024) conducted a meta-analysis in which low SES (including low educational attainment) was associated with an increased risk of CVD: RR=1.56 (95% CI 1.27-1.91) for low educational attainment compared to high educational attainment [28].

This emphasizes that education is not just one of the factors, but one of the most significant social determinants shaping the "gradient" of CVD risk.

Educational attainment and health literacy have a significant impact on the risk of developing cardiovascular disease. Low educational status and limited health information skills are associated with a higher risk of CVD, less adherence to prevention, and poorer control of risk factors. From a prevention perspective, strengthening educational initiatives and improving health literacy can be effective tools for reducing the cardiovascular burden.

Environmental and urban environment (Environmental SDOH)

The environmental and urban environment are key socio-environmental determinants that have a significant impact on the risk of developing cardiovascular disease. Factors that shape the environmental profile of cardiovascular risk include air pollution, traffic noise, access to green spaces, neighborhood safety, and urban infrastructure parameters. These factors exert their effects through mechanisms of chronic stress, inflammation, sleep disturbances, physical activity limitations, and unequal access to healthcare (Table 2).

Table 2 - Environmental SDOH and pathways to CVD

Environmental/urban factors	**Main mechanisms of action**	**Proven effects on CVD**
PM2.5 air pollution	Systemic inflammation; endothelial dysfunction; oxidative stress	↑ Loss of life expectancy (on average 1.7-2.9 years due to air pollution) [29]
Traffic noise	Activation of the stress axis (HPA), sleep disturbances, sympathoadrenal activation	↑ Hypertension (OR=1.034 for every 5 dB(A)); ↑ Stroke (by +14% for every +10 dB(A)); ↑ Risk of atrial fibrillation by 6% for every 10 dB(A) [30]
Lack of green spaces	Stress, physical activity, air quality	↓ Protective effect with increasing NDVI: HR 0.96 for every +0.1 NDVI (decrease in all-cause mortality); ↓ IHD and stroke (OR≈0.98) [31]
Unfavourable urban environment	Physical activity, environmental hazards	↑ Risk of coronary heart disease and stroke; ↓ Risk with improved urban environment (OR≈0.98 for coronary heart disease and stroke in a more favourable environment) [32]
Poor transport accessibility	Restricted access to medical care, reduced mobility and activity, physical activity, air quality, noise levels	↑Risk of adverse outcomes with CVD (For example, a study in Romania found that only 15% of the population can reach the nearest cardiology hospital in less than 20 minutes, 23% must travel more than 60 minutes, and 45.7% live more than 20 km from a cardiology hospital. Residents of remote areas, especially rural areas, are in the most vulnerable position, as they have to travel the longest to reach a hospital and cover the greatest distance) [33,34]

Compiled by the authors

Environmental and urban factors such as air pollution, noise, lack of green spaces, low social security, and limited transport accessibility form a pronounced environmental gradient of risk for cardiovascular disease. Given the accelerating pace of urbanization, their systematic inclusion in preventive and public health strategies is a prerequisite for reducing the burden of CVD.

Psychosocial risk factors for cardiovascular disease

Psychosocial factors are an important component of the socially determined risk of CVD. They affect neurohumoral mechanisms, health behavior, and adherence to therapy, forming persistent differences in cardiovascular outcomes. Recent studies show that chronic stress, depression, social isolation, and insufficient social support contribute significantly to the development and progression of CVD.

Chronic stress. Chronic stress activates the hypothalamic-pituitary-adrenal axis and the sympathetic nervous system, leading to increased cortisol levels, changes in blood pressure regulation, increased inflammatory processes, and accelerated atherogenesis. A review by Steptoe and Kivimäki (Nat Rev Cardiol, 2012) showed that chronic psychological stress is associated with a 40-50% increase in the incidence of ischemic heart disease in prospective observational studies [35].

Depression. Depression is recognized as a significant non-traditional risk factor for CVD. In a large national study involving more than 6.3 million adults in the United States, Kwapong et al. (J Am Heart Assoc., 2023) found that depression and low subjective mental health are associated with an increased risk of cardiovascular morbidity and mortality [36].

A recent review by Li et al. (Front Cardiovasc Med, 2023) confirmed that depression worsens cardiovascular outcomes through autonomic dysregulation, increased inflammatory markers, sleep disturbance, and reduced adherence to therapy [37].

Social isolation and loneliness. Social isolation and lack of interpersonal contact are significant psychosocial determinants of CVD. A systematic review and meta-analysis by Wang et al. (BMC Public Health, 2025) showed that social isolation and loneliness are associated with an increased risk of cardiovascular disease (HR≈1.17) regardless of biomedical and behavioral factors [38]. These data are consistent with the findings of an earlier review by Freak-Poli et al. (Health Promot J Austr, 2022), confirming the potential role of social inclusion as a protective factor for CVD [39].

Social support and family environment. A high level of social support is considered a protective mechanism that reduces the effects of chronic stress and improves treatment adherence. A study by Wang et al. based on NHANES 2005–2018 data showed that sufficient social support can reduce the risk of all-cause mortality by up to 45% and cardiovascular mortality by 60% [38].

Data from Datta et al. (Am J Cardiol, 2023) show that low levels of perceived social support are associated with an unfavorable profile of cardiovascular risk factors in young people and adults [40]. That is, respondents who reported low levels of social and emotional support were more likely to have hypertension, high cholesterol, and diabetes, as well as higher risks of CVD.

As shown, chronic stress, depression, social isolation, and insufficient social support are significant psychosocial determinants of cardiovascular disease. These factors act through neurohumoral, inflammatory, and behavioral mechanisms, affecting the frequency, severity, and prognosis of CVD. Taking them into account is an important part of modern prevention strategies aimed at reducing the cardiovascular burden in the population.

Behavioral risk factors as a 'bridge' between SDOH and cardiovascular disease

Social determinants of health (SDOH) are considered key structural factors that shape the lifestyle and behavioral habits of the population. According to the World Health Organization's definition, SDOH include the conditions in which people are born, grow up, live, work, and age; they affect access to education, income, employment, housing, and environmental quality, thereby determining a significant part of the social gradient of health [12].

Behavioral risk factors for cardiovascular disease are formed precisely within these socio-economic conditions, acting as a mechanism ('bridge') that links structural determinants to individual outcomes.

Smoking. The prevalence of smoking shows a pronounced social gradient: it is higher among population groups with low income, low education, high employment in physically and psycho-emotionally stressful work, as well as among residents of disadvantaged areas [41]. According to the results of a study by Tomioka K et al. (2020), the prevalence of smoking among university graduates was significantly lower (3 times) than among people without education [42]. Also, according to a CDC report, the prevalence of smoking among men with average and above-average incomes was 41.1%, while among men with minimum incomes it was 23.7% [43].

The US Centers for Disease Control and Prevention (CDC) emphasizes that commercial tobacco smoking is one of the most pronounced areas of social inequality in healthcare, determined by living conditions and levels of available resources. The CDC also notes that

eliminating adverse social conditions is a prerequisite for reducing the burden of tobacco [44].

Nutrition. The quality of nutrition is primarily determined by household income, access to fresh and healthy foods, price levels, and the ability to make regular purchases. A joint report by the FAO and WHO emphasizes that low income and lack of food accessibility create 'food deserts' and contribute to high consumption of cheap, energy-dense, but low-value foods [45]. The WHO confirms that the high cost of healthy foods is a critical barrier to their regular selection.

The structural nature of food behavior is also highlighted by The Lancet in the context of the global 'syndemic' of obesity, malnutrition, and environmental change. The 2018 Global Nutrition Report found that out of 141 countries, 83 countries (59%) had a double burden of malnutrition (i.e. a high prevalence of two out of three nutrition-related diseases [46].

Physical activity. Currently, 27.5% of the adult population does not meet the WHO-recommended levels of physical activity, which affects the life expectancy not only of individuals but also of their families, as well as health services. Insufficient physical activity is largely due to the characteristics of the living environment: the availability of parks and recreational areas, the safety of neighborhoods, transport infrastructure, and the quality of the urban environment. In its Global status report on physical activity, the WHO emphasizes that the lack of safe and accessible spaces is a key barrier to regular physical activity in countries of all income levels. The CDC also points to the influence of environmental conditions and social factors on activity levels [47].

Sleep. Sleep quality and duration are closely linked to social conditions: shift work, low income, chronic stress, and crowded and noisy living conditions increase the risk of sleep disorders. The WHO notes a significant link between psychosocial conditions and sleep disorders [48]. The CDC confirms that socioeconomic factors determine inequalities in sleep quality among different population groups. For example, the 2020 National Health Interview Survey found that people with higher incomes had fewer sleep problems (12.6%), while people with lower incomes had more sleep problems (21.9%) [49].

Alcohol consumption. Alcohol consumption and associated risks are higher in conditions of economic stress, unemployment, low income and high availability of alcohol in the environment. The WHO Global Report on Alcohol highlights that alcohol consumption shows a marked social gradient. A regional review by WHO Europe notes significant differences in alcohol consumption between social groups [50]. The authors Yuanwei Xu et al. (2022) concluded that 49.9% of men abuse alcohol in low- and middle-income countries. However, among women, the situation is as follows: regular consumption in countries with above-average wages (29.5%), while the prevalence of binge drinking is high among women in low-income countries (36.8%) [51].

Ultra-processed foods (UPFs). UFP consumption is closely linked to socioeconomic status: people with low incomes consume more UFPs because of their low cost, high availability, and intensive marketing. Compared to those with the lowest consumption, participants with the highest UFP consumption had a 15% increased risk of all-cause mortality (HR=1.15, 95% CI 1.09-1.22; I2=83.0%). In addition, a 10% higher risk of all-cause mortality was found with each 10% increase in UOP consumption (HR=1.10, 95% CI 1.04-1.16; I2=91.0%) [52].

The NOVA classification, which describes the degree of food processing, is presented by Monteiro et al. (2018). NOVA defines ultra-processed foods as industrial food and beverage products made mainly or entirely from substances derived from food, together with additives.

Taken together, behavioral risk factors such as smoking, unhealthy eating, insufficient physical activity, sleep disorders, alcohol consumption, and high consumption of ultra-processed foods are not individual choices, but the result of social conditions. SDOH shape the conditions in which behavior becomes either protective or harmful, and it is through this mechanism that socioeconomic inequality translates into differences in cardiovascular risk [53].

Research from 2017–2024 on early determinants and CVD

Table 3 summarizes the results of recent studies from 2017–2024 on the impact of early childhood adverse experiences (ACEs), early malnutrition, stunting, and social deprivation on the risk of cardiovascular disease in adulthood. The studies presented include large prospective cohort studies, systematic reviews, and epigenetic studies, allowing for a comprehensive view of the problem.

All studies show that adverse conditions in childhood have a long-term impact on health. ACEs and social deprivation disrupt the body's stress regulatory systems, increase chronic inflammation and contribute to the development of behavioral risk factors. Early malnutrition and growth retardation alter the body's metabolic programming, increasing the likelihood of future metabolic and cardiovascular disorders. Several studies also demonstrate that childhood stressors accelerate biological and vascular ageing by affecting epigenetic mechanisms and increasing arterial stiffness.

Overall, the data in the table show that early life experiences shape biological vulnerability that persists throughout life and significantly increases the risk of cardiovascular disease in adulthood. This highlights the importance of early preventive and social interventions to reduce future risks and prevent adverse outcomes.

Table 3- Early determinants (ACE, malnutrition, social deprivation) and cardiovascular risks

Author, Year	Type of study/sample	Early factor (exposure)	Outcomes	Key mechanisms	Conclusions
Wang et al., 2023 (BMC Medicine)	Prospective cohort, n≈5,800, ≥3 years of follow-up	ACE and adverse events in adulthood	Incidental CVD: CHD, stroke	Chronic stress, depression, inflammation, behaviour	ACE significantly increase the risk of CHD and stroke, especially when combined with adverse events in adulthood [54]
Zou et al., 2024 (eClinicalMedicine/Lancet)	Cohort study of young adults, n=136,073	Adverse childhood and adolescent events	Incidental CVD	Increased stress reactivity, cortisol dysregulation	ACEs increase the risk of CVD at a young age, regardless of gender and education level [55]
Grey et al., 2021 (BMJ Global Health	Systematic review of 57 studies	Childhood severe malnutrition, starvation, exposure to starvation	Hypertension, diabetes, CHD in adulthood	Metabolic programming, insulin resistance	Childhood malnutrition increases the risk of CVD throughout life [56]
Soliman, 2021 (Frontiers in Endocrinology)	Scientific review on growth retardation	Chronic malnutrition → growth retardation	Obesity, diabetes, metabolic syndrome	Alteration of the GH/IGF-1 hormonal axis, low muscle mass	Early malnutrition is associated with a high risk of metabolic and CVD complications [57]
Martens et al., 2023	Stratified analysis, n=446,485, of which 52,946 had cases of CHD	Socioeconomic status	Incidental CVD	BMI, systolic blood pressure	Socioeconomic status influences the extent to which BMI increases the risk of developing CHD [58]
Du et al. (2020)	Longitudinal study n=259,657	Malnutrition in early childhood	Incidental CVD: CHD, myocardial infarction	Organ vulnerability, possible developmental impairment	Malnutrition in early childhood is associated with a significantly increased risk of CVD in later life [59]
Jakubowski et al. (2018)	Quantitative meta-analysis	At least 2 adverse childhood experiences before age 18	Diabetes, hypertension, ischaemic heart disease	Stress, living conditions	Cumulative childhood adversity is moderately associated with adult cardiometabolic disease [60]
Bertele et al., 2022 (Front Psychiatry)	Clinical study N=210	Adverse childhood experiences	CVD through psychological and behavioural factors	Depression, low activity, smoking	Behavioural factors are key mediators ACE → CVD [61]
Han et al. (2025)	Prospective study N=16,521	Adverse childhood experiences (family, domestic, social)	New CVD events during follow-up	Demographics, socioeconomic status	The impact of adverse childhood experiences is closely linked to an increased risk of CVD in later life [62]

Continuation of the Table 3 - Early determinants (ACE, malnutrition, social deprivation) and cardiovascular risks

Author, Year	Type of study/sample	Early factor (exposure)	Outcomes	Key mechanisms	Conclusions
Lee et al. (2023)	Cross-sectional study N=31,242	Violence, household dysfunction	IHD, stroke	Smoking, obesity, diet	Certain types of ACE are particularly strongly associated with CVD [63]

Compiled by the authors

Gender and ethnic differences

Gender and ethnic characteristics are key aspects through which social determinants of health (SDOH) influence the prevalence, manifestations, course, and outcomes (PCO) of disease. Sex (biological) and gender (sociocultural roles), as well as ethnicity and migration status, are associated with differences in biology, behavior, access to healthcare, and social conditions, which shape unequal trajectories of cardiovascular risk.

Gender differences. A large body of contemporary research demonstrates that, although men have an earlier onset of CVD and higher morbidity, women often have worse outcomes after acute events and less access to diagnosis and high-quality treatment. The review 'Gender medicine: effects of sex and gender on cardiovascular disease manifestation and outcomes' (Regitz-Zagrosek & Gebhard, 2023) examines both biological aspects (hormones, vascular reactivity) and gender structures (access to care, clinical stereotypes) [64].

A more recent study by Lv et al. (2024) found that men had a significantly higher risk of overall and cardiovascular mortality compared to women, even after considering socioeconomic status and lifestyle (Hazard Ratio ~1.60) [65].

This gender differentiation is due not only to biology, but also to systemic barriers: stereotypes in diagnosis, underuse of therapy in women, and insufficient consideration of gender factors in clinical guidelines [66].

Ethnic and migration differences. Ethnic minorities and migrants are exposed to additional layers of CVD risk due to a combination of biological, behavioral, and social determinants. A systematic review by Patel et al. (2022) showed that South Asians have a ~32% higher risk of CVD mortality compared to white Europeans (RR=1.32; 95% CI = 1.14–1.54) [67].

The results of a study by Post et al. (2022) highlight the persistent racial and ethnic disparities in overall mortality and cardiovascular disease mortality, largely driven by social determinants of health, and confirm the need to identify systemic factors that determine health disparities between racial and ethnic groups and to take appropriate measures [68].

This suggests that ethnicity itself is not a 'genetic' source of risk, but rather a marker of a complex set of factors: poverty, access to health care, cultural barriers, social isolation, discrimination, and unfavorable living conditions.

The conclusion is clear: approaches to the prevention and treatment of CVD must consider gender- and ethnicity-dependent differences. Universal strategies are insufficient: adaptation to specific groups, rejection of stereotypes, removal of barriers to access, and increased consideration of diversity in clinical and public health programs are required. Only by recognizing gender and ethnic differences as components of SDOH can cardiovascular inequality be significantly reduced.

Kazakhstan: Social Determinants of Health and Cardiovascular Disease (SDOH and CVD)

Kazakhstan represents a unique model of interaction between social determinants of health (SDOH) and CVD, where socio-economic heterogeneity, regional differences in access to healthcare, urbanization processes, migration flows, and ethno-cultural characteristics form pronounced inequalities in the cardiovascular health of the population. A number of high-quality studies conducted in recent years have made it possible to reconstruct a comprehensive picture of the impact of SDOH on the risk of CVD in the country.

Preventable mortality rates, including treatable and preventable mortality from CVD, declined between 2011 and 2019, but rose again between 2020 and 2021. Overall preventable mortality rates decreased by 6.0 points (from −10.6 to −1.1) between 2011 and 2021 (p=0.017), while in men they decreased by −4.2 (−8.3 to 0.1) and in women by 5.1 (−8.8 to −1.3) (p=0.009) [8].

The study by Bermagambetova et al. showed that there is no significant difference between the prevalence of hypertension among urban and rural residents [69]. However, the analysis by Yerdessov et al. revealed a difference between the number of patients with hypertension in urban and rural areas. The number of patients living in cities is much higher, which suggests that living in urban areas is a risk factor for the development of arterial hypertension [70].

Data from Glushkova et al. (2023) highlight structural inequalities between urban and rural areas: screening coverage is significantly lower in rural areas, access to diagnosis and drug therapy is poorer, and the

incidence of uncontrolled hypertension is significantly higher than in urban populations. This study is one of the few that provides direct quantitative data on differences in CVD prevention in Kazakhstan. In particular, the incidence of hypertension in urban areas increased from 462 per 100,000 population in 2006 to 1,566.8 in 2020, while the incidence of CHD increased more moderately from 370.3 per 100,000 in 2006 to 702.9 in 2020. In contrast, in rural areas, the increase in the incidence of hypertension was less pronounced, at 1.7 times, and the incidence of IHD did not change, as the corresponding time series remained stable throughout the observation period. These data indicate that IHD screening in Kazakhstan is less effective than hypertension screening, especially in rural areas [71].

Social determinants in Kazakhstan interact with biological risk mechanisms, as confirmed by a series of studies by Abzaliyev, Suleimenova, Abzaliyeva, and colleagues (2023–2025), conducted within the framework of modern biomedical and computational sciences. These studies demonstrate that immunological markers, inflammation indicators, lipid and biochemical profiles, as well as clinical and biological parameters are closely associated with accelerated cardiovascular ageing (premature cardiovascular ageing). This allows social determinants to be considered as factors that increase biological vulnerability [72].

For example, a study by Abzaliyev et al. (2025, Biomedicines) showed that multidimensional visualization of biomarkers combined with machine learning methods effectively identifies patterns of premature vascular ageing. Risk modelling showed that in the 65–74 age group, smoking and alcohol increased the risk of myocardial infarction, hypertension, and obesity by up to 53%. In the 75–89 age group, these factors increased the likelihood of hypertension by 21%, chronic heart failure by 16%, and IHD by 14%. Among people aged 90 and older, hypercholesterolemia increased the risk of chronic heart failure by 17%, and hypertension increased the risk of myocardial infarction by 16% [72].

The work of Suleimenova et al. (2025, Diagnostics) confirms that the integration of immunological and clinical-biochemical indicators into predictive models significantly improves the accuracy of CVD risk stratification. Immunological indicators, especially in patients with established cardiovascular diseases, have high prognostic value, while biochemical markers are informative and accessible tools for assessing ageing in individuals without diagnosed diseases. The most significant interactions were HLA-DR (50%), CD14 (41%) and CD16 (38%). Thus, the use of modern methods of analysis and data processing using mathematical modelling and machine learning algorithms allows for the formation of highly accurate predictions of cardiovascular ageing risk based on population data from Kazakhstan [73,74].

The combination of social and biological determinants creates a unique 'Kazakhstan trajectory' for the formation of cardiovascular risk. On the one hand, social factors such as income level, access to primary health care, ethnicity, and place of residence determine access to prevention and behavioral patterns. On the other hand, biomarkers of inflammation, immune status, and vascular ageing studied by domestic research groups demonstrate the biological realization of these risks.

4. Discussion

The burden of cardiovascular disease caused by modifiable risk factors continues to grow worldwide. The GBD data present the dynamics of diseases ranging from ischemic heart disease to stroke and show the burden of CVD at the global, regional, and national levels [13]. The article provides information on the 13 leading causes of death from cardiovascular disease and 9 associated risk factors, allowing for a comprehensive assessment of the contribution of modifiable determinants to the increase in the cardiovascular burden. The article emphasizes that the global burden of cardiovascular disease is determined not only by metabolic, behavioral, and environmental risk factors, but also by social conditions that create unequal levels of vulnerability among populations. Socio-demographic differences between countries and population groups exacerbate unequal mortality and prevalence of CVD, although direct quantitative estimates of such factors are limited.

Data obtained from an analysis of 50 countries with high rates of COVID-19 cases showed that socioeconomic status plays an important role, with countries where income is more evenly distributed having lower mortality rates [75].

A meta-analysis summarizing data from several studies showed that, compared to high-income groups, people with low and middle incomes have a significantly higher risk of developing cardiovascular outcomes. The relative risk of ischemic heart disease was 1.49 (95% CI 1.16–1.91) and 1.27 (1.10–1.47) for low and middle income, respectively. The risk of cardiovascular events was higher, reaching 1.17 (0.96–1.44) and 1.05 (0.98–1.13), while the risk of stroke was 1.30 (0.99–1.72) and 1.24 (1.00–1.53). For mortality from cardiovascular disease, the relative risk was 1.76 (1.45–2.14) and 1.34 (1.17–1.54) [25]. Social determinants, particularly income level, remain significant risk factors for cardiovascular disease even in countries with

developed healthcare systems, but data from Asian countries are still needed to update the meta-analyses.

According to a systematic review by Soares et al. (2021), adverse childhood experiences, such as inadequate family care, violence, and social deprivation, are considered important medical and social factors that shape long-term vulnerability to chronic diseases, including cardiovascular diseases. The authors emphasize that such early social and psychological stressors have a long-term impact on the body, affecting stress regulation and inflammatory processes, and subsequently increasing the risk of adverse somatic outcomes in adulthood [76].

From 2014 to 2022, the overall mortality rate in Kazakhstan increased from 550.84 to 678.37 cases per 100.000 population. Throughout this period, IHD was consistently among the top three leading causes of years of life lost (YLL). At the same time, in several regions (in particular, the Karaganda, Kyzylorda, and Kostanay regions), a rapid increase in mortality was recorded, indicating significant regional inequality. Possible reasons for this inequality may be differences in social determinants of health or limited access to quality healthcare [77].

The findings of Glushkova et al. (2023) show that the incidence of hypertension in cities increased from 462 to 1,566.8 cases per 100.000 population between 2006 and 2020, while in rural areas it increased from 732.3 to 1,243 cases per 100.000. The authors suggest that the identified differences in registered incidence between urban and rural areas may be related to differences in the effectiveness of screening and detection of patients with AH [71].

Social differences within the country are confirmed by the work of Supiyev (2018), which shows that low income, insufficient education, ethnicity, and living in rural areas are associated with late diagnosis, low attendance at primary health care facilities, and poorer control of chronic diseases [78].

Contemporary Kazakhstani studies on biomarkers and accelerated cardiovascular ageing make an additional contribution to understanding the mechanisms of risk. The work of Abzaliyev, Suleimenova, Abzaliyeva, and colleagues (2023–2025) demonstrates that clinical, biochemical, and immunological markers–inflammatory cytokines, lipid profiles, and indicators of immune ageing– are important elements of biological vulnerability that can be exacerbated by adverse social conditions [72,73,79].

The integration of social and biological data allows for the creation of a comprehensive risk model in which social determinants (income, education, environmental conditions, access to primary health care) influence behavioral mechanisms (smoking, diet, activity) and then through biological pathways (inflammation, immune ageing, hormonal regulation), shape the trajectory of cardiovascular disease and mortality.

5. Conclusion

The analysis showed that medical and social factors play a key, systemic role in the formation of cardiovascular risk. Their influence is realized through interrelated mechanisms: socio-economic conditions determine the availability of medical care and the level of prevention; behavioral factors act as mediators between the social environment and biological processes; biomarkers of inflammation, metabolism, and vascular ageing reflect the ultimate realization of these effects in the body.

It has been found that socially vulnerable groups, such as rural residents, low-income populations, people with limited education, migrants, and ethnic minorities, have poorer control of risk factors, seek treatment later, and have higher mortality from CVD. The Kazakh context is characterized by the intensification of global trends, pronounced regional differences, uneven access to primary health care, and a combination of social and biological risk mechanisms.

Thus, the aim of the study has been achieved: the most significant medical and social determinants of CVD have been identified, the mechanisms of their influence on the prevalence of risk factors have been established, and the need for a comprehensive multi-level approach combining social interventions, prevention, and early biomedical risk stratification has been confirmed.

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Жүрек-қантамыр ауруларының дамуының медициналық және әлеуметтік-экономикалық қауіп факторлары

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Түйіндеме

Жүрек-қантамыр аурулары (ЖҚА) әлемдегі өлім-жітімнің жетекші себебі болып қала береді. Дүниежүзілік денсаулық сақтау ұйымының деректеріне сәйкес, 2022 жылы ЖҚА салдарынан шамамен 19,8 млн адам қайтыс болды, бұл барлық жаһандық өлім-жітімнің 32%-ын құрайды.

Зерттеу мақсаты: жүрек-қантамыр ауруларының дамуына әсер ететін медициналық және әлеуметтік факторлардың рөлін кешенді бағалау, олардың қауіп факторларының таралуына қосатын үлесін анықтау және жүрек-қантамырлық қауіптің қалыптасуына ықпал ететін негізгі детерминанттарды айқындау.

Әдістері. 2005–2025 жылдар аралығында PubMed, Scopus және Web of Science дерекқорларында құрылымдалған іздеу жүргізіліп, әлеуметтік детерминанттардың ЖҚА даму қаупінің әсеріне арналған нарративті әдеби шолу жасалды. Іріктеу және толық мәтінді бағалау нәтижесінде шолу құрамына 79 жарияланым енгізілді.

Нәтижелері. Жүрек-қантамыр аурулары әлемде өлім-жітім мен DALY көрсеткіштері бойынша жетекші орын алады, әрі бұл көрсеткіштер елдердің әлеуметтік-демографиялық даму деңгейіне байланысты айтарлықтай ерекшеленеді. Жаһандық деректер тұрақты әлеуметтік градиентті көрсетеді: табыстың төмен деңгейі, білімнің шектеулілігі, қалалық ортаның қауіпсіз болмауы және медициналық көмекке қолжетімділіктің жеткіліксіздігі жағдайында ЖҚА қаупі жоғарылап, клиникалық нәтижелер нашарлайды. Экономикалық және психоәлеуметтік факторлар (кедейлік, тұрақсыз жұмыспен қамтылу, қаржылық стресс, депрессия, әлеуметтік оқшаулану), сондай-ақ экологиялық әсерлер (ауа ластануы, шу, жасыл аймақтардың тапшылығы) мінез-құлықтық және биологиялық механизмдер арқылы, соның ішінде созылмалы стресс пен жүйелік қабыну арқылы жүрек-қантамырлық қауіпті арттырады. Қазақстан үшін айқын өңіраралық және қала-ауыл айырмашылықтары тән, бұл әлеуметтік детерминанттар мен медициналық көмекке қолжетімділік кедергілерін ескеретін профилактикалық стратегияларды әзірлеу қажеттілігін көрсетеді.

Қорытынды. ЖҚА-ның маңызды медициналық-әлеуметтік детерминанттары анықталды, олардың қауіп факторларының таралуына әсер ету механизмдері белгіленді және әлеуметтік интервенцияларды, алдын алуды және ерте биомедициналық қауіп стратификациясын біріктіретін кешенді көпдеңгейлі тәсілдің қажеттілігі дәлелденді.

Түйін сөздер: жүрек-қантамыр аурулары, медициналық факторлар, әлеуметтік факторлар, денсаулықтың әлеуметтік детерминанттары, DALY.

Медико-социальные факторы риска развития сердечно-сосудистых заболеваний

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Резюме

Сердечно-сосудистые заболевания (ССЗ) остаются основной причиной смертности во всем мире. По данным Всемирной организации здравоохранения, в 2022 году около 19,8 миллиона случаев смерти были связаны с ССЗ, что составляет 32% всех смертей в мире.

Цель обзора: всесторонне оценить роль медицинских и социально-экономических факторов в развитии сердечно-сосудистых заболеваний, определить их вклад в распространенность факторов риска и выявить наиболее значимые детерминанты, влияющие на формирование сердечно-сосудистого риска.

Методы. Был проведен обзор научной литературы с использованием стратегии структурированного поиска в базах данных PubMed, Scopus и Web of Science за период 2005-2025 гг. Основное внимание в обзоре

было уделено влиянию социальных детерминант здоровья на риск сердечно-сосудистых заболеваний. После отбора и полнотекстовой оценки в окончательный анализ были включены 79 публикаций.

Результаты. Сердечно-сосудистые заболевания остаются основной причиной смертности и продолжительности жизни с поправкой на инвалидность (DALY) во всем мире, причем они существенно различаются в зависимости от уровня социально-демографического развития стран. Глобальные данные демонстрируют устойчивый социальный градиент: низкий доход, ограниченный уровень образования, небезопасная городская среда и ограниченный доступ к здравоохранению связаны с более высоким риском сердечно-сосудистых заболеваний и худшими клиническими исходами. Экономические и психосоциальные факторы (бедность, нестабильная занятость, финансовый стресс, депрессия и социальная изоляция), а также воздействие окружающей среды (загрязнение воздуха, шум и ограниченный доступ к зеленым насаждениям) повышают риск сердечно-сосудистых заболеваний через поведенческие и биологические механизмы, включая хронический стресс и системное воспаление. В Казахстане ярко выраженные региональные различия и различия между городом и деревней подчеркивают необходимость разработки стратегий профилактики, направленных на устранение социальных детерминант и барьеров на пути доступа к медицинской помощи.

Выводы. Были выявлены наиболее значимые медицинские и социально-экономические детерминанты ССЗ и установлены механизмы их влияния на распространенность факторов риска. Полученные результаты подтверждают необходимость комплексного, многоуровневого подхода, объединяющего социальные вмешательства, профилактические стратегии и раннюю биомедицинскую стратификацию риска.

Ключевые слова: сердечно-сосудистые заболевания, медицинские факторы, социально-экономические факторы, социальные детерминанты здоровья (SDOH), DALYs.

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