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Assessment of the morbidity of the population of Bishkek city in respect to climate change

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Abstract. To assess the human health status of the city's population under the impact of climatic factors, epidemiological studies were carried out based on data from Bishkek Emergency Care Station in the Kyrgyz Republic. This paper presents the main results of an assessment of climate change-related vulnerability on a number of indicators of population morbidity. Expected levels of morbidity indices were calculated using climatic scenarios (A2-ASF and B-2MES) in Kyrgyzstan. The climate-related health impact assessment revealed relationships between diseases of the circulatory system, the respiratory system and climatic-meteorological factors. Based on greenhouse release scenarios (models A2-ASF and B-2-MESSAGE) and predicted climate changes, forecast tables for levels of morbidity of the population of the Kyrgyz Republic were developed. Ranges of seasonal variation of infectious and non-infectious disease morbidity levels were calculated.

Key words: age groups, climate change, climate scenarios, diseases, health, morbidity

Introduction

Kyrgyzstan is a Central Asian republic with a population of 5 million people and borders with China, Kazakhstan, Tajikistan and Uzbekistan. The Kyrgyz Republic is situated within the Tien-Shan and Pamir-Alai mountain ranges. The country has an area of 199,900km^2 and is situated at an altitude of 480 to 7,439m above sea level. More than 90% of its territory is above 1,500m a.s.l.

In the framework of its commitments to the UN FCCC, the Kyrgyz Republic prepared two National Communications (2003, 2009). These identified priority sectors affected by climate change: water, agriculture, health and emergency situations (Iliasov *et al.* 2003, Iliasov and Yakimov 2009).

Kyrgyzstan is a sunny country. Average annual duration of solar radiation varies within the range 2,500 to 2,700 hours. However, the complex relief of the Tien-Shan, a combination of high peaks and deep depressions with various expositions in the mountains, results in substantial local variation in duration of solar radiation (Iliasov and Yakimov 2009).

The Kyrgyz Republic has four climate regions: North-West, North-East, South-West and Inner Tien-Shan. Large fluctuations of air temperature are typical for Kyrgyzstan. Precipitation is brought mainly by the north-west, west and south-west air masses. Their extent depends mainly on the exposition of mountain slopes in relation to prevailing winds.

Mountain ranges open to air masses receive the most rainfall. While 300 - 400mm of precipitation per year is observed in the plains of the Chui oblast, 750 - 770mm of precipitation is observed on the slopes of the Kyrgyz mountain range at an altitude of 3,000m. In the south-west part of Kyrgyzstan, precipitation is highest on the slopes of the Fergana range facing the south-west (900 - 1,000mm), while 200 - 250mm is observed on the opposite slopes, facing towards Inner Tien-Shan.

Glaciers and snow fields are unique landscape decorations and one of the treasures of the republic. Water reserves in the glaciers are actually inexhaustible. It has been estimated that 6,578km^2 of Kyrgyzstan is glaciated. Multiyear studies by glaciologists in Kyrgyzstan show that glaciers are currently retreating.

In recent years, the number of emergency situations related to mudflows and floods, earthquakes and flooding has increased by 1.8-, 2.7- and 3-times, respectively. The most dangerous scenarios are mudflows and floods occurring as a result of snowmelt and strong rainfall. They cause great economic damage (destruction of roads and railways, bridges and protective dams, irrigation facilities, houses, crops and livestock) and people sometimes die in mudflows. In spring and summer, mudflows and floods are observed across Kyrgyzstan, having higher prevalence in the Osh, Jalal-Abad and Batken oblasts. There are about 3,100 mudflow basin rivers.

Health problems related to the impact of climate change (WHO 2010a,b,c and Robine *et al.* 2008) are given insufficient attention in the Kyrgyz Republic, which is the reason for the present work. These studies were carried out in the framework of the WHO - BMU project "Climate change-related health impact in the Kyrgyz Republic".

In the present work, the impact of climate change on the health of the population of Kyrgyzstan is demonstrated in the city of Bishkek. Population morbidity and mortality (Mathers *et al.* 2009) were examined in relation to retrospective and current climatic-meteorological parameters and to two climatic scenarios for the Kyrgyz Republic (Desyatkov and Katkova 2007). Climate scenarios were developed by a group of IT experts and presented in the Second National Communication (Iliasov and Yakimov 2009).

The purpose of the work was to analyse and assess the morbidity of the population of the city of Bishkek in relation to meteorological data and to calculate expected morbidity rates for priority disease classes using climatic scenarios.

Climate change scenarios

Climatic scenarios were developed using MAGICC/SCENGEN (version 4.1), recommended for climate change analysis under the National Communications of countries. Preliminary analysis resulted in selection of the following GHG emission scenarios:
- A2-ASF – a scenario giving the maximum value of CO_2 concentration by year 2100 among scenarios of the A2 family (A2 scenarios with more moderate economic and demographic parameters)
- B2-MESSAGE – a scenario giving the minimum value of CO_2 concentration by year 2100 among scenarios of the B2 family (B2 scenarios with more moderate economic and demographic parameters)

Calculations on the basis of these scenarios conducted within the preparation of the Second National Communication on Climate Change of the Kyrgyz Republic reveal that average annual temperature could increase from 3.5° C to 8.8° C for various climate-geographic areas up to 2100 (Table 1).

Studies also show that during 2020 - 2025, it is expected that surface run-off will increase due to an increase in its glacier component. However, it is expected that run-off will reduce by up to 42.4 - 20.4 km^3 in 2100, which is 43.6 - 88.4% of the run-off volume in 2000.

Data on the predicted increases in temperature and changes in precipitation in regions of Kyrgyzstan under the two climatic scenarios are shown in Table 1.

Averaged - model change of annual precipitation totals for all three areas estimated is insignificant. For the northern part of the Republic a small increase in precipitation is predicted (1.3 - 2.1% compared to the base period, irrespective of scenario), whereas for the southern part of the Republic a small decrease is expected (from -2.0% to -3.1% compared to the base period for scenarios A2 and B2, respectively).

Regions more prone to heat - waves include the city of Bishkek and Chui oblast, the southern region and the Fergana Valley. The greatest risk of floods, mud-flows, avalanches and dangerous places are found in the Osh, Jalalabad and Batken oblasts.

Direct impact of climate change on health (Parry et al. 2007) of the population of Kyrgyzstan will be determined by rapid differentials of air pressure, frequently changing weather and frequent periods of heavy rain. People with limited adaptive capacities - infants, elderly, meteorologically affected patients with cardiovascular, cerebro - vascular and respiratory diseases - will be most affected.

Material and Methods

This work is part of an initiative of seven WHO/Europe countries and is funded by the Federal German Ministry for Environment, Nature Reservation and Nuclear Safety (BMU). The project is aimed at protecting human health from climate change through addressing adaptation issues, strengthening health systems and increasing institutional capacity (WHO 2001).

WHO/Europe coordinated the project by contributing to a WHO regional workshop on climate

Name and coordinates of regions	**A2-ASF**		**B2-MESSAGE**	
	range ΔT	**average mode ΔT**	**range ΔT**	**average mode ΔT**
NNW 40–45° N, 70–75° E.	4.7–7.8° C	6.2° C	3.6–5.8° C	4.6° C
NE and TShan 40–45° N, 75–80° E.	4.5–8.2° C	6.1° C	3.5–6.0° C	4.6° C
SW 35–40° N, 70–75° E.	5.1–8.4° C	6.2° C	3.8–6.1° C	

Name and coordinates of regions	**A2-ASF**		**B2-MESSAGE**	
	range of change (%)	**average mode (%)**	**range of change (%)**	**average mode (%)**
NNW 40–45° N, 70–75° E.	(-)41.8 – 48.0	2.1	(-)27.2 – 24.0	2.1
NE and TShan 40–45° N, 75–80° E.	(-)25.9 – 59.9	1.3	(-)16.7 – 40.9	1.3
SW 35–40° N, 70–75° E.	(-)43.4 – 28.7	(-)2.0	(-)30.9 – 17.5	(-)3.1

Table 1. Predicted temperature increases and changes in precipitation by region in Kyrgyzstan under different climate scenarios.

change and health. In addition, the WHO Office provided technical support, guidance, training and expertise. In each country a multi-sector committee was established; a project coordinator oversees implementation of the project at national level. Country coordinators receive support from WHO/Europe. All activities are carried out in collaboration with BMU and national governments of the seven countries.

Methodological approach

In the present work, modern hygienic and epidemiological methods and approaches were used in consideration of recommendations of WHO as well as manuals on the problem of climate change and human health (WHO 2005, 2006; Revich 2006, Menne and Ebi 2006).

Data sources

To assess population health in terms of the impact of climatic factors, epidemiological research was undertaken in the city of Bishkek, Kyrgyz Republic. For analysis of morbidity, data from different sources were used: Bishkek Health Department Ambulance Service Station; Bishkek Centre for Sanitary-Epidemiologic Surveillance; and the Republican Medical Information Centre of the Ministry of Health of the Kyrgyz Republic (Ministry of Health Kyrgyz Republic 2011). Information on population size by gender and age was obtained from the National Statistical Committee (Abdykalykov 2010).

Meteorological data

Climatic-meteorological data were provided by the Hydro-meteorological Agency (Kyrgyzhydromet) under the Ministry of Emergency Situations of the Kyrgyz Republic (Arnell 2003). The health of the human population in Bishkek was assessed using two climate scenario models (A2-ASF and B2-MES).

Meteorological data for the city of Bishkek were analysed for the period from 2003 to 2009. To investigate the influence of climatic factors on the health of the population the following meteorological parameters were used:
- air temperature (daily and monthly average levels)
- atmospheric pressure
- monthly and annual precipitation

Three- and six-hour intervals were considered. Cold- and heat-wave temperatures were also analysed. The period 1961 - 1990 was used as a baseline.

To calculate expected health parameters under different emission scenarios, we used temperature predictions for corresponding stations made by an IT expert group during preparation of the Second National Communication (2006 - 2009). Data on the health of the population were standardized by age and sex which included selected morbidity parameters for the population of the city of Bishkek.

Population morbidity

To assess the level of circulatory disease morbidity of the population of the Kyrgyz Republic, data on emergency calls made to Bishkek Ambulance Service Station (BASS) were collected and analysed with the participation of BASS staff under the direction of physician Z.S. Sepisheva and programmer B.Sh. Aitkozhoev. BASS provided data on emergency calls by nosological forms, by age and sex. Between May 2006 and December 2009 a total of 452,381 calls were recorded. It should be noted that 25,960 of these calls (5.7%) were excluded from analysis because data were incomplete.

Results were analysed by age, gender and disease classes. Patient data were grouped into seven age classes: 0 - 1, 2 - 14 , 15 - 44, 45 - 64, 65 - 74, 75 years and over and unknown (i.e. persons of unidentified age). Group 7 was subsequently excluded from analysis due to lack of data. The following disease classes were used according to ICD (X^{th} Revision):
- A00 - R99 - all natural causes
- A00 - A99 - infectious diseases
- I00 - I99 - diseases of the circulatory system
- I00 - I52 - cardiac diseases (diseases of the heart)
- I70 - I79 - diseases of the circulatory system (arteries, arterioles, capillaries etc.)
- J00 - J99 - diseases of the respiratory system

Data were examined over time (average monthly and average annual rates), correlational analysis was performed followed by regression analysis. Regression analysis included calculation of coefficients (multiple R, coefficient of regression F, data reliability level 95%, standardized residues) for health parameters in association with meteorological data for particular observation periods (temperature, precipitation, relative humidity). With the use of basal data of morbidity and climatic parameters (temperature, precipitation, atmospheric pressure) and climate scenario models (Desyatkov and Katkova 2007), the expected (projected) population morbidity levels were calculated. Statistical analyses were performed using the SPSS software package.

Results

Study of population health based on emergency calls

Characteristics of calls to Bishkek Ambulance Service Station are presented in Table 2. The most vulnerable age classes were people aged 75 years and older, followed by 0 - 1 and 65 - 74 years old. A seasonal analysis of calls to BASS (Table 3) shows that more calls were made in summer (26.1%) than in winter (24%).

Observed morbidity

Analysis of the main causes of emergency calls (Fig. 1) shows that the priority disease class is circulatory diseases in females (4060.7 per 100,000 people) and respiratory diseases in males (3008.3 per 100,000 people). Because the greatest number of cases seeking ambulance service assistance was related to circulatory diseases (I00 - I99) and respiratory diseases (J00 - J99), these disease classes should be priorities for the public health system.

Among people who called the ambulance service for diseases of natural causes (A00 - R99), the most vulnerable age classes were people aged 75 years and older, 0 - 1 year then 65 - 74 years old, with males having higher levels than females. The total number of calls to BASS for heart diseases (I00 - I52) was highest in the three oldest age classes, with females having higher levels than males. In the class of respiratory diseases (J00 - J99), the most vulnerable age classes were infants aged 0 - 1, then adults of 75 years and older followed by 1 - 14 year olds. Males had higher levels than females. Priority prevention measures should therefore be targeted at children and the elderly. An analysis of calls to BASS for diseases of arteriole vessels (I70 - I79) showed that men were 1.5 - 2.0 times more vulnerable than women in the oldest three age classes.

Results of correlation analysis showed a relationship between population morbidity due to all natural causes (disease classes A00 - R99) in the 65 - 74 age class and atmospheric pressure as well as air temperature. A direct relationship was found between the state of health among women and men (morbidity from all natural causes) and atmospheric pressure data, i.e. the higher the atmospheric pressure values the higher the morbidity levels, whereas a reverse relationship was found observed for air temperature, i.e. lower temperatures were associated with higher morbidity rates in both women and men.

Correlations of cardiac disease morbidity with climatic-meteorological parameters

Direct, medium-strength relationships were found between morbidity due to diseases of the heart (I00 - I52) and atmospheric pressure as well as precipitation (Fig. 2). In the case of temperature, a reverse relationship of medium strength was observed.

Years	Age category	Both genders		Males		Females	
		Abs. no.	Per 100,000	Abs. no.	Per 100,000	Abs. no.	Per 100,000
2007	Combined	99,034	12,222.4	37,302	9,642.9	61,732	14,579.1
	0-1	5,640	34,522.9	2,989	35,732.2	2,651	33,253.9
	2-14	11,402	7,309.3	5,919	7,481.5	5,483	7,132.0
	15-44	38,100	8,538.9	13,416	6,150.3	24,684	10,823.7
	45-64	22,836	16,338.3	8,801	13,832.2	14,035	18,432.4
	65-74	10,572	33,042.7	3,421	28,066.3	7,151	36,105.2
	75+	10,484	52,480.4	2,756	51,008.7	7,728	53,025.9
2008	Combined	102,726	12,542.7	39,849	10,184.4	62,877	14,700.0
	0-1	5,953	34,604.4	3,219	36,372.9	2,734	32,730.8
	2-14	15,116	9,407.7	8,029	9,831.3	7,087	8,969.9
	15-44	38,736	8,719.8	13,621	6,279.6	25,115	11,048.2
	45-64	22,295	15,222.7	8,753	13,096.6	13,542	17,007.2
	65-74	10,263	33,503.1	3,312	28,480.5	6,951	36,576.5
	75+	10,363	52,319.9	2,915	54,131.8	7,448	51,643.3
2009	Combined	114,409	13,628.2	45,078	11,581.0	69,331	15,398.1
	0-1	7,717	46,471.2	4,167	49,278.6	3,550	43,558.3
	2-14	19,630	11,163.6	10,629	11,969.7	9,001	10,341.1
	15-44	41,907	9,046.1	14,790	6,795.8	27,117	11,040.0
	45-64	24,061	17,353.3	9,181	15,405.9	14,880	18,821.1
	65-74	10,053	35,783.4	3,239	32,315.7	6,814	37,706.8
	75+	11,041	64,783.2	3,072	64,892.3	7,969	64,741.2

Table 2. A00 - R99 (all natural causes). Total number of ambulance calls (absolute number) and morbidity rates by gender and age group (per 100,000 people)

Months/ Years	2006	2007	2008	2009	Total
January	n/db	10,627	9,959	11,146	31,732
February	n/db	9,462	11,561	11,335	32,358
March	n/db	10,624	10,841	11,528	32,993
April	n/db	10,333	10,375	10,743	31,451
May	8	10,984	11,303	12,321	34,616
June	44	11,154	10,725	11,712	33,635

continued...

July	5,511	10,951	11,702	12,569	40,733
August	9,113	10,552	11,678	12,385	43,728
September	9,288	9,986	10,366	11,882	41,522
October	9,581	9,797	10,449	12,189	42,016
November	9,636	9,617	10,508	13,672	43,433
December	11,150	10,251	11,020	9,424	41,845
Total 2006 - 2009	***54,331***	***124,338***	***130,487***	***140,906***	***450,062***

Table 3. Number of ambulance arrivals by BASS for diseases A00 – Z99 (all causes) in 2006 – 2009 (absolute number). Note: n/db – no database

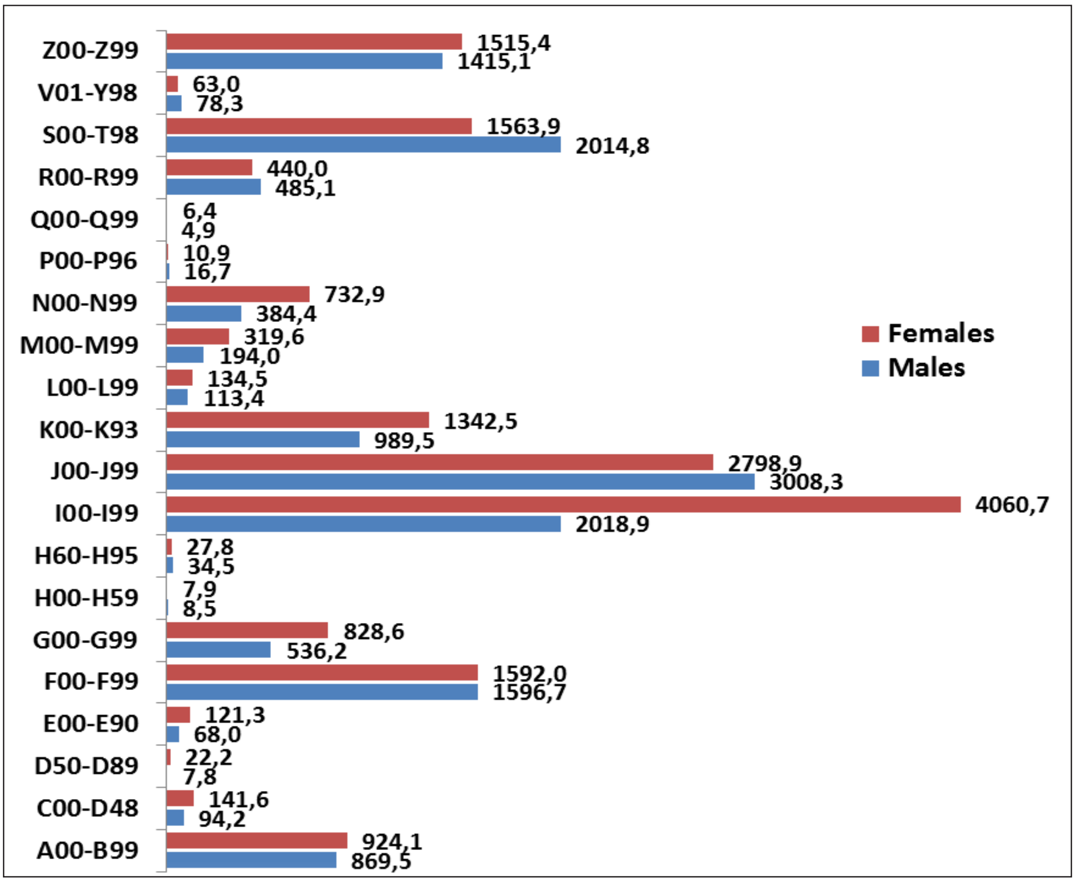

Fig. 1. Distribution by set of disease classes (ICD - X) in 2007 – 2009 (per 100,000 people).

Regression analysis of population morbidity and climatic-meteorological parameters

Regression analysis was performed on primary data of population morbidity provided by Bishkek Ambulance Service Station for the period from 2006 to 2009. The most significant regression coefficients between morbidity levels (A00 - R99, I00 - I52, I70 - I79 and J00 - J99) and climate-meteorological data on temperature and precipitation are presented in Table 4 - 7.

Predicted levels of population morbidity with scenarios of climate change

Predicted morbidity indices for different disease classes, stratified by gender and age class, were calculated

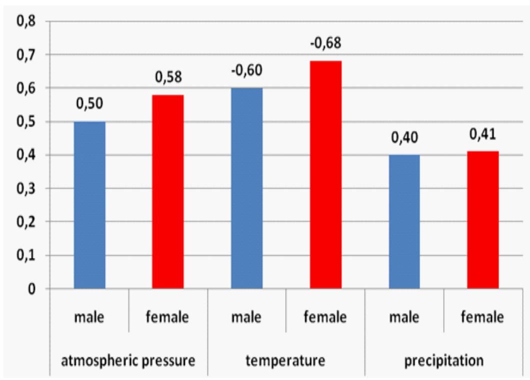

Fig. 2. Correlation coefficients for cardiac diseases (I00 - I52) in the age class 65 - 74 years old with atmospheric pressure, temperature and precipitation.

on the basis of regression analysis under two climatic scenarios, temperature and precipitation models. Averaged data on population morbidity for the leading disease classes for the baseline period (2007 - 2009) and the expected period (2010 - 2100) and for the individual year 2100 are given in Table 8 - 9.

The highest levels of morbidity from all natural causes (A00 - R99) were in age class 65 - 74 years, with higher levels in women than men (Table 8). Compared to the baseline period 2007 - 2009, by the year 2100 morbidity in women is expected to increase by 8.1% (2948.9 per 100,000 people) and 9.2% (2979.2 per 100,000) respectively under the two climatic scenarios (A2 - ASF and B2 - MES). In contrast, the reverse is expected in men: by 2100 morbidity is expected to decrease under both scenarios, with the percent change being greater under scenario A2 - ASF (3.7% or 2376.8 per 100,000) than B2 - MES (2.4% or 2408.2 per 100,000).

Analysis of population morbidity from cardiac diseases (I00 - I52) showed that the most sensitive age classes are 75+ years and 65 - 74 years

Disease classes / gender / age group	F	P-value	Intersection point	Average temperature	Precipitation
A00-R99_f_65-74	18.76	0.0001	3,283.24	-20.07	
A00-R99_m_65-74_2	12.35	0.000074	2,436.18	-16.22	5.61
A00-R99_65-74_2	16.66	-0.000006	2,893.95	-17.68	3.92

Table 4. Regression coefficients for population morbidity levels from all natural causes (A00 - R99) with temperature and precipitation parameters.

Disease classes / gender / age group	F	P-value	Intersection point	Average temperature	Precipitation
I00-I52_all	25.2	0.0	225.6	-1.81	0.31
I00-I52_65-74	33.0	0.0	1,501.0	-15.18	3.10
I00-I52_75	7.9	0.0013	2,221.2	-13.18	5.48
I00-I52_f_65-74	21.7	0.000001	1,769.7	-17.25	3.25
I00-I52_f_75	3.5	0.0404	2,354.1	-10.65	4.73
I00-I52_f_all	14.7	0.000019	299.9	-2.28	0.41
I00-I52_m_65-74	14.9	0.000017	1,059.9	-11.95	2.67
I00-I52_m_75	7.2	0.002276	1,863.5	-19.78	7.55
I00-I52_m_all	16.0	0.000009	144.0	-1.31	0.18

Table 5. Regression coefficients for population morbidity levels from diseases of the heart (I00 - I52) with temperature and precipitation parameters.

Disease classes / gender / age group	F	P-value	Intersection point	Average temperature
I70-I79_m_all	4.7325	0.036	0.57	0.016
I70-I79_all	4.4173	0.042	0.55	0.013

Table 6. Regression coefficients for population morbidity levels from diseases of arteries and arterioles (I70 - I79) with temperature parameters.

Disease classes / gender / age group	F	P-value	Intersection point	Average temperature
J00-J99_all	4.30	0.045	265.83	-2.50
J00-J99_0-1	6.91	0.012	2,258.38	-22.55
J00-J99_65-74	21.70	0.00004	376.12	-4.81
J00-J99_75	13.53	0.0007	578.94	-6.12
J00-J99_m_all	3.23	0.079	273.63	-2.39

continued...

J00-J99_m_0-1	5.24	0.027	2,343.54	-21.74
J00-J99_m_65-74	23.18	0.00002	410.48	-6.10
J00-J99_m_75	6.55	0.015	908.80	-9.26
J00-J99_f_all	5.48	0.024	258.99	-2.61
J00-J99_f_0-1	8.50	0.006	2,169.17	-23.40
J00-J99_f_65-74	13.32	0.0008	356.01	-4.04
J00-J99_f_75	9.79	0.003	454.87	-4.96

Table 7. Regression coefficients for population morbidity levels from respiratory diseases (J00 - J99) with temperature parameters.

ICD-X and Age class	Climate scenario	Years	Males		Females	
			per 100,000	% (+/-)	per 100,000	% (+/-)
A00–R99 65–74	Baseline	2007–09	2,468.4		2,728.2	
	A2-ASF	2100	2,376.8	-3.7	2,948.9	8.1
	B2-MES	2100	2,408.2	-2.4	2,979.2	9.2
I00–I52 All ages	Baseline	2007–09	134.1		284.7	
	A2-ASF	2100	128.9	-3.9	277.1	-2.7
	B2-MES	2100	131.1	-2.2	281.1	-1.2
I00–I52 65–74	Baseline	2007–09	1,023.0		1,672.1	
	A2-ASF	2100	961	-6.1	1,604.7	-4
	B2-MES	2100	982.3	-4	1,634.7	-2.2
I00–I52 75+	Baseline	2007–09	1,897.1		2,424.9	
	A2-ASF	2100	1,817.9	-4.2	2,354.7	-2.9
	B2-MES	2100	1,857.1	-2.1	2,376.6	-2

Table 8. Predicted A00 - R99 (natural causes) and I00 - I52 (cardiac disease) morbidity levels in susceptible age groups under two climatic scenarios.

ICD-X and Age class	Climate scenario	Years	Males		Females	
			per 100,000	% (+/-)	per 100,000	% (+/-)
J00–J99 0–1	Baseline	2007–09	2,129	100	1,932	100
	A2-ASF	2100	1,981.2	-6.9	1,779.2	-7.9
	B2-MES	2100	2,014.1	-5.4	1,814.6	-6.1
J00–J99 65–74	Baseline	2007–09	343	100	313	100
	A2-ASF	2100	308.8	-9.7	288.8	-7.8
	B2-MES	2100	318	-7	294.9	-5.8
J00–J99 75+	Baseline	2007–09	798	100	410	100
	A2-ASF	2100	754.5	-5.5	372.2	-9.3
	B2-MES	2100	768.5	-3.7	379.7	-7.4

Table 9. Predicted population morbidity levels due to respiratory diseases (J00 - J99) in sensitive age classes under two climatic scenarios.

and overall (all ages), with higher morbidity in women than in men (284.7 and 134.1 cases per 100,000 people, respectively). Detailed analysis of population morbidity from I00 - I52 diseases by gender and age in relation to climatic scenario showed that percent changes were greater in men than in women and greater in age class 65 - 74 years than 75+ years. In age class 65 - 74 years, morbidity in men is expected to decrease from baseline to the year 2100 by 6.1% under scenario A2 - ASF and by 4.0% under scenario B2 - MES. In women, percentage changes are less great under both scenarios: 4.0% and 2.2%, respectively.

However, the highest prevalence of cardiac disease is found in the oldest age class (Table 8). By 2100, under scenario A2 - ASF, morbidity levels are expected to reach 1817.9 cases per 100,000 men and 2354.7 per 100,000 women (compared to baseline levels of 1897.1 and 2424.9, respectively). Under scenario B2 - MES, the respective levels are expected to be 1857.1 and 2376.6. Predicted levels of morbidity due to diseases of the arteries, arterioles and capillaries (I70 - I79) in the population of Bishkek are presented in Fig. 3.

Analysis of population morbidity from diseases of the circulatory system (I70 - I79) based on calls to Bishkek Ambulance Service Station shows that the highest number of cases occurred in the summer (July: 0.91 cases per 100,000 people) and the lowest in winter (December - January: 0.58 - 0.55 cases per 100,000 people). By the year 2100 cases of diseases of the circulatory system are expected to increase by 10.5% compared to 2010.

Predicted population morbidity levels due to diseases of the respiratory system (J00 - J99) for the three most sensitive age groups are shown in Table 9. The highest prevalence levels of diseases of respiratory system are found in children under one year of age, with the morbidity being higher in boys than in girls (2,129 cases and 1,932 cases, respectively, per 100,000 children in the baseline period 2007 - 2009).

Regarding the influence of climatic scenarios on health, it should be noted that the percentage change in population morbidity due to diseases of the respiratory system in the three age groups is higher under A2 - ASF than under B2 - MES, which is consistent with predictions of temperature (higher for A2 than B2).

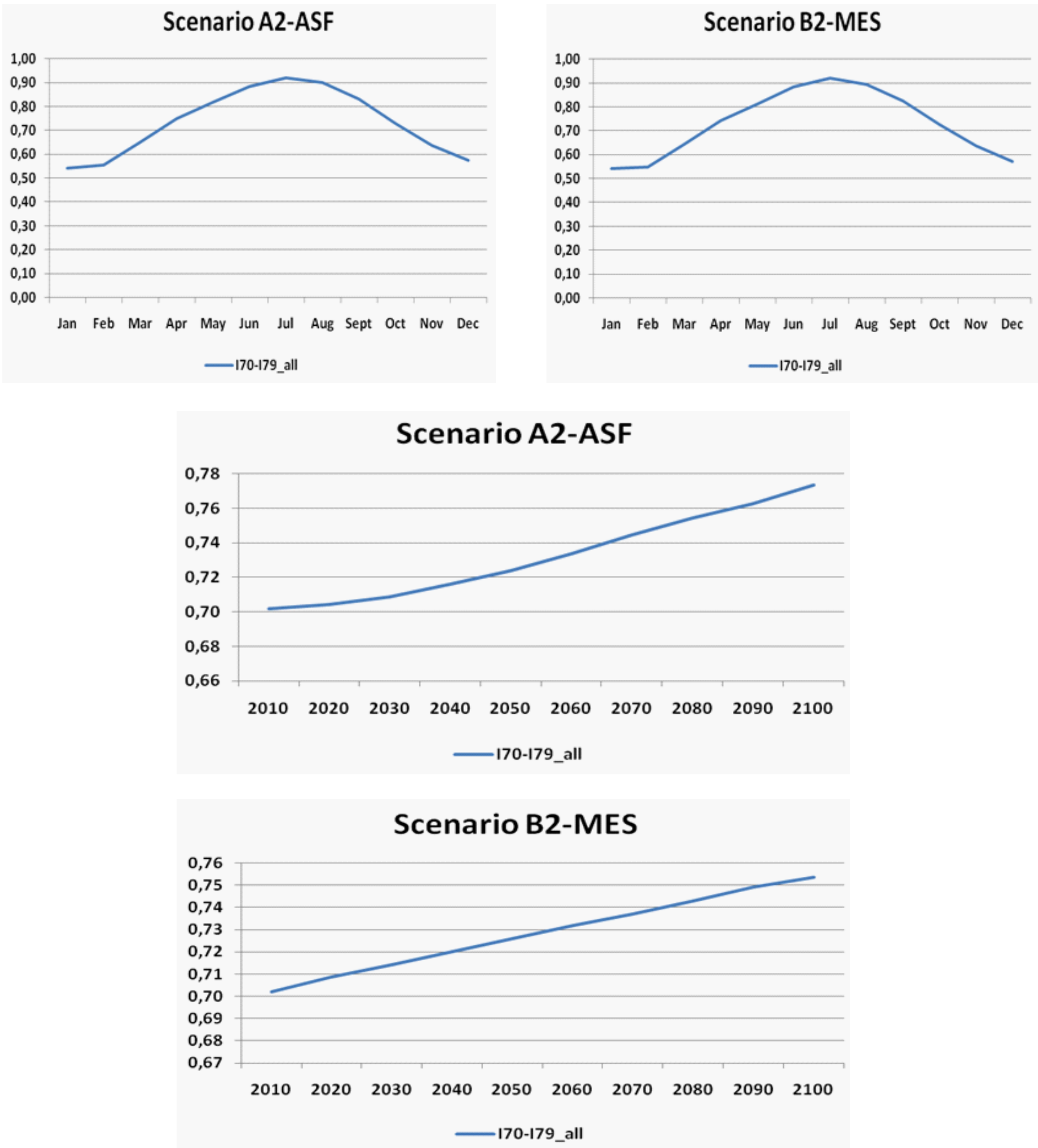

Fig. 3. Predicted morbidity levels in the city of Bishkek due to diseases of the arteries, arterioles and capillaries (all age classes combined)

It should be noted that responses to the expected temperature changes differed among age classes. Thus, in age classes 0 - 1 and 75+ years by 2100, compared to the baseline period 2007-2009, the percent change from baseline to 2100 under the two climatic scenarios is greater in females than in males, whereas a different situation is expected in age class 65 - 74 years: under both scenarios, by the year 2100, morbidity levels due to diseases of the respiratory system (J00 - J99) will be lower in males than females, while the percentage change will be greater in males under scenario A2 - ASF (9.7%, 308.8 cases per 100,000 people) than under scenario B2 - MES (7.0%, 318.0 per 100,000), compared to the baseline of 343.0 cases per 100,000 people. Predicted population morbidity levels due to respiratory diseases (J00 - J99) in the three vulnerable age classes under the higher temperature model are shown in Fig. 4.

Analysis of projected infectious morbidity (A00 - A99) of the population of Bishkek according to ambulance call data revealed that the maximum number of cases was observed for age class 0 - 1 year in the summer (790 - 890 cases per 100,000 people in July) and the minimum in winter (300 - 370 cases per 100,000 population in January). Under climatic scenario A2, acute intestinal infectious diseases are expected to increase in children under one year of age by 18.2% (boys) and 17.8% (girls) by the year 2100 compared to the year 2010.

Conclusions

1. Assessment of the impact of climate change on health revealed dependences of the circulatory system and respiratory diseases on climatic-meteorological factors.

Fig. 4. Predicted population morbidity levels (J00 - J99) by age class under climate change scenario A2 - ASF.

2. The most vulnerable individuals according to registered calls to the ambulance station in Bishkek city were in age classes 75 years and older, infants from 0 to 1 year old and 65 - 74 year olds. The number of calls was higher in summer (26.1%) than in winter (24%).
3. Adults of 75 years of age and older suffered most from diseases of the heart (I00 - I52), followed by individuals of 65 - 74 and 45 - 64 years of age, with morbidity rates being higher in women than in men.
4. Artery, arteriole and capillary disease cases (I70 - I79) are expected to increase by 10.5% in 2100 compared to 2010.
5. A relationship was observed between the morbidity rate of circulatory system diseases (I00 - I99) in 65 - 74 year old men and 45 - 64 year old women and meteorological data (amount of precipitation). Men aged 75 years and older are more vulnerable to change of air temperature and air pressure compared to women of the same age.
6. Rate of morbidity due to circulatory diseases (I00 - I99) per 100,000 people is 1.4 - 2.1 times higher in men than women. The most vulnerable individuals are those aged 64 - 75 years, followed by age classes 75 and higher and 45 - 64 years.
7. High levels of morbidity in circulatory system diseases (I00 - I99) among individuals of 75+ years of age will be observed in July (240 cases per 100,000 people) under two climate scenarios A2-ASF and B2-MES. By 2100, compared with 2010, population morbidity will increase by 2.4% under scenario A2-ASF and by 1.6% under scenario B2-MES.
8. In respect of respiratory diseases, it was found that three age classes are vulnerable to air temperature: infants aged 0 - 1, individuals aged 75 years and older and those aged 64 - 75 years.
9. Men are more vulnerable to low temperature climate changes, in respect of respiratory diseases (J00 - J99). Men aged 75 years and older are therefore expected to have rates of disease 1.9 times higher than women (917.7 cases per 100,000 people versus 459.9, respectively).
10. Women aged 15 - 44 years are more sensitive to change in air pressure; they showed a direct effect of air pressure on population mortality due to respiratory diseases (J00 - J99).

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