


Recent Trends in Cardiovascular Disease Mortality in Kazakhstan

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Introduction: Cardiovascular diseases (CVD) are the leading cause of mortality in Kazakhstan. In the last decade, Kazakhstan has carried out a number of reforms in the healthcare sector, in particular, to reduce mortality from significant diseases, including CVD. This study aimed to provide the trend of avoidable mortality from CVD in Kazakhstan.

Methods: We extracted data from the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan on population by age; mortality rates from chronic rheumatic heart disease (I05-I09); hypertensive diseases (I10-I15); ischaemic heart disease (I20-I25); cerebrovascular diseases (I60-I69) from 2011 to 2021, by gender and 5-year age group (0, 1–4, 5–9, 74). We applied join point regression to calculate the average annual percentage change (AAPC). In addition, crude mortality and trends were calculated per 100,000 population.

Results: The avoidable mortality rates, including treatable and preventable mortality decreased between 2011 and 2019 and then increased in the last two years (2020 and 2021) in all four studied disease groups. The AAPC showed that total avoidable mortality rates decreased between 2011 and 2021–6.0 points (–10.6 to –1.1) ($p = 0.017$), whereas in males –4.2 (–8.3 to 0.1) and females –5.1 (–8.8 to –1.3) ($p = 0.009$). Avoidable mortality rates from ischemic heart disease, cerebrovascular and hypertensive disease has been reduced stronger in male compared to female. The crude mortality declined over the period given; however, among young people mortality is still high.

Discussion: Our findings showed that avoidable mortality from CVD decreased over the last years, which could be related to the policy on strengthening the primary care on early diagnosis and detection of CVD and its risk factors. However, primary healthcare facilities need to improve activities on health literacy (drug adherence, risk factors) of the population, including the prevention of CVD.

Keywords: cardiovascular diseases, heart disease, avoidable mortality, trends, Kazakhstan

Introduction

Cardiovascular diseases (CVDs) are the leading cause of mortality worldwide. According to the World Health Organization annually, 17.9 million deaths relate to CVD¹ and this number increased over the 19 years (from 12.1 million in 1990, to 18.6 million in 2019).² In Europe CVD causes 3.9 million deaths,³ in Kazakhstan the overall mortality rate from CVD was 219 per 100,000 in 2015,⁴ which is higher than in developed countries.⁵ Studies have shown that the provision of timely preventive care to patients with CVD can reduce complications and the costs associated with the treatment.^{6,7}

A comprehensive analysis of health indicators allows to monitor the performance of the healthcare system and identify the strategy to improve the health of the population. Rutstein et al⁸ presented in 1976 a tool for measuring the quality of medical care by introducing the concept of “unnecessary premature death”, where it was proposed that conditions in which death should not occur if “timely and effective” medical care is provided. Canada,⁹ the United Kingdom¹⁰ and the European Union¹¹ have introduced measures of avoidable mortality that allow the evaluation of healthcare systems in reducing premature mortality from various diseases.¹² Avoidable mortality includes causes of death

from preventable mortality (can be avoided through effective public health and primary prevention interventions) and treatable mortality (can be avoided through timely and effective health care interventions, including secondary prevention and treatment).¹²

Kazakhstan adheres to the policy of implementing the Astana Declaration and universal health coverage (UHC).¹³ Hence, government policy is aimed to strengthen primary care, where special attention is paid to the provision of person-centered care.¹⁴ Currently, a number of screening programs (for early detection of arterial hypertension, coronary heart disease and diabetes, and early detection of behavioral risk factors), as well as disease management programs (primary hypertension, diabetes mellitus and chronic heart failure)¹⁵ are being implemented in the primary care. Earlier studies presented the results of age-standardized data on CVD mortality by sex and regions of Kazakhstan.^{4,16} However, no data is available on avoidable mortality from CVD. Thus, in this study, we described trends in avoidable mortality from CVD in Kazakhstan from 2011 to 2021.

Methods

Data Source

From the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan (<https://stat.gov.kz>), the following data was obtained to analyse the mortality rates: population by age categories in the Republic of Kazakhstan; mortality rates due to CVD from 2011 to 2021, by gender and 5-year age group (0, 1–4, 5–9, 10–14, 70–74). The causes of mortality were classified according to the 10th revision of the International Classification of Diseases—ICD 10 and included Chronic rheumatic heart disease (I05-I09); Hypertensive diseases (I10-I15); Ischaemic heart disease (I20-I25); Cerebrovascular diseases (I60-I69). The definition of avoidable mortality was used from the UK Office of National Statistics.¹⁷ Selection of causes of death for the lists of preventable and treatable causes was based on Organisation for Economic Cooperation and Development (OECD)/Eurostat lists of preventable and treatable causes of death (January 2022 version).¹⁸ Avoidable mortality includes two components: preventable (causes of death that can be mainly avoided through effective public health and primary prevention interventions) and treatable (causes of death that can be mainly avoided through timely and effective health care interventions, including secondary prevention and treatment) mortality.¹⁸ In this study, we analyzed preventable and treatable mortality for four types of diseases separately and by sex.

Statistical Analysis

We used the age-standardised death rates given from the OECD 2015,¹² and corresponding 95% confidence intervals (95% CIs) were calculated for the age group 0–74 years and gender.

To calculate preventable, treatable and avoidable mortality, there is a need to sum the standardized mortality rate (tst) by age group, including the causes of death.

$$t_{preventable} = \sum_{i=1}^m t_{st_i} \text{ for } i=1. \text{ m causes of death included as preventable.}$$

$$t_{treatable} = \sum_{i=1}^m t_{st_i} \text{ for } i=1. \text{ m causes of death included as treatable.}$$

$$t_{avoidable} = \sum_{i=1}^m t_{st_i} \text{ for } i=1. \text{ m causes of death included as avoidable.}$$

The standardized death rate is calculated as follows:

$$t_{st} = \sum_{j=1}^n p_{ej}/p_e * t_j$$

where “n” number of age groups considered for adjustment;

p_{ej} standard population j_{th} age group ($j=1, \dots, n$)

$$p_e = \sum_{j=1}^n p_{ej}$$

p_e is the total standardized population;

and

$t_j = c_j/p_j$ is a weight indicator j_{th} age group, where

c_j the number of deaths in j_{th} age group ($j = 1, \dots, n$);

p_j population j_{th} age group measured per 100,000 inhabitants.

To identify changes in avoidable mortality rate trends for the period 2011–2021, join point regression (Joinpoint Regression Program 4.9.1.0) was used to calculate the average annual percentage change (AAPC)^{19,20} for every age and sex group. Joinpoint calculates the trend in segments whose start and end are defined to best fit the data; sometimes, it is useful to summarize the trend over a fixed specified interval. Crude mortality rates were calculated per 100,000 population. The trend function in Excel was used to calculate a linear trend line based on a given linear data set (the forecast values of Y (years) were taken for the given values of the array \times (number of deaths)).

Results

The contribution of age-adjusted avoidable, treatable and preventable mortality from cardiovascular disease during 2011–2021 is shown in “Figure 1”. The age-adjusted avoidable mortality rates decreased between 2011 and 2019, from 267.6 (95% CI: 264.1–271.1) to 126.4 (95% CI: 124.2–128.5) per 100,000 population (pop.), after which there has been an increase up to 165.8 (95% CI: 163.5–168.2) per 100,000 pop. in 2021 (Figure 1). Preventable (from 132.2 (95% CI: 129.8–134.7) to 62.6 (95% CI: 61.1–64.1)) and treatable mortality from 135.3 (95% CI: 132.9–137.8) to 63.8 (95% CI: 62.3–65.3)) dropped about twice from 2011 to 2019, following an increase in 2021 of 82.4 (95% CI: 80.8–84.1) and 83.4 (95% CI: 81.7–85.0), respectively (see [Supplementary Table 1](#)).

Males consistently experienced higher (about twice) avoidable mortality rate compared to females (Table 1). The AAPC showed that total avoidable mortality rates decreased between 2011 and 2021 from -10.6 to -1.1 (-6.0 points) ($p = 0.017$), whereas in males -4.2 (-8.3 to 0.1) and in females -5.1 (-8.8 to -1.3) ($p = 0.009$). Significant changes can be seen in the first five years (2011–2015) in both genders, in males -11.2 (-14.6 to -7.5) ($p < 0.001$) and in females -12.8 (-20.2 to -4.8) ($p = 0.002$), (Table 1).

In all four diseases, the avoidable mortality rate (AMR) decreased over the given period of time. The most common cause of death was ischemic heart disease, which declined from 127.8 (95% CI: 125.4–130.2) to 86.7 (95% CI: 85.0–88.4) per 100,000 pop. and cerebrovascular diseases 115.7 (95% CI: 113.4–118.0) to 71.6 (95% CI: 70.1–73.1) per 100,000 pop. AAPC in ischemic heart disease mortality declined to -5.5 (95% CI: -11.1 to 0.4) and in cerebrovascular diseases to -5.5 (95% CI: -9.1 to -1.7) ($p = 0.005$) respectively (Table 2).

The AMR for hypertensive diseases and chronic rheumatic heart disease were relatively low compared to ischemic heart disease and cerebrovascular disease. AMR for hypertensive diseases dropped about three times during 2011 and 2021 from 21.0 (95% CI: 21.1–22.0) to 6.6 (95% CI: 6.1–7.1) per 100,000 pop.; AAPC -9.6 (95% CI: -17.4 to 1.0) ($p = 0.029$). AMR for chronic rheumatic heart disease decreased from 3.1 (95% CI: 2.7–3.5) to 1.0 (95% CI: 0.8–1.1) per 100,000 pop. and AAPC -11.0 (95% CI: -13.2 to -8.8) ($p < 0.001$) per 100,000 pop. (Table 2).

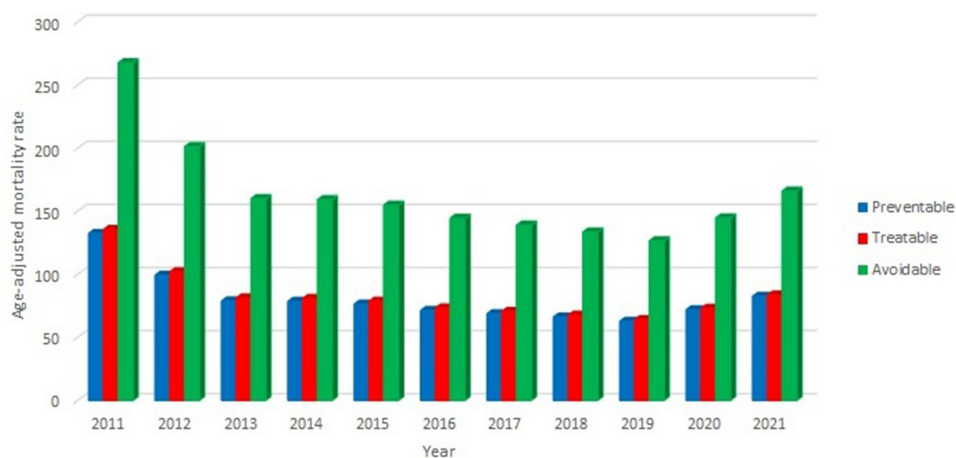


Figure 1 Age-adjusted avoidable, treatable and preventable mortality rate from cardiovascular disease.

Table 1 Number and Rate of Avoidable Mortality from Cardiovascular Disease (100,000 Population), by Age and Sex in Kazakhstan from 2011 to 2021

		2011		2021			Average Annual Percentage Change (95% CI)*		
		No	Rate (95% CI)	No	Rate (95% CI)	Rate Ratio	2011–2021	2011–2015	2016–2021
Sex	Males	15,614	389.6 (383.0 to 396.2)	12,604	243.7 (239.2 to 248.1)	2.2	-4.2 (-8.3 to 0.1)	-11.2 (-14.6 to -7.5)* (p < 0.001)	3.3 (-4.2 to 11.4)
	Females	9740	179.6 (175.8 to 183.3)	7632	109.5 (107.0 to 111.9)	1	-5.1 (-8.8 to -1.3)* (p = 0.009)	-12.8 (-20.2 to -4.8)* (p = 0.002)	0.4 (-2.4 to 3.3)
Total		25,354	267.6 (264.1 to 271.1)	20,236	165.9 (163.5 to 168.2)		-6.0 (-10.6 to -1.1)* (p = 0.017)	-13.4 (-22.7 to -2.9)* (p = 0.013)	-0.7 (-4.3 to 3.0)

Notes: *Indicates that mean annual percentage change is significantly different from zero (p < 0.05).

Abbreviations: CI, confidence interval; No, Number of deaths.

Table 2 Trends in Age-Adjusted Rates of Avoidable Mortality Attributed to Cardiovascular Disease in Kazakhstan, 2011–2021

Disease subtype		Rate Per 100 000 (95% CI)		Average Annual Percentage Change (95% CI)*
		2011	2021	2011–2021
Chronic rheumatic heart disease	105-109	3.1 (2.7 to 3.5)	1.0 (0.8 to 1.1)	-11.0 (-13.2 to -8.8)* (p < 0.001)
Hypertensive diseases	110-115	21.0 (21.1 to 22.0)	6.6 (6.1 to 7.1)	-9.6 (-17.4 to 1.0)* (p = 0.029)
Ischaemic heart disease	120-125	127.8 (125.4 to 130.2)	86.7 (85.0 to 88.4)	-5.5 (-11.1 to 0.4)
Cerebrovascular diseases	160-169	115.7 (113.4 to 118.0)	71.6 (70.1 to 73.1)	-5.5 (-9.1 to -1.7)* (p = 0.005)

Notes: *Average annual percentage change shown for age-adjusted mortality rates for specified time range.

AMR from hypertensive disease was higher in males compared to females. In males, it has decreased rapidly by about twice in the first year (from 26.8 (95% CI: 25.1–28.5) to 16.8 (95% CI: 15.7–18.0)), after which the number has declined, reaching a peak of 5.8 (95% CI: 5.0–6.5) in 2019, following that it was observed an increase up to 8.5 (95% CI: 7.6–9.3) in 2021. Among females, a noticeable decline has been observed between 2011 and 2013 from 16.7 (95% CI: 15.6–17.9) to 7.9 (95% CI: 7.2–8.6), after which there has been a stable decrease until 2019 of 3.1 (95% CI: 2.7–3.6) and an increase up to 5.2 (95% CI: 4.7–5.8) by 2021. AMR from chronic rheumatic heart diseases slightly prevails among females in the most studied years and in both groups the rate decreased. By contrast, the ischemic heart diseases were higher among males, which has decreased from 202.0 (95% CI: 197.3–206.7) to 104.2 (95% CI: 101.2–107.2), and in females from 73.4 (95% CI: 71.0–75.8) to 29.8 (95% CI: 28.5–31.2) between 2011 and 2019 and then rose in both genders to 132.6 (95% CI: 129.3–135.9) and 53.2 (95% CI: 51.5–54.9), respectively. Cerebrovascular diseases were higher among males (about twice) in comparison to females in all years. The rates decreased from 158.0 (95% CI: 153.7–162.2) to 85.2 (95% CI: 82.5–88.0) in males and from 85.9 (95% CI: 83.3–88.5) to 40.5 (95% CI: 38.9–42.1) in females until 2019, after which increased to 101.8 (95% CI: 98.9–111.9) and 49.7 (95% CI: 48.1–51.4) per 100,000 pop. (“[Figure 2A and B](#)”) and [Supplementary Table 2](#)).

Crude Mortality

For all four diseases (Chronic rheumatic heart disease (I05-I09); Hypertensive diseases (I10-I15); Ischaemic heart disease (I20-I25); Cerebrovascular diseases (I60-I69)), mortality rates have been reduced between 2011 and 2019, after which an increase was observed between 2020 and 2021. Trends for all four diseases are expected to decline by 2027 (“[Figure 3](#)”,

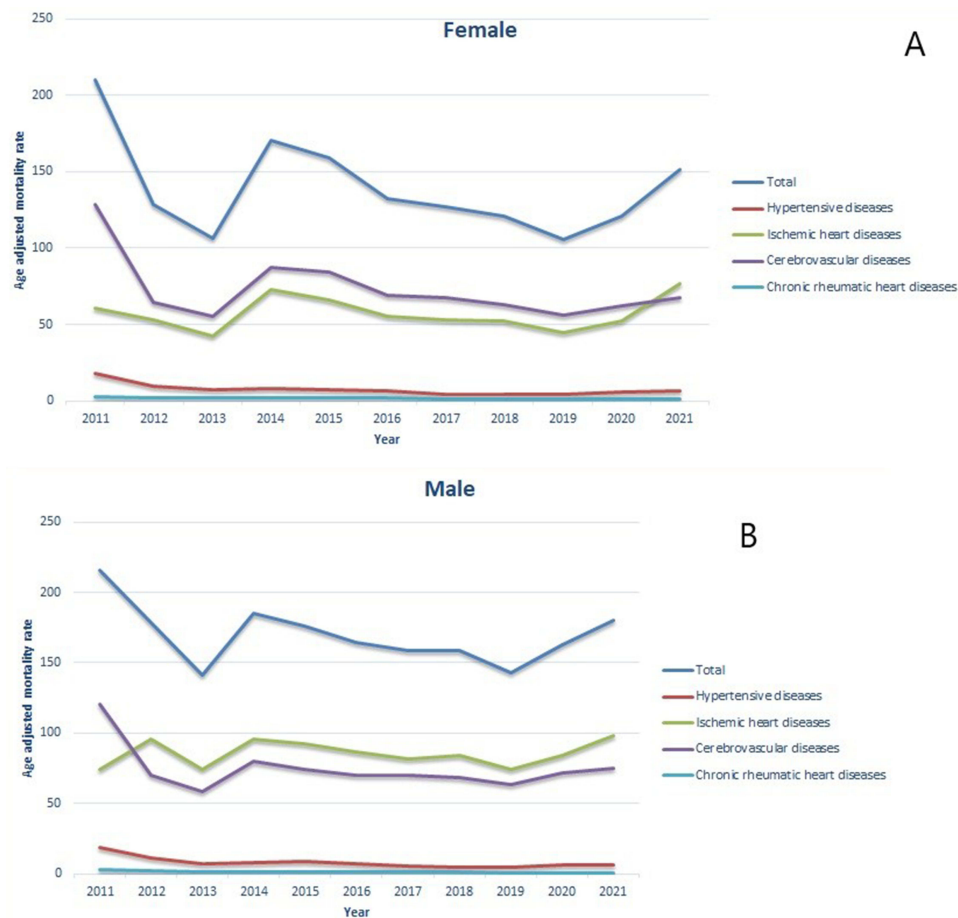


Figure 2 (A) Age-adjusted mortality rate from cardiovascular diseases in Kazakhstan, 2011–2021 (in female). **(B)** Age adjusted mortality rate from cardiovascular diseases in Kazakhstan, 2011–2021 (in male).

“[Supplementary Figure 1](#)”). In general, the mortality rate for males was higher than for females. Only mortality from chronic rheumatic heart diseases was higher in females compared to males ([Supplementary Table 3](#)).

Mortality from ischaemic heart diseases in all age groups decreased from 2011 to 2019. An increase in mortality since 2019 has been observed in the age group over 50–54 years old, whereas an increase in mortality under 50 years of age has been registered in 2020 ([Supplementary Table 3](#)).

A slight increase in mortality from cerebrovascular diseases was observed in the age group of 40–49 years in the period 2018–2020, after which it could be seen a sharp increase. In the group over 50 years of age, a sharp increase in mortality began in 2020 ([Supplementary Table 3](#)). Mortality rate from hypertensive diseases doubled between 2020 and 2021 in the group of over 50 years.

Discussion

This study found an overall decrease in avoidable and crude mortality from CVD during 2011 and 2021 in Kazakhstan. Gregory A. Roth et al note that there is a decrease in burden of CVD in several countries.²¹ In Korea, it was found consistent decreasing trends for mortalities from rheumatic heart disease and hypertensive heart disease, which is similar to Kazakhstan.²²

In Kazakhstan, this can be related to the policy to support the provision of UHC, and the strengthening of primary care in Kazakhstan.²³ The implementation of the policy on early diagnosis has begun within the introduction of State programs, which include screening programs for the early detection of CVD and risk factors, which has led to an increase in morbidity rates and a decrease in mortality.²⁴ Moreover, the positive dynamics may be associated with the

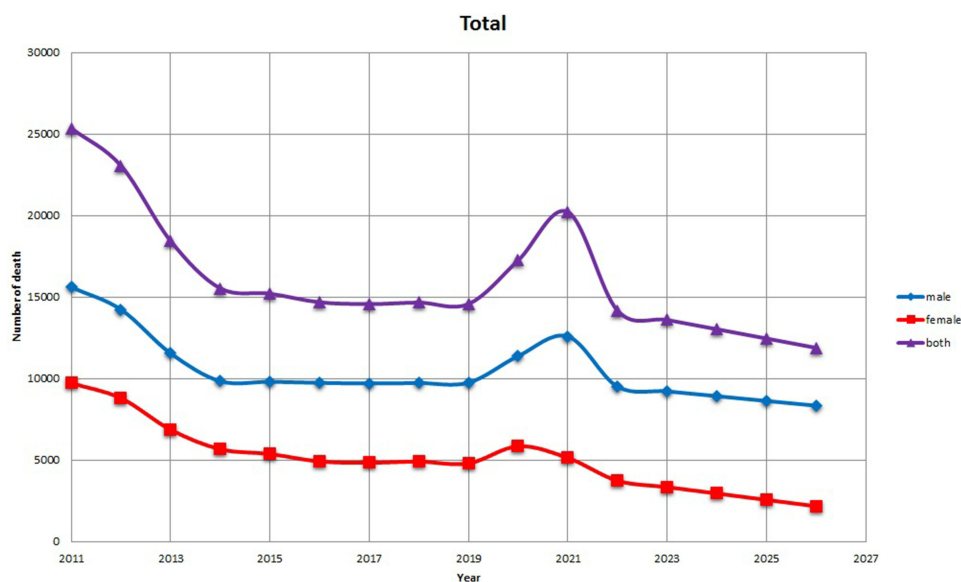


Figure 3 Trends in crude mortality from circulatory system disease (Chronic rheumatic heart disease (I05-I09); Hypertensive diseases (I10-I15); Ischaemic heart disease (I20-I25); Cerebrovascular diseases (I60-I69)).

implementation of disease management programs (DMPs);²⁵ for instance, the World Bank report indicates that 75% of patients with hypertension participating in the DMP stabilized their blood pressure, improved performance of patients with diabetes, and reduced hospitalization rates for patients with heart failure.²⁶ However, the avoidable mortality in Kazakhstan from CVD remains high compared to developed countries.^{27,28}

Aringazina et al identified that for Central Asian countries, the leading cause of premature mortality from CVD was due to ischemic heart disease and stroke.⁴ Similarly, in studies in developed countries, we also found a higher avoidable mortality rate from ischemic heart disease and cerebrovascular disease and a higher rate among males compared to females.^{19,29} A high mortality rate from CVD among males could be due to the ethnic characteristics of the Kazakh population,¹⁶ as well as to a higher commitment to a healthy lifestyle in women compared to men.³⁰ Moreover, Sharma et al³¹ identified a number of risk factors affecting the occurrence of CVD in women, which indicates the needs of different group approaches to care depending on gender characteristics.

On the other hand, it is worth noting that over the past two years (from 2019 to 2021), we have seen a negative growth trend, which is most likely due to the COVID pandemic similar to other countries, when the health sector faced the difficulty of providing timely care for chronic patients.^{32,33}

Nevertheless, in some primary healthcare facilities in Kazakhstan, there has been identified the need to strengthen the work (as screening programs on CVD, etc) to provide comprehensive care to patients with CVD.³⁴ In addition, Kulkaeva et al observed the low awareness of the Kazakh population regarding CVD risk factors,³⁵ which led to intensify the work in this area, including among rural residents.³⁶ Other factors which influence high levels of mortality can include low adherence of patients with arterial hypertension to treatment, and very low clinical efficacy.³⁷ Increasing health literacy of the population, including the prevention of CVD, is important to reduce mortality rates. Considering that primary care in Kazakhstan has departments for disease prevention, managers should make it an important priority to increase literacy among the population served by this medical organization. High mortality rate from CVD among the male population deserves special attention and primary health care needs to consider separate programs for this category based on international practice.³⁷

Future direction: A more in-depth study of the avoidable causes of mortality is needed, depending on the location (urban or rural area), the influence of social status (high and low living standards), the level of education, health literacy. This will allow decision makers to justify in greater details the allocation of available health resources. Moreover, other

avoidable circulatory system diseases (Venous thromboembolism (I26, I80, I82.9); Other atherosclerosis (I70, I73.9); Aortic aneurysm (I71)) can be calculated in future works.

Conclusion

In the last decade, Kazakhstan has achieved significant progress in decreasing the avoidable mortality from CVD. However, high differences in mortality rate are still observed between genders. Fortunately, the State policies and strategies allow the implementation of programs that promote early detection and provide person-centered care, which can subsequently contribute to reduction in CVD mortality rates.

Ethical Approval

The study was approved by the Local Ethics Committee of Kazakh National Medical University (Protocol number 4 (140) 03 May 2023), Almaty, Kazakhstan. Data accessed complied with relevant data protection and privacy regulations.

Acknowledgment

The authors would like to thank Giselle Sarganas (PhD) and Kamshat Tolganbayeva for externally reviewing the article and providing recommendations for its improvement.

Funding

This research has been funded by the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. AP09058136).

Disclosure

The authors declare that they have no competing interests in this work.

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