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Original Article

Incidence and Mortality of Cardiovascular Disease in the Republic of Kazakhstan: 2004-2017

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Abstract

Background: We aimed to evaluate the impact of national health programs implemented in Kazakhstan from 2011 on CVD incidence and mortality.

Methods: Incidence and mortality rates from CVD were studied in Kazakhstan from 2004 to 2017. The official data obtained from "Medinform" company were analyzed based on the annual population statistics.

Results: There was an increase in the incidence of cardiovascular disease among the population of Kazakhstan from 1845.4 per 100,000 in 2004 to 2597.5 per 100,000 in 2017. This might be attributed to the implementation of the national health programs, which improved early CVD identification. Incidence of ischemic heart disease (IHD) was grown almost in all provinces of Kazakhstan during the study period. The mortality from cardiovascular disease had a considerable decline over the study period, in particular after 2010, it might be influenced by early diagnosis and provision of timely treatment.

Conclusion: The experience of Kazakhstan national health programs shows improved identification of CVD and IHD and timely treatment for cardiovascular disease. A significant variation in incidence and mortality rates of cardiovascular disease was observed between the country provinces.

Keywords: Incidence; Mortality; Republic of Kazakhstan; Cardiovascular disease; Ischemic heart disease

Introduction

Cardiovascular disease still remains important public health problem around the world being a leading cause of mortality. 17.9 million people die every year from CVD, estimated as one-third of all deaths worldwide. Around 75% of CVD deaths occur in low- and middle income countries (1). Ischemic heart disease is the main cause of death attributable to CVD accounting for 7.4 million deaths (13.2%), followed by other cardiovascular disorders (2).

According to European Society of Cardiology (ESC) Atlas

(https://www.googleadservices.com/pagead/aclk?sa=L&ai=DChcSEwibzbK6_O32AhXDp9UKHUjRA-0YABAAGgJ3cw&ae=2&ohost=www.google.com&cid=CAASJeRolf428M6A1aboa7R3xAgpuM7q5eFe0SMlp62n9hn7TrFBXMI&sig=AOD64_1uJJGvswtNLVCzlJaadFttGiMtrw&q&adurl&ved=2ahUKEwiPnKm6_O32AhWnhP0HHX2KAKgQ0Qx6BAgCEAE) that contains CVD statistics for 56 ESC member countries, in 2015 there were 11 million of newly diagnosed cases of CVD in 47 countries. A half of them (50%) were due to ischemic heart disease (IHD). Data from Republic of Kosovo, Republic of San Marino, Algeria, Egypt, Lebanon, Libya, Morocco, Syrian Arab Republic and Tunisia were not available. The highest incidence was observed in Russian Federation, where around 2.5 million people were affected. Meanwhile, the lowest prevalence was established in Iceland (2,500). In general, there was a sustainable raise in incidence rate within the time period from 1990 to 2015 among women from approximately 4.9 million cases in 1990 to 5.7 million cases in 2015. As for men, the incidence of CVD grew up from 4.3 million cases in 1990 to 5.3 million cases in 2015. The exception could be made for Denmark, Republic of Georgia, Germany, Latvia, and the UK, which experienced the decrease in CVD incidence. While global mortality trend from CVD has increased during the period of 23 years (1990-2013) by 43%, almost half of it (45%) belongs to ESC member countries, where 3.8 million people die from CVD every year. In ESC member countries one-fifth of all – cause mortality is due to IHD (20%), which is equivalent to 1.7 million people every year (3).

There are 9 main risk factors and health behaviours that are associated with increased CVD, including alcohol intake, hypertension, dyslipidaemia, diabetes, unhealthy diet, obesity, psychosocial factors, sedentary lifestyle, and smoking (4). High cholesterol levels and increased blood pressure also increase the chance for CVD (5,6). Unhealthy diet leading to CVD contains excessive intake of high-energy nutrients with great content in trans-fats and sugars, and salts (7,8). The consequences of unhealthy diets and lack of physical activities can manifest in some people as hypertension, hyperglycemia, dyslipidaemia, and also as overweight and obesity (9). Globally, in 2013 around 5.9 million premature deaths due to CVD were estimated to be associated with tobacco use (10).

Certain strategies could be implemented to reduce harmful effects related to these factors(1). Those measures are targeting to reduce incidence and mortality rate at population and individual levels. At population level measures are targeting in tobacco control, promotion of healthy diet, promotion of physical activity in everyday life, and the control of environmental and indoor pollution. At individual level such measures are targeted on early screening of people with hypertension, high cholesterol levels and diabetes (11).

Experience of the Republic of Kazakhstan in the field of implementation of national health programs received much attention and has in many ways contributed to the work in this area (12). Beginning 2009, Kazakhstan started implementation of National Health Programs targeted on multiple health indicators. “Salamatty Kazakhstan” program was implemented and covered the period from 2011 to 2015, which was gradually transferred to the “Densaulyk” program scheduled for 2016-2020. The effects of these programs on population health are not fully understood yet.

Thus, the aim of our study was to assess the impact of national health programs in terms of CVD incidence and mortality, including ischemic heart disease.

Materials and Methods

Study design and procedures

This was a retrospective study based on the data obtained from the "Medinform" Company, which is the database of all medical statistics in the country. From this database we retrieved information about cardiovascular disease incidence and mortality from 2004 to 2017. The rational behind this decision is to cover two equal time periods: 2004-2010 and 2011-2017 that include 7

years prior to national health programs beginning and 7 consecutive years of their implementation.
"Medinform" database contains data about newly diagnosed cases of CVD and IHD, which are gathered by medical doctors working in primary health care facilities throughout the country. Data collection process is standardized and compulsory for all medical doctors of primary practice.
To enable comparative analysis of incidence and mortality rates, we divided territory of Kazakhstan to five geographic areas: East, which consists of East Kazakhstan and Pavlodar provinces; West, that includes Aktobe, Atyrau, Mangystau and West Kazakhstan provinces; North, which covers Kostanay and North Kazakhstan provinces; South, that consists of Almaty, Zhambyl, Kyzylorda, and South Kazakhstan provinces; Central (Akmola and Karagandy provinces). According to national policy, two cities – Almaty and Astana – are categorized as cities of republican significance and are treated as provinces in statistical analysis.
Ethical Committee of Semey Medical University (Semey, Kazakhstan) approved our study before it was started (protocol 2 dated 18 October 2019).
The entire dataset used for statistical analysis was obtained from official sources and was extracted from "Medinform" database, which is an official open source database. The data on population numbers for each year were obtained from the Statistical yearbooks issued by the Agency of Statistics, Kazakhstan. Informed consent from each patient was not needed as we solely relied on anonymous data.

Statistical analysis

Crude incidence and mortality rates per 100,000 population were calculated. To compare the indicators of incidence and mortality before and after implementation of national health programs, we used the average incidence for two time periods: 2004-2010 and 2011-2017.
The annual crude incidence rates were calculated by dividing the number of incident cases of CVD or IHD, respectively, by the total number of people in each year beginning from 2004 to 2017:

- number of new cases of CVD or IHD within one specified year in all age groups/ mid-year general population × 100,000.

The crude mortality rate was calculated as the ratio between total number of deaths due to CVD and estimated population number:

- number of deaths from CVD within one specified year in all age groups/ midyear general population × 100,000.

All calculations were performed with SPSS software, version 20.0 (IBM Corp., Armonk, NY, USA).

Results

Table 1 presents information on incidence rates of different basic disease groups in Kazakhstan over a period of fourteen year (from 2004 to 2017). Looking at the details, incidence of respiratory system disease was almost five-fold higher than that of other diseases. The incidence of cardiovascular disease had upward trend during the study period (1845.1 in 2004, 2595.7 in 2017). Still, it was the lowest among other disease groups. Incidence rates of few disorders showed negligible decrease, although much of the incidence rates showed increase over the whole time period. Next table (Table 2) demonstrates the mortality rates for certain disease categories in Kazakhstan in the period from 2004 to 2017. Overall, the mortality rates for all selected diseases slightly declined during this time period, despite mortality from respiratory disease that showed mild improvement. Table 3 presents average incidence rates of cardiovascular disease across different provinces of Kazakhstan within 2004-2010 and 2011-2017. In general, average incidence rates of cardiovascular disease considerably grew over the specified time periods, except for Aktobe, Mangystau, Almaty and Kyzylorda provinces.

Table 1: Incidence of basic disease groups in the Republic of Kazakhstan: 2004-2017 (per 100,000 population)

Disease groups	***Year***													
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Diseases of the respiratory system	22419.1	22802.8	22346.9	22978.3	22957.3	24535.5	23575.3	23277	22936.3	22561.6	21573	22018.8	24706.1	24819.6
Diseases of the genitourinary system	4050.2	4365.1	4377.9	4420.5	3998.3	4132.3	3973.5	3907.1	3777.6	3563.9	3420.6	3852.3	4235	4231.2
Injury and poisoning	4099.2	4136.5	3813.4	4075.8	4011.4	4080.4	3865.3	3678.6	3615.6	3575.3	3493.2	3270.4	3442.2	3389.3
Diseases of the digestive system	3754.2	3762	3780.4	3644.8	3769	3590.8	3626.3	3632.2	3548.6	3648.5	3671	3840.1	4227.5	4517.9
Diseases of the skin and subcutaneous	3936.2	3758.1	3661.8	3543.4	3547.2	3460.7	3582	3047.8	2888.2	2745.6	2635.1	2565.1	2736.4	2849
Cardiovascular disease	1845.1	1749.1	1911.4	1906.6	2170.5	2273.1	2086.7	2277.1	2454	2463.1	2394.7	2429.7	2592.5	2595.7

Table 2: Mortality from basic disease groups in the Republic of Kazakhstan: 2004-2017 (per 100,000 population)

Disease groups	***Year***													
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Cardiovascular disease	517.7	535.5	533.1	528.3	489.66	416.4	403.99	309.61	256.76	207.4	207.2	193.8	178.92	517.7
Injury and poisoning	148	147.9	150.2	145.2	125.64	108.37	108.72	102.6	98.25	95.85	87.6	82.5	75.05	69.38
Neoplasms	123.1	122.6	118.6	117.7	115.86	112.78	109.87	103.38	105.32	101.03	94.8	93.8	90.2	85.81
Diseases of the respiratory system	58.2	58.7	53.9	56.1	49.5	48.52	43.55	52.09	57.3	67.23	95.9	105	102.12	92.22
Infectious and parasitic diseases	26.7	28.3	25.4	23.3	22.16	18.2	15.66	13.27	11.96	10.33	9.3	8.6	7.78	26.7
Tuberculosis	20.6	20.8	20.3	18.1	16.9	12.9	10.6	8.4	7.4	5.6	4.9	4.1	3.4	3

Table 3: Average incidence rate of cardiovascular disease across provinces of Kazakhstan: 2004-2010 and 2011-2017 (per 100,000 population)

Geographic zone	***Province (City)***	***2004-2010 (mean)***	***2011-2017 (mean)***
East	East Kazakhstan	1957.11	2702.49
	Pavlodar	1630.09	2027.01
Central	Akmola	1814.60	1993.35
	Karaganda	1526.24	1927.15
North	Kostanay	1279.11	1822.28
	North Kazakhstan	1753.71	2540.90
West	Aktobe	2034.20	1867.89
	Atyrau	1572.04	1971.44
	Mangystau	2280.29	1943.45
	West Kazakhstan	1543.69	1885.20
South	Almaty	2945.59	2657.23
	Zhambyl	2098.97	2997.14
	Kyzylorda	2512.00	2362.09
	South Kazakhstan	2049.51	2425.33
Cities	Almaty	2136.40	3541.93
	Astana	1790.63	2116.23
Republic of Kazakhstan		1991.79	2595.70

Table 4 demonstrates the average incidence of IHD within two time periods: 2004-2010 and 2011-2017. In this case, Almaty city had the highest mean of IHD in2011-2017 that was equal to 801.40. Over the same time period, the second highest rate was seen in Zhambyl province (724.08). Almost all provinces showed upward trend in average incidence of IHD, although average incidence rates in several provinces had a downward trend. Detailed data on the average incidence of IHD are demonstrated in Table 4.

Table 4: Average incidence of ischemic heart disease across provinces of Kazakhstan: 2004-2010 and 2011-2017 (per 100,000 population)

Geographic zone	*Province (City)*	*2004-2010 (mean)*	*2011-2017 (mean)*
East	East Kazakhstan	328.87	502.00
	Pavlodar	349.35	368.76
Central	Akmola	373.88	409.90
	Karaganda	333.90	363.34
North	Kostanay	242.52	308.43
	North Kazakhstan	404.00	532.66
West	Aktobe	392.93	348.90
	Atyrau	225.47	324.71
	Mangystau	369.53	353.98
	West Kazakhstan	313.57	365.49
South	Almaty	497.78	598.76
	Zhambyl	548.05	724.08
	Kyzylorda	305.42	317.48
	South Kazakhstan	441.33	461.20
Cities	Almaty	511.68	801.40
	Astana	226.02	237.23
Republic of Kazakhstan		387.98	474.85

Table 5 shows average mortality rates from CVD in provinces of Kazakhstan within the periods of 2004-2010 and 2011-2017. In general, the average mortality rates decreased across all provinces of Kazakhstan. Karaganda province reached a peak of average mortality in 2004-2010 (700.06). East Kazakhstan, Akmola and Kostanay provinces had second, third and fourth highest mortality rates following Karaganda province. In common, it can be clearly observed that average mortality rate showed dramatic decrease in each province. Overall mortality from CVD in Kazakhstan had almost two-fold decline, from 489.24 to 241.56 in 2004-2010 and 2011-2014, respectively.

The line graph (Fig. 1) illustrates trends of incidence and mortality throughout the country over the period of 2004-2017. Incidence of CVD experienced fluctuations over the study period with significant increase after 2010. Incidence of IHD showed lesser fluctuations and gradually went up during the study period. IHD incidence stayed constant during the first 7 years and slightly grew up after 2010. On the other hand, the mortality from CVD had a considerable decline over the study period, in particular after 2010.

Table 5: The average mortality rates of cardiovascular disease across provinces of Kazakhstan: 2004-2010 and 2011-2017 (per 100,000 population)

Geographic zone	*Province (City)*	*2004-2010 (mean)*	*2011-2017 (mean)*
East	East Kazakhstan	671.58	324.63
	Pavlodar	583.51	326.61
Central	Akmola	619.14	326.88
	Karaganda	700.06	396.07
North	Kostanay	646.10	266.78
	North Kazakhstan	580.39	344.52
West	Aktobe	411.65	198.68
	Atyrau	299.14	150.85
	Mangystau	244.90	106.58
	West Kazakhstan	512.15	258.31
South	Almaty	492.24	219.31
	Zhambyl	405.56	220.22
	Kyzylorda	342.95	169.72
	South Kazakhstan	314.18	153.64
Cities	Almaty	522.50	265.55
	Astana	247.82	159.44
Republic of Kazakhstan		489.24	241.56

Map of Kazakhstan (Fig. 2) presents CVD incidence by provinces of Kazakhstan in 2010 and 2017. Overall, there was an increase in CVD incidence in 2017 as compared with 2010 data almost in all provinces of Kazakhstan, apart from Aktobe and Almaty provinces. The highest CVD incidence was observed in the South of Kazakhstan. East Kazakhstan province had the highest incidence rate of CVD in 2017(3228.6) as compared with 2010 (2340.7). The second highest incidence rate was seen in Almaty city in 2017 (3141.7).These were followed by Zhambyl (2968.7) and Kyzylorda (2920.9) provinces that occupied third and fourth places among other provinces in 2017.Generally, in Kazakhstan CVD incidence rate was 2086.7 in 2010, and 2595.7 in 2017, which means that CVD incidence has increased significantly.

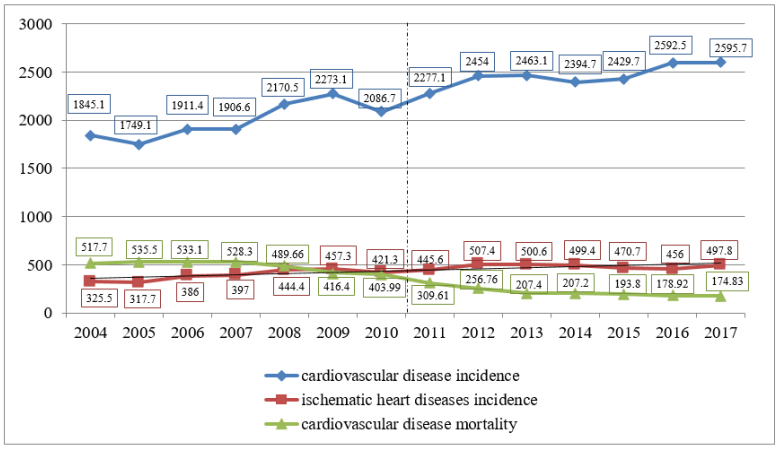

Fig. 1: Incidence of and mortality from CVD and incidence of IHD: 2004- 2017(per 100,000 population)

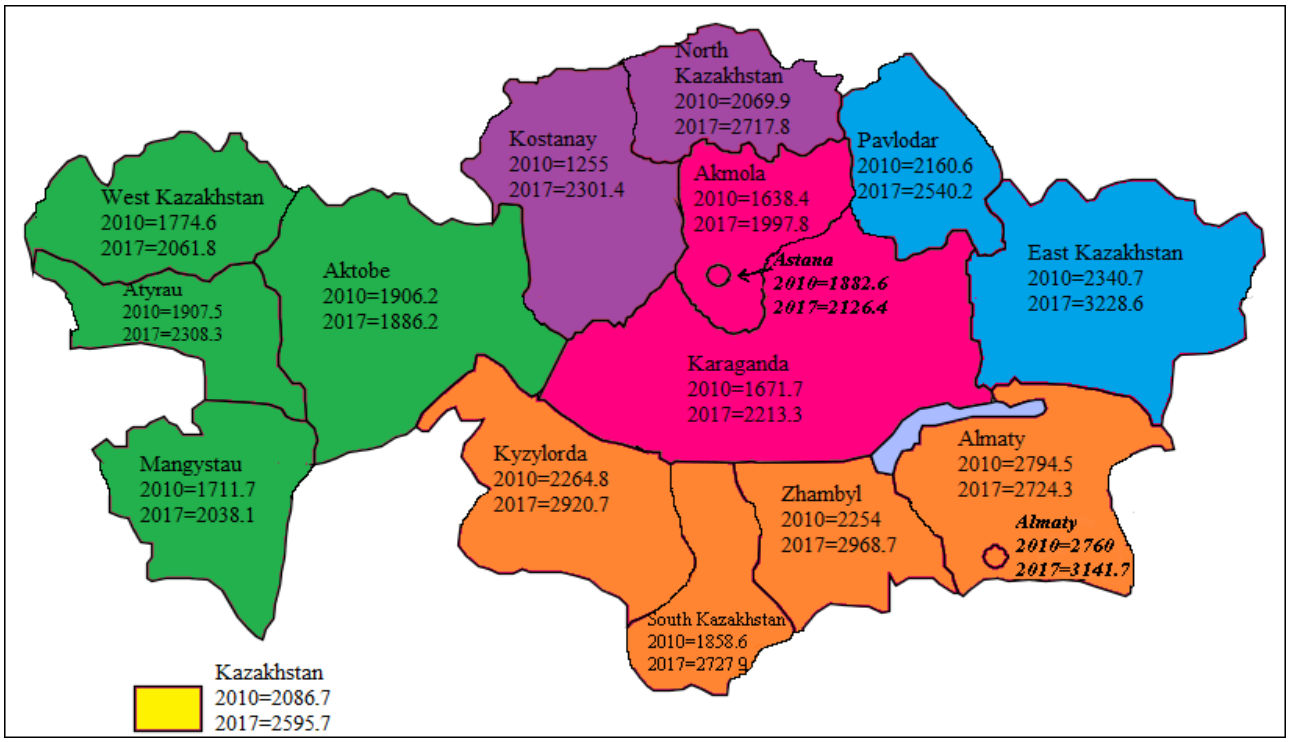

Fig. 2: Cardiovascular disease incidence by provinces of Kazakhstan in 2010 and 2017 (per 100,000 population)

Discussion

The results of this study demonstrate an increase in the incidence of cardiovascular disease in Kazakhstan from 2004-2010 to 2011-2017. This increase has been observed in Western, Central, and Northern provinces of Kazakhstan, as well as in two large cities – Almaty and Astana. Still, a number of provinces of Western Kazakhstan (Aktobe, Mangystau) and Southern Kazakhstan (Almaty and Kyzylorda) experienced decline in the CVD incidence over the same time periods. As for the incidence of ischemic heart disease, it was grown almost in all provinces of Kazakhstan during the study period. However, the exception could be made of some provinces of Western Kazakhstan, such as Aktobe and Mangystau, where it has decreased. The incidence rate of CVD has grown much more than the incidence of ischemic heart disease. On the other hand, the mortality rate from cardiovascular disease decreased significantly in Kazakhstan from 2004-2010 to 2011-2017.

According to 2014 data, 84 percent of deaths in Kazakhstan were caused by noncommunicable diseases. More than half (54%) of those deaths were due to CVD. Kazakhstan holds a top position in cardiovascular mortality rates among nations of the European Union, Central and Eastern Europe, and Central Asia. One-fifth of all – cause mortality is due to CVD (22.3%), the most frequent form of which are ischemic heart disease and stroke, which altogether lead to lethal outcome in about 30,000 cases every year (13). While the mortality from ischemic heart disease accounts for 47.7%, the mortality from cerebrovascular disease accounts for 36.4%(14). Kazakhstan holds the first place in terms of mortality from CVD among countries of European Union, Central and Eastern Europe and Central Asian region. According to WHO, standardized mortality rate from CVD in population of the Kazakh-

stan Republic is two times higher than that in the countries of European Union (15).

Raised mortality from CVD is related to increased incidence, which could be partly explained by a number of environmental problems experienced by the Republic of Kazakhstan. For example, three provinces of the country – East-Kazakhstan, Pavlodar and Karaganda – are contaminated by the activity of the former Semipalatinsk Nuclear Test Site and this reflects negatively on the incidence of cardiovascular disease (16,17). Another major public health problem in Kazakhstan is Vitamin D deficiency that was identified in in all regions of the country (18). Because Vitamin D is needed to maintain cardiovascular health (19), this could have an impact on cardiovascular disease incidence.

Kazakhstan started implementation of national health programs in 2011 and the first program launched was "Salamatty Kazakhstan", which was gradually transferred to the "Densaulyk" program scheduled for 2016-2020. CVD was among the greatest public health problems concerned by both programs. This helped to reduce the CVD mortality rate by 4.3%. Within the implementation of the national health programs, clinical protocols were updated, legal regulatory documents were upgraded, medical facilities became better equipped, and more than 300 medical professionals got training abroad: in Israel, Russia, Japan. The shortage of equipment supply in medical facilities providing medical care to patients with acute myocardial infarction (AMI) decreased by 21%. The proportion of surgical interventions in cardiology practice also increased by 16.6% (from 2.4% in 2015 to 2.8% in 2016). The Republican Stroke Coordination Center was founded(19). Annually, the number of cardiac surgeries is increasing by 10%, so by the end of 2016 it amounted 36,027 operations, including 11,862 open heart surgeries and 24,165 surgical interventions. It should be noted that the number of contrast coronary angiography increased by 13%, which, according to the results of 2016, amounted to 49,225 against 43,648 in 2015.In addition, 5 programs for the management of chronic noncommunicable disorders were introduced since 2016,the one of which was for IHD. Introduction of this program also gave positive results and contributed to a decrease in mortality from CVD by 4.3%, and from IHD by 4% (20). Still, within the reforms of the national healthcare system a number of sensitive issues has to be addressed, such as the improvement of patient satisfaction, which is significantly undermined in Kazakhstan (21, 22).

The country has unequal distribution of health care professionals depending on locality: there is typically a higher density of health workers in urban areas because of better standards of living and higher salaries as compared to rural ones. Around 40% of the country population resides in rural areas and such patients have higher prevalence of chronic somatic disorders that necessitate healthcare interventions but travel burdens to specialty services may be overwhelming to navigate for this population. Access to specialty care is a key priority in the health administration and understanding the geographic distribution and province designation of this population in relation to medical centers can assist in care coordination. Additionally, lack of equal and fair access of the population to all levels of medical care is also explained by poor road infrastructure (23). Our study established a disparity in incidence of and mortality from CVD between different provinces of Kazakhstan. Such, in 2017 the higher incidence rates were established in East Kazakhstan, Pavlodar, Karaganda, Akmola, North Kazakhstan and West Kazakhstan provinces. These regions of Kazakhstan have colder climates, lower population density and well-developed industry (24).

Kazakhstan is committed to further reduction of CVD mortality and drafted a new regulatory document entitled "People's Health and the Health Care System" and proposed a new national public health program scheduled for 2020–2025. This program is grounded on highly cost-effective evidence-based population strategies that can reach very wide cross sections of the population and includes legislative measures to control the use of tobacco products through taxation and restrictions on advertising. Other cost-

effective strategies are presented by nicotine replacement therapies for smoking cessation and low-dose, fixed-combination of blood pressure-lowering therapies for those patients who have moderate to severe hypertension (25). The introduction of compulsory social health insurance system in Kazakhstan that will start in 2020, will introduce the solidary responsibility for health state. However, it is critical that any such systems provide benefits for outpatient care and medication, and not just hospitalization, which has been a focus of earlier community health insurance schemes. Finally, better health information systems, such as mortality surveillance system, are required to inform health policies and set targets, as well as to monitor the effects of intervention programs (26).

Conclusion

The experience of Kazakhstan's national health programs shows a great potential for population-based prevention of CVD. These results demonstrate that an integrated CVD prevention program is feasible in practice and reduces cardiovascular risks in patients with established CVD and in those at high multifactorial risk. The incidence of and mortality from CVD in Kazakhstan in 2010-2017 are comparable with those in the neighboring Russian Federation. Incidence estimates of CVD in the Republic of Kazakhstan has escalated during the study period, while the mortality rates have slowly decreased, which might be attributed to the provision of national population-based screening and intervention programs. Significant variations in incidence and mortality rates were noticed between the country provinces. There is a need to further investigate the factors that may have helped to enable better understanding of CVD epidemiology in Kazakhstan.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflicts of interest

The authors declare no conflict of interest.

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