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Forecasting the Population Mortality Rate from Cardiovascular Diseases as a Condition of the Economic Security of the State

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ABSTRACT

The article analyzes the population mortality rate in Ukraine from cardiovascular diseases (for example of Sumy region). The structure and dynamics of mortality among the region residents as a result of these diseases during 2012-2019 are also considered. Prognostic assessment the population mortality rate in Ukraine from diseases of the circulatory system (regional aspect). Also, the work carried out the forecast of the population mortality rate from various cardiovascular diseases in the territorial respect. The forecast showed that mortality from cardiovascular diseases will increase in 10 of 19 administrative-territorial units of Sumy region.

Keywords: Cardiovascular diseases; Nosological class; Morbidity; Public health; Economic security of the state.

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Pronosticar la Tasa de Mortalidad de la Población por Enfermedades Cardiovasculares como Condición de la Seguridad Económica del Estado

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RESUMEN

El artículo analiza la tasa de mortalidad de la población en Ucrania por enfermedades cardiovasculares (por ejemplo, en la región de Sumy). También se considera la estructura y dinámica de la mortalidad entre los residentes de la región como consecuencia de estas enfermedades durante el período 2012-2019. Evaluación pronóstica de la tasa de mortalidad de la población en Ucrania por enfermedades del sistema circulatorio (aspecto regional). Asimismo, el trabajo llevó a cabo la previsión de la tasa de mortalidad de la población por diversas enfermedades cardiovasculares en el ámbito territorial. El pronóstico mostró que la mortalidad por enfermedades cardiovasculares aumentará en 10 de las 19 unidades administrativo-territoriales de la región de Sumy.

Palabras clave: Enfermedades cardiovasculares; Clase nosológica; Morbosidad; Salud pública; Seguridad económica del estado.

Clasificación JEL: A12, A13.

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1. Introduction

Preservation of health and reducing of population mortality is one of the priority directions of the state policy of the European countries. Ukraine as a member of the United Nations (UN) joined the implementation of the Sustainable Development Goals by developing national strategic objectives, related to building a national public health system on ambushes of preventive (prophylactic) medicine and the development of primary health care. In Ukraine main responsible structure for monitoring the incidence of the population, preventing the risk of disease (prevention) and fighting epidemics is State Institution "Center for Public Health of the Ministry of Health of Ukraine", which was established in 2015. Prompt response to emergency events in public health at the regional level provides Interregional Public Health Laboratory Centers with Epidemiological Monitoring Laboratories.

The population mortality level is one of the most important demographic indicators of public health, characterizing the state of health of the population in terms of the spread of the most severe pathology (Hrebniak & Fedorchenko, 2016; Ivanov et al., 2012). During the years of independence (1991 - early 2020) Ukraine has lost more than 10 million people. In 2019 in Ukraine the rate of natural population decline was -272,3 thousand people (State Statistics Service of Ukraine, 2020). The socio-economic consequences of premature mortality are not only the loss of years of potential life, and a significant government economic loss (Hrebniak & Fedorchenko, 2016). In the structure of reasons of population mortality both the world and Ukraine, the first place is occupied by cardiovascular diseases (CVDs). Therefore, in modern conditions, the problem of population mortality by this nosology group is not purely medical, and now is in the field of view of a wide range of scientists, in particular geographers, economists, biologists, ecologists, etc. (Kornus et al., 2015; Heidenreich et al., 2011; Liao, 2002; Weinstein et al., 1987).

Because of high rates of population mortality, the problem of CVDs has acquired a global scale. According to WHO (Mendis et al., 2013) every year from pathologies of this group in the world dies 17.5 million people. The most widespread among CVDs are coronary heart disease and cerebrovascular disease; their percentage in the structure of population mortality in Europe is 35%. It should be noted, that in high-income countries human mortality due to CVDs constantly declining, instead in Ukraine it remains high and is much higher, than in neighboring European countries. So, in Poland the population mortality from CVDs in comparison with Ukraine is by 2.3 times lower, in Sweden − almost by 4 times, in Great Britain − by 4.6 times, in France − by 6 times (Amiri, 2010; Huovinen et al., 2006).

According to forecasts, by 2030 coronary heart disease and cerebral strokes will be the leading causes of population death and disability in the world, and mortality rate from them will increase to 23 400,000 people per year (Basanets & Andrushchenko, 2010; Kornus et al., 2020). In Ukraine in 2017 most deaths (62%) were caused by CVDs. Moreover, from a demographic and life point of view most of these deaths were premature. Premature mortality in Ukraine is much higher, in accordance with other European countries, and among men it is twice as high as among women (State Statistics Service of Ukraine, 2020). The foregoing indicates the need to predict the population morbidity and mortality, which is related to problems of prediction and planning socio-economic processes and development of society as a whole. After all, without a preliminary forecast of morbidity/mortality it is impossible to determine the prospects of development of the health care system, social insurance and social security, medical education, etc. (Antoniuk, 2012; Drozdova et al., 2017).

Today in world have been developed and used various forecasting techniques and models for modeling of various diseases and mortality by them. Computer analysis makes it possible to process a large set of statistics on morbidity and mortality data as well as forecasting the further development of these events. The forecast is needed not only to find out the death rate in the future, and to develop the effective ways to overcome or stabilization of an unfavorable situation and to ensure the national security. Therefore, forecasting the level of population mortality from CVDs, as well as forecast estimates population morbidity by these pathologies is relevant and timely, especially at the regional level (Kornus, et al., 2015; Kyzym & Dorovskyi, 2010; Suranova et al., 2017; Terenda, 2015; Knuiman, 1997; Menotti et al., 1994).

2. Material and Methods

On the basis of the data from annual statistical reports of medical institutions of the Sumy region, subordinate to the Ministry of Public Health of Ukraine (2012-2019), statistical yearbooks (State Statistics Service of Ukraine, 2019), the forecast of mortality of the population from CVDs was made. The study is based on the data about following nosoforms of CVDs: coronary heart disease, acute myocardial infarction, cerebrovascular diseases, cerebral strokes and strokes with hypertension. To create the forecast of the population mortality of Sumy region before 2025 was taken time series of observations during 2012-2019. Forecast of mortality rate from CVDs was based on a linear relationship of the form a+bx, where:

$$\mathrm{a} = \bar{y} - b\bar{x} \tag{1}$$

And

$$b = \frac{\sum(x-\bar{x})(y-\bar{y})}{\sum(x-\bar{x})^2}\mathrm{a} = \bar{y} - b\bar{x} \tag{2}$$

where y – years of observation, x – mortality rates.

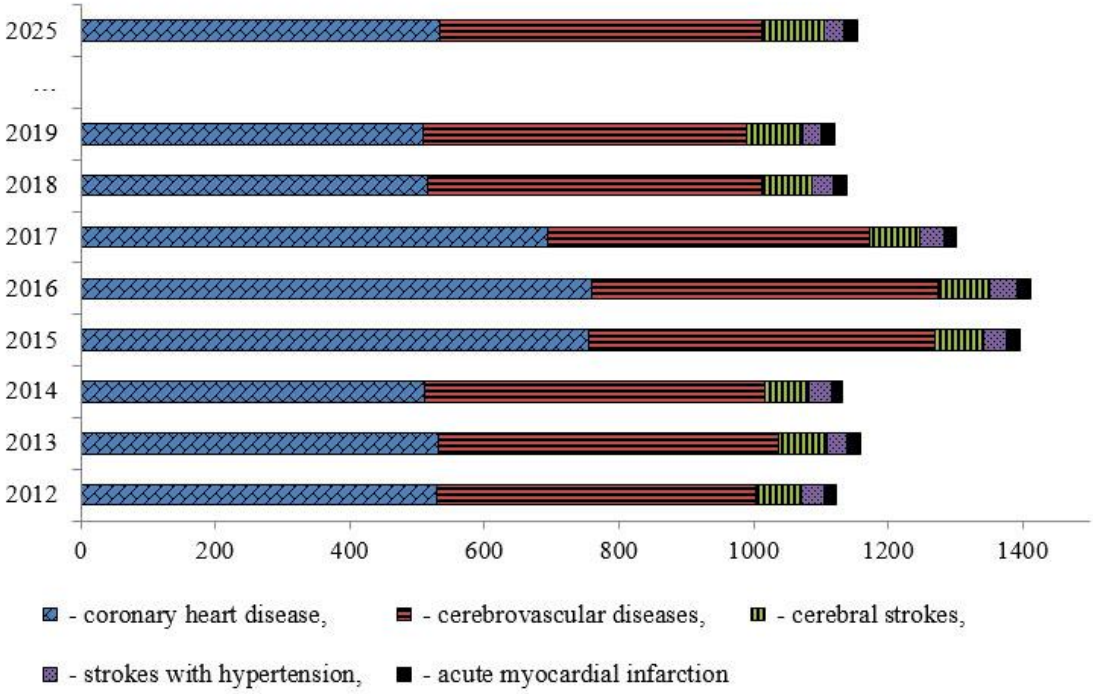
All calculations and computation, as well as graphic constructions were obtained using the capabilities of a computer program Microsoft Excel 2016. The research was performed according to the Word Medical Associations Declaration of Helsinki and Council of Europe Protocol of the Convention on Human Rights and Biomedicine, approved by the Ethics Committee of Sumy State Pedagogical University named after A. S. Makarenko. This work was carried out within the framework of the scientific research topic of the Department of Public Health and Medical and Biological Foundations of Physical Culture, Sumy State Pedagogical University named after A. S. Makarenko.

3. Results and Discussion

As known, the forecast begins with a study of the current state and retrospective analysis of the forecasted object, in our case the mortality from CVDs. These diseases, as already indicated, are among the top three in terms of morbidity, prevalenc e and are the leading cause of death of the inhabitants of Ukraine. During 2018 in Ukraine about 400 000 persons was by these diseases (or 996.6 cases per 100 000 people, among of them 171 511 or 937.6 deaths per 100 000 men and 220 549 or 1 048.0 deaths per 100 000 women). Among the urban inhabitants in 2018 registered 234 397 deaths (874.5 cases per 100 000 people) from CVDs, incl. among men – 104 886 deaths (852.8 cases per 100 000 people), and among women – 129 511 deaths (893.1 cases per 100 000 people). The mortality rate among rural inhabitants was 157 663 deaths (1 231.4 cases per 100 000 people), including among men – 66 625 deaths (1 096.2 per 100 000 people), and among women – 91 038 deaths (1 353.3 per 100 000 people) cases.

In 2018 the Sumy region by the level of population mortality from CVDs among others regions of Ukraine occupied 8th place with mortality rate 1 037.7 cases per 100 000 people, which is higher than the average Ukrainian mortality rate – 996.6 deaths per 100 000 people (State Statistics Service of Ukraine, 2019). The level of primary morbidity and prevalence of CVDs among the population of Sumy region we considered in (Kornus et al., 2020). As in Ukraine as a whole, in Sumy region CVDs are occupy a leading position for primary morbidity and prevalence of diseases and is main cause of disability inhabitants of region. In 2019 the mortality of the region population from CVDs traditionally has been in the first place, although the number of deaths due to this reason has decreased as compared to 2018 (Fig. 1). It should be noted, that during the study period the mortality rate of Sumy region from different CVDs, except cerebral strokes, was the largest in 2015-2016 (percentage of cerebral strokes, as cause of death, increasing during the all observation period).

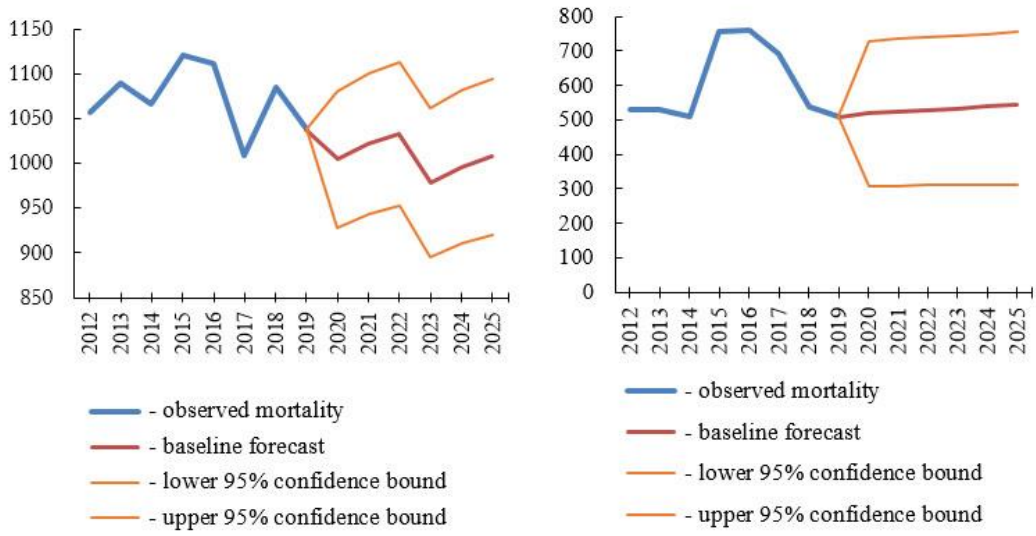
Figure 1. Dynamics of structure of mortality of the population of Sumy region from CVDs during 2012-2019 and its forecast by 2025 (deaths per 100 000 people)



Source: systematized by the authors

The results of analysis of the actual mortality rates became as the basis for calculating the prognostic indicator of the population mortality level due to pathologies of cardiovascular system. Given the length of the time series of actual observations (time series of mortality statistics) we have limited the forecast range by 2025. Our result showed a slight increase of mortality by CVDs from 1037.7 cases per 100 000 people to 1043.8 cases per 100 000 people by 2025 (Fig. 2a). At the same time, the limits of 95 % confidence interval of the forecast indicator admitted as a reduction of mortality by 7.4 % (or to level 966.3 cases per 100 000 people), and its growth by 6.9 % (or to 1121.3 cases per 100 000 people).

Figure 2. The forecast of mortality rate of the population of Sumy region by 2025: a) from all CVDs, b) from coronary heart disease (per 100 000 people)



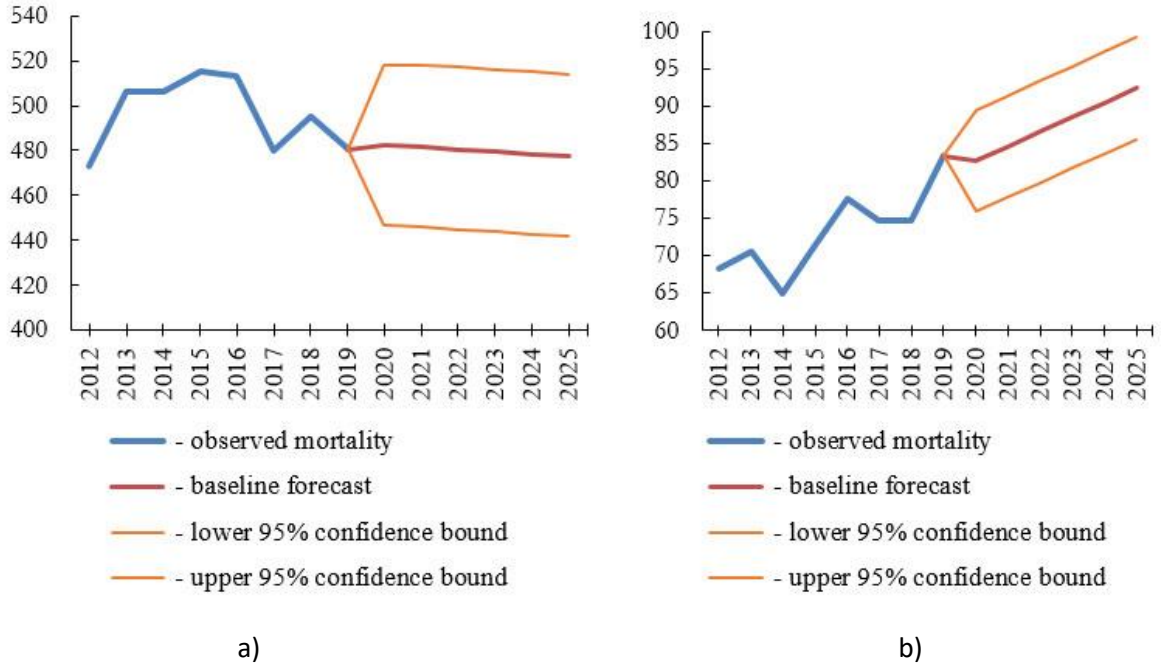
a) b)

Source: systematized by the authors

As can be seen from Fig. 1, most of the region population dies from coronary heart disease. Most deaths from this reason were recorded during 2015-2016. Since 2017 the mortality from coronary heart disease started to decrease – for period 2017-2019 it was decreased by 8.8 %. However, forecast of Sumy region population mortality by coronary heart disease is adverse, – by 2025 we expecting its increase by 7% – to 544 cases per 100 000 people. Lowest and upper values of 95 % confidence bound indicate possible variations level of mortality of the population by coronary heart disease from 313.6 to 754.5 deaths per 100 000 people (Fig. 2b).

The 2nd place in structure of mortality of the population from CVDs takes cerebrovascular disease. Compared to 2012, in 2019 mortality from them increased by 1.55 % (Fig. 1). However, our forecast points to insignificant (0.58 %) decrease its percentage in the structure of reasons, causing mortality of the inhabitants of Sumy region. Possible variations of the predicted mortality rate as a result of cerebrovascular disease are in the range from 442.06 to 514,13 cases per 100 000 people (Fig. 3a). The 3rd place among CVDs which conditioning mortality of the population of Sumy region is occupies cerebral strokes. During observation period, the mortality from them was increased by 22.3 %. We expecting an increase of deaths due to cerebral strokes predicted in the future, and we suppose, that the population death rate in the region from cerebral strokes by 2025 will increase by 10.7 % (Fig. 3b). Its absolute values can range from 85.47 to 99.25 deaths per 100 000 people.

Figure 3. The forecast of mortality rate of the population of Sumy region by 2025: a) from cerebrovascular disease, б) from cerebral strokes (cases per 100 000 people)

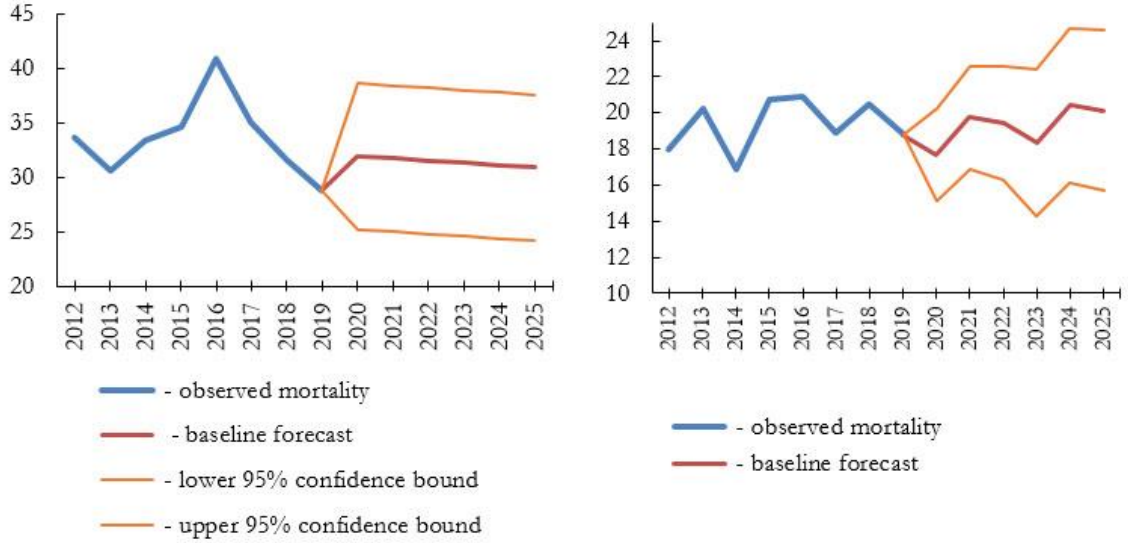


a) b)

Source: systematized by the authors

The 4th place in the structure of causes of death of the inhabitants of Sumy region from CVDs, takes mortality from strokes with hypertension. Although for the period from 2012 to 2019 mortality from them decreased by 14.3 %, our forecast shows an increase of mortality due to this pathology by 2025 by 7.15 % (Fig. 4a). According to the optimistic forecast the mortality rate from strokes with hypertension will be 24.16 cases per 100 000 people and 37.56 cases per 100 000 people – for the pessimistic forecast.

Figure 4. The forecast of mortality rate of the population of Sumy region by 2025: a) from strokes with hypertension, b) from acute myocardial infarction (cases per 100 000 people)



a) b)

Source: systematized by the authors

Acute myocardial infarction takes 5th place among CVDs causing death of the population of Sumy region. By level of morbidity by acute myocardial infarction fluctuates noticeably from year to year, but compared to 2012, in 2019 it grew by 4.4 % (Fig. 4b). Our forecast shows a further increase of mortality from acute myocardial infarction by 7 % by 2025. At the same time, the bounds of 95% confidence interval of the population mortality from acute myocardial infarction allow to expect both its decrease 16.7 % (or to level 15.66 cases per 100 000 people), and its increase by 30.6 % (or to level 24.55 deaths per 100 000 people).

Forecasting of the population mortality rates by administrative districts of Sumy region showed that by 2025 in 10 of 19 administrative-territorial districts the mortality of inhabitants from CVDs will increase. The greatest of population mortality increasing by diseases of this nosological class is expecting in Velyka Pysarivka, Okhtyrka (increase by 11.2 %) and Seredyna-Buda (by 9.8 %) districts. At the same time for districts with high mortality rates from CVDs its decline is projected. It will be most significant in Krasnopillia (by 13.5 %), Putyvl' (by 7 %), Sumy (by 6 %) and Trostyanets (by 5.9 %) district. According to our forecasts, by 2025 among all CVDs the highest mortality will by strokes. In 15 of 19 districts the mortality rate from them will increase significantly. A particularly unfavorable situation is forecasted in Hlukhiv (increase by 88 %), Seredyna-Buda (by 86.6 %) and Lebedyn (by 82.3 %) districts.

4. Conclusions

CVDs are leading cause of death and disability of the population of Sumy region and Ukraine. Today Sumy region occupies 8th place among others Ukraine's regions of by level of population mortality from CVDs. Established that the level of the population mortality from CVDs by 2025 will increase slightly – by 0.6%. This slightly increasing will be achieved due to so reduction by mortality from cerebrovascular diseases. But, mortality from others pathology CVDs by 2025 will increase (from ischemic heart disease – by 5.0 %, from cerebral strokes − by 10.7 %, from strokes with essential hypertension – by 7.1 %, from acute myocardial infarction – by 6.9%). Forecast of population mortality from CVDs by 2025 in territorially attitude showed that in 10 of 19 administrative-territorial districts of Sumy district mortality will increase. According to the study results by nosologies it was found that the mortality from cerebral strokes will increase most intense. Particularly unfavorable situation with the increase of mortality due to cerebral strokes by 2025 predicted in Hlukhiv, Seredyna-Buda and

Lebedyn districts. These administrative-territorial districts require more attention from the central government and local authorities, the purpose of which should be to reduce the morbidity by this pathology and stabilize the level of the population mortality.

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