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Diseases of the circulatory system: Structure and dynamics of mortality and survival // Erkrankungen des Kreislaufsystems: Struktur und Dynamik von Sterblichkeit und Überleben

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ERWO PHARMA

Diseases of the circulatory system: Structure and dynamics of mortality and survival

A. Alisheva, S. Mamyrbekova, V. Kamkhen

Abstract: Based on the population data of the Department of Statistics for the city of Almaty, Republic of Kazakhstan for the period 2019–2020, the structure and dynamics of deaths from diseases of the circulatory system were analysed, and age survival was studied using the method of constructing survival tables and the Kaplan-Meier method.

The number of deaths from circulatory system diseases among Almaty residents in 2020 increased by 1.5 times compared to 2019. At the same time, the proportion of deaths from diseases of the circulatory system among women decreased and increased among men. The leading cause of death in diseases of the circulatory system has changed in dynamics: in 2019, the first rank was occupied by cerebrovascular diseases (I60–I69), and in 2020 by coronary heart disease (I20–I25). A significant ($p \leq 0.001$) shift of the median survival time in diseases of the circulatory system towards a decrease (73.5 years → 70.9 years) was revealed. Also, significant ($p \leq 0.001$) differences in the survival rate of Almaty residents with circulatory system disease (CSD) in 2020 by gender were found: the survival rate in the male population is significantly lower compared to the female population (66.1 years vs 77.5 years). Survival rates for chronic rheumatic heart disease (I05–I09), pulmonary heart and pulmonary circulatory disorders (I26–I28), arterial, arteriolar and capillary diseases (I70–I79) have increased, but survival rates have decreased for diseases I10–I15), coronary heart disease (I20–I25), other heart diseases (I30-I52), cerebrovascular diseases (I60–I69), diseases of veins, lymphatic vessels and lymph nodes (I80–I89).

The main conclusion that can be drawn is that during the COVID-19 pandemic, in comparison with the previous year, the number of deaths increased (by 1.5 times) and the nosological structure of causes of death and survival in diseases of the circulatory system among residents of Almaty changed. To a greater extent, the increase in deaths occurred due to deaths from coronary heart disease (I20-I25), cerebrovascular diseases (I60-I69) and other heart diseases (I30–I52). There is also a greater increase in deaths from CSD in the male population. It is recommended to conduct an additional study to verify the assumption that mortality from diseases of the circulatory system is related to the level of anxiety/depression, as well as studies to assess the accounting of deaths from diseases of the circulatory system of comorbid COVID-19-patients.

Key words: circulatory system diseases; fatal outcomes; dynamics; structure; survival rate; Kazakhstan.

Kurzfassung: Erkrankungen des Kreislaufsystems: Struktur und Dynamik von Sterblichkeit und Überleben. Basierend auf den Bevölkerungsdaten des Statistischen Amtes der Stadt Almaty, Kasachstan, für den Zeitraum 2019–2020 wurden die Struktur und Dynamik der Todesfälle durch Erkrankungen des Kreislaufsystems analysiert und das Altersüberleben mit der Methode zur Erstellung von Überlebenstabellen mithilfe des Kaplan-Meier-Verfahrens untersucht. Die Zahl der Todesfälle durch Kreislauferkrankungen unter den Einwohnern Almatys stieg im Jahr 2020 im Vergleich zu 2019 um das 1,5-Fache. Gleichzeitig nahm der Anteil der Todesfälle durch Kreislauferkrankungen bei Frauen ab und bei Männern zu. Die führende Todesursache bei Erkrankungen des Kreislaufsystems hat sich in der Dynamik verändert: 2019 lagen zerebrovaskuläre Erkrankungen (I60–I69), 2020 die koronare Herzkrankheit (I20–I25) an erster Stelle. Es zeigte sich eine signifikante ($p \leq 0{,}001$) Verschiebung der medianen Überlebenszeit bei Erkrankungen des Kreislaufsystems (73,5 Jahre → 70,9 Jahre). Außerdem wurden signifikante ($p \leq 0{,}001$) Unterschiede in der Überlebensrate der Einwohner Almatys mit Erkrankungen des Kreislaufsystems im Jahr 2020 nach Geschlecht festgestellt: Die Überlebensrate in der männlichen Bevölkerung ist im Vergleich zur weiblichen Bevölkerung signifikant niedriger (66,1 Jahre vs. 77,5 Jahre). Die Überlebensraten für chronisch-rheumatische Herzerkrankungen (I05–I09), Lungen-Herz- und Lungen-Kreislauferkrankungen (I26–I28), arterielle, arterioläre und kapilläre Erkrankungen (I70–I79) sind gestiegen, für die Krankheiten I10–I15 sanken die Überlebensraten jedoch, ebenso wie für koronare Herzkrankheit (I20–I25), andere Herzerkrankungen (I30–I52), zerebrovaskuläre Erkrankungen (I60–I69) und Erkrankungen der Venen, Lymphgefäße und Lymphknoten (I80–I89).

Die wichtigste Schlussfolgerung, die gezogen werden kann, ist, dass während der COVID-19-Pandemie im Vergleich zum Jahr davor die Zahl der Todesfälle um das 1,5-Fache gestiegen ist und sich die nosologische Struktur der Todesursachen und des Überlebens bei Erkrankungen des Kreislaufsystems innerhalb der Einwohnerschaft Almatys verändert hat. Der Anstieg der Todesfälle ist in größerem Umfang auf Todesfälle durch koronare Herzkrankheit (I20–I25), zerebrovaskuläre Erkrankungen (I60–I69) und andere Herzerkrankungen (I30–I52) zurückzuführen. Es gibt auch einen größeren Anstieg an Todesfällen bedingt durch Erkrankungen des Kreislaufsystems in der männlichen Bevölkerung. Es wird empfohlen, eine zusätzliche Studie durchzuführen, um die Annahme zu überprüfen, dass die Sterblichkeit durch Erkrankungen des Kreislaufsystems mit dem Ausmaß von Angstzuständen/Depressionen zusammenhängt, sowie Studien zur Bewertung der Bilanzierung von Todesfällen durch Erkrankungen des Kreislaufsystems von komorbiden COVID-19-Patienten. **Z Gefäßmed 2023; 20 (2): 9–13.**

Schlüsselwörter: Erkrankungen des Kreislaufsystems, tödliche Folgen, Dynamik, Struktur, Überlebensrate, Kasachstan.

Introduction

The first cases of the spread of a new coronavirus infection (COVID-19) were recorded at the end of December 2019 in Wuhan, China [1, 2]. In March 2020 the World Health Organization (WHO) has recognized the spread of the virus as a pandemic [3]. According to WHO, as of October 3, 2021, 234.551,981 confirmed cases of coronavirus infection and 4.796,171 deaths were recorded in the world [4]. According to John Hopkins University, as of October 6, 2021, 972.679 cases of COVID-19 and 16.218 deaths were confirmed in the Republic of Kazakhstan.

To date, it is known that coronavirus infection is characterized by damage not only to the respiratory system, but also involves the cardiovascular system, the nervous system, the gastrointestinal tract and, in general, the disease can be expressed in the form of a systemic immune-inflammatory process. Thus, several studies report that 12% of patients with COVID-19 were diagnosed with acute myocardial infarction [5], the general prevalence of gastrointestinal symptoms was detected in 15% of cases [6], neurological disorders such as stroke in 6% of cases [7].

The spread of coronavirus infection is particularly dangerous in patients at risk, such as men, people over 65 years of age, and patients with chronic diseases [8]. Comorbid conditions

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are predictors of an unfavourable prognosis. Patients with concomitant chronic pathology have an increased risk of decompensation of existing chronic diseases and a high risk of complications when infected with coronavirus infection. The diseases associated with an unfavourable prognosis include arterial hypertension, coronary heart disease, chronic heart failure, obesity, type 2 diabetes mellitus, chronic obstructive pulmonary disease, liver and kidney diseases, etc. [9–13]. This means that preventive measures should be aimed not only at measures to prevent COVID-19 infection, but also at the prevention and control of comorbid diseases.

Circulatory system diseases (CSD) pose a particular danger in relation to an unfavourable prognosis for coronavirus infection. Patients with CSDs are at high risk for mortality from COVID-19. Thus, according to a large study conducted in China [14], among patients, the risk of death increased in patients with concomitant diseases: CSD: 10.5%, diabetes mellitus: 7.3%, chronic diseases of the respiratory system: 6.3%, arterial hypertension: 6%, oncological diseases: 5.6%. Myocardial injury is observed in 19.7% of hospitalized patients with COVID-19 and is one of the independent risk factors for nosocomial mortality [15]. The combination of coronavirus infection with cardiovascular diseases creates additional difficulties in diagnosis, determining priority tactics, changing the routing orders of patients with urgent conditions, and choosing therapy [16]. The situation is complicated by a lack of information, a significant volume of daily, often contradictory, publications on these issues, and the extremely high importance of solving several issues for clinical practice [17–20]. WHO recommends confirming the diagnosis of coronavirus infection using laboratory diagnostics, however, many countries, including China, the USA, Australia, Germany, have faced problems with the reliability of test systems and difficulties in diagnosing COVID-19 [21, 22]. To date, a large amount of information about the diagnosis and treatment tactics of patients with coronavirus infection has been published and continues to be published in leading medical journals, online resources and social networks. These are mainly descriptions of clinical cases and data from observational prospective and retrospective clinical studies and their meta-analyses [23–25]. At the same time, hundreds of randomized clinical trials have been initiated, which will provide convincing answers to existing questions, especially regarding patient management tactics [26–28].

The purpose of this research was to study the features of the dynamics and structure of deaths in case of CSD among residents of Almaty before and during the COVID-19 pandemic, as well as the features of survival of residents with this pathology.

Materials and Methods

A retrospective study using descriptive and analytical statistics was used as a basic method.

The main source of information was the official data of the Department of Statistics for the city of Almaty of the Ministry of Economy of the Republic of Kazakhstan and information systems of the Ministry of Health of the Republic of Kazakhstan on cases of deaths from diseases of the circulatory system among residents of Almaty for 2019 and 2020 (population data).

The structure and dynamics of fatal outcomes due to circulatory system diseases were studied. The frequency of deaths by gender, age, as well as the frequency of cases by nosologically forms (by categories of class IX diseases, according to ICD-10) was analysed. The average values of the specific weight and the standard error of the mean were calculated.

To perform the survival analysis, the method of constructing survival tables and the Kaplan-Meier method [29, 30] (median survival time, the proportion of „deceased", the proportion of „survivors", the survival function) was used. The time variable is age. All cases of deaths were uncensored. The features of survival were studied depending on the year of death (2019 and 2020), by gender (male, female), by age (age groups with an interval of 10 years) and survival in case of CSD, considering nosologically forms (under the headings of class IX diseases, according to ICD-10). The comparative analysis was carried out using the Wilcoxon (Gehan) test and the Log Rank, Breslow and Tarone-Ware tests. The null hypothesis (about the absence of differences) was rejected in the case of $p < 0.05$.

Microsoft Excel and the IBM SPSS Statistics package served as a tool for statistical processing of the data obtained.

Results and Discussion

According to the results of the analysis, it was found that in 2020 the number of deaths from CSD among residents of Almaty amounted to 2412 cases, in 2019 1637 cases. The absolute increase in deaths in 2020 compared to 2019 was 775 cases (an increase of 1.5 times). The incidence of deaths from CSD among men was 49.2 ± 1.24% or 806 cases in 2019 and 53.5 ± 1.02% or 1290 cases in 2020, and among women 50.8 ± 1.24% or 831 cases in 2019 and 46.5 ± 1.02% or 1.122 cases in 2020. The mean age of those who died from CSD in 2019 was 72 years (68 years among men and 75 years among women) and in 2020 69 years (65 years among men and 74 years among women).

Table 1. Structure of causes of death among residents of Almaty from CSD (2019–2020)

Circulatory System Diseases (Class IX, according to ICD-10)	2019		2020	
	Abs. numbers	%	Abs. numbers	%
Chronic rheumatic heart diseases (I05–I09)	23	1.4	29	1.2
Hypertensive diseases (I10–I15)	31	1.9	68	2.8
Ischaemic heart diseases (I20–I25)	640	39.1	1046	43.4
Pulmonary heart disease and diseases of pulmonary circulation (I26–I28)	34	2.1	42	1.7
Other forms of heart disease (I30–I52)	99	6.0	249	10.3
Cerebrovascular diseases (I60–I69)	712	43.5	870	36.1
Diseases of arteries, arterioles and capillaries (I70–I79)	59	3.6	78	3.2
Diseases of veins, lymphatic vessels and lymph nodes, not elsewhere classified (I80–I89)	39	2.4	30	1.2

The structure of deaths from CSD has been studied (by categories, according to ICD-10). It was found that in the structure of causes of death of Almaty residents from CSD in 2019, the first rank place was occupied by cerebrovascular diseases (I60–I69), the second rank place coronary heart disease (I20–I25) and the third rank place other heart diseases (I30–I52). In 2020, the first rank place was occupied by coronary heart disease (I20–I25), the second rank place by cerebrovascular diseases (I60–I69) and the third rank place by other heart diseases (I30–I52) (Tab. 1).

The average survival rates were determined. The performed analysis showed that the median survival time of Almaty residents with CSD in 2020 decreased in comparison with 2019: 73.5 years versus 70.9 years, respectively. Differences in survival are confirmed by the results of the Wilcoxon (Gehan) test: test statistics W = 24,264, df = 1, $p \leq 0.001$. Also, the features of the dynamics of the average survival rates in the male and female populations were studied. It was found that the median survival time with CSD in the male population decreased significantly (Wilcoxon (Gehan) test: W = 24.017, df = 1, $p \leq 0.001$): 69.1 years in 2019 vs 66.1 years in 2020. In the female population, the median survival time for CSD changed slightly (Wilcoxon (Gehan) test: W = 1747, df = 1, p = 0.186): 77.6 years in 2019 versus 77.5 years in 2020.

The probabilities of survival of Almaty residents in 2019 and 2020 are calculated: the proportion of "deceased", the proportion of "survivors" and the cumulative function of survival (Tab. 2). In 2020, in comparison with 2019, the proportion of "deceased" in the age range "20–30 years", "30–40 years" and "80–90 years" increased by 1%, by 2% in the age range "40–50 years", by 3% in the age range "60–70 years", by 4% in the age range "50–60 years". The proportion of "deceased" in the age range "70–80 years" decreased by 2%.

Table 2. Survival probabilities, taking into account age intervals (2019–2020)

Year	Age range (in years)	The proportion of "deceased" (the probability that the event will occur in the studied age range)	The proportion of "survivors" (the probability that the event will not occur in the studied age range)	Survival function (probability of survival or non-fatal outcome; cumulative proportion)
2019	0	0	1	1
	10	0	1	1
	20	0	1	0.99
	30	0.01	0.99	0.98
	40	0.04	0.96	0.95
	50	0.12	0.88	0.83
	60	0.29	0.71	0.59
	70	0.44	0.56	0.33
	80	0.81	0.19	0.06
	90	0.99	0.01	0
	100	1	0	0
2020	0	0	1	1
	10	0	1	1
	20	0.01	0.99	0.99
	30	0.02	0.98	0.97
	40	0.06	0.94	0.92
	50	0.16	0.84	0.77
	60	0.32	0.68	0.52
	70	0.42	0.58	0.3
	80	0.82	0.18	0.05
	90	0.99	0.01	0
	100	1	0	0

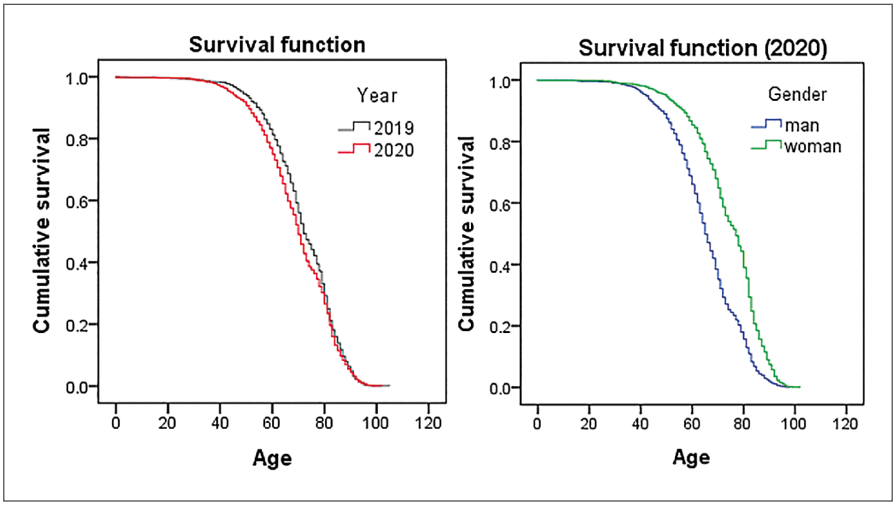

Figure 1. Survival curves of Almaty residents with CSD (2019–2020)

The cumulative survival function was evaluated. In general, in 2020 compared to 2019, a decrease in the survival rate with CSD is characteristic. The cumulative life expectancy in the interval "from 0 to 70 years" decreased maximally (by 7%) in the dynamics. In 2020 and 2019, the probabilities of survival in the range "from 0 to 30 years" are identical.

Figure 1 shows survival curves for CSD in 2019 and 2020 in Almaty, as well as the survival curves for CSD in 2020 among the male and female populations. It should be noted that the differences in survival by gender statistically valid: significance level of the Log Rank test (χ^2 = 238,581, df = 1, $p \leq 0.001$), Breslow (χ^2 = 264,397, df = 1, $p \leq 0.001$), and Tarone-Ware (χ^2 = 269,388, df = 1, $p \leq 0.001$) less than 0.001.

It is necessary to talk about the survival rate in case of CSD separately, taking into account nosological forms (Tab. 3). Differences (adjusted for time/year) in the survival of the residents of Almaty city with different forms of CSD statistically valid: significance level of the Log Rank test (χ^2 = 177.743, df = 1, $p \leq 0.001$), Breslow (χ^2 = 253,399, df = 1, $p \leq 0.001$), and Tarone-Ware (χ^2 = 223,952, df = 1, $p \leq 0.001$) less than

Table 3. Survival rates among residents of Almaty with CSD, taking into account nosological forms (2019–2020)

Circulatory System Diseases (Class IX, according to ICD-10)	Median survival time 2019	2020
Chronic rheumatic heart diseases (I05–I09)	63.7	66.5
Hypertensive diseases (I10–I15)	69.5	68.7
Ischaemic heart diseases (I20–I25)	76.5	72.6
Pulmonary heart disease and diseases of pulmonary circulation (I26–I28)	65.8	66.0
Other forms of heart disease (I30–I52)	66.8	58.6
Cerebrovascular diseases (I60–I69)	72.4	72.2
Diseases of arteries, arterioles and capillaries (I70–I79)	72.8	80.0
Diseases of veins, lymphatic vessels and lymph nodes, not elsewhere classified (I80–I89)	73.7	68.1

0.001. In 2020, the highest median survival time is typical for the category I70–I79 (diseases of the arteries, arterioles and capillaries), and the lowest is for the category I30–I52 (other forms of heart disease). The survival rate increased in dynamics at I05–I09, I26–I28, I70–I79 and the survival rate decreased at I10–I15, I20–I25, I30–I52, I60–I69, I80–I89.

There is no doubt that mortality from diseases of the circulatory system is a serious problem for health systems around the world (including in Kazakhstan), especially during this pandemic. The main question answered by the results of this study was the following: what are the features of the dynamics and structure of deaths in case of CSD among residents of Almaty before and during the COVID-19 pandemic and what are the features of survival of residents with this pathology.

According to the results of the study, the number of deaths from CSD among Almaty residents in 2020 increased by 1.5 times compared to 2019. At the same time, the increase in the number of deaths was largely due to deaths among the male population; due to deaths from ischaemic heart diseases (I20–I25), cerebrovascular diseases (I60–I69) and other forms of heart disease (I30–I52). We believe that the increase in the number of deaths from CSDs may be due to the influence of anxiety/depression associated with the COVID-19 pandemic, and may also be a consequence of inaccuracies/errors in the statistical accounting of deaths (erroneous registration of CSD instead of COVID-19), since CSDs are the most common comorbid pathologies in patients with COVID-19. Additional research is needed to verify these assumptions.We have studied the average survival rates, which indicate a change in the survival rate of Almaty residents from CSDs before and during the pandemic: a significant (error probability less than 1%) shift in the median survival time downward (73.5 years → 70.9 years).

Conclusions

The main conclusion that can be drawn is that during the COVID-19 pandemic, in comparison with the previous year, the number of deaths increased (by 1.5 times) and the nosological structure of causes of death and survival in diseases of the circulatory system among residents of Almaty changed. To a greater extent, the increase in deaths from CSD occurred due to deaths from ischaemic heart diseases (I20–I25), cerebrovascular diseases (I60–I69) and other forms of heart disease (I30–I52). There is also a greater increase in deaths from CSD in the male population.

It was found that the cumulative survival rate of Almaty residents with CSD before age 50 years is about 90% (in 2019 95% and 92% in 2020), and with increasing age, the probability of survival decreases significantly (less than 90%). The fifty percent threshold of cumulative survival in case of CSD is reached by the age of 60–70 years. In comparison with 2019, a decrease (by 7%) is typical for Almaty residents with CSD in 2020 cumulative survival in the age range "from 0 to 70 years". Also, the study revealed significant differences in the survival rate of Almaty residents with CSD in 2020 by gender: survival in the male population is significantly lower compared to the female population (66.1 years versus 77.5 years in 2020). The above is consistent with the generally accepted opinion expressed in modern literature that deaths due to CSD (including comorbid COVID-19) are related to gender.

The results obtained by us indicate a change in the dynamics of survival of residents of Almaty with different nosological forms of CSD (differences in survival are statistically significant). In 2020, in comparison with 2019, the survival rate for chronic rheumatic heart diseases I05–I09, pulmonary heart disease and diseases of pulmonary circulation (I26–I28), diseases of arteries, arterioles and capillaries (I70–I79), however, decreased survival in diseases characterized by hypertension (I10–I15), ischaemic heart diseases (I20–I25), other forms of heart diseases (I30–I52), cerebrovascular diseases (I60–I69), diseases of the veins, lymphatic vessels and lymph nodes (I80–I89).

An additional study is recommended to test the hypothesis of an association of mortality from CSD and the level of anxiety/depression, as well as a study to assess the registration of deaths from CSD comorbid COVID-19.

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Conflict of interest

None.

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