center for scientific research of economics and entrepreneurship

The Contribution of Weather and Climatic Conditions in Shaping Population Health

Yakovleva T. P.[1], Soshenko M.[1], Arslanbekova F.[1]

[1]Department of Ecology and Technospheric Safety, Russian State Social University, (RUSSIA)

yakoff.t@yandex.ru, soshenkomv@mail.ru,

Abstract

Objective: to assess the contribution of natural and climatic conditions to the formation of health of the population living in the third climatic zone of Russia (compared to the second zone); the relationship between the daily calls for emergency medical care of the adult population in connection with diseases of the circulatory system and daily levels of meteorological parameters. The object of the study was the adult population living in different climatic zones of Russia with different winter temperatures (-9,0 °C; -18,0 °C). The contribution of the climate factor was assessed by calculating the hypothetical (standardized) mortality rate (SIR) for cerebrovascular diseases (CVB) according to the international classification of diseases (ICD-X). The index method was used to assess the contribution of the studied factor to the formation of public health. Our research has shown that living in natural and climatic conditions with low winter temperatures contributes to an increase in the mortality rate of men from cerebrovascular diseases (CVB).

Keywords: climatic zone, socio-economic characteristics of the region, age groups, mortality of rural population, challenges to emergency medical care.

1 INTRODUCTION

Well-being, and moreover, health, is often associated with weather and climatic conditions: changes in air temperature, air humidity, fluctuations in atmospheric pressure [1-14]. This is especially true for people suffering from chronic diseases of the circulatory system and respiratory system. Although it is known that the causes of these diseases often lie in the biological and social sphere, it is necessary to consider other factors that can provoke their exacerbation and affect everywhere and constantly - these are meteorological factors. In addition to weather characteristics in winter, it should be borne in mind that a significant territory of Russia is in the Urals, Siberia, the Far East, where winter temperatures reach extremely low values.

The territory of Russia includes various climatic zones, with their inherent complex of factors: temperature, wind speed, snow cover, etc. [15-17].

Permanent residence in the Northern regions of Russia with a sharp reduction in daylight hours in the autumn-winter period, a long period of stable snow cover cause stress adaptation mechanisms of the human body and the human body cannot be indifferent to it. This factor is considered by physiologists as a stress factor that requires the mobilization of all resources of the body. As a result of the long-term interaction of the human body with the environment adaptation occurs with the formation of a certain level of homeostatic regulation of body functions. At high intensity of climatic factors, maladaptation may occur, accompanied by the development of pathological conditions [18].

The aim of the work is to assess: 1) the contribution of natural and climatic conditions to the formation of health of the population living in the third climatic zone of Russia; 2) the relationship between the daily calls for emergency medical care of the adult population of the Moscow region in connection with diseases of the circulatory system (hypertension, coronary heart disease, vegetative-vascular dystonia) and daily levels of individual meteorological parameters (temperature, humidity) and ozone concentrations in the surface layer of the atmosphere.

The aim of the work is to assess: 1) the contribution of natural and climatic conditions to the formation of health of the population living in the third climatic zone of Russia; 2) the relationship between the daily calls for emergency medical care of the adult population of a town near Moscow in connection with diseases of the circulatory system (hypertension, coronary heart disease, vegetative-vascular

dystonia) and daily levels of individual meteorological parameters (temperature, humidity) and ozone concentrations in the surface layer of the atmosphere.

The objects of the study were: 1) the population of the subjects of Russia II and III climatic zones; 2) the settlement of the Moscow region (II climatic zone) to assess the impact of meteorological parameters and geomagnetic background on the health of the population (75 thousand people).

Materials and methods. To achieve the objectives of the study with the use of mathematical-statistical methods.

For climatic zoning, the division of the territory of Russia into zones is used depending on the combination of low temperatures and wind speed characteristic of different regions of Russia (table 1).

Table 1 – Climatic zoning of the territory of Russia in the cold period of the year1

Climate zone	Temperature air in winter months, °C	Average wind speed in winter months, m/s
III	-18	3,6
II-I	-9,7	6,0

The climate of the region determines the degree of cooling of the human body when it is in the open area. This principle of climatic zoning is used as a criterion for the harmful effects of cooling on the human body when working in the open area in the cold season, in the development of clothes for protection from the cold, determining the permissible time of stay of a person in the cold, used in the Technical regulations of the Customs Union "On the safety of personal protective equipment" (TR CU 019/2011).

The basis for the allocation of climatic zones in these regulations are the features of climate, expressed in the form of a set of conditions that affect the processes of heat exchange, and subjectively, the perception of climate comfort [18].

Natural and climatic conditions of the III and II climatic zones of Russia (Novosibirsk and Penza regions) in the cold period of the year differ in terms of average annual temperature (more than -5°C), wind speed in winter (6.0 m/s against 3.6 m/s), the average temperature in January (-18°C against -9.8°C), which characterizes the features of the 3rd and 2nd climatic zones of the Russian Federation. In the Novosibirsk region climatic conditions are characterized by long winters (up to 180 days), low winter temperatures (up to -46°C) with a significant wind speed.

These areas are comparable in several characteristics: the national composition is mainly represented by the Russian population: 93.1% and 86.8% respectively, socio-economic characteristics are also comparable. Socio-economic indicators of the Novosibirsk and Penza regions are presented in table. 2.

Table 2 - Main socio-economic characteristics of the Novosibirsk and Penza regions in 2017[2]

Socio-economic characteristics	III climate zone (Novosibirsk region)	II climatic zone (Penza region)
Population (thousand people))	2788,8	1331,7
Average per capita cash income (per month), RUB	25313	21611
The cost of a fixed set of consumer goods and services (at the end of the year): RUB.	7764	13073,5
Unemployment rate, percent	6,0	4,5
Number of doctors, people (per 10,000 population)	53,1	42,0
Number of persons with higher and incomplete higher education (per 1000 population)	291	229

[1] Source: Technical regulation of the Customs Union TR CU 019/2011 "On the safety of personal protective equipment", approved. The decision of the Commission of the Customs Union of December 9, 2011 N 878.
[2] Federal state statistics service. region of Russia. The main characteristics of the subjects of the Russian Federation. – 2018.

To solve this problem, the official data of Rosstat were used: the Russian statistical Yearbook 2013-2017, information and analytical materials: regional data on the population of the Russian Federation by sex and age, Statistical Bulletin "Socio-economic indicators of poverty, Regions of Russia. Socio-economic indicators, statistical Bulletin "Cash incomes and expenditures of the population", Demographic Yearbook of Russia 2017.

The contribution of the climate factor was calculated based on additional deaths from causes, the formation of which may be the result of exposure to cold and prolonged winter [19-21]. Deaths from cerebrovascular diseases were analyzed.

The method of standardization by age, with the subsequent calculation of the share of the influence of factors of age structure and intensity of indicators, allows to solve the task and to expand the analytical capabilities of the overall mortality rates. Age-specific indicators of the rural population of the Novosibirsk and Penza regions (men and women) and age-specific mortality rates from these causes of the study (for 2017) were used for calculations. Statistical evaluation of the presence of "impact – death" was carried out by calculating the standardized relative risk of SIR (standardized incident ratio), with 95% confidence intervals (CI) [21]. The standardized relative risk (SIR) of adverse health effects was calculated as the ratio of the actual number of cases among the exposed persons to their expected number, if risk indicators in the control are taken as the standard. The formula was used to calculate 95% CI of the relative risk index:

$$95\%\ CI = \exp \ln RR \pm 1{,}96\sigma(\ln RR).$$

2 RESULTS

Mortality coefficient from CVB, as well as the age structure of the population of the Penza and Novosibirsk regions are presented in table 3. It is obvious that in the Novosibirsk region the proportion of persons 60 years and older was slightly lower than in the Penza region, therefore, structural changes could adjust the mortality rate from cerebrovascular diseases (CVB).

Table 3 - Age structure and mortality from CVB in men in rural areas of Novosibirsk and Penza regions (2017.)

The age	The age structure of the rural male population		CSM from CVB (per 1000 population)	
	Novosibirsk region	Penza region	Novosibirsk region	Penza region
20 -29	0,18	0,18	0,08	0,07
30 – 39	0,2	0,18	0,19	0,14
40 – 49	0,18	0,19	0,48	0,43
50 - 59	0,25	0,24	1,5	1,5
60 - 69	0,13	0,14	4,7	3,12
70 -79	0,06	0,08	14,9	8,0
Итого	**∑1,0**	**∑1,0**	**2,04**	**1,52**

The differences in mortality rates of the population living in different climatic conditions are obvious. But it is also clear that in the more northern region, the proportion of older persons is lower. This, of course, affects the overall mortality rate from circulatory system diseases, including cerebrovascular diseases.

The standardized (hypothetical) mortality rate (SOR) of the conditional population group was based on their assumption that the age structure of the population of the Penza region remains, but the death rates of workers in each age group correspond to the population of the third climate zone, i.e. population of the Novosibirsk region.

The obtained value of the standardized death rate from CVD (COP = 2,3, 95% CI 1.5-2.7) is higher than the mortality rate obtained for both the rural male population of the Penza region and the corresponding population of the Novosibirsk region (1.52 <2.04; 2, 04 <2,3). Age-related structural differences and differences in intensive indicators contribute to the final actual difference in mortality rates of the rural male population of the Penza and Novosibirsk regions of Russia.

The overall difference between the death rates of rural male tsv on the population of the two regions is 0.53% 0 (taken as 100%). The difference between the hypothetical death rate from the CVD and the

actual death rate obtained for the rural population of the Penza region is (2.3% 0 - 1.52% 0 = 0.78% 0) and reflects the influence of climate (147.2%).

Comparison of the death rate of the male population of the Novosibirsk region compared with the hypothetical mortality rate reflects the contribution of age-related structural differences among the male population of rural areas in two regions of Russia. The difference between the real mortality rate of the rural population of the Novosibirsk region and the hypothetical indicator was: 2.05% 0-2.3% 0 = -0.25% 0. Those. the influence of structural age differences between the subjects of Russia located in the third and second climatic zones is an inhibiting factor and amounts to (-47.2).

Table - 4 Percentage of the impact of structural differences and mortality rates on the differences in mortality rates of the population from the CVD of different climatic zones (Climate Belt II and Climate Belt III).

CVD	Difference in mortality rates	Impact share (%)	
		Age structure	Climatic factor
	0,53 ‰	-0,25 ‰	0,78 ‰
	100,0 %	-47,2	147,2

During the observation period (0.5 years), 2,800 calls to the emergency medical service were registered in the Moscow region in connection with hypertension, coronary heart disease and vegetative-vascular dystonia. More than 70% (71%) of applicants were 60 years old and older. Almost all weather characteristics correlated with each other. For example, the correlation coefficient between the concentration of ozone in the atmospheric surface layer and air temperature was -0.5, i.e. the higher the air temperature (in winter), the lower the concentration of ozone in the surface layer of the atmosphere.

In the cold period (November-December), with a decrease in air temperature by 1 ° C, the number of emergency medical care calls increased by 1.25%. The correlation coefficient between a decrease in air temperature and an increase in blood pressure in patients with hypertension was moderate and negative (r = -0.64) during the cold winter period (November, December) of observation: the lower the air temperature, the more urgent medical care calls were recorded. . The data obtained are reliable with a probability of 99.9%.

The geomagnetic background made almost no adjustments to the well-being of the population. The strength of the connection between the magnetic background and ambulance calls was insignificant - the correlation coefficient was only -0.02.

Thus, it was shown that lowering the temperature of atmospheric air during the winter period by 1 ℃ contributes to an increase in the number of ambulance calls by 1.25% due to circulatory system diseases. Living on a territory with a long cold winter (III climatic zone of Russia) contributes to the formation of higher mortality rates from cerebrovascular diseases, respiratory diseases in the population, compared with the population living in the II climatic zone of Russia.

3 FINDINGS

1. Among the meteorological characteristics of the most significant impact on the rate of ambulance calls has air temperature. Lowering the temperature of the atmospheric air in winter by 1 ℃ contributes to an increase in the number of ambulance calls by 1.25% (g = -0.64, P = 99.9).

2. Among those who applied for emergency medical care more than 70% make up a person 60 years or more.

3. Correlation between the indicators of geomagnetic background and ambulance calls were not identified.

4. It was revealed that the contribution of the climatic factor (III climatic zone of Russia) to the formation of differences in the mortality rates of the male and female rural population of the Novosibirsk region, compared with similar indicators obtained for the population of the Penza region (II climatic zone of Russia), due to cerebrovascular diseases and respiratory diseases in the age range from 20 to 80 years, is leading, while the influence of age differences (structural) of the compared areas has the opposite effect, reducing them, because in the structure of the population of the Novosibirsk region, the proportion of persons 60 years and older is significantly less.

REFERENCES

[1] Ellis KN, Brown VM, Hathaway JM, Howe DA, Epps TH, Mason LR. Summer temperature variability across four urban neighborhoods in Knoxville, Tennessee, USA. Theor Appl Climatol. 2017;127(3-4):701.

[2] Tomczyk AM, Bednorz E, Piotrowski P. Warm periods in northern Europe with respect to atmospheric circulation. Theor Appl Climatol. 2017;129(1-2):623-34.

[3] Zhang B, Li G, Ma Y, Pan X. Projection of temperature-related mortality due to cardiovascular disease in Beijing under different climate change, population, and adaptation scenarios. Environ Res. 2018 Apr; 162:152-59.

[4] Revich BA, Shaposhnikov DA, Avaliani, SL, Rubinshtein KG, Yemelina SV, Shiryaev MV, Semutnikova EG, Zakharova PV, Kislov OYu. Assessment of health risks posed by high temperature and air pollution for population of Moscow. Hygiene and Sanitation. 2015; 1: 36-40.

[5] Mazzarella A, Scafetta N. Evidences for a quasi 60-year north Atlantic oscillation since 1700 and its meaning for global climate change. Theor Appl Climatol. 2012;3-4:599-609.

[6] Li Y, Ren T, Kinney PL, Joyner A, Zhang W. Projecting future climate change impacts on heat-related mortality in large urban areas in China. Environ Res. 2018 May; 163:171-85.

[7] Pascal M, Wagner V, Corso M, Laidi K, Bodo P. Mortality from heat and cold in 18 French cities. Environ Int. 2018 Dec;121(1):189-98.

[8] Lee W, Choi HM, Lee JY, Kim DH, Kim H. Temporal changes in mortality impacts of heat wave and cold spell in Korea and Japan. Environ Int. 2018 July; 116:136-46.

[9] Smith ET, Sheridan SC. The influence of extreme cold events on mortality in the United States. Sci Total Environ. 2019 Jan 10; 647:342-51.

[10] Chen TH, Li X, Zhao J, Zhang K. Impacts of cold weather on all-cause and cause-specific mortality in Texas, 1990-2011. Environ Pollut. 2017 June; 225:244-51.

[11] Dorshakova NV, Karapetyan TA. Features of pathology for northern residents. Hum Ecol. 2004; 6:48-52.

[12] 12.Borisenkova E.P., Karpenko V.N. Climate and human health. International symposium of WMO, WHO, UNEP. [Mezhdunarodny simpozium VMO, VOZ, YuNEP]. Leningrad;1986, September 22-26. (in Russian).

[13] Rocheva E.V., Smirnov V. D. About tendencies in change of duration of "heat waves" in the territory of Russia. Problemy ekologicheskogo monitoringa i modelirovaniya ekosistem. 2013; 25: 94-114. (in Russian).

[14] Sedov V.E. About climatic fluctuations and tendencies of climate of modern Moscow. Meteorologiya i gidrologiya. 2012; 8: 47–58. (in Russian).

[15] Prokhorov BB. Environmental health zoning and regional health forecast for the population of Russia. Moscow: MNEPU; 1996.

[16] Trofimova IE, Balybina AS. Classification of climates and climatic zoning of the West Siberian plain. Geography and Natural Resources 2014; 2:11-21.

[17] Ivanov AI, Chernyshov NV, Kuzin EN. Natural conditions of the Penza Region. Contemporary condition. Volume 1. Geological environment, relief, climate, surface water, soil and vegetation. Monograph. Penza: RIO PGAU; 2017.

[18] Kaznacheev V.P. Modern aspects of adaptation. [Sovremennye aspekty adaptatsi]. Novosibirsk: Novosibirskoe otdelenie izdatel'stva «Nauka»; 1980. (in Russian).

[19] Federal State Statistics Service. Regions of Russia. Main characteristics of subjects of the Russian Federation. Moscow; 2017. 835 p.

[20] Kupriyanov VV. Climate. Penza encyclopedia. Moscow: Scientific publishing company “The Big Russian Encyclopedia”; 2001. p. 238-40.

[21] Breslow NE, Day NE. Statistical methods in cancer research. Vol. II – The design and analysis of cohort studies. IARC Scientific Publication 82. Lyon: International Agency for Research on Cancer; 1987.