

CLIMATE-METEOROLOGICAL FACTORS AND MORTALITY OF THE POPULATION OF BISHKEK

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The influence of climate-meteorological factors on various aspects of human vital activity is among the most widely discussed medical and social problems. In this regard, a comprehensive multi-factor analysis of the impact of climatic factors for the mortality rate of residents of Bishkek is presented. The most vulnerable categories in the classes of diseases of the circulatory and respiratory systems are ages 65-75 years and older, with mortality rates being significantly higher in men than in women. Potential years of life lost due to premature death are greater in men compared to women: by 3.0 times for diseases of the circulatory system and diseases 3.0 times and 2.6 times diseases of the respiratory system. The presented response model under two climatic scenarios (A2-ASF and B2-MES) predicts the death rate of the urban population of the most vulnerable age groups (65-75 years) in the classes of diseases of the circulatory system (I00-I99) and of the respiratory system (J00-J99). Such a burden of non-communicable diseases presents a complex task to the health care system regarding provision of medical services. The growing awareness of climate problems encourages many states to seek a new approach with broad social solidarity to improve environmental conditions and optimizing population health.

Keywords: climate, mortality, disease classes, predicting, health

The impact of noncommunicable diseases (NCDs) on human health is evident, determining (2011-2030) economic losses of more than \$ 21 trillion for low- and middle-income countries. Diseases of the circulatory system (DCS) are responsible for a third of this amount [1]. In the Kyrgyz Republic, NCDs for the period 2015-2019 were causes of 80% of all deaths, with probability of premature death at the age of 70 and over being 24% or 1 in 4 (DCS, diabetes, chronic respiratory diseases, cancer) – 32% in men, 17% in women [2, 3, 4]. It is known that for these age groups of the population a great part of the burden is related to the impact of weather and climatic phenomena as they manifest themselves in the conditions of climate change, affecting human health and the quality of medical care [5, 6, 7]. Today, global trends until 2030 determine 3 main priorities: climate change, demography and urbanization with low rates of population growth, which will largely have a negative impact on the health of the elderly population, requiring synergistic actions of the health care system and gerontology [8, 9, 10].

Aim of the study: The influence of climatic and meteorological factors on the mortality of the population of the city Bishkek.

Material and research methods

A range of indicators are presented for Bishkek which were collected from the data of the Center for Electronic Health of the Ministry of Health of the Kyrgyz Republic, calls to the Ambulance Station (morbidity of the population); archives of the Registry Office (mortal-

ity) for individual classes of diseases in accordance with the ICD-10 revision: A00-R99 – all causes; A00-A99 – infectious diseases; I00-I99 – diseases of the circulatory system; J00-J99 – diseases of the respiratory system, by age and gender. The results were evaluated in dynamics (monthly and annual averages) with correlation-regression analysis according to the generally accepted method [11]. Based on the baseline morbidity / mortality and climatic parameters (temperature, precipitation, atmospheric pressure) and climate scenario models, the expected (projected) mortality rates of the population were calculated.

Research results and their discussion

Bishkek, the capital of the Kyrgyz state (S – 169.6 km²), is located in the north of the country in the Chui valley. The territory has an accumulative type of relief in the range of heights from 700 to 1100 m, with average annual temperatures of -5.0°C in winter and +24.4°C in summer. Moreover, temperatures above +10°C last from 160 to 190 days, with an accumulating sum of active temperatures of 2900 to 3650°C. According to average annual temperatures (1991-2010), there is observed a warming of 11.7°C by 1.0-1.5°C compared to 1961-1990 (10.7°C), being more pronounced in the winter period and this pattern continues to 2019. Certain attention should be given to the tendency of increasing hot days above 30°C in 1998-2008 (up to 225) and 2009-2019 (up to 283), averaging 699 or 47 per year over the trend period. Over time during these years, there is noted an increase in the number

of days with a sharp change in weather within a range of 80-110 days. As regards annual precipitation amounts, the main growth is observed in winter, spring, autumn, and in summer it practically did not change or had a tendency to decrease. The wind regime is of southern and southeastern directions, weak, with intensification to more than 15 m / s up to 10-15 days a year.

In general, the values and patterns of the spatial and temporal distribution of natural and climatic conditions over the past two decades of the 21st century fit into the parameters of a sharp continental climate. However, a number of weather and meteorological conditions indicate an increase in the number of hot days by 1.5-2 times and sharp weather changeability, a noticeable intensity of warming in the autumn-winter and spring seasons, and it is June in the summer. Seasonal mortality indicators, by the climatic zone, do not differ significantly both in the country and in Bishkek for the studied trend periods (1990-2019). Against this background, higher mortality levels (2011-2019) by seasons: winter (25.97%) and spring (25.99%) occur in the capital compared to national figures (Table 1).

the largest share (47.8% – 49.9%) went to diseases of the circulatory system DCS I00-I99 (Table 2). Regarding the observed average DCS mortality rates of the population, they are higher in men compared with women by age groups: 45-64 years (2.7 times – 48.2 versus 17.3 per 100 thousand population), 65-74 years (1.8 times – 227.8 versus 122.3 per 100 thousand population), 75 years and older (1.2 times – 641.1 versus 543.7 per 100 thousand population). Correlation analysis of the mortality rates of the population of Bishkek from DCS with meteorological factors – atmospheric pressure revealed that the association is direct and moderate for men aged 45-64 years ($r = 0.30$), direct and weak for women aged 65-74 years ($r = 0.22$), and the coefficients were equal for both sexes in the age group 75 years and older ($r = 0.35$ and $r = 0.33$). Moreover, regarding mortality from diseases I00-I99 the most significant regression coefficients with temperature data were found in age groups for men (45-64 years and 75 years) and women (45-64 years, 65-75 years, and older).

The projected average monthly mortality rates in men and women from DCS (I00-I99) under the two climatic scenarios (A2-ASF and

Table 1
Seasonal mortality of the population by climatic zone in the Kyrgyz Republic and the city Bishkek (%)

Seasons of the year	Climatic zone: Northern, Northern-Western			
	1990-2010		2011-2019	
	Kyrgyz Republic	Bishkek	Kyrgyz Republic	Bishkek
Winter	26,93	26,79	25,90	25,97
Spring	25,48	25,46	24,79	25,99
Summer	23,87	23,87	25,11	24,43
Autumn	23,71	23,87	24,20	23,61

During the observed period (2003-2009) for Bishkek the number of deaths was recorded among men (54.0%) and women (45.9%), with the maintaining of a similar proportional trend (2010-2019). The largest total number of deaths was noted in the age group of 65-75 years and older (54.0%) followed by 45-64 years olds (27.3%). Figures on the main causes of death according to ICD-10 for residents of Bishkek revealed that 36387 people died from all natural causes (A00-R99) in 2003-2009 and 45305 in 2010-2019 constituting relative to the total recorded number of diseases – 87.0% (41,816) and 91.3% (49637), respectively. Along with this, among natural causes of death for the population of Bishkek,

B2-MES) in the age categories 45-64 years old and 75 years and older revealed high mortality from DCS for the group 75 years and older, being higher for men than women. At the same time, regarding the latter group the monthly trend was similar, with the lines being almost “parallel”, the largest number of deaths was recorded in the cold season and the minimum – in the hot season (Fig. 1). In the age group 45-64 years, mortality is higher in men compared to women, while the monthly trend differed significantly in the group of men, with higher mortality in winter months compared to the summer season, the line had a sharp turn. As we can see from fig. 1 the mortality rates in women changed insignificantly and the highest

rates were in the hot period of the year, compared with the winter months; the line was almost “straight”. It should be noted that the population, depending on gender and age, reacts to temperature changes differently, and climate changes indicate that by 2100, relative to the base period (2003-2009 and 2010-2019), certain reactions (conditions) of the body can be predicted, especially in the age group 75 years and over. Negative developments are more pronounced in men compared to women according to the A2-ASF scenario – 4.6% (611.9 cases per 100 thousand population) and the B2-MES scenario – 3.1% (621.2 cases per 100 thousand population) and for age groups of 65-74 years (8.8% and 9.4%, respectively).

Of interest is the influence of climatic factors on mortality rates of the population from diseases of the respiratory system (DRS), which amounts to 3.2% -4.3%. The largest number of deaths from DRS (J00-J99) is observed among the adult population in the age groups 75 and older and 65-74 years. The DRS mortality is higher among men than women, being in average values by 3.3 times higher in persons of the older generation of 75 years and

older (45.8 cases per 100 thousand population versus 13.8 cases), and 4.2 times (25.2 cases per 100 thousand versus 6.0 cases) for the population age group 65-74 years.

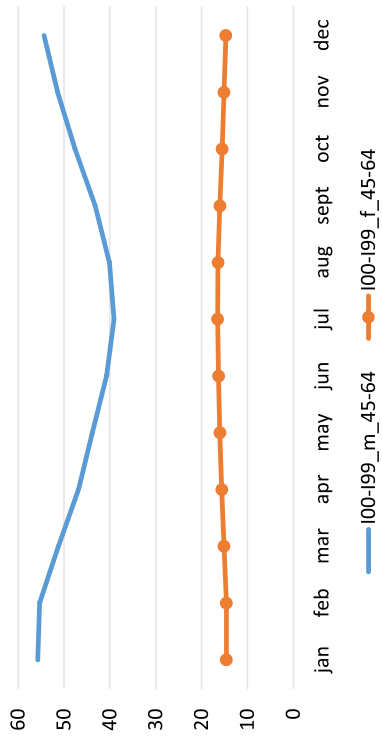
The results of correlation analysis indicate that there is a weak direct mortality – atmospheric pressure relationship for these population age groups ($r = 0.2$ and $r = 0.3$). Certain temperature related associations can be seen as well – there is a weak inverse mortality – temperature relationship in women of 75 years of age and over ($r = -0.3$) with no such relationship in men. Apparently, women of the older age group (65-75 years old and over) are more sensitive to changes in atmospheric pressure and temperature regime. For this age group of women, under the climatic scenarios (A2-ASF and B2-MES), the regression analysis predicts temperature related mortality from DRS J00-J99 in the population of Bishkek to be 7.5% and 10% by 2100, respectively. Thus, the most significant regression analysis coefficients were found regarding the relationship between the mortality of population from diseases of the respiratory system (J00-J99) and the averaged temperature data over the study years.

Table 2

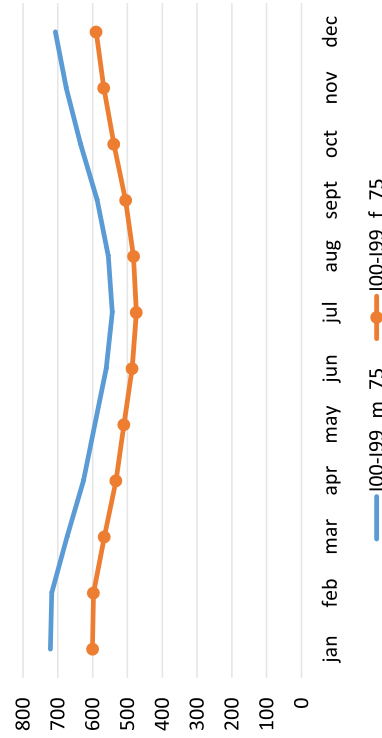
Deaths from main causes in the city Bishkek

Years	Natural causes (A-R)	Some infectious and parasitic diseases	Diseases of the circulatory system	Diseases of the respiratory system	Unestablished causes	Total
2003	5368	321	2957	306	275	6229
2004	5287	293	2860	271	218	6076
2005	5263	271	2926	256	245	6117
2006	5209	223	2875	230	261	6077
2007	5442	233	3016	241	193	6226
2008	5078	188	2791	243	145	5756
2009	4740	155	2551	239	152	5335
2003-2009	36387	1684	19976	1786	1489	41816
%	87,0	4,0	47,8	4,3	3,6	
2010	4653	147	2545	182	160	5256
2011	4679	125	2648	180	173	5261
2012	4569	119	2627	181	122	5058
2013	4457	168	2440	128	148	4917
2014	4699	122	2526	155	163	5131
2015	4495	100	2400	120	178	4901
2016	4332	92	2351	159	129	4691
2017	4401	99	2403	139	123	4762
2018	4504	108	2362	155	140	4815
2019	4516	94	2470	169	126	4845
2010-2019	45305	1174	24772	1568	1462	49637
%	91,3	2,4	49,9	3,2	2,9	

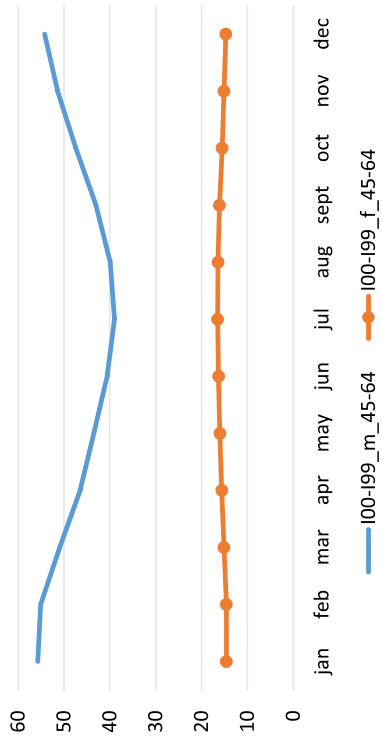
Scenario B2-MES



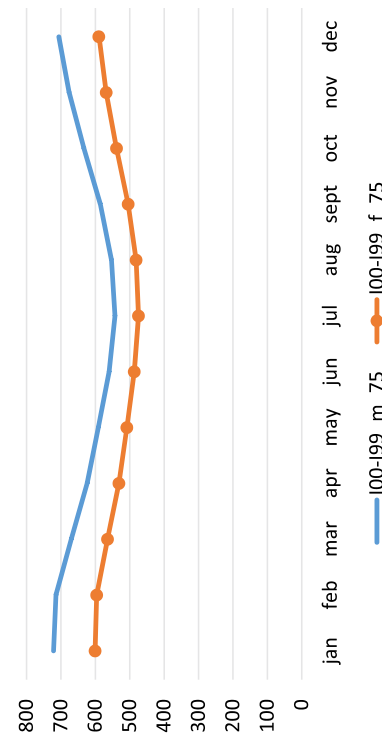
Scenario B2-MES



Scenario A2-ASF



Scenario A2-ASF



Predicted average monthly mortality rates in males (m) and females (f) from diseases of the circulatory system (100-199) under the two climate scenarios (A2-ASF and B2-MES) in the age groups 45-64 and 75 years and older

The calculations of potential years of life lost among the population of Bishkek as related to the climatic-factor impact using the two climatic scenarios, show the following total numbers of years lost due to premature death: from diseases of the circulatory system – DCS (I00-I99) – 5258 for men and 1948 for women, and from diseases of the respiratory system – DRS (J00-J99) 1694 and 734 for respectively. Besides, it was found that potential years of life lost at age 65 years or older (PYLL-65) in the male population are 3 times higher than in females due to premature death from DCS and 2.6 times from DRS (Table 3).

Table 3

Potential years of life lost (PYLL) due to premature death in the population of Bishkek: diseases of the circulatory system (DCS) and of the respiratory system (DRS)

Gender	Class of DCS (I00-I99)		Class of DRS (J00-J99)	
	Total PYLL	PYLL 65 years	Total PYLL	PYLL 65 years
Males	5258	1,40	1694	0,45
Females	1948	0,46	734	0,17

Conclusion

The presented mortality rates of the population of Bishkek indicate the existence of a relationship between the state of health and climatic-meteorological parameters. Based on the model of changes in the temperature regime under the two climatic scenarios (A2-ASF and B2-MES), the predicted monthly and average annual mortality rates of the population of Bishkek were calculated for vulnerable age groups according to the disease classes DCS (I00-I99) and DRS (J00-J99). In the population aged 65-75 years and older, mortality rates are

higher in men compared to women and so are potential years of life lost (3.0 and 2.6 times, respectively), which requires the attention of the health care system and gerontology.

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