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Geographical peculiarities of the mortality risk of the population of Sumy region from cardiovascular diseases

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Abstract. Cardiovascular diseases (CVDs) are the main group of diseases from which the population of Sumy region suffers. They have not only high rates of primary morbidity and prevalence, but also play the leading role among the causes of mortality in the region. The aim of the article is clarification of the geographical features of mortality of the population

of Sumy region from diseases of the circulatory system. In 2018 compared to 2012 the mortality of the general population in Sumy region from this class of nosology decreased by 1.17%, although among the able-bodied population it grew by 1.94%. The geographical differences of mortality (including separately the group of able-bodied population) from various CVDs: coronary heart disease, acute myocardial infarction, cerebrovascular disease, cerebral strokes and strokes with hypertension, were established. For determining the regional features of mortality of the population from cardiovascular diseases we used the integrated indicator «disease mortality risk assessment». This indicator takes into account the relationship between the primary morbidity, prevalence of diseases and the causes of mortality and makes it possible to assess the state of health of the population in terms of CVDs. It was found that the inhabitants of Sumy, Romny, Nedryhailiv, Putyvl' and Lypova Dolyna districts, where the highest integrated indicator value was observed, have a high risk of dying from diseases of the cardiovascular system. At the same time for the city of Sumy, Bilopillia and Krasnopillia districts, a low level of the mortality risk from CVDs is characteristic. Among the able-bodied population of Sumy region, the inhabitants of Seredyna-Buda and Yampil' districts are at the highest risk of mortality from CVDs. A forecast of the mortality of the population of Sumy region before 2023 was made. The baseline scenario showed a decrease of mortality from CVDs by 2.1%. From the optimistic forecast (lower 95% confidence bound) the mortality rate from CVDs for 2023 will fall by 19.4%, while the pessimistic forecast (upper 95% confidence bound) shows an increase in the mortality rate by 13.3%. As a result of ranking the values of the integrated indicator of mortality from cardiovascular diseases, it was found that in the first place is the risk of dying from a stroke, in the second place – from cerebrovascular diseases, and in third place – from strokes with hypertension. Next are the risks of dying from coronary heart disease and myocardial infarction. The results of the study can be used by local authorities to prevent the growth of morbidity and mortality from diseases of this nosological class, as well as for development of preventive measures and stabilization of the health status of the population of Sumy region.

Key words: cardiovascular diseases, mortality, primary morbidity, prevalence of diseases, morbidity factors, Sumy region

Географічні особливості ризику смертності населення Сумської області від серцево-судинних захворювань

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Анотація. Стаття присвячена розгляду географічних особливостей смертності населення Сумської області, зумовленої серцево-судинними захворюваннями (ССЗ). Отримані результати ґрунтуються на даних щорічних статистичних звітів медичних установ Сумської області, які підпорядковуються Міністерству охорони здоров'я України. Спостереженням охоплено період 2012–2018 рр. Встановлено географічні відмінності смертності населення (у т.ч. окремо серед населення працездатного віку) від різних ССЗ: ішемічної хвороби серця, гострого інфаркту міокарда, цереброваскулярних хвороб, мозкових інсультів та інсультів з гіпертонічною хворобою. Для визначення географічних особливостей смертності населення від даної групи патологій було використано комплексний індикатор «оцінка смертності у результаті захворювання». Цей показник враховує співвідношення первинної захворюваності, поширеності ССЗ та спричиненої ними смертності й дає можливість оцінити стан серцево-судинного здоров'я населення. Встановлено, що найвищий ризик померти від хвороб системи кровообігу мають жителі

Сумського, Роменського, Недригайлівського, Путивльського та Липоводолинського районів, де спостерігаються найвищі значення названого вище комплексного показника. У той же час для мешканців м. Суми, Білопільського та Краснопільського районів ймовірність померти від цієї групи нозологій нижча. Серед вікової групи працездатного населення області найвищі ризики смертності від ССЗ мають жителі Середино-Будського та Ямпільського районів. Для передбачення рівня смертності населення Сумської області від ССЗ, було розроблено прогноз до 2023 р., який показав зниження рівня смертності жителів від хвороб системи кровообігу на 2,1 % за базовим сценарієм. Разом з тим, межі 95% довірчого інтервалу прогнозного показника смертності населення від хвороб системи кровообігу до 2023 р. допускають як скорочення рівня смертності на 19,4 %, так і її зростання на 13,3 %. У результаті ранжування отриманих значень комплексного індикатора смертності населення від ССЗ встановлено, що на першому місці за ризиком спричинити смерть знаходиться мозкові інсульты, на другому місці – цереброваскулярні хвороби, і на третьому місці – інсульты з гіпертонічною хворобою. Далі розташувалися ризики смертності від ішемічної хвороби серця та інфаркту міокарда. Результати оцінки географічних особливостей смертності населення області від ССЗ можуть бути використані місцевими органами управління для запобігання зростання рівня захворюваності та смертності населення від хвороб даного нозологічного класу, для розробки профілактичних заходів і стабілізації стану здоров'я населення Сумської області.

Ключові слова: серцево-судинні захворювання, смертність, первинна захворюваність, поширеність захворювань, фактори захворюваності, Сумська область

Introduction. The mortality rate is one of the criteria for assessing the health status of populations. Cardiovascular diseases (CVDs) are among the main causes of mortality. This nosology class is the leader by most indicators of population health – primary morbidity, prevalence of diseases, mortality as well as temporary disablement and disability. Many CVDs are diagnosed in an advanced state, therefore they are difficult to cure, which quite often leads to mortality. WHO estimates (Global, 2017) that the most significant cause of deaths globally was CVDs. So, in 2016 from this category of disease 17.9 million people died (31% of all deaths in the world). Most (85 %) of these deaths were the result of heart attack and stroke. WHO projected (Cardiovascular, 2017) that in 2030 23.6 million will die from CVDs, primarily from heart diseases heart and stroke. These diseases are leading causes of death globally (Cardiovascular, 2017). Compared to other European countries, the mortality of the population in Ukraine from CVDs is higher. E.g., compared to Poland it is twice as high, three times more than in Greece, four times higher than in Germany, and six times higher than France (Kovalenko, 2013). Also, it is worth saying that in most countries of Europe mortality from CVDs is tending to decrease, for example (Almendra, 2020) during 1991-2017 the level of mortality from CVDs in Portugal decreased by 33.3 % (from 468.1 cases of mortality per 100 000 people to 312.4 cases per 100 000).

During 1991-2013 in Ukraine the morbidity of the population from CVDs grew twofold and the prevalence of diseases – three times. The level of mortality of the population of Ukraine from CVDs doubled (6 out of 10 deaths are caused by CVDs). Therefore, CVDs are the unchallenged leaders in the structure of causes of death of the population (Smertnist, 2016). Annually from these pathologies about 160 thousand people die, which is more than all other causes of death together (cancer, tuberculosis, AIDS,

etc.) (Kornus, 2015; Rosul, 2015; Sertsevo-sudynni, 2018). Back in the 1960s CVDs were recognized as an epidemic, named «silent killer», this was especially true for coronary heart disease and hypertension (Kulchytska, 2001). As noted in the monograph by E. Libanova (Libanova, 2007), deaths from CVDs in Ukraine occur much earlier than in highly developed countries. This is a consequence of the lack of tradition of preventive health examinations, irresponsible attitude to the life of majority of the population, poor health system, among others. Moreover, as a result of CVDs in Ukraine annually more than 14-15 people per 100 000 inhabitants become invalid.

Mortality is not only a demographic indicator, but also an informative indicator of the population's health, as well as an indicator of socio-economic development. Therefore, study of the level of the mortality of the population, in our case from CVDs, provides an opportunity to evaluate the functioning of the health care system of both the country and individual regions. The relevance of the study is emphasized by the high rates of the mortality from CVDs. The negative upward trend of incidence of CVDs in the population and the high rate of death from them requires comprehensive research not only by medical professionals, but also by geographers, economists, sociologists, ecologists, etc.

Review of previous research indicates that significant attention has been paid by scientists of different profile (medicine, geography, economics, ecology, etc.) to this subject. Regional differences of the Ukrainian's population morbidity by various diseases, including CVDs, were considered in the works of various geographers. However, there are few works aimed at a socio-geographical study of mortality of the population from CVDs on the regional level and they are mainly aimed at analyzing the morbidity rate of the population. Thus, the work by I. Horbas (Horbas, 2010) shows the results of a 30-year study of

the epidemiological situation with CVDs in Ukraine.

In I. Horbas's research the high prevalence of the cardiovascular risk factors was established and a forecast of growth of mortality of the population in Ukraine from CVDs was made. In article by V. Handziuk (Handziuk et al, 2017) the main indicators of primary morbidity, prevalence of diseases and mortality of the population caused by circulatory system diseases are analyzed in regional aspect. The findings indicated the differentiation between regions of the primary morbidity rate, prevalence of diseases and index of accumulation of CVDs. In the article by V. Kovalenko (Kovalenko et al, 2013) the regional structure of the mortality of the population from CVDs is analyzed and a methodological approach proposed for the analysis of its structure. CVDs as medico-social and socio-political problems were considered in the works by V. Kovalenko and V. Kornatskiy (Kovalenko & Kornatskiy, 2013; 2014).

Medical-geographical investigations of mortality from CVDs of the population of Ternopil region were made by I. Demianchuk (Demianchuk, 2014), N. Fedishyn (Fedishyn, 2013). The prevalence of CVDs in Poltava region was studied by T. Pluznikova (Pluznikova, 2015). The analysis of population morbidity and mortality from CVDs in Transcarpathian region were examined in the article by Ya. Slivka & M. Virag (Slyvka, 2011). The mortality from CVDs of inhabitants of Kharkov region is considered in the article by A. Kotvitska & I. Lobova (Kotvitska, 2012); the scientific research on the main components of the population morbidity and mortality in Vinnitsa region was conducted by O. Hovorko (Hovorko, 2015). The territorial features of population morbidity and mortality from CVDs in the city of Kryvyi Rih are presented in work by D. Shyyan (Shyyan, 2012). In the Sumy region, the role of CVDs in the structure of mortality of the population has not been clarified. This is what determined the aim of our article.

The aim of the article is clarification of the geographical features of the mortality of the population of Sumy region from cardiovascular diseases.

Material and research methods. The observation covers the period from 2012 to 2018. This study analyzed the data of annual statistical reports of medical institutions of the Sumy region, which are subordinate to the Ministry of Public Health of Ukraine. This made it possible to establish regional differences in the mortality of the population (including separately the able-bodied population) from various types of CVDs: coronary heart disease, acute myocardial infarction, cerebrovascular disease, cerebral strokes and strokes with hypertension.

For determining the regional features of population mortality from cardiovascular diseases, we used the integrated indicator, proposed and named by N. Rogozinskaya as «disease mortality risk assessment» (Rogozinskaya, 2013):

$$EDdis = \frac{DRdis}{DIS} \cdot DISnew,$$

where: *EDdis* – integrated indicator «disease mortality risk assessment», characterizing the risk of dying from CVDs at this incidence rate (cases per 100 000 people); *DRdis* – mortality due to the disease (cases per 100 000 people); *DIS* – prevalence of the disease (cases per 100 thousand people); *DISnew* – primary morbidity by the disease (cases per 100 000 people).

Using the above-mentioned indicator makes it possible to increase the information content of the statistical analysis and make the best determination of the health dynamics of the population of the administrative-territorial districts.

Forecast of mortality rate from CVDs was grounded on the linear regression $a+bx$,

$$\text{where } a = \bar{y} - b\bar{x}, \quad b = \frac{\sum(x-\bar{x})(y-\bar{y})}{\sum(x-\bar{x})^2},$$

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

In the article a systems approach, cartographic, comparative geographic, forecasting analytical, statistics and other methods of scientific research were applied.

All calculations, figures and the graphic images were obtained using SPSS Statistic 17.0 computer software by SPSS Inc., Microsoft Excel 2010 and Statistica 10 by StatSoft Inc.

Results and discussion. In Ukraine in 2017 the mortality rate from CVDs was 907 cases per 100 000 people, that is, these diseases are the main cause of death (Shchorichna, 2018). Sumy region takes 11th place in the national rating of primary morbidity by pathologies of cardiovascular system (Kornus, 2017). As of January 1, 2019 in Sumy region CVDs take 1st place (57,459.63 cases per 100 000 people) in total prevalence of diseases among the population. In structure of this nosology class, arterial hypertension (26,199.26 cases per 100 000 people), coronary heart (18,900.88) and cerebrovascular (8,960.23) diseases are in the leading places.

We have studied the primary morbidity and prevalence of CVDs among the population of Sumy region and their territorial differences among administrative districts (Kornus, 2020). The highest primary morbidity rate is registered in Lypova Dolyna, Romny, Nedryhailiv, Krolevets and Okhtyrka districts. The

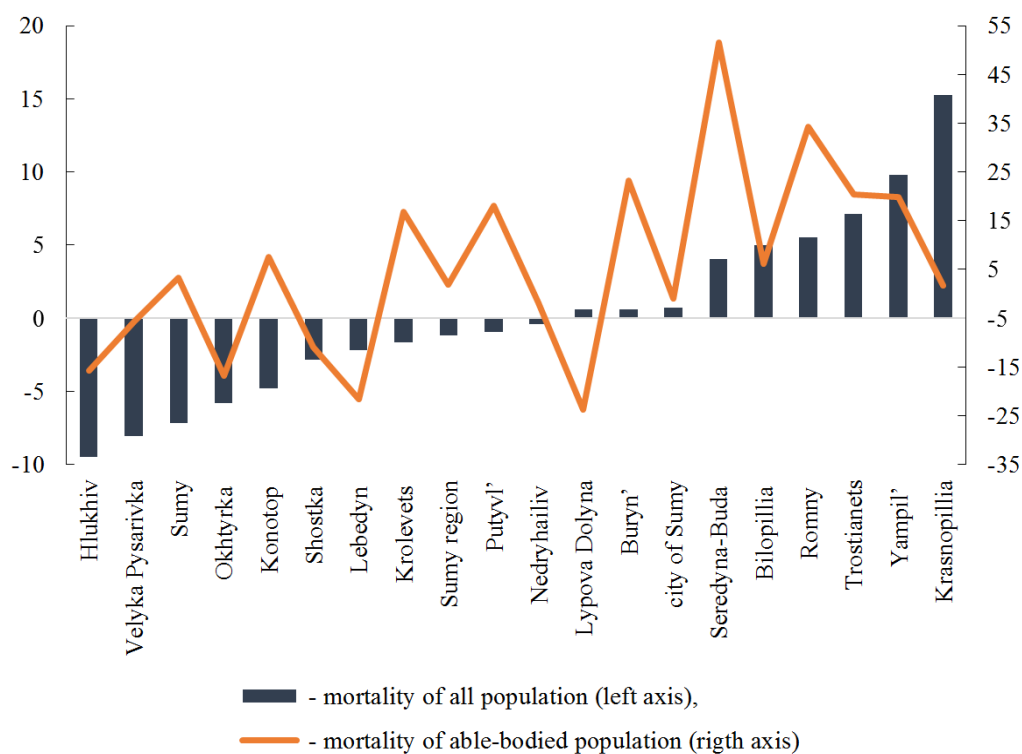


Fig. 1. Increase/decrease (%) of mortality rate from circulatory system diseases of the population of Sumy region in 2018 compared to 2012 (Source: Dovidnyk, 2013, 2019)

highest prevalence of CVDs is registered among the residents of Romny, Nedryhailiv, Lypova Dolyna and Lebedyn districts. In these districts cerebral strokes, strokes with hypertension, coronary heart disease, and myocardial infarction were observed most often.

According to medical statistics (Tablytsi, 2019) as of January 1, 2019 the mortality rate of the population (recalculation of actual total mortality rates in conditional indicators, calculated by fixed structure of the population (European standard)) from CVDs in Ukraine was 673.5 cases per 100 000 people. By this indicator Sumy region occupied 18th place among 23 administrative-territorial regions of Ukraine (excluding the temporarily occupied territory of the Autonomous Republic of Crimea, the city of Sevastopol and the temporarily occupied territories in the Donetsk and Luhansk regions). However, detailed study indicates significant differences in population mortality for specific reasons. For example, Sumy region occupied 20th place in Ukraine for mortality rate from coronary heart disease but 1st place (282.1 cases per 100 thousand people) for mortality rate from cerebrovascular diseases.

Among all administrative-territorial districts of the region, Romny (63,358.02), Velyka Pysarivka (62, 401.63), Lypova Dolyna (61,714.87), Bilopil'ia (61,350.86), Buryń (60,426.99) and Nedryhailiv (60,325.27 cases per 100 thousand people) districts are the leading ones by prevalence of CVDs among the inhabitants.

In Sumy region during 2018 the mortality from CVDs was 1,045 per 100,000 people, including 131.5 per 100,000 of the able-bodied population. From 2012 to 2018 there was a decrease in mortality of population from these causes by 1.17 %. Among administrative-territorial districts, the greatest reduction of deaths from CVDs was in Hlukhiv (by 9.47 %), Velyka Pysarivka (by 8.05 %) and Sumy (by 7.18 %) districts, while in Trostianets (by 7.16 %), Yampil' (by 9.78 %) and Krasnopillia (by 15.28 %) districts deaths from the diseases of this nosology class increased.

In 2018 compared to 2012, there was an increase of mortality from CVDs among the able-bodied population by 1.94 %. However, in 8 administrative-territorial districts a decrease was observed, especially among the inhabitants of Okhtyrka (by 16.82 %), Lebedyn (by 21.67 %) and Lypova Dolyna (by 23.81 %) districts, while among inhabitants of 11 other districts an increase was recorded, especially among the residents of Seredyna-Buda (by 51.56 %), Romny (by 34.36 %) and Buryń (by 23.3 %) districts (Fig. 1).

In spatial aspect, during 2018 the highest mortality from CVDs among the population was registered in Nedryhailiv (1,384.9), Yampil' (1,385.7) and Buryń (1,478.8 cases per 100 000 people) districts. Among the able-bodied population the highest mortality level was in Putyvl' (202.9), Buryń (204.8) and Romny (210.4 cases per 100 000 people) districts.

Arterial hypertension occupies the first place in the structure of CVDs of the population of Sumy re-

gion. This is a multifactorial disease, characterized by high blood pressure and is often the main cause of myocardial infarction, strokes, hypertensive crises, heart failure, chronic cerebrovascular diseases, etc. Factors influencing development of arterial hypertension include heredity, traumatic brain injuries, age-related changes of functioning of the nervous and endocrine systems, obesity, kidney disease, psycho-emotional overload and stress, constant mental strain, physical inactivity, excessive consumption of salt, coffee, sugar (Kornus, 2018).

According to medical statistics (Dovidnyk, 2019) as of January 1, 2019 in Sumy region arterial hypertension was most common among the residents of Romny (29,227.81 cases per 100 000 people), Konotop (28,800.45) and Shostka (28,160.85) districts. The highest rates of primary morbidity by this pathology were in Romny (2,259.75), Krolevets (2,167.14) and Seredyna-Buda (2,139.33 cases per 100 thousand people) districts.

One of most common pathologies of the cardiovascular system is coronary heart disease. This disease includes angina pectoris, myocardial infarction and atherosclerotic cardiosclerosis. In the structure of

2018). In Sumy region the highest prevalence rates of coronary heart disease are fixed among the inhabitants of Velyka Pysarivka (22,849.19), Lebedyn (21,449.29) and Lypova Dolyna (21,071.66 cases per 100 000 people) districts. In 2018 by the number of newly registered cases of this pathology, the leaders were Lypova Dolyna (1,645.8), Putyvl' (1,387.86) and Okhtyrka (1,385.39 cases per 100 000 people) districts.

Mortality from coronary heart disease in the region during 2018 was 516.7 cases per 100 000 people. During the study period, the population mortality rate from this pathology fell by 2.51 %, including able-bodied population – by 6.68 %. It should be noted that in 10 administrative-territorial districts of the region reduction of mortality from coronary heart disease was recorded. However for such districts as Bilopil'lia (by 12.63 %), Seredyna-Buda (by 15.75 %) and Krasnopillia (by 25.39 %) high growth of the mortality rates in 2018 compared to 2012 was characteristic. Among the able-bodied population, deaths from coronary heart disease increased in Hlukhiv (by 32.71 %), Bilopil'lia (by 41.19 %) and Buryn' (twice) districts (Fig. 2).

In 2018 the highest rates of registered cases of

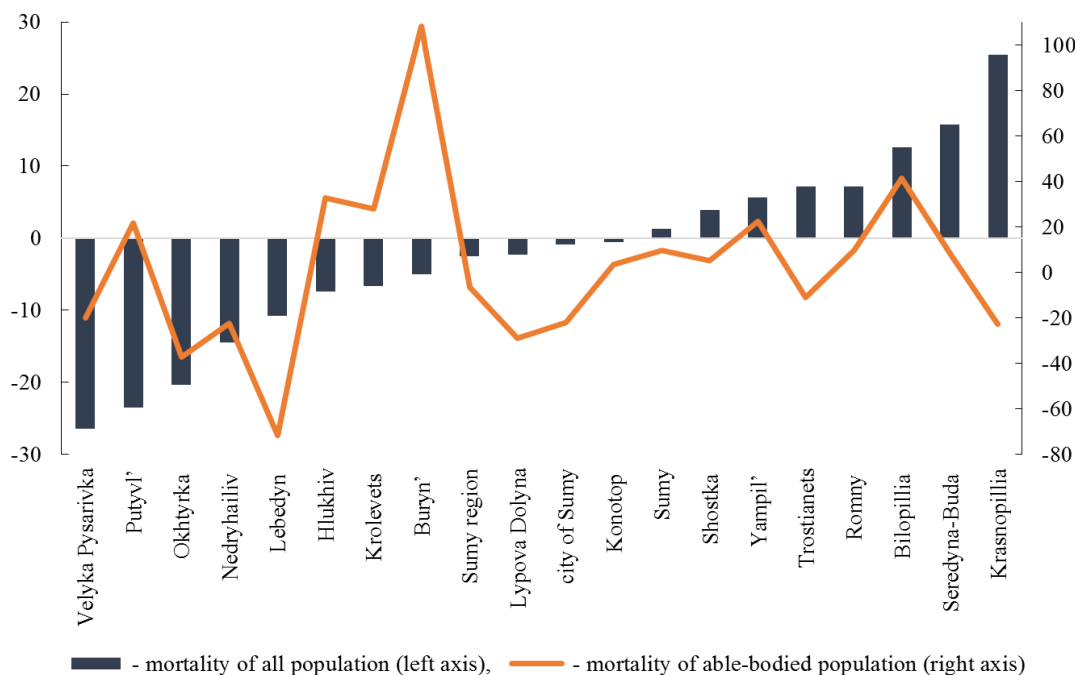


Fig. 2. Increase/decrease (%) of mortality rate from coronary heart disease among the population of Sumy region in 2018 compared to 2012 (Source: Dovidnyk, 2013, 2019).

CVDs it takes 1st place. The main factors causing development of this disease are an unhealthy lifestyle, including smoking, stress, high-calorie nutrition, arterial hypertension, diabetes mellitus, hereditary factors, hyperlipidemia, overweight, hypodynamia, age-related changes, various inflammations, as well as lack of preventive investigations, late diagnosis (Kornus,

death from coronary heart disease were observed in Buryn' (756.1), Lypova Dolyna (816.7) and Bilopil'lia (947.2 cases per 100 000 people) districts, the highest death rates among able-bodied population were in Yampil' (75.6), Romny (78.6) and Buryn' (90.1 cases per 100 000 people) districts.

Acute myocardial infarction is another common

reason of population mortality of the Sumy region. In 2018 in the region the mortality rate from myocardial infarction was 20.5 cases per 100 000 people. In 2018 compared to 2012, mortality from myocardial infarction in the region grew by 13.89 %. The highest mortality rate from myocardial infarction in 2018 was observed in such districts as Trostyanets (26.3), Shostka (29.3), Krolevets (29.5), Lebedyn (33.5) and Nedryhailiv (33.8 cases per 100 000 people). In 2018 only in Yampil' district were no cases of mortality from myocardial infarction registered, whereas at the same time in Nedryhailiv, Romny and Okhtyrka districts a 2-3 times growth in this indicator was registered (Fig. 3).

The negative point is the significant increase of mortality from myocardial infarction among the able-bodied population. During the study period the mortality by infarction in this age group grew by 71.05 %.

They include such pathologies as hemorrhage, cerebral infarction, cerebral strokes, blockage and stenosis of the cerebral and cerebral arteries, etc. The WHO experts noted that in 2000 CVDs became the cause of 9.2 % of world mortality (in high-income countries – 13.7 %, in low-income – 8 %). It should be noted that the number of strokes in the world is growing – about 16 million new cases are recorded annually, of which 5.7 million result in death (Global, 2017; Kornus, 2018). The main factors affecting the population morbidity by cerebrovascular diseases are high blood pressure, overweight, constant stress, unhealthy lifestyle, etc.

In 2018 the prevalence of cerebrovascular diseases in the region was 8,960.23 cases per 100 000 people). The highest prevalence of this pathology was observed among the population of Shostka (11,378.02

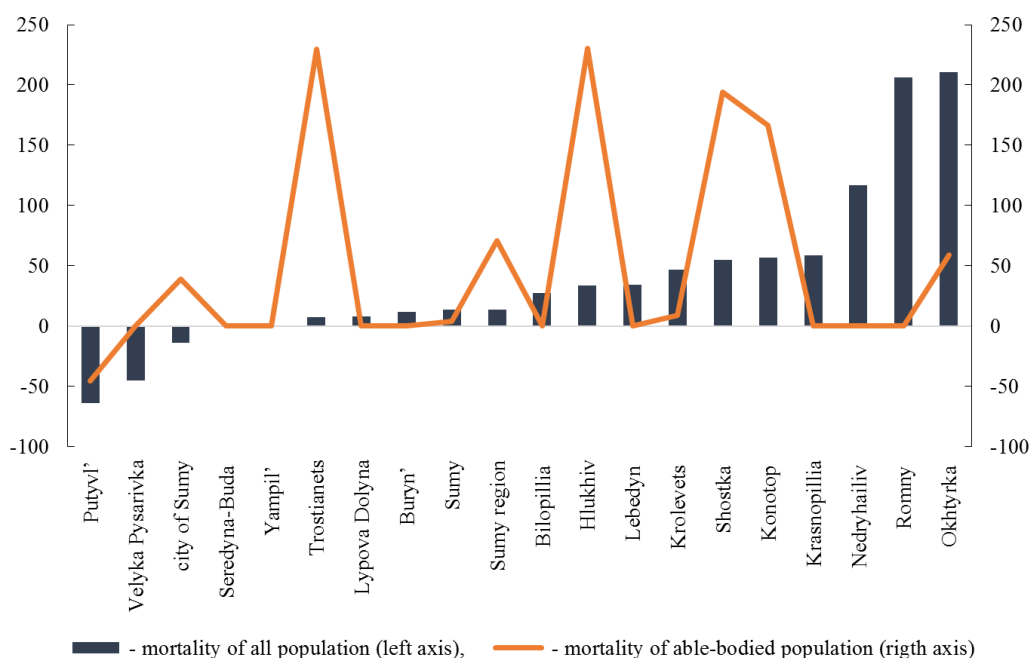


Fig. 3. Increase/decrease (%) of mortality rate from myocardial infarction among the population of Sumy region in 2018 compared to 2012 (Source: Dovidnyk, 2013, 2019).

Especially negative dynamics were observed among the inhabitants of Hlukhiv (by 3.3 times), Trostianets (by 3.2 times), Shostka (by 2.9 times) and Konotop (by 2.6 times) districts. The population mortality rate from myocardial infarction is most polarized: if in 7 districts of the region (Bilopillia, Buryn', Lebedyn, Lypova Dolyna, Romny, Seredyna-Buda and Yampil') in 2018 no cases of mortality from this pathology were registered among the able-bodied population, then in Shostka, Nedryhailiv, Trostianets and Hlukhiv districts myocardial infarction was cause of 14-18 deaths per 100 000 able-bodied inhabitants.

The 3rd place by level of morbidity of the Sumy region population is occupied cerebrovascular dis-

cases per 100 000 people), Buryn' (10,872.98) and Romny (10,364.51) districts. The highest primary incidence rates were characteristic for the inhabitants of Romny (1,130.57), Lypova Dolyna (1,106.19) and Shostka (908.58 cases per 100 000 people) districts.

In 2018 475.8 deaths from cerebrovascular diseases were registered per 100 000 inhabitants of Sumy region. Among administrative-territorial districts the highest population mortality rate from cerebrovascular diseases was in Buryn' (685.1), Putyvl' (722.2) and Velyka Pysarivka (728.0) districts. In 2018 compared to 2012 the mortality from cerebrovascular disease grew by 0.57 %. There are 12 administrative-territorial districts with negative mortality dynamics,

especially high mortality rates were in Buryn' (higher by 12.27 %), Yampil' (by 12.82 %) and Putyvl' (by 18.39 %) districts.

Among the able-bodied population the mortality rate from this pathology was 30.5 cases per 100 000 people. The highest mortality of working age people from cerebrovascular diseases was recorded in Velyka Pysarivka (58.8), Krasnopillia (62.4) and Buryn' (65.5 cases per 100 000 people) districts. Although for the research period the mortality level in the region decreased by 7.85 %, in 8 administrative-territorial districts it increased. This increase was especially characteristic of Krasnopillia (increase by 76.77 %), Velyka Pysarivka (mortality doubled) and Trostianets districts (increase by 2.5 times). Mortality rates did not change only in Konotop district – 37.3 cases per 100 000 people (Fig. 4).

In 2018 compared to 2012 the mortality from strokes increased in 14 districts of the region. Especially negative dynamics were characteristic of residents of Hlukhiv (increase by 62.42 %), Krasnopillia (by 62.45 %), Lebedyn (by 87.81 %) and Seredyna-Buda (by 2.5 times) districts (Fig. 5).

Geographical analysis of the population mortality from strokes in 2018 showed significant chorological differences. So, in Krolevets (101.8), Lebedyn (129.4) or Krasnopillia (176.1 cases per 100 000 inhabitants) districts the highest values of this indicator were registered, at the same time in Trostianets district only 29.2 cases of mortality per 100 000 people were recorded.

Mortality from strokes among the able-bodied population grew by 1.56 %. Only in 6 districts was the dynamic of mortality positive. In all other administrative-territorial districts increasing mortality

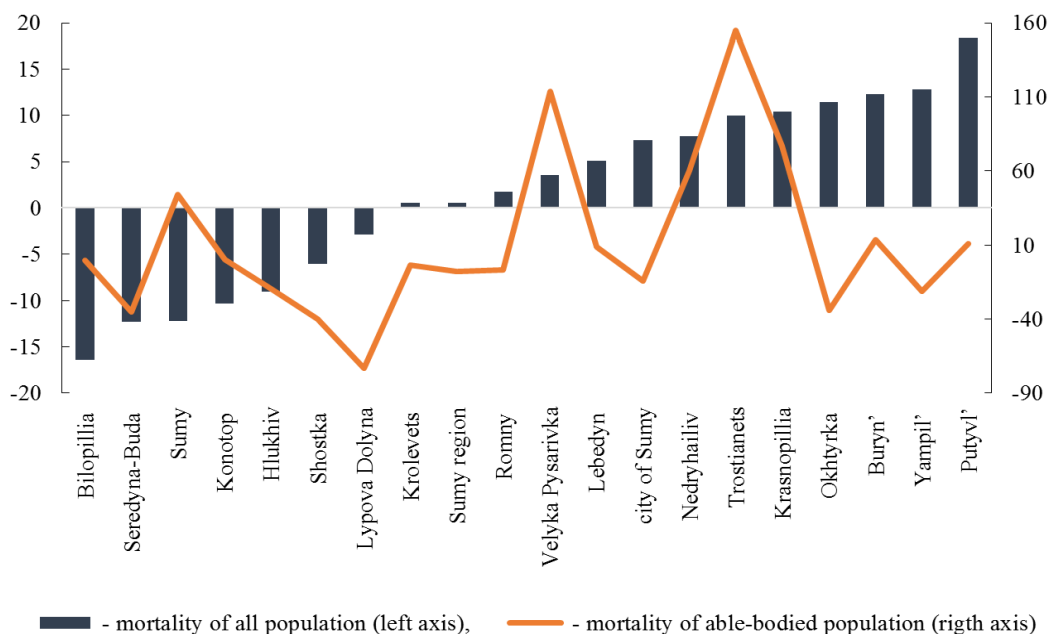


Fig. 4. Increase/decrease (%) of mortality rate from cerebrovascular diseases among the population of Sumy region in 2018 compared to 2012 (Source: Dovidnyk, 2013, 2019).

Strokes take 4th place among CVDs causing death of the population in Sumy region, especially among the working-age population. As of January 1, 2019 in the region 74.8 cases per 100 000 people were registered, which is more by 9.67 % than in 2012. It should be noted, among the residents of Ukraine there are 150 000 strokes per year (1/3 of them among the able-bodied population), 30-40 % of stroke patients die within a month after the event and up to 50 % – during 1 year from the onset of the disease, 20-40 % of recovered patients become dependent on assistance (12.5 % of all primary disability), and only 20 % return to a full life. This disease most often leads to temporary or permanent disability and significantly affects the quality of life of people (Insult, 2019).

from this category of nosology was registered. Especially high negative dynamics were characteristic for inhabitants of Krasnopillia (increase by 2.1 times), Trostianets (by 2.2 times) and Velyka Pysarivka (by 6.4 times) districts. Altogether, during 2018 the highest mortality among the able-bodied population was in Buryn' (49.1 cases per 100 000 people), Velyka Pysarivka (58.8) and Krasnopillia (62.4) districts. As can be seen, the two last districts are leaders by the number of deaths, as well as by the tempi of mortality dynamics during the entire period of research.

Also, in the structure of population mortality from CVDs one can distinguish strokes with hypertension. Most often, a stroke develops against the background of high blood pressure and is a complica-

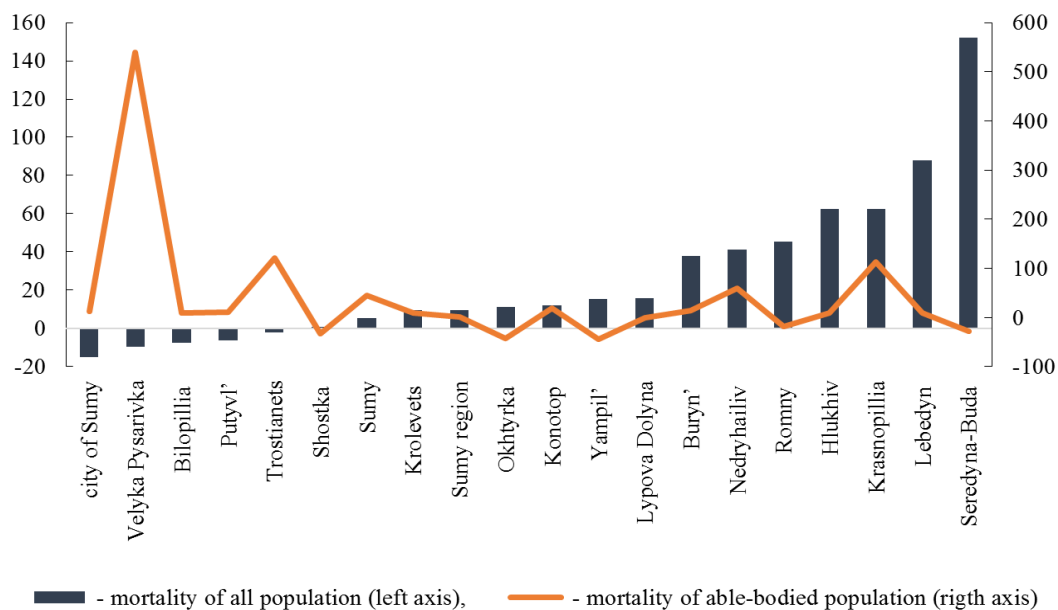


Fig. 5. Increase/decrease (%) of mortality rate from strokes among the population of Sumy region in 2018 compared to 2012 (Source: Dovidnyk, 2013, 2019).

tion of hypertension. As of January 1, 2019 in Sumy region 31.5 persons per 100 000 people died from this pathology. During the entire period of research the number of deaths from strokes with hypertension decreased by 6.25 % and among able-bodied population by 37.8 %. However, among the 19 administrative-territorial districts of the region an increase in the mortality rate was observed in 11. Increase was especially characteristic in Romny (by 2 times), Lebedyn (by 2.1 times), Bilopillia (by 3.1 times), Buryn' (by 3.7 times), Nedryhailiv (by 4.3 times) and Seredyna-Buda (by 6.5 times) districts. Only in Krolevets district during 2018 were no cases of mortality registered from this category of nosology. But the greatest num-

ber of deaths from this pathology occurred among the residents of Shostka (57.5), Sumy (59.2) and Lebedyn (95.9 cases per 100 000 people) districts (Fig. 6).

During 2018 cases of mortality from strokes with hypertension were not registered in 7 districts of the region mortality cases (Velyka Pysarivka, Hlukhiv, Krasnopillia, Krolevets, Lypova Dolyna, Nedryhailiv and Yampil' districts). At the same time from 2012 to 2018 the mortality from this pathology grew in 8 districts. An especially unfavourable situation was observed among the able-bodied population of Sumy, Putyvl', Trostianets, Romny and Bilopillia districts, where twofold growth of deaths from strokes with hypertension was fixed.

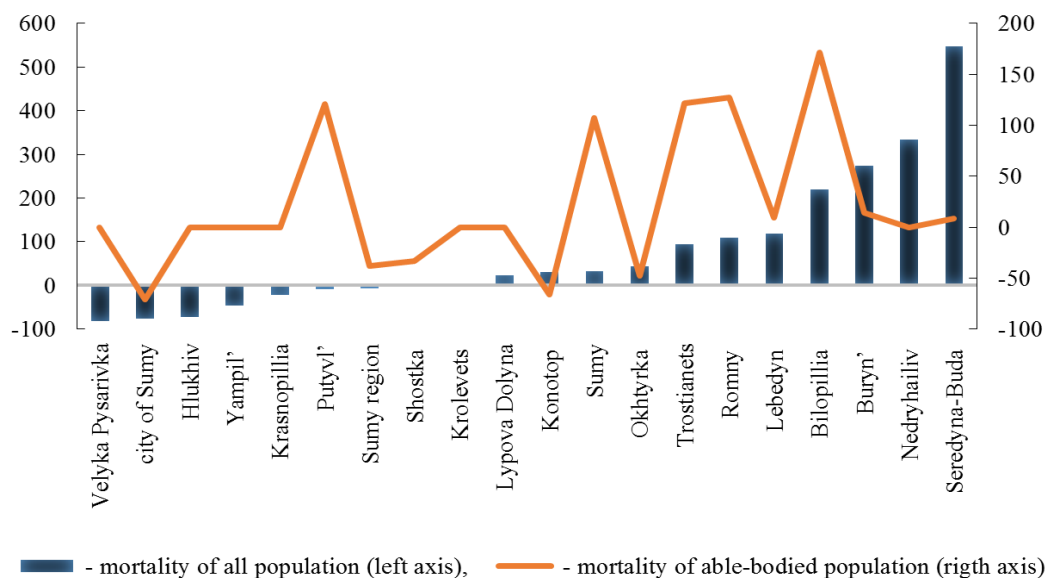


Fig. 6. Increase/decrease (%) of mortality rate from strokes with hypertension among the population of Sumy region in 2018 compared to 2012 (Source: Dovidnyk, 2013, 2019).

To establish the level of risk of death from CVDs for the population of Sumy region we used the above-mentioned integrated indicator «disease mortality risk assessment». This indicator takes into account the relationship between the primary morbidity, prevalence of diseases and the causes of mortality and makes it possible to assess the state of the population's health in terms of CVDs.

So, with high morbidity and low mortality, prevalence of diseases will be fairly high and integrated indicator value low. The integrated indicator value at the low level of prevalence of diseases and mortality will depend on the morbidity rate. If there is low morbidity and high mortality, the prevalence of diseases will be low, however the integrated indicator «disease mortality risk assessment» will be high. If there are high morbidity and mortality rates and low prevalence of CVDs, then the value of the integrated indicator will be high. An integrated approach allows one to make a comparative analysis of different administrative-territorial districts and different diseases that reduces estimation errors. Use of this indicator will increase the information content of the analysis of population mortality among administrative-territorial districts and also allow assessment of the mortality risk from CVDs taking into account the total cases of diseases as well as the primary morbidity and prevalence of diseases (Rogozinskaya, 2013).

Analysing the «disease mortality risk assessment» characterizing the risk of dying from CVDs at this morbidity rate, we obtained the following results. The highest mortality risks from CVDs are for the inhabitants of Sumy, Romny, Nedryhailiv, Putyvl' and Lypova Dolyna districts, where the highest integrated indicator value was observed. At the same time for the city of Sumy, Bilopillia and Krasnopillia districts low level of the mortality risk from CVDs is characteristic (Table).

Among the individual nosologies, a high level of mortality risk from coronary heart disease was characteristic for the inhabitants of Buryn', Sumy and Lypova Dolyna districts. In Lebedyn and Nedryhailiv districts high rates of mortality risk from myocardial infarction were fixed. Among the residents of Putyvl', Romny, Velyka Pysarivka and Yampil' districts high mortality risk from cerebrovascular diseases was observed. High risk of death from cerebral strokes was characteristic for Krolevets, Lebedyn and Krasnopillia districts. Analyzing the mortality risks from strokes with hypertension we found 4 districts in which the levels of the integrated indicator are high – Bilopillia, Shostka, Sumy and Lebedyn.

Studying of the risk of mortality from CVDs among the able-bodied population of Sumy region,

we found two districts where the values of the integrated indicator of risk are high – Seredyna-Buda and Yampil'. Among this age group, the population of Yampil', Buryn' and Hlukhiv districts was at the highest mortality risk from coronary heart disease. The mortality risk from myocardial infarction was highest in Shostka, Nedryhailiv, Trostianets and Hlukhiv districts. The risk of dying from coronary heart disease was highest among the residents of Buryn', Seredyna-Buda, Velyka Pysarivka and Yampil' districts. The highest rates of the risk of mortality from cerebral stroke were characteristic for Buryn', Velyka Pysarivka and Krasnopillia districts, and from strokes with hypertension – among the inhabitants of Shostka, Putyvl' and Bilopillia districts.

To forecast the population mortality of Sumy region, a forecast up to 2023 was made. The baseline scenario showed a decrease in mortality from CVDs by 2.1 % or to level 1021.88 per 100 000 people. According to the optimistic forecast (lower 95% confidence bound) the mortality rate from CVDs for 2023 will fall by 19.4% or to level 840.03 cases per 100 000 people. The pessimistic forecast (upper 95% confidence bound) shows an increase in the mortality rate by 13.3 % or 1,203.74 cases per 100 000 people (Fig. 7).

Conclusions. The study assessed the mortality of the population of Sumy region from CVDs. In 2018 the mortality level of the overall population of Sumy region compared to 2012 decreased by 1.17 %, but mortality of the able-bodied population on the contrary grew by 1.94 %.

Based on the use of the integrated indicator «disease mortality assessment» we identified the districts with the worst situation with CVDs. Taking into account the primary morbidity and prevalence of these diseases among the residents of the region, the population mortality risk from CVDs was established. The geographical features of mortality were clarified and we identified 9 administrative-territorial districts where during the study period the total mortality of the population from this class of pathology increased. As for the able-bodied population, the mortality rate in this age group increased in 11 districts. This indicates a negative trend of CVDs morbidity and requires increased attention from the local authorities.

In general, having ranked the indicators of the mortality risk from CVDs, we found that the greatest risk is of death from a stroke, in the second place – from cerebrovascular diseases, and in third place – from strokes with hypertension. Next are the risks of dying from coronary heart disease and myocardial infarction. Among the causes of mortality of the able-bodied population, cerebral strokes take the first place,

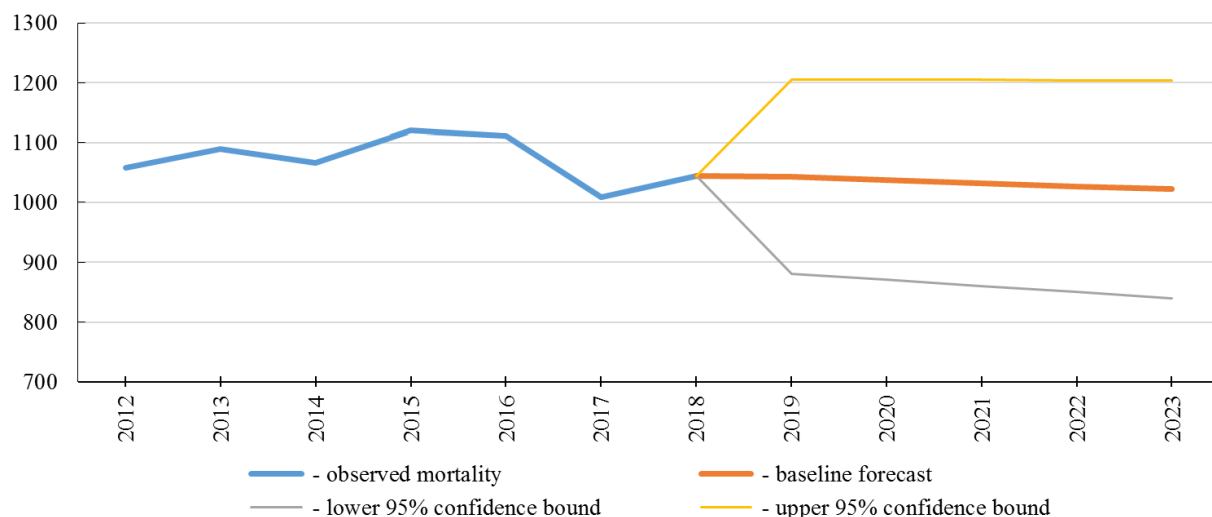


Fig. 7. The forecast of the mortality rate from CVDs of the population of Sumy region before 2023 (deaths per 100 000 people).

Table. The risk of population mortality of the Sumy region from CVDs, cases per 100 000 people as of January 1, 2019

Administrative-territorial districts	All population						Able-bodied population					
	The mortality risk from CVDs	The mortality risk from coronary heart disease	The mortality risk from acute myocardial infarction	The mortality risk from cerebrovascular diseases	The mortality risk from cerebral strokes	The mortality risk from strokes with hypertension	The mortality risk from CVDs	The mortality risk from coronary heart disease	The mortality risk from acute myocardial infarction	The mortality risk from cerebrovascular diseases	The mortality risk from cerebral strokes	The mortality risk from strokes with hypertension
Sumy region	72.07	29.40	20.50	38.83	74.80	31.50	12.96	4.06	6.50	5.87	25.90	9.20
City of Sumy	42.46	14.39	22.50	28.42	63.40	12.00	8.20	2.31	5.70	4.66	21.50	3.80
Bilopillia	51.91	29.73	12.10	12.37	66.80	54.60	9.34	2.14	0.00	5.70	40.00	36.40
Buryn'	98.53	47.08	12.50	41.37	87.70	41.80	22.56	10.56	0.00	11.56	49.10	8.20
Velyka Pysarivka	92.25	25.24	10.90	67.19	98.50	5.50	18.63	6.39	9.80	16.04	58.80	0.00
Hlukhiv	80.59	35.17	18.00	40.22	73.90	7.20	19.67	15.86	18.50	5.21	27.80	0.00
Konotop	71.58	28.92	17.70	35.35	75.00	37.90	12.68	1.82	7.20	5.89	30.10	8.60
Krasnopillia	61.57	21.89	10.80	38.25	176.10	28.80	10.95	3.58	6.20	7.38	62.40	0.00
Krolevets	89.31	36.43	29.50	46.59	101.80	0.00	15.36	7.19	4.80	7.14	33.30	0.00
Lebedyn	81.96	35.49	33.50	36.93	129.40	95.90	12.40	2.94	0.00	5.25	23.90	16.00
Lypova Dolyna	116.37	63.79	21.90	55.58	82.20	43.90	11.51	3.88	0.00	1.67	0.00	0.00
Nedryhailiv	108.08	43.62	33.80	48.15	71.80	16.90	18.62	6.40	14.90	4.72	22.40	0.00
Okhtyrka	73.62	34.43	20.20	34.69	56.60	28.30	14.02	5.15	7.00	4.27	14.00	7.00
Putyvl'	110.77	32.77	3.70	63.04	48.40	18.60	20.16	6.73	6.30	5.49	38.00	25.40
Romny	107.76	41.72	23.60	65.74	92.80	34.60	14.40	3.63	0.00	6.68	25.40	15.20
Seredyna-Buda	92.52	44.66	6.30	41.78	43.90	37.60	28.90	5.84	0.00	13.60	21.50	10.70
Sumy	102.18	49.72	14.40	50.85	73.60	59.20	9.29	4.59	2.80	2.83	19.30	11.00
Trostianets	64.29	31.04	26.30	17.77	29.20	26.30	10.93	2.33	15.50	6.28	10.40	10.40
Shostka	71.36	21.67	29.30	44.36	68.00	57.50	17.44	6.40	14.40	4.77	25.10	19.70
Yampil'	93.07	39.29	0.00	70.08	73.60	13.00	30.66	10.48	0.00	20.16	22.70	0.00

strokes with hypertension – the second place, and the risks of mortality from myocardial infarction are in the third place. There is a lower risk of dying in this age group from cerebrovascular diseases and coronary heart disease. It should be noted that the residents of Sumy, Romny, Nedryhailiv, Putyvl' and Lypova Dolyna districts have the highest mortality risk from CVDs, but among the able-bodied population the risk is highest for the inhabitants of Seredyna-Buda and Yampil' districts.

The results of the study can be used by local authorities to prevent the growth of morbidity and mortality from diseases of this nosological class, as well as for development of preventive measures and stabilization of the health status of the population of Sumy region.

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