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ELDERLY MORTALITY AND CLIMATE AT THE RUSSIAN FAR EAST

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Medical and demographic statistics for elderly population is analysed for the regions at the Russian Far East, namely Primorsky and Khabarovsky Krai, Amur Region and the Jewish Autonomous Region (JAR), showing rapid growth of people at age cohort 65 years and older with double excess of women over men. On the contrary, "gender mortality dimorphism" at elderly ages is registered meaning all-cause mortality is 1.5-2.5 times higher for men than for women. More than 70% of all human losses for elderly population are caused by diseases of the circulatory system and neoplasms. Wet Kata Cooling Power by Hill, Net Effective Temperature and Wind Chill are bioclimatis indices chosen to illustrate the impact of climate on elderly mortality. The results show strong dependence of cardiovascular mortality on climate. Even keeping in mind that man-made social and economic environment plays great role in morbidity and mortality of elderly population, medical society must remember that critical exacerbation of chronic diseases can be triggered by discomfortable weather conditions. The results obtained can be used by health professionals in the development of strategies to mitigate the effect of weather in a changing climate, to promote, preserve and maintain public health.

Keywords: *elderly population, mortality, climatic discomfort, Russian Far East.*

Introduction

Modern medicine faces challenges of global scale in providing assistance to a person at the vital stage near the limit of biological age. Population ageing accelerates morbidity rate, lead to an increase in morbidity and mortality worldwide. Older people diseases are aggravated by age-related changes in various organs and systems; elderly morbidity is characterized by a growing number of patients with chronic diseases of endogenous character (cardiovascular system and cancer). As a result of the population ageing and stable growth in morbidity during the last decades, elderly mortality increase occurs in Russia and its regions [2].

Social development is the priority issue for the eastern regions of Russia, especially those close to the state border [23]. In general it has obvious social, economic and geopolitical consequences for the future of the Russian Far East (FE). The problem creates potential threat to national security not only on the regional scale, but also throughout the country [20]. Statistics show that the rate of population aging is 2.6 times higher at the FE than the national average, raising significant social, economic, medical and social challenges [16].

It is well known, that FE is a climatically extreme region with a massive gradient of thermal comfort; weather and climate here affects human health and well-being, causing additional increase in morbidity and mortality [7, 9, 10]. Elderly people with cardiovascular and respiratory disease are sensitive to weather and its changes, and are considered the most climate vulnerable part of the population [3–5, 7, 17, 18, 25]. The aim of the current work is medical and demographic analysis of the elderly population, and the study of the relationship between elderly all-cause and cause-specific mortality and thermal (dis)comfort in the south of the FE.

Data and Methods

Russian FE is located at the territory with diverse topography, including plains and mountains, in the temperate monsoon climatic zone. It is characterized by an extreme continental regime of annual temperatures, noted for its excessive variability. The area is influenced by the great Asian continent, on the one hand, and the vast water basin of the Pacific Ocean, on the other. Conditions in winter are similar to those in Siberia with cold temperatures and high wind. In summer, the climate is like that of the warm, humid tropics with high air temperatures and high relative humidity [11, 12].

The study area is a continental part at the south of the Russian FE, and includes Primorsky and Khabarovsky Krai, Amur Region and the Jewish Autonomous Region (JAR). Standard climatic data used are monthly air temperature, relative air humidity and wind speed from the Handbook of Climate. Demographic data used are for period 2000-2015 [24]; mortality all-cause and cause specific data separately for two gender groups with special interest on elderly people of age cohorts 65 years and older (age cohorts 65–70 (D65), 70–75 (D70), 75–80 (D75), 80–85

(D80), 85 and older (D85)), are taken for period from 2011 to 2017 [19]. Non-accidental mortality is classified according to the International Classification of Diseases and Related Health Problems, 10th revision (ICD-10 codes A00-R99; World Health Organization 2007): ICD codes I00-I99 for cardiovascular mortality.

Human thermal stress and climatic discomfort it causes is analyzed; combination of bioclimatic thermal indices is calculated using climatic data. Thermal indices most suitable for a particular application are chosen according to the results of the previous special research project [6, 8]. Particularly, indices accepted for thermal (dis)comfort estimation in current work are: Net Effective Temperature [1], NET (°C); Wet Kata Cooling Power by Hill [14], H (W m^{-2}); and Wind Chill by Siple and Passel [21], WC (kcal m^{-2} hr^{-1}) – those highly explored in the former Soviet Union and in Russia. The output for NET is equivalent temperature, for H and WC – calorific unit [1, 8, 14, 21]. The previous research has shown that indices chosen are the most appropriate in the assessment of the climatic thermal impact on human well-being and comfort [9, 10, 12, 13]. There are three main advantages to using them: a) they are based on the main environmental parameters: air temperature, humidity and wind speed; b) simplicity of calculation and ease for interpretation by both specialists and laypersons; c) possibility of application all year round [6, 8, 13]. Methods for calculation of a particular index and its characteristics are available elsewhere [1, 10, 13, 14, 21, etc.].

Bioclimatic indices are estimated for each month and averaged for summer (months from June till August), winter (months from December till February) and for the whole year. Pearson's correlation is used to assess the linear relationship between thermal indices and elderly mortality. The following points are the accepted guidelines for interpreting the correlation coefficient (r): $r < 0.3$ – weak, 0.3 to 0.7 – moderate, $r > 0.7$ – strong positive relationship; negative values indicates an inversely proportional relationship.

Results and Discussion

Retrospective assessment of population dynamics in period from 2000 to 2015 demonstrates that change in its age and gender structure repeats the national trends with reduce of working-age population and the rapid growth of other cohorts, especially older ones. Proportion of elderly people in 2015 was 12.0 % in Khabarovsky Krai, the Amur Region and Primorsky Krai, and 11.1% in the JAR. According to the UN standards, the population of these regions has remained "old", and trends towards dramatic ageing coupled with a steady decline in total population. During study period population of 65 years and older increased by 5.9% in Primorsky Krai (with total 259.3 thousand people in 2015), by 3.1% in Khabarovsky Krai (161.5 thousand people), by 2.7% in the Amur Region (90 thousand people), and by 6% in the JAR (18.8 thousand people). Another issue of concern is a double excess in the number of elderly women over men, which demonstrates a significant gender disproportion.

At the same time, analysis of elderly mortality shows that gender disparity is stratified reversely with excess of male mortality over the female mortality. In 2000–2015 the indicator of "gender mortality dimorphism" for age cohort 65-69 years was 2.4–2.7 in Khabarovsky Krai, 2.2–2.5 in the JAR, 2.2–2.7 in the Amur Region, 1.8–2.3 in Primorsky Krai. For the age cohort 70 years and older, the excess was 1.4–1.5 in Khabarovsky and Primorsky Krai and in the Amur region; 1.4–1.8 in the JAR.

During the last years the structure of mortality causes for elderly population has not changed significantly both in the study area and in Russia as a whole. The leading causes of death in cohorts 65–69, and 70 years and older are diseases of the circulatory system and neoplasms, giving almost 75–85% of all human loss. In the JAR in 2015 diseases of the circulatory system was at the first place contributing 59% to the total mortality, 50.6% of which were coronary heart disease and 26.6% – cerebrovascular diseases [22].

Bioclimatic comfort indices are calculated separately for both warm and cold seasons. Winter thermal conditions refer the entire study area to the zone with "extremely cold" conditions and an extremely high probability of freezing. Low temperatures are aggravated by strong winds and high humidity. As a result, the perceived temperatures expressed by NET (°C) are lower than the actual ones by up to 20–30°C, reaching −50…−55°C. For example, extreme weather caused by strong winds is observed in river valleys (e.g. Amur River) or on the coast of the Pacific Ocean. At the same time, intermountain basins are described by less severity, despite lower actual temperatures. In summer almost all study area is characterised by comfort conditions with cool thermal discomfort further north. Overall, the negative NET value is lower if winter is more severe; vice versa, in summer positive NET is higher further to south where climate is warmer with maximum probability of heat waves. In winter both H and WC increase in regions where climate conditions are characterised by stronger discomfort.

Linear correlation coefficients (r) were calculated to determine the relationship between bioclimate indices averaged for winter, summer and the whole year, and all-cause and cardiovascular mortality for two gender groups. All-cause elderly mortality showed moderate positive correlation for yearly NET (0.66) and for winter H (0.66). The most significant dependence on weather is found for cardiovascular disease. As an example, the highest results of correlation coefficients for bioclimatic indices and cardiovascular mortality separately for two gender groups and age cohorts 65–70 (D65), 70–75 (D70), 75–80 (D75), 80–85 (D80), 85 and older (D85), are summarized in Table.

Summary in Table demonstrates that cardiovascular mortality is recorded better by both yearly Hill index and winter Wind Chill, for both men and women and all selected age groups. In almost all cases male mortality has higher correlation coefficients than female mortality. Results in Table are almost similar for all age groups. The values with lower coefficients not shown in Table, present moderate correlation for cohorts from 65–70 till 75–80 indicating these age groups are sensitive to weather, especially those with cardiovascular disease. However, correlation is weak for elder groups 75–80, 85 and older; they die mostly of old age and depend more on quality of life.

Previous studies have shown that NET is the better indicator of the relationship between climate and morbidity [9, 10]. Current analysis reveals elderly mortality can be determined by any index, with particular interest to Hill for cardiovascular male and female mortality.

Generally speaking, elderly population is more vulnerable to climate effects than younger age groups, as heat transfer mechanisms in older people are not sufficiently stable. Literature review shows that physiologically aged blood vessels are influences by weather more effectively [2–5, 15, 17, 18, etc.]. Moreover, comprehensive assessment of climate and weather impact on human life should consider not only its thermal load, but sudden changes of air temperature, air pressure and wind speed [7]. Changeable weather with day-to-day fluctuations, especially in winter and in transitional seasons, adversely affects people with heart failure and bronchopulmonary diseases.

Nevertheless, it must be borne in mind that man-made social and economic environment plays a great role in morbidity and mortality of the whole population, as well as of its elderly cohort. Center for control and prevention of diseases of the United States notes that the risk of additional deaths related to the weather (including heat waves, cold, floods and storms), can be 2–7 times higher in areas with low income compared to areas with high income [4]. At the same time, climate and weather amplify negative economic situation. In most cases, an increase in mortality can be recorded, when specific cause of death is not hypothermia or heat stroke, but other pathological conditions, for example, aggravation of chronic illnesses. This identification of death causes is mainly associated with a critical exacerbation of chronic diseases triggered by discomfortable weather conditions.

Conclusion

Current research illustrates rapid growth in elderly age population at the south of the Russian Far East in last decades with a double excess of elderly women over men. Conversely, the all-cause elderly mortality is higher for men than for women: in study ares "gender mortality dimorphism" is more than 1.5-2.5 for age cohort 65 years and older. The structure in death causes of elderly population indicates that diseases of the circulatory system and neoplasms are the leading causes of elderly mortality, giving more than 70% of all human losses in old age. Bioclimatic indices selected for the characteristics of climatic discomfort show good results in estimation of their effect on mortality of people 65 years and older, and can be used for detailed studies at the meso-and micro levels. Future research on daily mortality and weather data will help to identify the primary drivers of weather-related health impacts, with the main ultimate goal to develop targeted interventions to mitigate the effects of weather in a changing climate.

Table

Results of correlation analysis between bioclimate indices averaged for summer and year, and cardiovascular elderly mortality, Russian Far East

Bioclimate Index	NET* (year)		H (year)		WC (summer)	
Age cohort/Gender	male	female	male	female	male	female
D65	−0,85	−0,77	0,96	0,95	0,98	0,95
D70	−0,83	−0,76	0,95	0,99	0,98	0,95
D75	−0,78	−0,68	0,96	0,93	0,95	0,90
D80	−0,84	−0,65	0,97	0,94	0,98	0,88
D85	−0,76	−0,60	0,98	0,95	0,95	0,85

*Net Effective Temperature, NET [1]; Wet Kata Cooling Power by Hill, H [14]; and Wind Chill, WC by Siple and Passel [21]

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