FUNCTIONAL RELATIONSHIP BETWEEN DRINKING WATER AND HUMAN HEALTH IN CLIMATE CHANGE

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Abstract: The article discusses the issues of determining the functional relationship between the quality of drinking water and the prevalence of diseases among the population in the context of climate change. In the context of globalization of global economy and intense competition and steady increase in population, mortality rates among people with infectious and parasitic diseases are increasing. International organizations are also paying much attention to fighting these problems and their consequences. In particular, the UN Sustainable Development Program up to 2030 emphasizes "issues related to the elimination of immunodeficiency, tuberculosis and malaria epidemics in the period up to 2030, as well as measures to combat hepatitis and other waterborne infections". Successful implementation of these tasks requires stabilization of nosocheological and nosogeographic situations in arid climates. Medical geographical situation in the regions is one of the most important factors determining the development of society and the way of life of the population. Addressing medical geographical problems and improving public health, reducing morbidity and increasing life expectancy are of vital scientific and practical importance.
Introduction

The main geographic factors affecting the health of the population of the Republic of Uzbekistan. The geographical position, relief, climatic features of our country determine its natural conditions. The combination of natural and geographical conditions, especially non-climatic factors (soil, water, air), affects the health of people living here.

One of the peculiarities of the climate of our republic is the change of seasons. Each season differs in its natural characteristics, with an increase in some diseases, with a decrease in some. In particular, due to a sharp drop in temperature in winter, the incidence of infectious diseases decreases, and in humans, due to sharp changes in temperature, the incidence of colds increases. Global and regional climate change in Uzbekistan shows that in 20-30 years the average annual temperature in the country is expected to increase by 2-30°C in the northern regions and by 10°C in the southern regions (Chub V.E., 2003). This leads to the development of certain diseases.

Main port

Climate change is the most significant challenge of the twenty-first century with the potential to cause significant human and economic damage¹. The 21st Conference of the Parties to the United Nations Framework Convention on Climate Change, held in Paris in December 2015, saw a commitment by states to keep the increase in temperature to no more than 2°C compared to preindustrial levels and to attempt to limit the increase to 1.5°C. Even if this is achieved, significant changes are likely to occur, posing increasing threats to communities and infrastructure[7,8,9].

¹Stern N. 2006. The Economics of Climate Change: The Stern Review. Cambridge, UK: Cambridge Univ. Press

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As humanity enters the 21st century, it is confronted with nosoeccological conditions, new and new drugs and treatments that were and are not typical of previous periods. This is often explained by the growing globalization of the world economy and the steady growth of the population, the increasing pressure on people, urgency, inactivity. Therefore, the UN Program for Sustainable Development until 2030 states that "until 2030, the elimination of epidemics of diseases such as AIDS, tuberculosis, malaria, as well as measures to combat hepatitis and other waterborne diseases" special attention was paid to The fact that some highly contagious diseases, which were reported to be completely extinct in the middle of the last century, are common among the population of some parts of the world, as well as the study of the geographical distribution of COVID-19 coronavirus infection, makes this issue extremely relevant. The implementation of these tasks poses important tasks not only for medical staff and the general public, but also for specialists in medical geography, who diagnose the existing diseases in the regions, ie the nosogeographic situation.

It is known that the analysis of regions in terms of nosogeographic situation is of great importance in medical geographical research. The nosogeographic situation is primarily characterized by the mortality rate of the population in a particular place or area, life expectancy, general morbidity, the presence of foci or areas of disease. As an extremely delicate, influential territorial system, it is highly variable as it depends on a variety of natural and socio-economic factors. The ecological and demographic conditions of places also have an impact on the nosogeographic situation. In economic and social geography, as well as in geography in general, regional complexes play an important role. A comprehensive approach to this science, the identification of different regional systems, regional structures and regional complexes are among the important methodological issues. In this regard, the study of such complexes is also required in the geography of human diseases - nozogeography.

Nozogeographic complexes or nosogeographic complexes are a territorial combination of various diseases that occur under the influence of certain natural geographical and socio-economic, social environment (space). Such complexes are
usually associated with natural geographical and economic landscapes as well as specific sociogeographical environments [1].

Nozo-complexes can be divided into the following groups:

1. Climate-related anomalies - in which the influence of air temperature and humidity, atmospheric pressure, etc. on their formation and development is primary.

2. Hydrogen anomalies - surface water sources, including canals, swamps, rivers or lakes are recognized as a leading factor in the emergence and spread of diseases (malaria, plague, etc.).

3. Disease-causing effects of groundwater on hydrogeogenic anomalies play a key role, for example, diseases caused by diseases of the kidneys, digestive system, metabolic disorders.

4. Chymogenic nosomasms - the formation of certain diseases (endemic goiter, urolithiasis, etc.) associated with the geochemical composition of landscapes, including the deficiency or excess of certain micronutrients.

5. Biogenic nosomomies - a set of diseases caused by living organisms (viruses, bacteria and other microorganisms; insects, rodents, etc.) and the diseases caused by them.

6. Socio-economic anomalies - mainly in industrial or transport hubs, in areas with high demographic pressure. Cardiac, vascular, nervous system, malignant tumors are more common in such nosomomies ².

It is known that the solution of environmental problems in the regions is largely determined by the socio-demographic and environmental policy on a scientific basis. The ethnic identity, lifestyle and traditions of the population of our country play an important role in this. In general, each region has its own environmental problems related to public health.

Discussion


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As a result of medical geographic surveys, a set of thematic cards can be created. Such cards are made at the Institute of Geography of the Russian Academy of Sciences, the Department of Geography of the Academy of Sciences of the Republic of Uzbekistan. In the zoning of the population in terms of its health, the allocated territories differ from each other by the prevalence of various diseases. From this point of view, geography of the population is an important area of social geography as the theoretical and methodological basis of medical geography.

In the study of medical geography, as in other geographical studies, a comprehensive, integrated approach is essential. This implies two distinct meanings: first, the complex, comprehensive, interdisciplinary study of the research object; This is especially true in the area of healthcare. It is well-known that regional complexes play an important role in economic and social geography and geography in general.

In the case of Samarkand region, we tried to determine the relationship between the quality of well water consumed by the population and some diseases. We took the hardness and mineralization level of the water as the main indicators of the well water and the associated kidney stone formation and gastrointestinal diseases.

Table 1

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3Compared to other regions, the large number of industrial enterprises, population size and density have a specific impact on the nosogeographic situation in the region, the incidence of disease groups (circulatory, malignant tumors, nervous system, birth defects, etc.) is mainly large population and industry in the region, observed in the centers. The cities of Tashkent, Angren, Almalik, Bekabad and Chirchik stand out not only in the region, but also in our country in terms of environmental pollution. At present, this medical geographical region has the highest mortality rate in the country. In 2019, among the deaths of the population of all causes in the country, the death rate in the circulatory system was more than 60.0%, while in Tashkent, the number of deaths from malignant tumors is equal, while in the capital it is significantly higher. The region also has the highest number of diseases in the nervous system, mental disorders, respiratory diseases. Analyzes show that the negative characteristics of the region, first of all, the large population, the concentration of industries, especially environmentally hazardous industrial enterprises (chemistry, thermal power plants, cement production, ferrous and nonferrous metallurgy) strongly influence the formation of nosogeographic situation. Probably, this is why the region is one of the leaders in the country in terms of infant and maternal mortality and overall mortality. In 2019, the overall mortality rate was slightly higher in Almalik, Yangiyul and Chirchik. This year, the infant mortality rate is highest in Parkent district, Almalyk and Ahangaron. It should be noted that this region is also in the worst position in the country in terms of maternal mortality. In the current year, the situation in Chirchik and Yangiyul in Almalik is slightly higher than the national level. This study focused on identifying the status of some common social diseases among the population in order to provide a more in-depth analysis of the nosogeographic situation. Because this region is characterized by the highest proportion of social diseases from other regions of the country. In 2019, a sad situation occurred in the cities of Chirchik, Yangiyul and Tashkent in the region. The cities of Chirchik and Almalik are also distinguished by the severity of mental illness. Even the rural district of Orta Chirchik has a much higher rate of mental illness than the national level[2].

The average hardness of well water and in the kidneys Indicators of stone formation diseases (per 100 thousand people)

<table>
<thead>
<tr>
<th>Cities and districts</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>Water hardness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urgut district</td>
<td>68</td>
<td>73</td>
<td>73</td>
<td>22</td>
<td>89</td>
<td>65</td>
<td>3.8</td>
</tr>
<tr>
<td>Taylak district</td>
<td>199</td>
<td>244</td>
<td>189</td>
<td>106</td>
<td>145</td>
<td>198</td>
<td>18.06</td>
</tr>
<tr>
<td>Payariq district</td>
<td>262</td>
<td>248</td>
<td>269</td>
<td>295</td>
<td>321</td>
<td>225</td>
<td>16.47</td>
</tr>
<tr>
<td>Ishtikhon district</td>
<td>63</td>
<td>36</td>
<td>72</td>
<td>40</td>
<td>55</td>
<td>83</td>
<td>17.29</td>
</tr>
<tr>
<td>Nurobod district</td>
<td>88</td>
<td>59</td>
<td>67</td>
<td>72</td>
<td>85</td>
<td>69</td>
<td>14.4</td>
</tr>
<tr>
<td>Narpay district</td>
<td>147</td>
<td>146</td>
<td>142</td>
<td>136</td>
<td>150</td>
<td>166</td>
<td>34</td>
</tr>
<tr>
<td>Average</td>
<td>137.8</td>
<td>134.3</td>
<td>135.3</td>
<td>111.8</td>
<td>140.8</td>
<td>134.3</td>
<td>17.3</td>
</tr>
</tbody>
</table>

Statistical analysis of the effect of chemical properties of well water on diseases of the gastrointestinal tract, kidney stones. First of all, we present the following statistics.

The histogram below shows the dynamics of the average change in kidney stone formation disease over the last 6 years:

![Histogram showing kidney stone formation disease dynamics](image)

Figure 1. Histogram of the dynamics of kidney stone formation
Based on Tables 1 and 2 above, we study the effects of the chemical properties of water on the corresponding diseases. We first examine this information for homogeneity: indicators of appropriate diseases $b_i (i = 1, 2, 3, 4, 5)$; correspondingly by means of indicators representing the chemical properties of water[3]. We use Fisher's test to check the homogeneity of the data:

$$F = \frac{\sigma_k^2}{\sigma_i^2},$$  \hspace{1cm} (1)$$

where $\sigma_k^2$ - large variance, $\sigma_i^2$ - small variance. We calculate the variances of the sample, first finding the average values of each sample (data are taken from Table 2):
\[
\bar{b} = \frac{1}{n} \sum_{i=1}^{n} b_i = \frac{1}{5} (4314 + 10256 + 12541 + 9521 + 8565) \approx 9039.4; \\
\bar{m} = \frac{1}{n} \sum_{i=1}^{n} m_i = \frac{1}{5} (0.952 + 1.248 + 1.856 + 2.448 + 4.104) = 2.12.
\]

This means that in 2016, the average rate of gastrointestinal diseases was 9039.4, and the average salinity of water was 2.12. We now calculate the errors, that is, the sample variances:

\[
\sigma_b^2 = \frac{1}{n} \sum_{i=1}^{n} (b_i - \bar{b})^2 = 7305543, \quad \sigma_m^2 = \frac{1}{n} \sum_{i=1}^{n} (m_i - \bar{m})^2 = 1.25.
\]

So, \(\sigma_b^2 = 7305543\) and \(\sigma_m^2 = 1.25\) will be. In that case

\[
F_{sys} = \frac{7305543}{1.25} = 5855554.
\]

Degrees of freedom \(k_1 = k_2 = n - k - 1\) (where \(k\) - number of selections, \(k = 2\) and the probability of confidence \(p = 0.95\) We find the corresponding critical point in the table of critical points of the Fisher distribution [1]:

\[
F_{kp} (2;2;0.05) = 19.0.
\]

As long as the calculated value of the statistic is greater than the critical point:

\[
F_{sys} = 4.9 < 19 = F_{kp}.
\]

This is about gastrointestinal disease and the degree of mineralization of water \((b_1,b_2,b_3,b_4,b_5)\) and \((m_1,m_2,m_3,m_4,m_5)\) indicates that the selections are not homogeneous. Based on the above calculations, the change in the incidence of gastrointestinal diseases in 2011-2016 can also be checked for homogeneity:

For 2011 and 2012 \(F_{sys} = 9.58\); 
For 2012 and 2013 \(F_{sys} = 6.26\); 
For 2013 and 2014 \(F_{sys} = 1.72\); 
For 2014 and 2015 \(F_{sys} = 1.04\);
For 2015 and 2016 $F_{sys} = 1.6$.

The value $F_{sys}$ of in each case is less $F_{kp}(2;2;0.05) = 19.0$ than the value of, which means that the change in gastrointestinal disease rates for 2011-2016 is homogeneous. We will now study the relationship between the chemical properties of water and the corresponding diseases. We determine the chemical properties of water $x_i$ ($i = 1, 2, 3, 4, 5$), disease indicators by $y_i$ ($i = 1, 2, 3, 4, 5$) (Taylak district):

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$x_i$</td>
<td>0.258</td>
<td>0.267</td>
<td>0.283</td>
<td>0.267</td>
<td>0.300</td>
<td>0.258</td>
</tr>
<tr>
<td>$y_i$</td>
<td>15307</td>
<td>7992</td>
<td>15089</td>
<td>4207</td>
<td>4561</td>
<td>15307</td>
</tr>
</tbody>
</table>

To determine the appearance of the relationship between them ($x, y$), we calculate the correlation coefficient of the random vector. The correlation coefficient is calculated using the following formula:

$$r_{x,y} = \frac{\overline{xy} - \overline{x} \cdot \overline{y}}{\sqrt{S_x^2 \cdot S_y^2}},$$

(2)

here $\overline{x} = \frac{1}{n} \sum_{i=1}^{n} x_i$, $\overline{y} = \frac{1}{n} \sum_{i=1}^{n} y_i$, $\overline{xy} = \frac{1}{n} \sum_{i=1}^{n} x_i y_i$ - accordingly $(x_1, x_2, x_3, x_4, x_5), (y_1, y_2, y_3, y_4, y_5)$ and $(x_1 y_1, x_2 y_2, x_3 y_3, x_4 y_4, x_5 y_5)$ average values of samples, $S_x^2 = \frac{1}{n} \sum_{i=1}^{n} (x_i - \overline{x})^2$, $S_y^2 = \frac{1}{n} \sum_{i=1}^{n} (y_i - \overline{y})^2$ - sample variances[4].

First, we calculate the following characteristics:

$$\overline{x} = 0.275; \overline{y} = 9431.2; S_x^2 = 0.0003; S_y^2 = 29904534;$$

Taking into account the above characteristics, $r_{x,y}$. We calculate: This means that these two indicators have an opposite effect. Correlation coefficient check the value. As a basic hypothesis for this $H_0 : r_b = 0$ we get Here $r_b$ - general set correlation coefficient. As an alternative hypothesis $H_2 : r_b \neq 0$ we get. $\alpha = 0.05$. We use the following statistics to test the hypothesis at the value level:
\[ T_{sys} = \frac{r_{xy}}{\sqrt{1-r_{xy}^2}}. \]  

We calculate the value of the statistics:

\[ T_{sys} = \frac{-0.32\sqrt{5-2}}{\sqrt{1-0.32^2}} = \frac{-0.55}{0.94} = -0.59. \]

\( \alpha = 0.05 \) degree of freedom in \( k = n - 2 = 3 \) which is the critical value of the Student distribution \( t_{kp}(0.05;3) = -3.18 \) га тенг[5].

In that case \( T_{sys} = -0.59 > -3.18 = t_{kp} \) we reject the basic hypothesis that, and that the correlation coefficient of random quantities is significant. Based on the data in Table 3, we create the following graph:

Table 1 provides a correlation table to study the relationship between kidney disease rates and water hardness levels for 2011-2016[4].

<table>
<thead>
<tr>
<th>Year</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>Waterrepellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>1</td>
<td>0.962924</td>
<td>0.989728</td>
<td>0.912499</td>
<td>0.925962</td>
<td>0.965267</td>
<td>0.304212</td>
</tr>
<tr>
<td>2012</td>
<td>0.962924</td>
<td>1</td>
<td>0.946921</td>
<td>0.774553</td>
<td>0.820126</td>
<td>0.95938</td>
<td>0.269947</td>
</tr>
<tr>
<td>2013</td>
<td>0.989728</td>
<td>0.946921</td>
<td>1</td>
<td>0.92033</td>
<td>0.943452</td>
<td>0.962375</td>
<td>0.272897</td>
</tr>
<tr>
<td>2014</td>
<td>0.912499</td>
<td>0.774553</td>
<td>0.92033</td>
<td>1</td>
<td>0.977032</td>
<td>0.843754</td>
<td>0.328196</td>
</tr>
<tr>
<td>2015</td>
<td>0.925962</td>
<td>0.820126</td>
<td>0.943452</td>
<td>0.977032</td>
<td>1</td>
<td>0.844218</td>
<td>0.187328</td>
</tr>
<tr>
<td>2016</td>
<td>0.965267</td>
<td>0.95938</td>
<td>0.962375</td>
<td>0.843754</td>
<td>0.844218</td>
<td>1</td>
<td>0.474633</td>
</tr>
<tr>
<td>Waterrepellent</td>
<td>0.304212</td>
<td>0.269947</td>
<td>0.272897</td>
<td>0.328196</td>
<td>0.187328</td>
<td>0.474633</td>
<td>1</td>
</tr>
</tbody>
</table>

According to the data in Table 3, the indicators of kidney disease in the districts for 2011-2016 are strongly correlated, and the level of water hardness is relatively positively correlated with the indicator of this disease in 2016. We determine the functional relationship between Urgut district kidney disease index and water hardness level. We use the least squares method. The functional relationship between kidney disease and water hardness is shown in Figure 3. If the water hardness level increases by 1% through this functional link, then the number of patients with kidney disease increases by 17.07.
Figure 3. Kidney disease and water hardness functional connection between

Table 5

The association of water mineralization with gastrointestinal diseases

<table>
<thead>
<tr>
<th>Years</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>Watermineralization</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>1</td>
<td>0.265569</td>
<td>0.662961</td>
<td>-0.21397</td>
<td>-0.12861</td>
<td>-0.00647</td>
<td>-0.22907</td>
</tr>
<tr>
<td>2012</td>
<td>0.265569</td>
<td>1</td>
<td>0.582555</td>
<td>0.683887</td>
<td>0.842102</td>
<td>0.664788</td>
<td>-0.34654</td>
</tr>
<tr>
<td>2013</td>
<td>0.662961</td>
<td>0.582555</td>
<td>1</td>
<td>-0.18626</td>
<td>0.057355</td>
<td>-0.13709</td>
<td>-0.44274</td>
</tr>
<tr>
<td>2014</td>
<td>-0.21397</td>
<td>0.683887</td>
<td>-0.18626</td>
<td>1</td>
<td>0.94981</td>
<td>0.962944</td>
<td>0.067121</td>
</tr>
<tr>
<td>2015</td>
<td>-0.12861</td>
<td>0.842102</td>
<td>0.057355</td>
<td>0.94981</td>
<td>1</td>
<td>0.878161</td>
<td>-0.20496</td>
</tr>
<tr>
<td>2016</td>
<td>-0.00647</td>
<td>0.664788</td>
<td>-0.13709</td>
<td>0.962944</td>
<td>0.878161</td>
<td>1</td>
<td>0.182225</td>
</tr>
</tbody>
</table>

* a negative correlation means that the mineralization of water with the disease is reversed.

Conclusions

In general, the natural conditions of the Republic of Uzbekistan play an important role in the formation of the nosogeographic situation. Consequently, the identification of the natural and geographical features of each region of the country that is unique for it serves as a key basis for improving the health of the population.
References


